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EXPOSURE FACTORS HANDBOOK: 2009 UPDATE

Office of Research and Development
National Center for Environmental Assessment
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This document is an external draft for review purposes only. It has not been subjected to peer and administrative review and does not constitute U.S. Environmental Protection Agency policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

FOREWORD

The U.S. Environmental Protection Agency (U.S. EPA) Office of Research and Development (ORD) National Center for Environmental Assessment's (NCEA) mission is to provide guidance and risk assessments aimed at protecting human health and the environment. To accomplish this mission, NCEA works to develop and improve the models, databases, tools, assumptions, extrapolations used in risk assessments. NCEA established the Exposure Factors Program to develop tools and databases that improve the scientific basis of exposure and risk assessment by: (1) identifying exposure factors needs in consultation with clients, and exploring ways for filling data gaps; (2) compiling existing data on exposure factors needed for assessing exposures/risks; and (3) assisting clients in the use of exposure factors data. The *Exposure Factors Handbook and* the *Child-specific Exposure Factors Handbook*, as well as other companion documents, such as *Example Exposure Scenarios,* are products of the Exposure Factors Program.

The *Exposure Factors Handbook* provides information on various physiological and behavioral factors commonly used in assessing exposure to environmental chemicals. The handbook was first published in 1989 and was updated in 1997. Since then, new data have become available. This updated version incorporates data available since 1997 up to June 2009. It also reflects the revisions made to the *Child-Specific Exposure Factors Handbook*, which was updated and published in 2008. Each chapter in the revised *Exposure Factors Handbook* presents recommended values for the exposure factors covered in the chapter as well as a discussion of the underlying data used in developing the recommendations. These recommended values are based solely on NCEA's interpretations of the available data. In many situations different values may be appropriate to use in consideration of policy, precedent, or other factors.

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The National Center for Environmental Assessment (NCEA), Office of Research and Development was responsible for the preparation of this handbook. Jacqueline Moya served as Work Assignment Manager for the current updated version, providing overall direction, technical assistance, and serving as contributing author. The current draft was prepared by Westat Inc. under contract with U.S. EPA (contract number GS-23F-8144H). Earlier drafts of this report were prepared by Versar Inc.

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The U.S. EPA Office of Water and Office of Pesticide Programs made important contributions by conducting an analysis of the USDA Continuing Survey of Food Intakes by Individual (CSFII) data. They provided food intake rates for the general population.

EXECUTIVE SUMMARY

This *Exposure Factors Handbook* has been prepared to provide information and recommendations on various factors used in assessing exposure to both adults and children. This handbook provides nonchemical-specific data on the following exposure factors:

- ingestion of water and other selected liquids (Chapter 3)
- non-dietary ingestion factors (Chapter 4)
- ingestion of soil and dust (Chapter 5)
- inhalation rates (Chapter 6)
- dermal factors (Chapter 7)
- body weight (Chapter 8)
- intake of fruits and vegetables (Chapter 9)
- intake of fish (Chapter 10)
- intake of meat and dairy products (Chapter 11)
- intake of grain products (Chapter 12)
- intake of homeproduced food (Chapter 13)
- total food intake (Chapter 14)
- human milk intake (Chapter 15)
- activity factors (Chapter 16)
- consumer products (Chapter 17)
- lifetime (Chapter 18)
- residential characteristics (Chapter 19)

The handbook was first published in 1989 and was revised in 1997. Recognizing that exposures among infants, toddlers, adolescents, and teenagers can vary significantly, the U.S. EPA published the *Child-Specific Exposure Factors Handbook* in 2002 (U.S. EPA, 2002) and its revision in 2008 (U.S. EPA, 2008). The 2008 revision of the *Child-Specific Exposure Factors Handbook* as well as this version of the *Exposure Factors Handbook* reflect the age categories recommended in the U.S. EPA *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA 2005). This version of the *Exposure Factors Handbook* also incorporates new factors and data provided in the 2008 *Child-Specific Exposure Factors Handbook* (U.S. EPA 2008) and other relevant information published through June 2009.

The data presented in this handbook have been compiled from various sources, including government reports and information presented in the scientific literature. The data presented are the result of analyses by the individual study authors. However, in some cases the U.S. EPA has conducted additional analysis of published primary data to present results in a way that will be useful to exposure assessors and/or in a manner that is consistent with the recommended age groups. Studies presented in this handbook were chosen because they were seen as useful and appropriate for estimating exposure factors based on the following considerations: (1) soundness (adequacy of approach and minimal or defined bias); (2) applicability and utility (focus on the exposure factor of interest, representativeness of the population, currency of the information, and adequacy of the data collection period); (3) clarity and completeness (accessibility, reproducibility, and quality assurance); (4) variability and uncertainty (variability in the population and uncertainty in the results); and (5) evaluation and review (level of peer review and number and agreement of studies). The handbook contains summaries of selected studies published through June 2009. Generally, studies were designated as “key” or “relevant” studies. Key studies were considered the most useful for deriving recommendations; while relevant studies provided applicable or pertinent data, but not necessarily the most important for a variety of reasons (e.g., data were outdated, limitations in study design). The recommended values for exposure factors are based on the results of key studies. The U.S. EPA also assigned confidence ratings of *low, medium, or high* to each recommended value based on the evaluation elements described above. These ratings are not intended to represent uncertainty analyses; rather, they represent the U.S. EPA’s judgment on the quality of the underlying data used to derive the recommendations.

Key recommendations from the Handbook are summarized in Table ES-1; additional recommendations and detailed supporting information for these recommendations can be found in the individual chapters of this handbook. In the providing recommendations for the various exposure factors, an attempt was made to present percentile values that are consistent with the exposure estimators defined in *Guidelines for Exposure Assessment* (U.S. EPA, 1992) (i.e., mean and upper percentile). However, this was not always possible, because the data available were limited for some factors, or the authors of the study did not provide such information. As used throughout this handbook, the term “upper percentile” is intended to represent values in the upper tail (i.e., between 90th and 99.9th percentile) of the distribution of values for a particular exposure factor. The recommendations provided in this handbook are not legally binding on any U.S. EPA program and should be interpreted as suggestions that Program Offices or individual exposure/risk assessors can consider and modify as needed based on their own evaluation of a given risk-assessment situation. In certain cases, different values may be appropriate in consideration of policy, precedent, strategy, or other factors (e.g., more up-to-date data of better quality or more representative of the population of concern).

References:

U.S. EPA (1992) Guidelines for exposure assessment. Washington, DC: U.S. Environmental Protection Agency, Office of Research and Development, Office of Health and Environmental Assessment. EPA/600/Z-92/001.

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Table ES-1. Summary of Exposure Factor Recommendations

Study population/Age category (yrs)

Chapter 3

Chapter 3	PER CAPITA INGESTION OF DRINKING WATER				CONSUMERS ONLY INGESTION OF DRINKING WATER			
	Mean		95th Percentile		Mean		95th Percentile	
	mL/day	mL/kg-day	mL/day	mL/kg-day	mL/day	mL/kg-day	mL/day	mL/kg-day
Children								
Birth to 1 mo	184	52	839	232	470	137	858	238
1 to <3 mo	227	48	896	205	552	119	1,053	285
3 to < 6 mo	362	52	1,056	159	556	80	1,171	173
6 to < 12 mo	360	41	1,055	126	467	53	1,147	129
1 to < 2 yrs	271	23	837	71	308	27	893	75
2 to < 3 yrs	317	23	877	60	356	26	912	62
3 to < 6 yrs	380	22	1,078	61	417	24	1,099	65
6 to < 11 yrs	447	16	1,235	43	480	17	1,251	45
11 to < 16 yrs	606	12	1,727	34	652	13	1,744	34
16 to < 18 yrs	731	11	1,983	31	792	12	2,002	32
18 to < 21 yrs	826	12	2,540	35	895	13	2,565	35
Adults								
>21 yrs	1,104	15	2,811	39	1,183	16	2,848	39
>65 yrs	1,127	16	2,551	36	1,242	18	2,604	37
Pregnant women	819	13	2,503	43	872	14	2,589	43
Lactating women	1,379	21	3,434	55	1,665	26	3,588	55

Chapter 3	INGESTION OF WATER WHILE SWIMMING			
	Mean		95th Percentile	
	mL/event	mL/hr	mL/event	mL/hr
Children	37	49	154	205
Adults	16	21	53	71
All	-	-	-	90

Chapter 4	MOUTHING FREQUENCY AND DURATION							
	Hand-to-Mouth				Object-to-Mouth			
	Indoor Frequency		Outdoor Frequency		Frequency		Duration	
	Mean contacts/hr	95th Percentile contacts/hr	Mean contacts/hr	95th Percentile contacts/hr	Mean contacts/hr	95th Percentile contacts/hr	Mean min/hr	95th Percentile min/hr
Birth to 1 mo	-	-	-	-	-	-	-	-
1 to <3 mo	-	-	-	-	-	-	-	-
3 to < 6 mo	28	65	-	-	-	-	11	26
6 to < 12 mo	19	52	15	47	31	-	9	19
1 to < 2 yrs	20	63	14	42	24	-	7	22
2 to < 3 yrs	13	37	5	20	12	-	10	11
3 to < 6 yrs	15	54	9	36	9	-	-	-
6 to < 11 yrs	7	21	3	12	1	-	-	-
11 to < 16 yrs	-	-	-	-	-	-	-	-
16 to < 21 yrs	-	-	-	-	-	-	-	-

Chapter 5	SOIL AND DUST INGESTION				
	Soil			Dust	Soil + Dust
		Upper Percentile			
	Central Tendency	Soil-Pica mg/day	Geophagy mg/day	Central Tendency mg/day	Central Tendency mg/day
6 to < 12 mo	30	-	-	30	60
1 to < 6 yrs	50	1,000	50,000	60	100
6 to < 21 yrs	50	1,000	50,000	60	100
Adult	50	-	50,000	-	-

Chapter 6	INHALATION	
	Long-term Inhalation Rates	
	Mean m³/day	95th Percentile m³/day
Birth to 1 mo	3.6	7.1
1 to <3 mo	3.5	5.8
3 to < 6 mo	4.1	6.1
6 to < 12 mo	5.4	8.0
1 to < 2 yrs	5.4	9.2
Birth to < 1yr	8.0	12.8
2 to < 3 yrs	8.9	13.7
3 to < 6 yrs	10.1	13.8
6 to < 11 yrs	12.0	16.6
11 to < 16 yrs	15.2	21.9
16 to < 21 yrs	16.3	24.6
21 to < 31 yrs	15.7	21.3
31 to < 41 yrs	16.0	21.4
41 to < 51 yrs	16.0	21.2
51 to < 61 yrs	15.7	21.3
61 to < 71 yrs	14.2	18.1
71 to < 81 yrs	12.9	16.6
≥ 81 yrs	12.2	15.7

	Short-term Inhalation Rates, by Activity Level									
	Sleep or Nap		Sedentary/Passive		Light Intensity		Moderate Intensity		High Intensity	
	Mean m³/min	95th m³/min	Mean m³/min	95th m³/min	Mean m³/min	95th m³/min	Mean m³/min	95th m³/min	Mean m³/min	95th m³/min
Birth to < 1yr	3.0E-03	4.6E-03	3.1E-03	4.7E-03	7.6E-03	1.1E-02	1.4E-02	2.2E-02	2.6E-02	4.1E-02
1 to < 2 yrs	4.5E-03	6.4E-03	4.7E-03	6.5E-03	1.2E-02	1.6E-02	2.1E-02	2.9E-02	3.8E-02	5.2E-02
2 to < 3 yrs	4.6E-03	6.4E-03	4.8E-03	6.5E-03	1.2E-02	1.6E-02	2.1E-02	2.9E-02	3.9E-02	5.3E-02
3 to < 6 yrs	4.3E-03	5.8E-03	4.5E-03	5.8E-03	1.1E-02	1.4E-02	2.1E-02	2.7E-02	3.7E-02	4.8E-02
6 to < 11 yrs	4.5E-03	6.3E-03	4.8E-03	6.4E-03	1.1E-02	1.5E-02	2.2E-02	2.9E-02	4.2E-02	5.9E-02
11 to < 16 yrs	5.0E-03	7.4E-03	5.4E-03	7.5E-03	1.3E-02	1.7E-02	2.5E-02	3.4E-02	4.9E-02	7.0E-02
16 to < 21 yrs	4.9E-03	7.1E-03	5.3E-03	7.2E-03	1.2E-02	1.6E-02	2.6E-02	3.7E-02	4.9E-02	7.3E-02
21 to < 31 yrs	4.3E-03	6.5E-03	4.2E-03	6.5E-03	1.1E-02	1.6E-02	2.6E-02	3.8E-02	5.0E-02	7.6E-02
31 to < 41 yrs	4.6E-03	6.6E-03	4.3E-03	6.6E-03	1.1E-02	1.6E-02	2.7E-02	3.7E-02	4.9E-02	7.2E-02
41 to < 51 yrs	5.0E-03	7.1E-03	4.8E-03	7.0E-03	1.2E-02	1.6E-02	2.8E-02	3.9E-02	5.2E-02	7.6E-02
51 to < 61 yrs	5.2E-03	7.5E-03	5.0E-03	7.3E-03	1.2E-02	1.7E-02	2.9E-02	4.0E-02	5.3E-02	7.8E-02
61 to < 71 yrs	5.2E-03	7.2E-03	4.9E-03	7.3E-03	1.1E-02	1.6E-02	2.6E-02	3.4E-02	4.7E-02	6.6E-02
71 to < 81 yrs	5.3E-03	7.2E-03	5.0E-03	7.2E-03	1.1E-02	1.5E-02	2.5E-02	3.2E-02	4.7E-02	6.5E-02
≥ 81 yrs	5.2E-03	7.0E-03	4.9E-03	7.0E-03	1.2E-02	1.5E-02	2.5E-02	3.1E-02	4.8E-02	6.8E-02

Chapter 7	TOTAL BODY SURFACE AREA	
	Mean m²	95th Percentile m²
Birth to 1 mo	0.29	0.34
1 to <3 mo	0.33	0.38
3 to < 6 mo	0.38	0.44
6 to < 12 mo	0.45	0.51
1 to < 2 yrs	0.53	0.61
2 to < 3 yrs	0.61	0.70
3 to < 6 yrs	0.76	0.95
6 to < 11 yrs	1.08	1.48
11 to < 16 yrs	1.59	2.06
16 to < 21 yrs	1.84	2.33
Adult Males		
21 to < 30 yrs	2.05	2.52
30 to < 40 yrs	2.10	2.50
40 to < 50 yrs	2.15	2.56
50 to < 60 yrs	2.11	2.55
60 to < 70 yrs	2.08	2.46
70 to < 80 yrs	2.05	2.45
80 yrs and over	1.92	2.22

Adult Females		
21 to < 30 yrs	1.81	2.25
30 to < 40 yrs	1.85	2.31
40 to < 50 yrs	1.88	2.36
50 to < 60 yrs	1.89	2.38
60 to < 70 yrs	1.88	2.34
70 to < 80 yrs	1.77	2.13
≥ 80 yrs	1.69	1.98

Chapter 7 SURFACE AREA OF BODY PARTS

	Head	Trunk	Arms	Hands	Legs	Feet
	Mean Percent of Total Surface Area					
Birth to 1 mo	18.2	35.7	13.7	5.3	20.6	6.5
1 to <3 mo	18.2	35.7	13.7	5.3	20.6	6.5
3 to < 6 mo	18.2	35.7	13.7	5.3	20.6	6.5
6 to < 12 mo	18.2	35.7	13.7	5.3	20.6	6.5
1 to < 2 yrs	16.5	35.5	13.0	5.7	23.1	6.3
2 to < 3 yrs	14.2	38.5	11.8	5.3	23.2	7.1
3 to < 6 yrs	13.7	31.7	14.2	5.9	27.3	7.3
6 to < 11 yrs	12.6	34.7	12.7	5.0	27.9	7.2
11 to < 16 yrs	9.4	33.7	12.9	5.3	31.3	7.5
16 to < 21 yrs	7.8	32.2	15.3	5.4	32.2	7.1
Adult Males ≥21	6.6	40.1	15.2	5.2	33.1	6.7
Adult Females ≥21	6.2	35.4	12.8	4.8	32.3	6.6

	Surface Area											
	Mean m^2	95th m^2	Mean m^2	95th m^2	Mean m^2	95th m^2	Mean m^2	95th m^2	Mean m^2	95th m^2	Mean m^2	95th m^2
Birth to 1 mo	0.053	0.062	0.140	0.121	0.040	0.047	0.015	0.018	0.060	0.070	0.019	0.022
1 to <3 mo	0.060	0.069	0.118	0.136	0.045	0.052	0.017	0.020	0.068	0.078	0.021	0.025
3 to < 6 mo	0.069	0.080	0.136	0.157	0.052	0.060	0.020	0.023	0.078	0.091	0.025	0.029
6 to < 12 mo	0.082	0.093	0.161	0.182	0.062	0.070	0.024	0.027	0.093	0.105	0.029	0.033
1 to < 2 yrs	0.087	0.101	0.188	0.217	0.069	0.079	0.030	0.035	0.122	0.141	0.033	0.038
2 to < 3 yrs	0.087	0.099	0.235	0.270	0.072	0.083	0.032	0.037	0.142	0.162	0.043	0.050
3 to < 6 yrs	0.104	0.130	0.241	0.301	0.108	0.135	0.045	0.056	0.207	0.259	0.055	0.069
6 to < 11 yrs	0.136	0.186	0.375	0.514	0.137	0.188	0.054	0.074	0.301	0.413	0.078	0.107
11 to < 16 yrs	0.149	0.194	0.536	0.694	0.205	0.266	0.084	0.109	0.498	0.645	0.119	0.155
16 to < 21 yrs	0.144	0.182	0.592	0.750	0.282	0.356	0.099	0.126	0.592	0.750	0.131	0.165
Adult Males ≥21	0.136	0.154	0.827	1.10	0.314	0.399	0.107	0.131	0.682	0.847	0.137	0.161
Adult Females ≥21	0.114	0.121	0.654	0.850	0.237	0.266	0.089	0.106	0.598	0.764	0.122	0.146

Chapter 8 BODY WEIGHT

	Mean kg
Birth to 1 mo	4.8
1 to <3 mo	5.9
3 to < 6 mo	7.4
6 to < 12 mo	9.2
1 to < 2 yrs	11.4
2 to < 3 yrs	13.8
3 to < 6 yrs	18.6
6 to < 11 yrs	31.8
11 to < 16 yrs	56.8
16 to < 21 yrs	71.6
Adults	80.0

Chapter 9 TOTAL FRUIT AND VEGETABLE INTAKE

	Per Capita		Consumers Only	
	Mean g/kg-day	95th Percentile g/kg-day	Mean g/kg-day	95th Percentile g/kg-day
	Total Fruits			
Birth to 1 yr	5.7	21.3	10.1	26.4
1 to < 2 yrs	6.2	18.5	6.9	19.0
2 to < 3 yrs	6.2	18.5	6.9	19.0
3 to < 6 yrs	4.6	14.4	5.1	15.0

6 to < 11 yrs	2.4	8.8	2.7	9.3
11 to < 16 yrs	0.8	3.5	1.1	3.7
16 to < 21 yrs	0.8	3.5	1.1	3.7
20 to < 50 yrs	0.9	3.9	1.2	4.4
≥ 50 yrs	1.4	4.8	1.6	5.0
Total Vegetables				
Birth to 1 yr	4.5	14.8	6.2	16.1
1 to < 2 yrs	6.9	17.1	6.9	17.1
2 to < 3 yrs	6.9	17.1	6.9	17.1
3 to < 6 yrs	5.9	14.7	5.9	14.7
6 to < 11 yrs	4.1	9.9	4.1	9.9
11 to < 16 yrs	2.9	6.9	2.9	6.9
16 to < 21 yrs	2.9	6.9	2.9	6.9
20 to < 50 yrs	2.9	6.8	2.9	6.8
≥ 50 yrs	3.1	7.0	3.1	7.0

Chapter 10	FISH INTAKE							
	Per Capita				Consumer Only			
	Mean		95th Percentile		Mean		95th Percentile	
	g/day	g/kg-day	g/day	g/kg-day	g/day	g/kg-day	g/day	g/kg-day
General Population - Total Fish								
3 to < 6 years	7.7	0.43	51.0	3.0	74	4.2	184	10
6 to < 11 years	8.5	0.28	56.4	1.9	95	3.2	313	8.7
11 to < 16 years	12.0	0.23	87.4	1.5	113	2.2	308	6.2
16 to < 18 years	10.6	0.16	83.5	1.3	136	2.1	357	6.6
>18 years	19.9	0.27	111.3	1.5	-	-	-	-
General Population - Marine Fish								
3 to < 6 years	5.5	0.31	39.4	2.3	66	3.7	165	9.3
6 to < 11 years	5.6	0.20	38.4	1.5	78	2.8	202	8.0
11 to < 16 years	7.6	0.15	56.5	1.3	102	2.0	262	5.2
16 to < 18 years	6.1	0.10	29.5	0.5	126*	2.0	353	6.5
>18 years	12.4	0.17	80.7	1.1	-	-	-	-
General Population - Freshwater/Estuarine Fish								
3 to < 6 years	2.2	0.12	12.2	0.7	40	2.3	129	7.2
6 to < 11 years	3.0	0.08	13.1	0.4	61	1.8	248	6.2
11 to < 16 years	4.3	0.08	25.8	0.5	71	1.3	199	4.4
16 to < 18 years	4.6	0.07	19.3	0.3	100	1.4	242	3.3
>18 years	7.5	0.10	49.6	0.7	-	-	-	-
Recreational Population - Marine Fish – Atlantic								
3 to < 6 years	2.5	-	8.2	-	-	-	-	-
6 to < 11 years	2.5	-	9.1	-	-	-	-	-
11 to < 16 years	3.4	-	14	-	-	-	-	-
16 to < 18 years	2.8	-	14	-	-	-	-	-
>18 years	5.6	-	18	-	-	-	-	-
Recreational Population - Marine Fish – Gulf								
3 to < 6 years	3.2	-	12	-	-	-	-	-
6 to < 11 years	3.3	-	13	-	-	-	-	-
11 to < 16 years	4.4	-	21	-	-	-	-	-
16 to < 18 years	3.5	-	20	-	-	-	-	-
>18 years	7.2	-	26	-	-	-	-	-
Recreational Population - Marine Fish – Pacific								
3 to < 6 years	0.9	-	3.1	-	-	-	-	-
6 to < 11 years	0.9	-	3.4	-	-	-	-	-
11 to < 16 years	1.2	-	5.3	-	-	-	-	-
16 to < 18 years	1.0	-	5.1	-	-	-	-	-
>18 years	2.0	-	6.8	-	-	-	-	-
Recreational Population - Freshwater Fish – See Chapter 10								
Native American Subsistence Population – See Chapter 10								
Other Populations – See Chapter 10								

Chapter11	MEATS, DAIRY PRODUCTS, AND FAT INTAKE			
	Per Capita		Consumers Only	
	Mean g/kg-day	95th Percentile g/kg-day	Mean g/kg-day	95th Percentile g/kg-day
Total Meats				
Birth to 1 yr	1.2	6.7	3.0	9.2

1 to < 2 yrs	4.1	9.8	4.2	9.8
2 to < 3 yrs	4.1	9.8	4.2	9.8
3 to < 6 yrs	4.1	9.4	4.2	9.4
6 to < 11 yrs	2.9	6.5	2.9	6.5
11 to < 16 yrs	2.1	4.8	2.1	4.8
16 to < 21 yrs	2.1	4.8	2.1	4.8
20 to < 50 yrs	1.9	4.2	1.9	4.2
≥ 50 yrs	1.5	3.3	1.5	3.3
Total Dairy Products				
Birth to 1 yr	12.6	48.7	15.9	57.5
1 to < 2 yrs	36.7	88.3	36.8	88.3
2 to < 3 yrs	36.7	88.3	36.8	88.3
3 to < 6 yrs	23.3	49.4	23.3	49.4
6 to < 11 yrs	13.6	31.5	13.6	31.5
11 to < 16 yrs	5.6	15.5	5.6	15.5
16 to < 21 yrs	5.6	15.5	5.6	15.5
20 to < 50 yrs	3.3	9.9	3.3	9.9
≥ 50 yrs	3.2	8.9	3.2	8.9
Total Fats				
Birth to 1 mo	5.2	16	7.8	16
1 to <3 mo	4.5	11	6.0	12
3 to < 6 mo	4.1	8.2	4.4	8.3
6 to < 12 mo	3.7	7.0	3.7	7.0
1 to < 2 yrs	4.0	7.1	4.0	7.1
2 to < 3 yrs	3.6	6.4	3.6	6.4
3 to < 6 yrs	3.4	5.8	3.4	5.8
6 to < 11 yrs	2.6	4.2	2.6	4.2
11 to < 16 yrs	1.6	3.0	1.6	3.0
16 to < 21 yrs	1.3	2.7	1.3	2.7
21 to < 31 yrs	1.2	2.3	1.2	2.3
31 to < 41 yrs	1.1	2.1	1.1	2.1
41 to < 51 yrs	1.0	1.9	1.0	1.9
51 to < 61 yrs	0.9	1.7	0.9	1.7
61 to < 71 yrs	0.9	1.7	0.9	1.7
71 to < 81 yrs	0.8	1.5	0.8	1.5
≥ 81 yrs	0.9	1.5	0.9	1.5

Chapter 12	GRAINS INTAKE			
	Per Capita		Consumers Only	
	Mean g/Kg-day	95th Percentile g/Kg-day	Mean g/Kg-day	95th Percentile g/Kg-day
Birth to 1 yr	2.5	8.6	3.6	9.2
1 to < 2 yrs	6.4	12	6.4	12
2 to < 3 yrs	6.4	12	6.4	12
3 to < 6 yrs	6.3	12	6.3	12
6 to < 11 yrs	4.3	8.2	4.3	8.2
11 to < 16 yrs	2.5	5.1	2.5	5.1
16 to < 21 yrs	2.5	5.1	2.5	5.1
20 to < 50 yrs	2.2	4.7	2.2	4.7
≥ 50 yrs	1.7	3.5	1.7	3.5

Chapter 13	HOME-PRODUCED FOOD INTAKE	
	Mean g/kg-day	95th Percentile g/kg-day
Home-produced Fruits		
1 to 2 yrs	8.7	60.6
3 to 5 yrs	4.1	8.9
6 to 11 yrs	3.6	15.8
12 to 19 yrs	1.9	8.3
20 to 39 yrs	2.0	6.8
40 to 69 yrs	2.7	13.0
≥ 70 yrs	2.3	8.7
Home-produced Vegetables		
1 to 2 yrs	5.2	19.6
3 to 5 yrs	2.5	7.7
6 to 11 yrs	2.0	6.2
12 to 19 yrs	1.5	6.0
20 to 39 yrs	1.5	4.9

	Mean	95th Percentile
40 to 69 yrs	2.0	6.9
≥ 70 yrs	2.5	8.2
	Home-produced Meats	
1 to 2 yrs	3.7	10.0
3 to 5 yrs	3.6	9.1
6 to 11 yrs	3.7	14.0
12 to 19 yrs	1.7	4.3
20 to 39 yrs	1.8	6.2
40 to 69 yrs	1.7	5.1
≥ 70 yrs	1.4	3.5
	Home-caught Fish	
1 to 2 yrs	-	-
3 to 5 yrs	-	-
6 to 11 yrs	2.8	7.1
12 to 19 yrs	1.5	4.7
20 to 39 yrs	1.9	4.5
40 to 69 yrs	1.8	4.4
≥ 70 yrs	1.2	3.7
Chapter 14	TOTAL FOOD INTAKE	
	Mean g/Kg-day	95th Percentile g/Kg-day
Birth to 1 mo	20	61
1 to <3 mo	16	40
3 to < 6 mo	28	65
6 to < 12 mo	56	134
1 to < 2 yrs	90	161
2 to < 3 yrs	74	126
3 to < 6 yrs	61	102
6 to < 11 yrs	40	70
11 to < 16 yrs	24	45
16 to < 21 yrs	18	35
20 to < 40 yrs	16	30
40 to < 70 yrs	14	26
≥ 70 yrs	15	27

Chapter 15	HUMAN MILK AND LIPID INTAKE			
	Mean		Upper Percentile	
	mL/day	mL/kg-day	mL/day	mL/kg-day
	Human Milk Intake			
Birth to 1 mo	510	150	950	220
1 to <3 mo	690	140	980	190
3 to < 6 mo	770	110	1,000	150
6 to < 12 mo	620	83	1,000	130
	Lipid Intake			
Birth to 1 mo	20	6.0	38	8.7
1 to <3 mo	27	5.5	40	8.0
3 to < 6 mo	30	4.2	42	6.1
6 to < 12 mo	25	3.3	42	5.2

Chapter 16	ACTIVITY FACTORS					
	Time Indoors (total) minutes/day		Time Outdoors (total) minutes/day		Time Indoors (at residence) minutes/day	
	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile
Birth to <1 month	1,440	-	0	-	-	-
1 to <3 months	1,432	-	8	-	-	-
3 to <6 months	1,414	-	26	-	-	-
6 to <12 months	1,301	-	139	-	-	-
Birth to <1 year	-	-	-	-	1,108	1,440
1 to <2 years	1,353	-	36	-	1,065	1,440
2 to <3 years	1,316	-	76	-	979	1,296
3 to <6 years	1,278	-	107	-	957	1,355
6 to <11 years	1,244	-	132	-	893	1,275
11 to <16 years	1,260	-	100	-	889	1,315
16 to <21 years	1,248	-	102	-	833	1,288
18 to <65 years	1,159	-	281	-	948	1,428

≥ 65 years	1,142	-	298	-	1,175	1,440

	Showering minutes/day		Bathing minutes/day		Bathing/Showering minutes/day	
	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile
Birth to <1year	15	-	19	30	-	-
1 to <2 years	20	-	23	32	-	-
2 to <3 years	22	44	23	45	-	-
3 to <6 years	17	34	24	60	-	-
6 to <11 years	18	41	24	46	-	-
11 to <16 years	18	40	25	43	-	-
16 to <21 years	20	45	33	60	-	-
18 to <65 years	-	-	-	-	17	-
≥65 years	-	-	-	-	17	-

	Playing on Sand/Gravel minutes/day		Playing on Grass minutes/day		Playing on Dirt minutes/day	
	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile
Birth to <1 year	18	-	52	-	33	-
1 to < 2 years	43	121	68	121	56	121
2 to <3 years	53	121	62	121	47	121
3 to <6 years	60	121	79	121	63	121
6 to <11 years	67	121	73	121	63	121
11 to <16 years	67	121	75	121	49	120
16 to <21 years	83	-	60	-	30	-
18 to < 64 years	0	121	60	121	0	120
≥ 65 years	0	-	121	-	0	-

	Swimming minutes/month	
	Mean	95th Percentile
Birth to <1 year	96	-
1 to < 2 years	105	-
2 to <3 years	116	181
3 to <6 years	137	181
6 to <11 years	151	181
11 to <16 years	139	181
16 to <21 years	145	181
18 to <65 years	45[a]	181
≥65 years	40[a]	181

	Occupational Mobility	
	Median Tenure (years) Men	Median Tenure (years) Women
All ages, ≥16	7.9	5.4
years	2.0	1.9
16-24 years	4.6	4.1
25-29 years	7.6	6.0
30-34 years	10.4	7.0
35-39 years	13.8	8.0
40-44 years	17.5	10.0
45-49 years	20.0	10.8
50-54 years	21.9	12.4
55-59 years	23.9	14.5
60-64 years	26.9	15.6
65-69 years	30.5	18.8
≥70 years		

	Population Mobility			
	Residential Occupancy Period		Current Residence Time	
	Mean	95th Percentile	Mean	95th Percentile
All	12 year	33 years	13 years	46 years
Chapter 17	See chapter 17			

Chapter 18	LIFE EXPECTANCY
	Yrs
Total	78
Males	75
Females	80

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ACRONYMS AND ABBREVIATIONS

A	=	Ratio of Food Energy Intakes to Basal Metabolic Rate
AAP	=	American Academy of Pediatrics
ADAF	=	Age Dependent Potency Adjustment Factors
ADD	=	Average Daily Dose
ADI	=	Average Daily Intake
AF	=	Adherence Factor
AIR	=	Acid Insoluble Residue
Al	=	Aluminum
ANOVA	=	Analysis of Variance
API	=	Asian Pacific Islander
ARS	=	Agricultural Research Service
ATSDR	=	Agency for Toxic Substances and Disease Registry
ATUS	=	American Time Use Study
Ba	=	Barium
BI	=	Bootstrap Interval
BLS	=	Bureau of Labor and Statistics
BMD	=	Benchmark Dose
BMI	=	Body Mass Index
BMR	=	Basal Metabolic Rate
BTM	=	Best Tracer Method
BW	=	Body Weight
C	=	Contaminant Concentration
C_{dw}	=	Dry Weight Concentration
C_{ww}	=	Wet Weight Concentration
CA_{urine}	=	Concentration of Cyanuric Acid in Urine
CA_{pool}	=	Concentration of Cyanuric Acid in Pool Water
CARB	=	California Air Resources Board
CATI	=	Computer Assisted Telephone Interviewing
CDC	=	Centers for Disease Control and Prevention
CDS	=	Child Development Supplement
CHAD	=	Consolidated Human Activity Database
CI	=	Confidence Interval
cm^2	=	Square Centimeter
cm^3	=	Cubic Centimeter
CNRC	=	Children’s Nutrition Research Center
CO_2	=	Carbon Dioxide
CPS	=	Current Population Study
CPSC	=	Consumer Product Safety Commission
CRITFC	=	Columbia River Inter-Tribal Fish Commission
CSFII	=	Continuing Survey of Food Intake by Individuals
CT	=	Central Tendency
CTFA	=	Cosmetic, Toiletry, and Fragrance Association
CV	=	Coefficient of Variation
DARLING	=	Davis Area Research on Lactation, Infant Nutrition and Growth
DCR	=	Daily Consumption Rate
DIY	=	Do-it-yourself
DK	=	Don’t Know
DLW	=	Doubly Labeled Water
DNP	=	Did Not Perform
DONALD	=	Dortmund Nutritional and Anthropometric Longitudinally Designed
E or EE	=	Energy Expenditure or Number of Eaters

EBF	=	Exclusively Breastfed
ECG	=	Energy Cost of Growth
ED	=	Exposure Duration
EFD	=	Food Energy Intake
EI	=	Energy Intake
EL	=	Elementary School
ENR	=	Equivalent Ventilation Rate
EPA	=	Environmental Protection Agency
ERS	=	Economic Research Services
EVR	=	Ventilation Rate per Square Meter of Body Surface Area
F	=	Fahrenheit or Frequency of Fishing or Female
F_i	=	Fecal Dry Weight
f_B	=	Breathing Frequency
$f_{i,e}$	=	Concentration of element e in Fecal Sample of Child i^{th}
FAO	=	Food Agriculture Organization
FCID	=	Food Commodity Intake Database
FDA	=	Food and Drug Administration
FITS	=	Feeding Infant and Toddler Study
FQPA	=	Food Quality Protection Act
F/S	=	Food/Soil
g	=	Gram
GAF	=	General Assessment Factor
GCW	=	General Construction Worker
GLM	=	General Linear Model
GM	=	Geometric Mean
GSD	=	Geometric Standard Deviation
H	=	Oxygen Uptake Factor
HEC	=	Human Equivalent Exposure Concentrations
HHHQ	=	Health Habits and History Questionnaire
HPV	=	High Production Volume
HR	=	Heart Rate
HS	=	High School
I	=	Tabulated Intake Rate
I_A	=	Adjusted Intake Rate
ICRP	=	International Commission on Radiological Protection
IEUBK	=	Integrated Exposure and Uptake Biokinetic Model
IFS	=	Iowa Fluoride Study
IOM	=	Institute of Medicine
IPCS	=	International Programme on Chemical Safety
IR	=	Intake Rate or Inhalation Rate
IR_{dw}	+	Dry Weight Intake Rate
IR_p	=	Intake Rate Percentile
IR_{ww}	=	Wet Weight Intake Rate
IRIS	=	Integrated Risk Information System
K	=	Number of Activity Periods or Edible Fraction of Fish
Kcal	=	Kilocalories
KJ	=	Kilo Joules
KS	=	Kolmogorov-Smirnov
kg	=	Kilogram
L	=	Liter
L_1	=	Cooking or Preparation Loss
L_2	=	Post-cooking Loss
LADD	=	Lifetime Average Daily Dose
LCI	=	Lower Confidence Interval

LCL	=	Lower Confidence Limit
LMP	=	Age of Last Menstrual Period
LSRO/FASEB	=	Life Sciences Research Office, Federation of American Societies for Experimental Biology
LTM	=	Limiting Tracer Method
M	=	Male
m^2	=	Square Meter
m^3	=	Cubic Meter
mg	=	Milligram
MJ	=	Mega Joules
mL	=	Milliliter
METS	=	Metabolic Equivalents of Work
Mn	=	Manganese
MSA	=	Metropolitan Statistical Area
MSB	=	Multiplicative Standard Error
MVPA	=	Moderate-to-Vigorous Physical Activity
N	=	Number of Subjects or Respondents
NA	=	Not Applicable
N_c	=	Weighted Number of Individuals Consuming Homegrown Food Item
N_T	=	Weighted Total Number of Individuals Surveyed
NAR	=	National Association of Realtors
NAS	=	National Academy of Sciences
NCEA	=	National Center for Environmental Assessment
NCHS	=	National Center for Health Statistics
NCI	=	National Cancer Institute
NERL	=	National Exposure Research Laboratory
NFCS	=	Nationwide Food Consumption Survey
NHANES	=	National Health and Nutrition Examination Survey
NHAPS	=	National Human Activity Pattern Survey
NHES	=	National Health Examination Survey
NHEXAS	=	National Human Exposure Assessment Survey
NIS	=	National Immunization Survey
NLO	=	Non-linear Optimization
NMFS	=	National Marine Fisheries Service
NOAEL	=	No-observed-adverse-effect-level
NPD	=	National Purchase Diary
NR	=	Not Reported
NRC	=	National Research Council
NS	=	No Statistical Difference
O_2	=	Oxygen
O_3	=	Ozone
OPP	=	Office of Pesticide Programs
ORD	=	Office of Research and Development
P	=	Percentile
p	=	Probability
PAL	=	Physical Activity Level
PBPK	=	Physiologically-Based Pharmacokinetic
PC	=	Percent Consuming
PDIR	=	Physiological Daily Inhalation Rate
PSID	=	Panel Study of Income Dynamics
r	=	Coefficient of Correlation
R^2	=	Coefficient of Determination
RAGS	=	Risk Assessment Guidance for Superfund
RDD	=	Random Digit Dial

RfD	=	Reference Dose
RfC	=	Reference Concentration
RME	=	Reasonable Maximum Exposure
ROP	=	Residential Occupancy Period
RQ	=	Respiratory Quotient
RTF	=	Ready to Feed
$S_{i,e}$	=	Concentration of Element e in Child i's yard
SA	=	Surface Area
SAB	=	Spontaneous Abortions
SA/BW	=	Surface Area to Body Weight Ratio
SCS	=	Soil Contact Survey
SD	=	Standard Deviation
SDA	=	Soaps and Detergent Association
SE	=	Standard Error
SEM	=	Standard Error of the Mean
SES	=	Socioeconomic Status
SFEI	=	San Francisco Estuary Institute
Si	=	Silicon
SMBRP	=	Santa Monica Bay Restoration Project
SPC	=	Science Policy Council
SPS	=	Statistical Processing System
SRD	=	Source Ranking Database
T	=	Exposure Time
t_i	=	Hours Spent per Day in i^{th} Activity
Ti,e	=	Estimated Soil Ingestion for i^{th} Child Based on Element e
TDEE	=	Total Daily Energy Expenditure
TFEI	=	Total Food Energy Intake
Ti	=	Titanium
TRI	=	Tuna Research Institute
UCL	=	Upper Confidence Limit
UCI	=	Upper Confidence Interval
USDA	=	United States Department of Agriculture
USDL	=	United States Department of Labor
USDHHS	=	United States Department of Health and Human Services
UV	=	Ultraviolet
V	=	Vanadium
V_{pool}	=	Volume of Pool f Water
V_{urine}	=	Volume of Urine
VO_2	=	Oxygen Consumption Rate
VQ	=	Ventilatory Equivalent
VR	=	Ventilation Rate
VT	=	Tidal Volume
W	=	Weight
w_i	=	Sample Weight Assigned to Observation x_i.
WHO	=	World Health Organization
WIC	=	USDA's Women, Infants, and Children Program
Y	=	Ytrium
Z	=	Zirconium
µ	=	Sample Mean
µm	=	Micrometer
x_i	=	i^{th} observation

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1 INTRODUCTION

1.1 PURPOSE

The purpose of the *Exposure Factors Handbook* is to (1) summarize data on human behaviors and characteristics that affect exposure to environmental contaminants, and (2) recommend values to use for these factors. These recommendations are not legally binding on any U.S. EPA program and should be interpreted as suggestions which program offices or individual exposure assessors can consider and modify as needed. Many of these factors are best quantified on a site or situation-specific basis. The decision as to whether to use site-specific or national values for an assessment may depend on the quality of the competing data sets as well as on the purpose of the specific assessment. The handbook has strived to include full discussions of the issues that assessors should consider in deciding how to use these data and recommendations.

Purpose
- Summarize data on human behaviors and characteristics affecting exposure
- Recommend exposure factors values

The handbook incorporates the changes in risk assessment practices that were first presented in the U.S. Environmental Protection Agency's (U.S. EPA) Cancer Guidelines, regarding the need to consider life stages rather than as subpopulations (U.S. EPA, 2005a). It also emphasizes a major recommendation in U.S. EPA's *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (U.S. EPA, 2005b) to sum exposures and risks across life stages rather than relying on the use of a lifetime average adult exposure to calculate risk. This handbook also uses updated information to incorporate any new exposure factors data/research that have become available since it was last revised in 1997 and is consistent with the U.S. EPA's new set of standardized childhood age groups (U.S. EPA 2005c), that are recommended for use in exposure assessments. Available data through June 2009 are included in the handbook.

1.2 INTENDED AUDIENCE

The *Exposure Factors Handbook* is intended for use by exposure and risk assessors both within and outside the U.S. EPA as a reference tool and primary source of exposure factor information. It may be used by scientists, economists, and other interested parties as a source of data and/or U.S. EPA recommendations on numeric estimates for behavioral and physiological characteristics needed to estimate exposure to toxic contaminants.

1.3 BACKGROUND

This handbook is the update of an earlier version prepared in 1997 (U.S. EPA 1997a) and it incorporates data from the *Child-Specific Exposure Factors Handbook* that was published in September 2008. All chapters have been revised to include published literature up to June 2009. Some of the main revisions are highlighted below:

- Added data from the United States Department of Agriculture Continuing Survey of Food Intake by Individuals (CSFII 1994-96, 98);
- Added fat intake data and total food intake data;
- Added mouthing behavior data for children;
- Updated soil ingestion rates for children and adults;
- Updated data on dermal exposure;
- Updated fish intake data;
- Updated body weight data with NHANES 1999 – 2006;
- Added body weight data for infants;
- Updated children's factors with new recommended age groupings (U.S. EPA, 2005c);
- Updated life expectancy data with U.S. Bureau of Census data 2006;
- Updated data on breast milk ingestion and prevalence of breast feeding;

This document does not include chemical-specific data or information on physiological parameters that may be needed for exposure assessments involving physiologically-based pharmacokinetic (PBPK) modeling. Information on the application of PBPK models and supporting data is found in U.S. EPA (2006a, 2006b).

Variation Among Studies

This handbook is a compilation of data from a variety of different sources. With very few exceptions, the data presented are the analyses of the individual study authors. Since the studies included in this handbook varied in terms of their objectives, design, scope, presentation of results, etc., the level of detail, statistics, and terminology may vary from study to study and from factor to factor. For example, some authors used geometric means to present their results, while others used arithmetic means or distributions. Authors have sometimes used different terms to describe the same racial populations. Within the constraint of presenting the original material as accurately as possible, the U.S. EPA has made an effort to present discussions and results in a consistent manner and using consistent terminology. The strengths and limitations of each study are discussed to provide the reader with a better understanding of the uncertainties associated with the values derived from the study.

Because of physiological and behavioral differences, exposures among children are expected to be different from exposures among adults. Children may be more exposed to some environmental contaminants, because they consume more of certain foods and water per unit of body weight and have a higher ratio of body surface area to volume than adults. Equally important, rapid changes in behavior and physiology may lead to differences in exposure as a child grows up. Recognizing that exposures among infants, toddlers, adolescents, and teenagers can vary significantly, the U.S. EPA attempted to reallocate source data for children into the standard age groups recommended by the U.S. EPA in the report entitled *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005c; see Section 1.7), when sufficiently detailed data are available. U.S. EPA's recommended set of childhood age groups are:

- Less than 12 months old: birth to <1 month, 1 to <3 months, 3 to <6 months, and 6 to <12 months.
- Greater than 12 months old: 1 to <2 years, 2 to <3 years, 3 to <6 years, 6 to <11 years, 11 to <16 years, and 16 to <21 years.

Also, in conjunction with the *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005c), this handbook adopted the age group notation "X to < Y" (e.g., the age group 3 to < 6 years is meant to span a 3-year time interval from a child's 3rd birthday up until the day before his or her 6th birthday). No specific guidance is available for presenting adult data. Adult data are presented using the age groups defined by the authors of the individual studies.

Most of the data presented in this handbook are derived from studies that target (1) the general population (e.g., USDA food consumption surveys) or (2) a sample population from a specific area or group (e.g., fish consumption among Native American children). If it is necessary to characterize a population that is not directly covered by the data in this handbook, the risk or exposure assessor may need to evaluate whether these data may be used as suitable substitutes for the population of interest or whether there is a need to seek additional population-specific data. If information is needed for identifying and enumerating populations who may be at risk for greater contaminant exposures or who exhibit a heightened sensitivity to particular chemicals, the reader is referred to *Socio-demographic Data Used for Identifying Potentially Highly Exposed Populations* (U.S. EPA, 1999).

Because of the large number of tables in this handbook, tables are presented at the end of each chapter, before the appendices, if any.

1.4 SELECTION OF STUDIES FOR THE HANDBOOK

Information in this handbook has been summarized from studies documented in the scientific literature and other publicly available sources. Studies were chosen that were seen as useful and appropriate for estimating exposure factors for both adults and children. The handbook contains summaries of selected studies published through June 2009.

Certain studies described in this handbook are designated as "key," that is, the most useful for deriving exposure factors. The recommended values for most exposure factors are based on the results of the key studies (See Section 1.5). Other studies are designated "relevant," meaning applicable or pertinent, but not necessarily the most important. This distinction was made on the strength of the attributes listed in Section 1.4.1, "General Assessment Factors" below.

1.4.1 General Assessment Factors

Many scientific studies were reviewed for possible inclusion in this handbook. Studies were designated as key or relevant. Key studies were generally defined as the most useful for deriving recommendations for exposure factors. The recommended values for most exposure factors were based on the results of these studies. The Agency recognizes the need to evaluate the quality and relevance of scientific and technical information used in support of Agency actions (U.S. EPA 2002, 2003a, 2006c). When evaluating scientific and technical information, the U.S. EPA's Science Policy Council (SPC) recommends using five General Assessment Factors (GAFs): (1) soundness, (2) applicability and utility, (3) clarity and completeness, (4) uncertainty and variability, and (5) evaluation and review (U.S. EPA 2003a). These GAFs were adapted and expanded to include specific considerations deemed to be important during evaluation of exposure factors data, and were used to judge the quality of the underlying data used to derive recommendations.

1.4.2 Selection Criteria

The confidence ratings for the various exposure factor recommendations, and selection of the key studies that form the basis for these recommendations, were based on specific criteria within each of the five GAFs, as follows:

(1) Soundness*: Scientific and technical procedures, measures, methods or models employed to generate the information are reasonable for, and consistent with, the intended application.* The soundness of the experimental procedures or approaches in the study designs of the available studies were evaluated according to the following:

> **Adequacy of the Study Approach Used:** In general, more confidence was placed on experimental procedures or approaches that more likely or closely captured the desired measurement. Direct exposure data collection techniques, such as direct observation, personal monitoring devices, or other known methods were preferred where available. If studies utilizing direct measurement were not available, studies were selected that relied on validated indirect measurement methods such as surrogate measures (such as heart rate for inhalation rate), and use of questionnaires. If questionnaires or surveys were used, proper design and procedures include an adequate sample size for the population under consideration, a response rate large enough to avoid biases, and avoidance of bias in the design of the instrument and interpretation of the results. More confidence was placed in exposures factors that relied on studies that gave appropriate consideration to these study design issues. Studies were also deemed preferable if based on primary data, but studies based on secondary sources were also included where they offered an original analysis. In general, higher confidence was placed on exposure factors based on primary data.

> **Minimal (or Defined) Bias in Study Design:** Studies were sought that were designed with minimal bias, or at least if biases were suspected to be present, the direction of the bias (i.e., an over or underestimate of the parameter) was either stated or apparent from the study design. More confidence was placed on exposure factors based on studies that minimized bias.

(2) Applicability and utility*: The information is relevant for the Agency's intended use.* The applicability and utility of the available studies were evaluated based on the following criteria:

> **Focus on Exposure Factor of Interest:** Studies were preferred that directly addressed the exposure factor of interest, or addressed related factors that have significance for the factor under consideration. As an example of the latter case, a selected study contained useful ancillary information concerning fat content in fish, although it did not directly address fish consumption.

> **Representativeness of the Population:** More confidence was placed in studies that addressed the U.S. population. Data from populations outside the U.S. were sometimes included if behavioral patterns or other characteristics of exposure were similar. Studies seeking to characterize a particular region or sub-population were selected, if appropriately representative of that population. In cases where data were limited, studies with limitations in this area were included and limitations were noted in the handbook. Higher confidence ratings were given to exposure factors where the available data were representative of the population of interest.

> **Currency of Information:** More confidence was placed in studies that were sufficiently recent to represent current exposure conditions. This is an important consideration for those factors that change with time. Older data were evaluated and considered in instances where the variability of the exposure factor over time was determined to be insignificant or unimportant. In some cases, recent data

were very limited. Therefore, the data provided in these instances were the only available data. Limitations on the age of the data were noted. Recent studies are more likely to use state-of-the-art methodologies that reflect advances in the exposure assessment field. Consequently, exposure factor recommendations based on current data were given higher confidence ratings than those based on older data, except in cases where the age of the data would not affect the recommended values.

Adequacy of data collection period: Because most users of the handbook are primarily addressing chronic exposures, studies were sought that utilized the most appropriate techniques for collecting data to characterize long-term behavior. Higher confidence ratings were given to exposure factor recommendations that were based on an adequate data collection period.

(3) Clarity and completeness**:** *The degree of clarity and completeness with which the data, assumptions, methods, quality assurance, sponsoring organizations and analyses employed to generate the information are documented*. Clarity and completeness was evaluated based on the following criteria.

Accessibility: Studies that the user could access in their entirety, if needed, were preferred.

Reproducibility: Studies that contained sufficient information so that methods could be reproduced, or could be evaluated, based on the details of the author's work, were preferred.

Quality Assurance: Studies with documented quality assurance/quality control measures were preferred. Higher confidence ratings were given to exposure factors that were based on studies where appropriate quality assurance/quality control measures were used.

(4) Variability and uncertainty: *The variability and uncertainty (quantitative and qualitative) in the information or the procedures, measures, methods or models are evaluated and characterized.* Variability arises from true heterogeneity across people, places or time and can affect the precision of exposure estimates and the degree to which they can be generalized. The types of variability include: spatial, temporal, and inter-individual. Uncertainty represents a lack of knowledge about factors affecting exposure or risk and can lead to inaccurate or biased estimates of exposure. The types of uncertainty include: scenario, parameter, and model. The uncertainty and variability associated with the studies was evaluated based on the following criteria.

Variability in the population: Studies were sought that characterized any variability within populations. The variability associated with the studies presented in this handbook is characterized as described in Section 1.5. Higher confidence ratings were given to exposure factors that were based on studies where variability was well characterized.

Uncertainty: Studies were sought with minimal uncertainty in the data, which was judged by evaluating all the considerations listed above. Studies were preferred that identified uncertainties, such as those due to inherent variability in environmental and exposure-related parameters or possible measurement error. Higher confidence ratings were given to exposure factors based on studies where uncertainty had been minimized.

(5) Evaluation and review: *The information or the procedures, measures, methods or models are independently verified, validated, and peer reviewed.* Relevant factors that were considered included:

Peer review: Studies selected were those from the peer-reviewed literature and final government reports. Unpublished and internal or interim reports were avoided, where possible, but were used in some cases to supplement information in published literature or government reports.

Number and agreement of studies: Higher confidence was placed on recommendations where data were available from more than one key study and there was good agreement between studies.

1.5 APPROACH USED TO DEVELOP RECOMMENDATIONS FOR EXPOSURE FACTORS

As discussed above, the U.S. EPA first reviewed the literature pertaining to a factor and determined key studies. These key studies were used to derive recommendations for the values of each factor. The recommended values were derived solely from the U.S. EPA's interpretation of the available data. Different values may be appropriate for the user in consideration of policy, precedent, strategy, or other factors such as site-specific information. The U.S. EPA's procedure for developing recommendations was as follows:

(1) Study Review and Evaluation: Key studies were evaluated in terms of both quality and relevance to specific populations (general U. S. population, age groups, gender, etc.). The criteria for assessing the quality of studies are described in Section 1.4.

(2) Single versus Multiple Key Studies: If only one study was classified as key for a particular factor, the mean value from that study was selected as the recommended central value for that population. If multiple key studies with reasonably equal quality, relevance, and study design information were available, a weighted mean (if appropriate, considering sample size and other statistical factors) of the studies was chosen as the recommended mean value. Recommendations for upper percentiles, when multiple studies were available, were calculated as the midpoint of the range of upper percentile values of the studies for each age group where data were available.

(3) Variability: The variability of the factor across the population is discussed. For recommended values, as well as for each of the studies on which the recommendations are base, variability was characterized in one or more of three ways: (1) as a table with various percentiles or ranges of values; (2) as analytical distributions with specified parameters; and/or (3) as a qualitative discussion. Analyses to fit standard or parametric distributions (e.g., normal, lognormal) to the exposure data have not been performed by the authors of this handbook, but have been reproduced as they were found in the literature. Recommendations on the use of these distributions were made where appropriate based on the adequacy of the supporting data. The list of exposure factors and the way in which variability has been characterized throughout this handbook (i.e., average, median, upper percentiles, multiple percentiles, fitted distribution) are presented in Table 1-1.

In providing recommendations for the various exposure factors, an attempt was made to present percentile values that are consistent with the exposure estimators defined in *Guidelines for Exposure Assessment* (U.S. EPA, 1992a) (i.e., mean, 50th, 90th, 95th, 98th, and 99.9th percentile). However, this was not always possible, because the data available were limited for some factors, or the authors of the study did not provide such information. It is important to note, however, that these percentiles were discussed in the guidelines within the context of risk descriptors and not individual exposure factors. For example, the guidelines state that the assessor may derive a high-end estimate of exposure by using maximum or near maximum values for one or more sensitive exposure factors, leaving others at their mean value. The term "upper percentile" is used throughout this handbook, and it is intended to represent values in the upper tail (i.e., between 90th and 99.9th percentile) of the distribution of values for a particular exposure factor.

(4) Uncertainty: Uncertainties are discussed in terms of data limitations, the range of circumstances over which the estimates were (or were not) applicable, possible biases in the values themselves, a statement about parameter uncertainties (measurement error, sampling error) and model or scenario uncertainties if models or scenarios were used to derive the recommended value. A discussion of variability and uncertainty for exposure factors is presented in Chapter 2 of this handbook.

(5) Confidence Ratings: Finally, the U.S. EPA assigned a confidence rating of *low, medium or high* to each recommended value. This qualitative rating is not intended to represent an uncertainty analysis; rather, it represents the U.S. EPA's judgment on the quality of the underlying data used to derive the recommendation. This judgment was made using the General Assessment Factors (GAFs) described in Section 1.4. Table 1-2 provides an adaptation of the GAFs, as they pertain to the confidence ratings for the exposure factor recommendations. Clearly, there is a continuum from *low to high*, and judgment was used to assign a rating to each factor. Recommendations given in this handbook are accompanied by a discussion of the rationale for their rating.

It is important to note that the study elements listed in Table 1-2 do not have the same weight when arriving at the overall confidence rating for the various exposure factors. The relative weight of each of these elements for the various factors were subjective and based on the professional judgment of the authors of this handbook. Also, the relative weights depend on the exposure factor of interest. For example, the adequacy of the data collection period may be more important when determining usual intake of foods in a population, but it is not as important for factors where long-term variability may be small, such as tapwater intake. In the case of tapwater intake, the currency of the data was a critical element in determining the final rating. In general, most studies ranked high with regard to "level of peer review," "accessibility," "focus on the factor of interest," and "data pertinent to the U.S." because the U.S. EPA specifically sought studies for the handbook that met these criteria.

The elements in Table 1-2 were important considerations for inclusion of a study in this handbook. However, a high score for these elements did not necessarily translate into a high overall score. Other considerations went into determining the overall score. One such consideration was the ease at which the exposure factor of interest could be measured. For example, soil ingestion by children can be estimated by measuring, in feces, the levels of certain elements found in soil. Body weight, however, can be measured directly, and it is therefore a more reliable measurement than estimation of soil ingestion. The fact that soil ingestion is more difficult to measure than body weight is reflected in the overall confidence rating given to both of these factors. In general, the better the methodology used to measure the exposure factor, the higher the confidence in the value.

(6) Recommendation Tables: The U.S. EPA developed a table at the beginning of each chapter that summarizes the recommended values for the relevant factor. Table ES-1 of the Executive Summary of this handbook summarizes the principal exposure factors addressed in this handbook and provides the confidence ratings for each exposure factor.

1.6 SUGGESTED REFERENCES FOR USE IN CONJUNCTION WITH THIS HANDBOOK

Some of the steps for performing an exposure assessment are: (1) identifying the source of the environmental contamination and the media that transports the contaminant; (2) determining the contaminant concentration; (3) determining the exposure scenarios, and pathways and routes of exposure; (4) determining the exposure time, frequency, and duration; and (5) identifying the exposed population. Many of the issues related to characterizing exposure from selected exposure pathways have been addressed in a number of existing U.S. EPA documents. Some of these provide guidance while others demonstrate various aspects of the exposure process. These include, but are not limited, to the following references listed in chronological order:

- *Methods for Assessing Exposure to Chemical Substances, Volumes 1-13* (U.S. EPA, 1983-1989);
- *Standard Scenarios for Estimating Exposure to Chemical Substances During Use of Consumer Products* (U.S. EPA, 1986a);
- *Selection Criteria for Mathematical Models Used in Exposure Assessments: Surface Water Models* (U.S. EPA, 1987);
- *Selection Criteria for Mathematical Models Used in Exposure Assessments: Groundwater Models* (U.S. EPA, 1988);
- *Risk Assessment Guidance for Superfund, Volume I, Part A, Human Health Evaluation Manual* (U.S. EPA, 1989);
- *Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions* (U.S. EPA, 1990);
- *Risk Assessment Guidance for Superfund, Volume I, Part B, Development of Preliminary Remediation Goals* (U.S. EPA, 1991a);
- *Risk Assessment Guidance for Superfund, Volume I, Part C, Risk Evaluation of Remedial Alternatives* (U.S. EPA, 1991b);
- *Guidelines for Exposure Assessment* (U.S. EPA, 1992a);
- *Dermal Exposure Assessment: Principles and Applications* (U.S. EPA, 1992b);
- *Estimating Exposures to Dioxin-Like Compounds* (U.S. EPA, 1994a);
- *Soil Screening Guidance* (U.S. EPA 1996a);
- *Series 875 Occupational and Residential*

Exposure Test Guidelines - Final Guidelines - Group A - Application Exposure Monitoring Test Guidelines (U.S. EPA 1996b);

- *Series 875 Occupational and Residential Exposure Test Guidelines - Group B - Post Application Exposure Monitoring Test Guidelines* (U.S. EPA 1996c);

- *Policy for Use of Probabilistic Analysis in Risk Assessment at the U.S. Environmental Protection Agency*, (U.S. EPA, 1997b);

- *Guiding Principles for Monte Carlo Analysis* (U.S. EPA, 1997c);

- *Sociodemographic Data for Identifying Potentially Highly Exposed Populations* (U.S. EPA, 1999);

- *Options for Developing Parametric Probability Distributions for Exposure Factors* (U.S. EPA 2000a);

- *Risk Assessment Guidance for Superfund, Volume I, Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments* (U.S. EPA, 2001a);

- *Risk Assessment Guidance for Superfund Volume III, Part A, Process for Conducting Probabilistic Risk Assessments* (U.S. EPA, 2001b);

- *Framework for Cumulative Risk Assessment* (U.S. EPA, 2003b);

- *Example Exposure Scenarios* (U.S. EPA, 2003c);

- *Risk Assessment Guidance for Superfund, Volume I, Part E, Supplemental Guidance for Dermal Risk Assessment* (U.S. EPA, 2004);

- *Cancer Guidelines for Carcinogen Risk Assessment Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (U.S. EPA, 2005a);

- *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (U.S. EPA, 2005b);

- *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005c);

- *Protocol for Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (U.S. EPA, 2005d);

- *Aging and Toxic Response: Issues Relevant to Risk Assessment* (U.S. EPA 2005e);

- *A Framework for Assessing Health Risk of Environmental Exposures to Children* (U.S. EPA 2006d);

- *Child-Specific Exposure Factors Handbook* (U.S. EPA 2008a); and

- *Concepts, methods, and data sources for cumulative health risk assessment of multiple chemicals, exposures and effects: a resource document* (U.S. EPA, 2008b).

These documents may serve as valuable information resources to assist in the assessment of exposure. The reader is encouraged to refer to them for more detailed discussion.

1.7 THE USE OF AGE GROUPINGS WHEN ASSESSING EXPOSURE

When this handbook was published in 1997, no specific guidance existed with regard to which age groupings should be used when assessing children's exposure. Age groupings varied from case to case and among Program Offices within the U.S. EPA. They depended on availability of data and were often based on professional judgment. More recently, the U.S. EPA has established a consistent set of age groupings and published guidance on this topic (U.S. EPA 2005c). This revision of the handbook attempts to present data in a manner consistent with the U.S. EPA's recommended set of age groupings for children. To this date, no specific guidance is available with regard to age groupings for presenting adult data. Therefore, adult data (i.e., >21 years old) are presented using the age groups defined by the authors of the individual studies. No attempt was made to reanalyze the data using a consistent set of age groups. In cases where data were analyzed by the U.S. EPA, age categories were defined as finely as possible based on adequacy of sample size.

The development of standardized age bins for children was the subject of discussion in a 2000 workshop sponsored by the U.S. EPA Risk Assessment Forum. The workshop was titled *Issues Associated with Considering Developmental Changes in Behavior and Anatomy When Assessing Exposure to Children* (U.S. EPA, 2001c). The purpose of this workshop was to gain insight and input into factors that need to be considered when developing standardized age bins and identify future research necessary to accomplish these goals. Panelists were divided into two groups. One group focused their discussions on defining and characterizing the important facets of behavioral development during childhood, while the other group focused on defining and characterizing physiological development during childhood. During the workshop, it was recognized that the ultimate goal of exposure assessment is to develop a day-to-day model of human life that can predict the chemical exposures an individual is likely to face at any point in life. However, this is not likely to be accomplished in the near future, and assessors often need to classify individuals into age bins in order to simplify the exposure model. The recommendations listed below are those of the panel members and were considered by the U.S. EPA in the development of age groupings:

- Panelists agreed that child development is a series of discrete events, but these events occur along a continuum.

- Age grouping/bins are a useful guide to fulfill the Agency's immediate need, but are only a crude approximation of an underlying distribution. Ultimately, sufficient data should be gathered to develop a continuous multivariate model that can replace bins.

- Adequacy of existing exposure data is highly variable.

- A considerable amount of additional information already exists, but it is dispersed in the literature. It was recommended that the U.S. EPA consults with experts in developmental biology, physiology, pharmacology, and toxicology and conducts an in-depth review of the literature.

- Long term research should include the development of integrated data sets that combines information about the exposure factors with biomarkers of exposure and effects.

- The definition of age groups/bins for childhood exposure assessment is inextricably linked to toxicokinetic and toxicodynamic issues.

- The two break out groups (i.e., behavioral and physiological) offered the following preliminary ideas for age groupings:

<u>Age grouping based on behavioral characteristics</u>

0 to 2 months
2 to 6 months
6 to 12 months
1 to 2 years
2 to 6 years
6 to 11 years
11 to 16 years
16 to 21 years

<u>Age grouping based on physiological characteristics</u>

0 to 1 month
1 to 6 months
6 to 12 months
1 to 3 years
3 to 9 years
9 to 21 years

One can observe that there was fairly good agreement among the two groups with regard to the age groupings that are important for infants and toddlers. However, there was some disagreement with regard to the older children. Appropriate age groupings depend not only on behavioral and physiological characteristics, but also on the specific scenario being studied and chemical of concern.

Based upon consideration of the findings of the technical workshop, as well as analysis of available data, U.S. EPA developed guidance that established a set of recommended age groups for development of exposure factors for children entitled *Guidance for Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005c). This revision of the handbook for individuals < 21 years of age presents exposure factors data in a manner consistent with U.S. EPA's recommended set of childhood age groupings. The recommended age groups (U.S. EPA, 2005c) are as follows:

Birth to <1 month
1 to <3 months
3 to <6 months
6 to <12 months
1 to <2 years
2 to <3 years
3 to <6 years
6 to <11 years
11 to <16 years
16 to <21 years

1.8 CONSIDERING LIFE STAGE WHEN CALCULATING EXPOSURE AND RISK

In recent years, there has been an increased concern regarding the potential impact of environmental exposures to children and other susceptible populations such as older adults and pregnant/lactating women. As a result, the U.S. EPA and others have developed policy, guidance, and undertaken research to better incorporate life stage data into human health risk assessment (Brown et al. 2008). A framework for considering life stages in human health risk assessments was developed by the U.S. EPA in the report entitled *A Framework for Assessing Health Risks of Environmental Exposures to Children* (U.S. EPA 2006d). Life stages are defined as "temporal stages (or intervals) of life that have distinct anatomical, physiological, behavioral, and/or functional characteristics that contribute to potential differences in environmental exposures" (Brown et al. 2008). Although the framework discusses the importance of incorporating life stages in the evaluation of risks to children, the approach can also be applied to other life stages that may have their own unique susceptibilities. For example, older individuals may experience differential exposures and risks to environmental contaminants due to biological changes that occur during aging, disease status, drug interactions, different exposure patterns and activities. More information on the toxicokinetic and toxicodynamic impact of environmental agents in older adults can be found in U.S. EPA's document entitled *Aging and Toxic Response: Issues Relevant to Risk Assessmen*t (U.S. EPA 2005e). The need to better characterize differential exposures of the older adult population to environmental agents was recognized at the U.S. EPA's workshop on the development of exposure factors for the aging (U.S. EPA 2007). A panel of experts in the fields of gerontology, physiology, exposure assessment, risk assessment, and behavioral science discussed existing data, data gaps, and current relevant research on the behavior and physiology of older adults, as well as practical considerations of the utility of developing an exposure factors handbook for the aging (U.S. EPA 2007). Pregnant and lactating women may also be a life stage of concern due to physiological changes during pregnancy and lactation. For example, lead is mobilized from the maternal skeleton during pregnancy and postpartum period increasing the chances for fetal lead exposure (Gulson et al. 2004).

The U.S. EPA encourages the consideration of all life stages and endpoints to ensure that vulnerabilities during specific time periods are taken into account (Brown et al. 2008). Although the importance of assessing risks from environmental exposures to all susceptible populations is recognized, most of the guidance developed thus far relates to children. A key component of U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA 2005c) involves the need to sum age-specific exposures across time when assessing long-term exposure, as well as integrating these age-specific exposures with age-specific differences in toxic potency in those cases where information exists to describe such differences: an example is carcinogens that act via a mutagenic mode of action (*Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* - U.S. EPA, 2005b). When assessing chronic risks (i.e., exposures greater than 10% of human lifespan), rather than assuming a constant level of exposure for 70 years (usually consistent with an adult level of exposure), the Agency is now recommending that assessors calculate chronic exposures by summing time-weighted exposures that occur at each lifestage; this handbook provides data arrayed by childhood age in order to follow this new guidance (U.S. EPA 2005c). This approach is expected to increase the accuracy of risk assessments, because it will take into account lifestage differences in exposure. Depending on whether body-weight-adjusted childhood exposures are either smaller or larger compared to those for adults, calculated risks could either decrease or increase when compared with the historical approach of assuming a lifetime of a constant adult level of exposure.

The *Supplemental Guidance* report also recommended that in those cases where age-related differences in toxicity were also found to occur, differences in both toxicity and exposure would need to be integrated across all relevant age intervals (U.S. EPA 2005b). This guidance describes such a case for carcinogens that act via a mutagenic mode of action, where age dependent potency adjustments factors (ADAFs) of 10× and 3× are recommended for children ages birth < 2 years, and 2 < 16 years, respectively when there is exposure during those years and available data are insufficient to derive chemical-specific adjustment factors.

Table 1-3, along with Chapter 6 of the *Supplemental Guidance* report have been developed to help the reader understand how to use the new sets of exposure and potency age groupings when calculating risk through the integration of lifestage specific changes in exposure and potency.

Thus, Lifetime Cancer Risk (for a population with average life expectancy of 70 years) = ∑ (Exposure × Duration/70 yrs × Potency × ADAF) summed across all the age groups presented in Table 1-3. This is a departure from the way cancer risks have historically been calculated based upon the premise that risk is proportional to the daily average of the long term adult dose.

1.9 FUNDAMENTAL PRINCIPLES OF EXPOSURE ASSESSMENT

The definition of exposure as used by the International Programme on Chemical Safety (IPCS, 2001) is the "contact of an organism with a chemical or physical agent, quantified as the amount of chemical available at the exchange boundaries of the organism and available for absorption." This means contact with the visible exterior of a person such as the skin, and openings such as the mouth, nostrils, and lesions. The process of a chemical entering the body can be described in two steps: contact (exposure) followed by entry (crossing the boundary). In the context of environmental risk assessment, risk to an individual or population can be represented as a continuum from the source through exposure to dose to effect as shown in Figure 1-1 (U.S. EPA, 2003d; IPCS, 2006). The process begins with a chemical or agent released from a source into the environment. Once in the environment, the chemical or agent can be transformed and transported through the environment via air, water, soil, dust, and diet. Individuals become in contact with the chemical through inhalation, ingestion, or skin/eye contact. The individual's activity patterns as well as the concentration of the chemical will determine the magnitude, frequency, and duration of the exposure. The exposure becomes an absorbed dose when the chemical crosses an absorption barrier. When the chemical or its metabolites interact with a target tissue, it becomes a target tissue dose, which may lead to an adverse health outcome. The text under the boxes in Figure 1-1 indicates the specific information that may be needed to characterize each box.

1.9.1 Dose Equations

Starting with a general integral equation for exposure (U.S. EPA, 1992a), several dose equations can be derived depending upon boundary assumptions. One of the more useful of these derived equations is the Average Daily Dose (ADD). The ADD, which is used for many noncancer effects, averages exposures or doses over the period of time exposure occurred. The ADD can be calculated by averaging the potential dose over body weight and an averaging time.

$$ADD_{pot} = \frac{External\ Dose}{Body\ Weight\ \ x\ \ Averaging\ Time} \quad \text{(Eqn. 1-1)}$$

The exposure can be expressed as follows:

External Dose = C × IR × ED (Eqn. 1-2)

Where:

C = Contaminant Concentration
IR = Intake Rate
ED = Exposure Duration

Contaminant concentration is the concentration of the contaminant in the medium (air, food, soil, etc.) contacting the body and has units of mass/volume or mass/mass.

The intake rate refers to the rates of inhalation, ingestion, and dermal contact, depending on the route of exposure. For ingestion, the intake rate is simply the amount of food containing the contaminant of interest that an individual ingests during some specific time period (units of mass/time). Much of this handbook is devoted to rates of ingestion for some broad classes of food. For inhalation, the intake rate is the rate at which contaminated air is inhaled. Factors presented in this handbook that affect dermal exposure are skin surface area and estimates of the amount of soil that adheres to the skin.

The exposure duration is the length of time of contaminant contact. The length time a person lives in an area, frequency of bathing, time spent indoors versus outdoors, etc., all affect the exposure duration. Chapter 16, Activity Factors, gives some examples of population behavior/activity patterns that may be useful for estimating exposure durations.

When the above parameter values IR and ED remain constant over time, they are substituted directly into the exposure equation. When they change with time, a summation approach is needed to calculate exposure. In either case, the exposure duration is the length of time exposure occurs at the concentration and the intake rate specified by the other parameters in the equation.

Note that the advent of childhood age groupings means that separate ADD's should be calculated for each age group considered. Chronic exposures can then be calculated by summing across each lifestage-specific ADD.

Cancer risks have traditionally been calculated in those cases where a linear non-threshold model is assumed, in terms of lifetime probabilities by utilizing dose values presented in terms of lifetime ADDs (LADDs). The LADD takes the form of the Equation 1-1, with lifetime replacing averaging time. While the use of LADD may be appropriate when developing screening level estimates of cancer risk, as discussed in Section 1.8, the U.S. EPA recommends that risks should be calculated by integrating exposures or risks throughout all lifestages (U.S. EPA, 1992a).

For some types of analyses, dose can be expressed as a total amount (with units of mass, e.g., mg) or as a dose rate in terms of mass/time (e.g., mg/day), or as a rate normalized to body mass (e.g., with units of mg of chemical per kg of body weight per day (mg/kg-day)). The LADD is usually expressed in terms of mg/kg-day or other mass/mass-time units.

In most cases (inhalation and ingestion exposures), the dose-response parameters for carcinogenic risks have been adjusted for the difference in absorption across body barriers between humans and the experimental animals used to derive such parameters. Therefore, the exposure assessment in these cases is based on the potential dose, with no explicit correction for the fraction absorbed. However, the exposure assessor needs to make such an adjustment when calculating dermal exposure and in other specific cases when current information indicates that the human absorption factor used in the derivation of the dose-response factor is inappropriate.

For carcinogens, the duration of a lifetime has traditionally been assigned the nominal value of 70 years as a reasonable approximation. For exposure estimates to be used for assessments other than carcinogenic risk, various averaging periods have been used. For acute exposures, the doses are usually averaged over a day or a single event. For nonchronic noncancer effects, the time period used is the actual period of exposure (exposure duration). The objective in selecting the exposure averaging time is to express the exposure in a way which can be combined with the dose-response relationship to calculate risk.

The body weight to be used in the exposure Equation 1-1 depends on the units of the exposure data presented in this handbook. For example, for food ingestion, the body weights of the surveyed populations were known in the USDA surveys, and they were explicitly factored into the food intake data in order to calculate the intake as g/kg body weight-day. In this case, the body weight has already been included in the "intake rate" term in Equation 1-2, and the exposure assessor does not need to explicitly include body weight.

The units of intake in this handbook for the incidental ingestion of soil and dust are not normalized to body weight. In this case, the exposure assessor will need to use (in Equation 1-1) the average weight of the exposed population during the time when the exposure actually occurs. When making body weight assumptions, care must be taken that the values used for the population parameters in the dose-response analysis are consistent with the population parameters used in the exposure analysis. Intraspecies adjustments based on lifestage can be made using a scaling factor of $BW^{3/4}$ (U.S. EPA 2006d, 2006e). Some of the parameters (primarily concentrations) used in estimating exposure are exclusively site specific, and therefore default recommendations should not be used. It should be noted that body weight is correlated with food consumption rates and inhalation rates.

The link between the intake rate value and the exposure duration value is a common source of confusion in defining exposure scenarios. It is important to define the duration estimate so that it is consistent with the intake rate:

- The intake rate can be based on an individual event (e.g., serving size per event). The duration should be based on the number of events or, in this case, meals.

- The intake rate also can be based on a long-term average, such as 10 g/day. In this case the duration should be based on the total time interval over which the exposure occurs.

The objective is to define the terms so that, when multiplied, they give the appropriate estimate of mass of contaminant contacted. This can be accomplished by basing the intake rate on either a long-term average (chronic exposure) or an event (acute exposure) basis, as long as the duration value is selected appropriately.

Inhalation dosimetry is employed to derive the human equivalent exposure concentrations on which inhalation unit risks, and reference concentrations, are based (U.S. EPA, 1994b). U.S.

EPA has traditionally approximated children's respiratory exposure by using adult values, although a recent review (Ginsberg et al., 2005) concluded that there may be some cases where young children's greater inhalation rate per body weight or pulmonary surface area as compared to adults can result in greater exposures than adults. The implications of this difference for inhalation dosimetry and children's risk assessment were discussed at a peer involvement workshop hosted by the U.S. EPA in 2006 (Foos et al., 2008).

Consideration of lifestage-particular physiological characteristics in the dosimetry analysis may result in a refinement to the human equivalent concentration to insure relevance in risk assessment across lifestages, or might conceivably conclude with multiple human equivalent concentrations, and corresponding inhalation unit risk values (e.g., separate for childhood and adulthood) (U.S. EPA, 2005a). The RfC methodology, which is described in *Methods for Derivation of Inhalation Reference Concentrations and Applications of Inhalation Dosimetry* (U.S. EPA, 1994b), allows the user to incorporate population-specific assumptions into the models. The reader is referred to U.S. EPA guidance (U.S. EPA, 1994b) on how to make these adjustments.

There are no specific exposure factor assumptions in the derivation of Reference Doses (RfDs) for susceptible populations. With regard to childhood exposures as a susceptible population, for example, the assessment of the potential for adverse health effects in infants and children is part of the overall hazard and dose-response assessment for a chemical. Available data pertinent to children's health risks are evaluated along with data on adults and the no-observed-adverse-effect-level (NOAEL) or benchmark dose (BMD) for the most sensitive critical effect(s), based on consideration of all health effects. By doing this, protection of the health of children will be considered along with that of other sensitive populations. In some cases, it is appropriate to evaluate the potential hazard to a susceptible population (e.g., children) separately from the assessment for the general population or other population groups.

1.9.2 Use of Exposure Factors Data in Probabilistic Analyses

Although this handbook is not intended to provide complete guidance on the use of Monte Carlo and other probabilistic analyses, some of the data in this handbook may be appropriate for use in probabilistic assessments. The use of Monte Carlo or other probabilistic analysis requires characterization of the variability of exposure factors and requires the selection of distributions or histograms for the input parameters of the dose equations presented in Section 1.9.1. The following suggestions are provided for consideration when using such techniques:

- The exposure assessor should only consider using probabilistic analysis when there are credible distribution data (or ranges) for the factor under consideration. Even if these distributions are known, it may not be necessary to apply this technique. For example, if only average exposure values are needed, these can often be computed accurately by using average values for each of the input parameters unless a non-linear model is used. Probabilistic analysis is also not necessary when conducting assessments for screening purposes, i.e., to determine if unimportant pathways can be eliminated. In this case, bounding estimates can be calculated using maximum or near maximum values for each of the input parameters. Alternatively, the assessor may use the maximum values for those parameters that have the greatest variance.

- The selection of distributions can be highly site-specific and dependent on the purpose of the assessment. In some cases the selection of distributions are driven by specific legislation. It will always involve some degree of judgment. Distributions derived from national data may not represent local conditions. The assessor needs to evaluate the site-specific data, when available, to assess their quality and applicability. The assessor may decide to use distributional data drawn from the national or other surrogate population. In this case, it is important that the assessor address the extent to which local conditions may differ from the surrogate data.

- It is also important to consider the independence/dependence of variables and data used in a simulation. For example, it may be reasonable to assume that ingestion rate and contaminant concentration in foods are independent variables, but ingestion rate and body weight may or may not be independent.

In addition to a qualitative statement of uncertainty, the representativeness assumption should be appropriately addressed as part of a sensitivity analysis.

- Distribution functions used in probabilistic analysis may be derived by fitting an appropriate function to empirical data. In doing this, it should be recognized that in the lower and upper tails of the distribution the data are scarce, so that several functions, with radically different shapes in the extreme tails, may be consistent with the data. To avoid introducing errors into the analysis by the arbitrary choice of an inappropriate function, several techniques can be used. One technique is to avoid the problem by using the empirical data itself rather than an analytic function. Another is to do separate analyses with several functions that have adequate fit but form upper and lower bounds to the empirical data. A third way is to use truncated analytical distributions. Judgment must be used in choosing the appropriate goodness-of-fit test. Information on the theoretical basis for fitting distributions can be found in a standard statistics text, (e.g., Gilbert, 1987, among others). Off-the-shelf computer software can be used to statistically determine the distributions that fit the data. Other software tools are available to identify outliers and for conducting Monte Carlo simulations.

- If only a range of values is known for an exposure factor, the assessor has several options.
  - keep that variable constant at its central value.
  - assume several values within the range of values for the exposure factor.
  - calculate a point estimate(s) instead of using probabilistic analysis.
  - assume a distribution. (The rationale for the selection of a distribution should be discussed at length.) There are, however, cases where assuming a distribution is not recommended. These include:
    - data are missing or very limited for a key parameter;
    - data were collected over a short time period and may not represent long term trends (the respondent usual behavior) - examples include: food consumption surveys; activity pattern data;
    - data are not representative of the population of interest because sample size was small or the population studied was selected from a local area and was therefore not representative of the area of interest; for example, soil ingestion by children; and
    - ranges for a key variable are uncertain due to experimental error or other limitations in the study design or methodology; for example, soil ingestion by children.

1.10 CUMULATIVE EXPOSURES

The U.S. EPA recognizes that individuals may be exposed to mixtures of chemicals both indoors and outdoors through more than one pathway. New directions in risk assessments in the U.S. EPA put more emphasis on total exposures via multiple pathways (U.S. EPA, 2003d, U.S. EPA, 2008b). Over the last several years, the U.S. EPA has developed a methodology for assessing risk from multiple chemicals (U.S. EPA, 1986b, 2000b). For more information, the reader is referred to the U.S. EPA's *Framework for Cumulative Risk Assessment* (U.S. EPA, 2003b). The recent report by the National Academy of Sciences (NAS) also recommends the development of approaches to incorporate the interactions between chemical and nonchemical stressors (NAS 2009).

1.11 ORGANIZATION

The handbook is organized as follows:

Chapter 1	Introduction
Chapter 2	Variability and uncertainty
Chapter 3	Ingestion of water and other select liquids
Chapter 4	Non-dietary ingestion
Chapter 5	Soil and dust ingestion
Chapter 6	Inhalation rates
Chapter 7	Dermal exposure factors
Chapter 8	Body weight
Chapter 9	Intake of fruits and vegetables

Chapter 10	Intake of fish and shellfish
Chapter 11	Intake of meats, dairy products, and fats
Chapter 12	Intake of grain products
Chapter 13	Intake of home-produced foods
Chapter 14	Total food intake
Chapter 15	Human milk intake
Chapter 16	Activity factors
Chapter 17	Consumer products
Chapter 18	Life Expectancy
Chapter 19	Residential Characteristics

Recommended values for exposure factors are presented at the beginning of each chapter, followed by detailed discussions of the data on which these recommendations are based. Because of the large number of tables in this handbook, tables are presented at the end of each chapter, before the appendices, if any.

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Table 1-1. Characterization of Variability in Exposure Factors					
Exposure Factors	Chapter	Average	Median	Upper percentile	Multiple Percentiles
Ingestion of water and other select liquids (Chapter 3)	3	✓	✓	✓	✓
Non-dietary ingestion	4	✓	✓	✓	
Soil and dust ingestion	5	✓	✓	✓ [a]	
Inhalation rate	6	✓	✓	✓	✓
Surface area	7	✓		✓	✓
Soil adherence	7	✓			
Body weight	8	✓	✓	✓	✓
Intake of fruits and vegetables	9	✓	✓	✓	✓
Intake of fish and shellfish	10	✓	✓	✓	✓
Intake of meats, dairy products, and fats	11	✓	✓	✓	✓
Intake of grain products	12	✓	✓	✓	✓
Intake of home produced foods	13	✓	✓	✓	✓
Total food intake	14	✓	✓	✓	✓
Human milk intake	15	✓		✓	
Time indoors	16	✓			
Time outdoors	16	✓			
Time showering	16	✓	✓	✓	✓
Time bathing	16	✓	✓	✓	✓
Time swimming	16	✓	✓	✓	✓
Time playing on sand/gravel	16	✓	✓	✓	✓
Time playing on grass	16	✓	✓	✓	✓
Time playing on dirt	16	✓	✓	✓	✓
Life expectancy	18	✓			
Volume of residence	19		✓	✓ [b]	
Air exchange rates	19		✓	✓ [b]	

[a] Soil pica and geophagy.
b lower percentile.
✓ = Data available.

Table 1-2. Considerations Used to Rate Confidence in Recommended Values

General Assessment Factors	Increasing Confidence	Decreasing Confidence
Soundness		
Adequacy of Approach	The studies used the best available methodology and capture the measurement of interest.	There are serious limitations with the approach used; study design does not accurately capture the measurement of interest.
	As the sample size relative to that of the target population increases, there is greater assurance that the results are reflective of the target population.	Sample size too small to represent the population of interest.
	The response rate is greater than 80 percent for in-person interviews and telephone surveys, or greater than 70 percent for mail surveys.	The response rate is less than 40 percent.
	The studies analyzed primary data.	The studies are based on secondary sources.
Minimal (or defined) Bias	The study design minimizes measurement errors.	Uncertainties with the data exist due to measurement error.
Applicability and Utility		
Exposure Factor of Interest	The studies focused on the exposure factor of interest.	The purpose of the studies was to characterize a related factor.
Representativeness	The studies focused on the U.S. population.	Studies are not representative of the U.S. population.
Currency	The studies represent current exposure conditions.	Studies may not be representative of current exposure conditions.
Data Collection Period	The data collection period is sufficient to estimate long-term behaviors.	Shorter data collection periods may not represent long-term exposures.
Clarity and Completeness		
Accessibility	The study data could be accessed.	Access to the primary data set was limited.
Reproducibility	The results can be reproduced or methodology can be followed and evaluated.	The results cannot be reproduced, the methodology is hard to follow, and the author(s) cannot be located.
Quality Assurance	The studies applied and documented quality assurance/quality control measures	Information on quality assurance/control was limited or absent.

Table 1-2. Considerations Used to Rate Confidence in Recommended Values (continued)

General Assessment Factors	Increasing Confidence	Decreasing Confidence
Variability and Uncertainty		
Variability in Population	The studies characterize variability in the population studied.	The characterization of variability is limited.
Uncertainty	The uncertainties are minimal and can be identified. Potential bias in the studies are stated or can be determined from the study design.	Estimates are highly uncertain and cannot be characterized. The study design introduces biases in the results.
Evaluation and Review		
Peer Review	The studies received high level of peer review (e.g., they are published in peer review journals).	The studies received limited peer review.
Number and Agreement of Studies	The number of studies is greater than 3. The results of studies from different researchers are in agreement.	The number of studies is 1. The results of studies from different researchers are in disagreement.

Table 1-3. Age-Dependent Potency Adjustment Factor by Age Group

Exposure Age Group[a]	Exposure Duration (yr)	ADAF (Age-Dependent Potency Adjustment Factor)
Birth to < 1 month	0.083	10×
1 < 3 months	0.167	10×
3 < 6 months	0.25	10×
6 < 12 months	0.5	10×
1 to < 2 years	1	10×
2 to < 3 years	1	3×
3 to < 6 years	3	3×
6 to < 11 years	5	3×
11 to < 16 years	5	3×
16 to < 21 years	5	1×
> 21 years (21 to < 70 yr)	49	1×

[a] U.S. EPA's recommended childhood age groups (excluding ages >21 years).

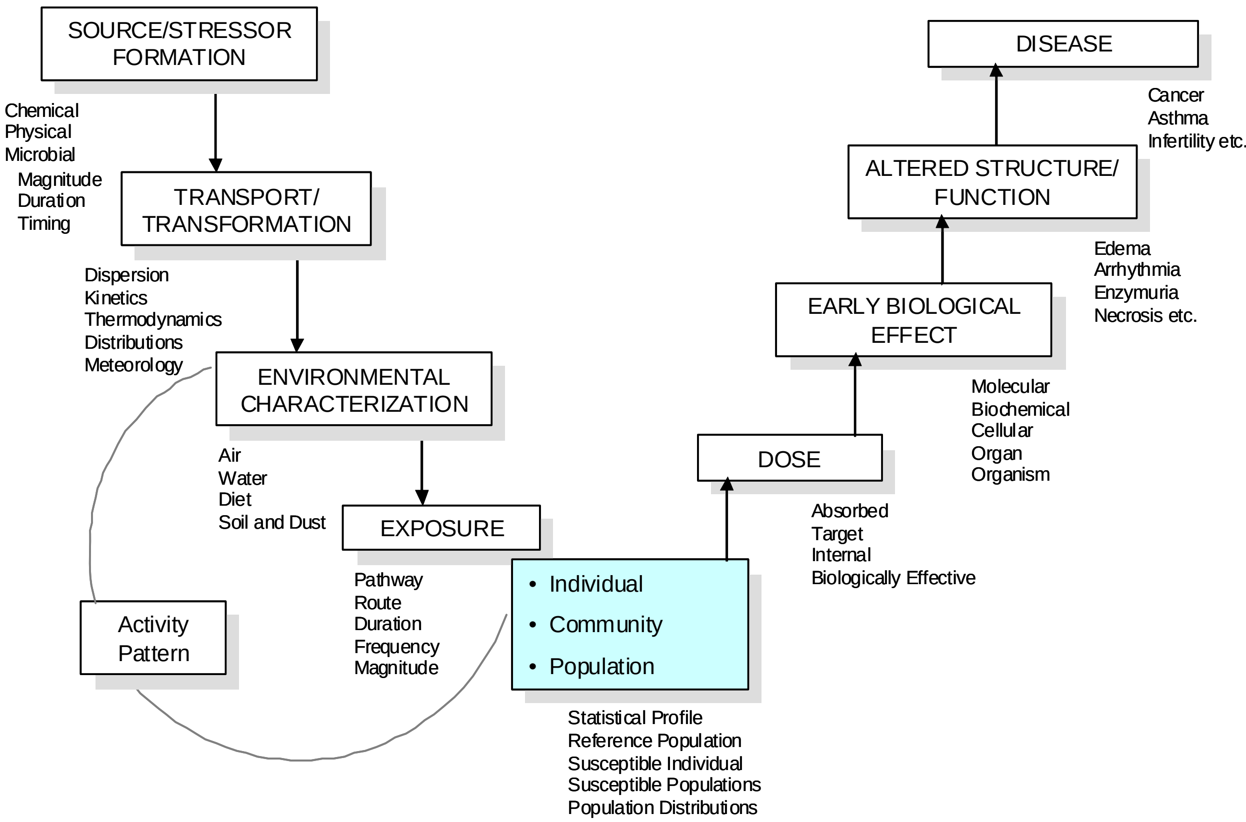

Figure 1-1. Exposure-Dose-Effect Continuum

Source: Redrawn from: U.S. EPA, 2003d; IPCS, 2006.

The exposure-dose-effect continuum depicts the trajectory of a chemical or agent from its source to an effect. The chemical or agent can be transformed and transported through the environment via air, water, soil, dust, and diet. Individuals can become in contact with the chemical through inhalation, ingestion, or skin/eye contact. The individual's physiology, behavior, and activity patterns as well as the concentration of the chemical will determine the magnitude, frequency, and duration of the exposure. The exposure becomes an absorbed dose once the chemical crosses the absorption barrier (i.e., skin, lungs, eyes, gastrointestinal tract, placenta). Interactions of the chemical or its metabolites with a target tissue may lead to an adverse health outcome. The text under the boxes indicates the specific information that may be needed to characterize each box in the exposure-dose-effect continuum.

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2 VARIABILITY AND UNCERTAINTY

Accounting for variability and uncertainty is fundamental to exposure assessment and risk analysis. Properly addressing variability and uncertainty will increase the likelihood that results of an assessment or analysis will be used in an appropriate manner. Characterizing and communicating uncertainty and variability should be done throughout all the components of the risk assessment process (NRC, 2009). Thus, careful consideration of the variabilities and uncertainties associated with the exposure factors information used in an exposure assessment is of utmost importance. Proper characterization of variability and uncertainty will also support effective communication of risk estimates to risk managers and the public.

Exposure assessment can involve a broad array of information sources and analysis techniques (U.S. EPA, 1992). Even in situations where actual exposure-related measurements exist, assumptions or inferences will still be required because data are not likely to be available for all aspects of the exposure assessment. Moreover, the data that are available may be of questionable quality. Thus, exposure assessors have a responsibility to present clear and explicit explanations of the implications and limitations of their analyses.

Morgan and Henrion (1990) provide an argument for the need for variability and uncertainty analysis in exposure assessment. They state that when scientists report quantities that they have measured, they are expected to routinely report an estimate of the uncertainty associated with such measurements. They conclude that because variabilities and uncertainties inherent in policy analysis (which includes exposure assessment) tend to be even greater than those in the natural sciences, exposure assessors also should be expected to report or comment on the variabilities and uncertainties associated with their estimates.

Some additional reasons for addressing variability and uncertainty in exposure or risk assessments (U.S. EPA, 1992, Morgan and Henrion, 1990) include the following:

- Decisions may need to be made about whether or how to expend resources to acquire additional information;
- Biases may occur in providing a so-called "best estimate" that in actuality is not very accurate; and
- Important factors and potential sources of disagreement in a problem may be able to be identified.

This chapter is intended to acquaint the exposure assessor with some of the fundamental concepts of variability and uncertainty as they relate to exposure assessment and the exposure factors presented in this handbook. It also provides methods and considerations for evaluating and presenting the uncertainty associated with exposure estimates. Subsequent sections in this chapter are devoted to the following topics:

- Variability versus uncertainty;
- Types of variability;
- Coping with variability;
- Types of uncertainty;
- Reducing uncertainty;
- Analysis of variability and uncertainty; and
- Presenting results of variability/uncertainty analysis.

Treatises on the topic of uncertainty have been provided, for example, by Morgan and Henrion (1990), the National Research Council (NRC, 1994) and the U.S. EPA (1992; 1995). The topic commonly has been treated as it relates to the overall process of conducting risk assessments. Because exposure assessment is a component of the risk-assessment process, the general concepts apply equally to the exposure-assessment component. Since the publication of the National Research Council's report entitled *Science and Judgement in Risk Assessment* (NRC, 1994), the field of variability and uncertainty analysis has continued to evolve. The use of probabilistic techniques to address variability and uncertainty has continued to increase. More recently, the NRC report *Science and Decisions Advancing Risk Assessments* (NRC, 2009) recommends a "tiered" approach for selecting the level of detail to be used in characterizing uncertainty and variability in risk assessments. Although there is a lack of guidance on the appropriate level of detail and sophistication needed in an uncertainty and variability analysis, NRC emphasizes the need to describe the extent and nature of the analysis needed in the planning and scoping phase of the risk assessment (NRC, 2009). Many problems can be addressed by an initial sensitivity analysis to help identify the parameters that have the most impact on a decision and thus needing a more detailed uncertainty analysis (NRC, 2009).

There are numerous ongoing efforts in the Agency and elsewhere to further improve the characterization of variability and uncertainty. The U.S. EPA's Risk Assessment Forum has established a workgroup to promote the use of probabilistic techniques to better assess and communicate risk.

The U.S. EPA's Science Policy Council is developing white papers on the use of expert elicitation for characterizing uncertainty in risk assessments. Expert judgment has been used in the past by some regulatory agencies when limited data or knowledge result in large uncertainties (NRC, 2009). The International Programme on Chemical Safety (IPCS) is developing guidance on characterizing and communicating uncertainty in exposure assessment (WHO, 2006). IPCS also encourages the use of a tiered approach consisting of a screening analysis followed by a qualitative analysis and two levels of quantitative analysis (WHO, 2006).

2.1 VARIABILITY VERSUS UNCERTAINTY

While some authors have treated variability as a specific type or component of uncertainty, the U.S. EPA (1995) has advised the risk assessor (and, by analogy, the exposure assessor) to distinguish between variability and uncertainty. Uncertainty represents a lack of knowledge about factors affecting exposure or risk, whereas variability arises from heterogeneity across people, places or time. In other words, uncertainty can lead to inaccurate or biased estimates, whereas variability can affect the precision of the estimates and the degree to which they can be generalized. The key difference between uncertainty and variability analysis is that variability cannot be reduced; only better characterized (NRC, 2009). Most of the data presented in this handbook concerns variability. Factors contributing to variability in risk in the population include variability in exposure potential (e.g., behavioral patterns, location), variability in susceptibility due to endogenous factors (e.g., age, gender, genetics, pre-existing disease), variability in susceptibility due to exogenous factors (e.g., exposures to other agents) (NRC, 2009).

> <u>Uncertainty</u> – a lack of knowledge about factors affecting exposure or risk.
>
> <u>Variability</u> – arises from heterogeneity among test subjects, populations, places or time.

It should be emphasized that variability and uncertainty can be confounded and it may not always be appropriate to give special significance to distinguishing between the two. Consider a situation that relates to exposure, such as estimating the average daily dose by one exposure route -- ingestion of contaminated drinking water. Suppose that it is possible to measure an individual's daily water consumption (and concentration of the contaminant) exactly, thereby eliminating uncertainty in the measured daily dose. The daily dose still has an inherent day-to-day variability due to changes in the individual's daily water intake or the contaminant concentration in water.

It is impractical to measure the individual's dose every day. For this reason, the exposure assessor may estimate the average daily dose (ADD) based on a finite number of measurements, in an attempt to "average out" the day-to-day variability. The individual has a true (but unknown) ADD, which has now been estimated based on a sample of measurements. Because the individual's true average is unknown, it is uncertain how close the estimate is to the true value. Thus, the variability across daily doses has been translated into uncertainty in the ADD. Although the individual's true ADD has no variability, the estimate of the ADD has some uncertainty. It should be noted, however, that a rigid delineation of variability and uncertainty may not be as useful as assessing the available information and attendant variation and properly accounting for it (e.g., sensitivity analysis).

The above discussion pertains to the ADD for one person. Now consider a probability distribution of ADDs across individuals in a defined population (e.g., the general U.S. population). In this case, variability refers to the range and distribution of ADDs across individuals in the population. By comparison, uncertainty refers to the exposure assessor's state of knowledge about that distribution, or about parameters describing the distribution (e.g., mean, standard deviation, general shape, various percentiles).

As noted by the National Research Council (NRC, 1994), the realms of variability and uncertainty have fundamentally different ramifications for science and judgment. For example, uncertainty may force decision-makers to judge how probable it is that exposures have been overestimated or underestimated for every member of the exposed population, whereas variability forces them to cope with the certainty that different individuals are subject to exposures both above and below any of the exposure levels chosen as a reference point.

2.2 TYPES OF VARIABILITY

Variability in exposure potential is a function of the variability in human exposure factors (i.e., those related to an individual's location, activity, behavior or preferences at a particular point in time, or physiological characteristics such as body weight), as well as variations in contaminants concentrations (i.e., those related to pollutant emission rates and physical/chemical processes that affect concentrations in various media; e.g., air, soil, food and water). The variations in human exposure factors and chemical concentrations are not necessarily independent of one another. For example, both personal activities and pollutant concentrations at a specific location might vary in response to weather conditions, or between weekdays and weekends.

At a more fundamental level, four types of variability can be distinguished:

- Variability across locations (Spatial Variability);
- Variability over time (Temporal Variability);
- Variability within an individual (Intra-individual Variability; and
- Variability among individuals (Inter-individual Variability).

Spatial variability can occur both at regional (macroscale) and local (microscale) levels. For example, fish intake rates can vary depending on the region of the country. Higher consumption may occur among populations located near large bodies of water such as the Great Lakes or coastal areas. As another example, outdoor pollutant levels can be affected at the regional level by industrial activities and at the local level by activities of individuals. In general, higher exposures tend to be associated with closer proximity to the pollutant source, whether it be an industrial plant or related to a personal activity such as showering or gardening. In the context of exposure to airborne pollutants, the concept of a "microenvironment" has been introduced (Duan, 1982) to denote a specific locality (e.g., a residential lot or a room in a specific building) where the airborne concentration can be treated as homogeneous (i.e., invariant) at a particular point in time.

Temporal variability refers to variations over time, whether long- or short-term. Seasonal fluctuations in weather, pesticide applications, use of woodburning appliances and fraction of time spent outdoors are examples of longer-term variability. Examples of shorter-term variability are differences in industrial or personal activities on weekdays versus weekends or at different times of the day.

Intra-individual variability is a function of fluctuations in an individual's physiologic (e.g., body weight), or behavioral characteristics (e.g., ingestion rates or activity patterns). For example, patterns of food intake change from day to day, and may change significantly over a lifetime. Intra-individual variability may be associated with spatial or temporal variability. For example, because an individual's dietary intake may reflect local food sources, intake patterns may change if place of residence changes. Also, physical activity may vary depending upon the season, life stage, or other factors associated with temporal variability.

Inter-individual variability can be either of two types: (1) human characteristics such as age or body weight, and (2) human behaviors such as location, activity patterns, and ingestion rates. Each of these variabilities, in turn, may be related to several underlying phenomena that vary. For example, the natural variability in human weight is due to a combination of genetic, nutritional, and other lifestyle or environmental factors. Variability arising from independent factors that combine multiplicatively generally will lead to an approximately lognormal probability distribution across the population, or across spatial/temporal dimensions. Inter-individual variability may also be related to spatial and temporal factors.

Variability in susceptibility can be a result of both endogenous and exogenous factors (NRC, 2009). Endogenous factors include age, gender, genetics, and pre-existing diseases and conditions. Exogenous factors include prior or current exposures to other agents, social and economic factors influencing exposure and biologic response (NRC, 2009).

2.3 COPING WITH VARIABILITY

As noted in Section 1.6 of this handbook, this document attempts to characterize variability of each of the exposure factors presented. Variability is addressed by presenting data on the exposure factors in one of the following three ways: (1) as tables with percentiles or ranges of values, (2) as probability distributions with specified parameters including confidence intervals to indicate the degree of uncertainty in the estimated values, or (3) as a qualitative discussion.

According to the National Research Council (NRC 1994), variability in exposure estimates can be addressed, especially with regard to point estimates such as central tendency (CT) or high end exposures (e.g., reasonable maximum exposure (RME) used in the Superfund program) in four basic ways (Table 2-1) when dealing with science-policy questions surrounding issues such as exposure or risk assessment. The first is to **ignore the variability**. This strategy is likely to be used in combination with one of the other strategies described below (e.g., use the average value), and tends to work best when the variability is relatively small, as in the case with adult body weights. For example, the U.S.EPA practice of assuming that all adults weigh 70 kg is likely to be correct within ±25% for most adults and within a factor of 3 for virtually all adults (NRC, 1994). However, it is cautioned that this approach may not be appropriate for children, where variability may be large.

The second strategy involves **disaggregating the variability** in some explicit way, in order to better understand it or reduce it. Mathematical models are appropriate in some cases, as in fitting a sine wave to the annual outdoor concentration cycle for a particular pollutant and location. In other cases, particularly those involving human characteristics or behaviors, it is easier to disaggregate the data by considering all the relevant subgroups or subpopulations. For example, probability distributions of body weight could be developed separately for adults, adolescents and children, and even for males and females within each of these subgroups. Temporal and spatial analogies for this concept involve measurements on appropriate time scales and choosing appropriate subregions or microenvironments.

The third strategy is to **use the average value** of a quantity that varies. Although this strategy might appear as tantamount to ignoring variability, it needs to be based on a decision that the average value can be estimated reliably in light of the variability (e.g., when the variability is known to be relatively small, as in the case of adult body weight).

The fourth strategy involves **using the maximum or minimum value** for an exposure factor. In this case, the variability is characterized by the range between the extreme values and a measure of central tendency. This is perhaps the most common method of dealing with variability in exposure or risk assessment -- to focus on one time period (e.g., the period of peak exposure), one spatial region (e.g., in close proximity to the pollutant source of concern), or one subpopulation (e.g., exercising asthmatics). As noted by the U.S. EPA (1992), when an exposure assessor develops estimates of high-end individual exposure and dose, care must be taken not to set all factors to values that maximize exposure or dose --such an approach will almost always lead to an overestimate.

While these approaches provide a means of addressing variability, they in effect remove variability from the analysis. That is, ignoring variability, use of an average, use of a subcategory average or use of a maximum or minimum value results in removing variability from the analysis by substituting a single value for a value characterized by variation that is appropriately described by a probability distribution. While it may not be possible in all situations to base analyses on a distributional properties, it should be possible in most, if not all, cases to investigate the sensitivity of the results to variation in key input variables. For example, if an analysis is based on a mean value, either assumed or observed, the effect of changing the mean to some alternative plausible value, such as a proportion of the value or an upper percentile of the distribution, should be investigated.

Another approach to investigating the effect of variation in key parameter values is the use of probabilistic techniques (e.g., Monte Carlo or Latin Hypercube Simulation) which may be used to characterize the variability in risk estimates by computer simulation of repeated sampling of the probability distributions of the risk equation variables and using the results to calculate a distribution of risk. Related to Monte Carlo analysis are **Bootstrap** methods which may be used to estimate confidence intervals for population parameters by simulated re-sampling of empirical distributions (see, e.g., Efron and Tibshirani (1993), the method was used in, e.g., Kahn and Stralka (2009) and (2008)). This approach is used less frequently in uncertainty analysis. Techniques for characterizing both uncertainty and variability are available, and generally require two-dimensional Monte Carlo analysis (U.S. EPA, 2001). In situations in which an analyst wishes to apply probabilistic techniques, and data lend themselves to such analysis, more robust techniques to describe model goodness-of-fit, identification of data outliers, and sensitivity analysis should be used to address parameter variability. These techniques are described in Section 1.9.2 of this document.

2.4 TYPES OF UNCERTAINTY

Uncertainty in exposure analysis is related to the lack of knowledge concerning one or more components of the assessment process.

The U.S. EPA (1992) has classified uncertainty in exposure assessment into three broad categories:

1. Uncertainty regarding missing or incomplete information needed to fully define exposure and dose (Scenario Uncertainty).
2. Uncertainty regarding some parameter (Parameter Uncertainty).
3. Uncertainty regarding gaps in scientific theory required to make predictions on the basis of causal inferences (Model Uncertainty).

Sometimes uncertainties can be characterized as “unknown unknowns.” These uncertainties refer to factors that the assessor is unaware of. They can only be addressed by an interactive approach to detect, analyze, and correct in a timely fashion (NRC, 2009). Sources and examples for each type of uncertainty are summarized in Table 2-2. As described in Section 1.6 of this handbook, U.S. EPA has attempted to address the uncertainty associated with the various exposure factors presented in the handbook by applying confidence ratings to the recommended data. In general, these confidence ratings are based on detailed discussions of any limitations of the data presented. This information may be useful in analyzing the uncertainty associated with an overall exposure/risk assessment.

2.5 REDUCING UNCERTAINTY

Identification of the sources of uncertainty in an exposure assessment is the first step in determining how to reduce that uncertainty. The types of uncertainty listed in Table 2-2 can be further defined by examining their principal causes. There are, however, some uncertainties that cannot be reduced or quantified (NRC, 2009). Because uncertainty in exposure assessments is fundamentally tied to a lack of knowledge concerning important exposure factors (i.e., parameter uncertainty), strategies for reducing uncertainty necessarily involve reduction or elimination of knowledge gaps. Example strategies to reduce uncertainty include (1) collection of new data using a larger sample size, an unbiased sample design, a more direct measurement method or a more appropriate target population, and (2) use of more sophisticated modeling and analysis tools if data quality allows. The strategy selected depends on the degree of confidence necessary in the results.

2.6 ANALYZING VARIABILITY AND UNCERTAINTY

There are different strategies available for addressing variability and uncertainty. These strategies vary in their level of sophistication (NRC, 2009). The level of effort required to conduct the analysis needs to be balanced against the need for transparency and timeliness (NRC, 2009). The analysis needs to be tailored to provide enough resolution to distinguish among the various decision-making options (NRC, 2009). The goal is to improve the capacity of the decision maker to make the best informed decisions given the presence of uncertainties.

Exposure assessments are often developed in a tiered approach. The initial tier usually screens out the exposure scenarios or pathways that are not expected to pose much risk, to eliminate them from more detailed, resource-intensive review. Screening-level assessments typically examine exposures on the higher end of the expected exposure distribution. Because screening-level analyses usually are included in the final exposure assessment, the final document may contain scenarios that differ quite markedly in sophistication, data quality, and amenability to quantitative expressions of variability or uncertainty.

According to the U.S. EPA (1992), uncertainty characterization and uncertainty assessment are two ways of describing uncertainty at different degrees of sophistication. Uncertainty characterization usually involves a qualitative discussion of the thought processes used to select or reject specific data, estimates, scenarios, etc. Uncertainty assessment is a more quantitative process that may range from simple to more complex measures and analytical techniques. The level of sophistication depends on the amount of information needed to inform specific risk management decisions (NRC, 2009). Its goal is to provide decision makers with information concerning the quality of an assessment, including the potential variability in the estimated exposures, major data gaps, and the effect that these data gaps have on the exposure estimates developed.

A distinction between variability and uncertainty was made in Section 2.1. Although the quantitative process mentioned above applies more directly to variability and the qualitative approach more so to uncertainty, there is some degree of overlap. In general, either method provides the assessor or decision-maker with insights to better evaluate the assessment in the context of available data and assumptions. The following paragraphs describe some of the more common procedures for analyzing variability and uncertainty in exposure assessments.

Several approaches can be used to characterize uncertainty in parameter values. These include the use of defaults, quantitative analysis, and expert judgment. When uncertainty is high, for example, the assessor may use the straightforward approach of setting order-of-magnitude bounding estimates of parameter ranges (e.g., from 0.1 to 10 liters for daily water intake). Exposure and risk assessors often rely on the use of default assumptions when data are unavailable. Selection and use of default assumptions is sometimes controversial. A consistent and credible approach for the use of defaults is important in the risk assessment process (NRC, 2009). Another simple method describes the range for each parameter including the lower and upper bounds as well as a "best estimate" determined by available data or professional judgment.

Most approaches to quantitative analysis, however, examine how variability and uncertainty in values of specific parameters translate into the overall uncertainty of the assessment. These approaches can generally be described (in order of increasing complexity and data needs) as: (1) sensitivity analysis; (2) analytical uncertainty propagation; (3) probabilistic uncertainty analysis; or (4) classical statistical methods (U.S. EPA 1992). The four approaches are summarized in Table 2-3. A sensitivity analysis can be used to determine which parameters have the most impact in the final risk calculation (NRC, 2009). The International Programme on Chemical Safety also proposes a four tier approach for addressing uncertainty and variability (WHO, 2006). The four tiers are similar to those proposed in U.S. EPA 1992 and include the use of default assumptions, a qualitative, systematic identification and characterization of uncertainty, a qualitative evaluation of uncertainty using bounding estimates, interval analysis, and sensitivity analysis, and a more sophisticated one or two-stage probabilistic analysis (WHO, 2006). The two-stage probabilistic analysis combines the analysis of both uncertainty and variability.

Notably, Cox Jr. (1999) argues that, based on information theory, models with greater complexity lead to more certain risk estimates. This may only be true if there is some degree of certainty in the assumptions used by the model. Uncertainties associated with the model need to be evaluated (NRC, 2009). Reviews of these methods are available in Bogen and Spear (1987), Cox and Baybutt (1981), Rish and Marnicio (1988), and Whitmore (1985). In another review by Seiler (1987), the analysis of error propagation is discussed with respect to general mathematical formulations typically found in risk assessment, such as linear combinations, powers of one variable, and multiplicative normally distributed variables. Even for large and uncertain errors, the formulations in Seiler (1987) are demonstrated to have practical value. Iman and Helton (1988) compared three methodologies for uncertainty and sensitivity analysis: response surface, Latin hypercube sampling (with and without regression analysis), and differential analysis. They found that Latin hypercube sampling with regression analysis had the best performance in terms of flexibility, estimability, and ease of use. Saltelli (2002) and Frey (2002) offer views on the role of sensitivity analysis in risk assessment, and Frey and Patil (2002) compare methods for sensitivity analysis and recommend that two or more different sensitivity assessment methods should be used in order to obtain robust results. A Bayesian perspective on sensitivity analysis is described in Greenland (2001), who recommends that sensitivity analysis and Monte Carlo risk analysis should begin with specification of prior distributions, as in Bayesian analysis. A Bayesian approach to uncertainty analysis is described in Nayak and Kundu (2001).

Price, et al. (1999) review the history of the inter-individual (or intra-species) uncertainty factor, as well as the relative merits of the sensitive population conceptual model versus the finite sample size model in determining the magnitude of the uncertainty factor. They found that both models represent different sources of uncertainty and that both should be considered when developing inter-individual uncertainty factors. Uncertainties related to inter-individual and inter-species variability are treated in Hattis (1997) and Meek (2001), respectively. And Renwick (1999) demonstrates how inter-species and inter-individual uncertainty factors can be decomposed into kinetic and dynamic defaults by taking into account toxicodynamic and toxicokinetic differences. Burin and Saunders (1999) evaluate the robustness of the intra-species uncertainty factor and recommend intra-species uncertainty factoring in the range of 1-10.

Based on Monte Carlo analysis, Shlyakhter (1994) recommends inflation of estimated uncertainties by default safety factors in order to account for unsuspected uncertainties.

Jayjock (1997) defines uncertainty as either natural variability or lack of knowledge, and also provides a demonstration of uncertainty and sensitivity analysis utilizing computer simulation. Additional approaches for coping with uncertainties in exposure modeling and monitoring are addressed by Nicas and Jayjock (2002).

Distributional risk assessment should be employed when data are available that support its use. Fayerweather, et al. (1999) describe distributional risk assessment, as well as its strengths and weaknesses. Exposure metrics for distributional risk assessment using log-normal distributions of time spent showering (Burmaster 1998a), water intake (Burmaster 1998b), and body weight (Burmaster, D.E.; Crouch, E.A.C. 1997), Burmaster, D.E. (1998c) have been developed. The lognormal provides a succinct mathematical form that facilitates exposure and risk analyses. However, Burmaster and his co-workers fit the lognormal distribution to data obtained from surveys that were designed according to complex weighting schemes. As a consequence, the data do not satisfy the basic assumption of the lognormal of independent and identically distributed observations. The fitted lognormal distributions are therefore approximations that should be carefully evaluated. One approach is to compare lognormal distributions with other models (e.g., Weibull, Gamma). As an alternative to the lognormal approximations, analysis of empirical distributions that account for data weighting should be considered where possible. This is the approach used by Jacobs et al (1998) and U.S. EPA (2002) in developing estimates of fish consumption and U.S. EPA (2004) and Kahn and Stralka (2009) for estimates of water ingestion. These estimates were derived from the Continuing Survey of Food Intake by Individuals (CSFII) which was a Nation wide statistical survey of the population of the United States conducted by the USDA. The CSFII collected extensive information on food and beverage intake by a sample that represented the population of the United States and the sample weights provided with the data supported the estimation of empirical distributions of intakes for the entire population and various sub-populations such as intake distributions by various age categories. Kahn and Stralka (2008) used the CSFII data to estimate empirical distributions of water ingestion by pregnant and lactating women and compared the results to those presented by Burmaster (1998b). The comparison highlights the differences between the older data used by Burmaster and the CSFII and the differences between fitted approximate lognormal distributions and empirical distributions. The CSFII also collected data on body weight self reported by respondents which supported the estimation of body weight distributions by age categories that are presented in Kahn and Stralka (2009). Detailed summary tables of results based on the CSFII data used by Kahn and Stralka (2009) are presented in Kahn (2008) personal communication (Kahn, 2008).

When sensitivity analysis or uncertainty propagation analysis indicate that a parameter profoundly influences exposure estimates, the assessor should, if possible, develop a probabilistic description of its range. It is also possible to use estimates derived from a large scale survey such as the CSFII as a basis for alternative parameter values that may be used in a sensitivity analysis. The CSFII provides the basis for an objective point of reference for food and beverage intake variables that are a critical component of many risk and exposure assessments. For example, an assumed value for a mean or upper percentile could be compared to a suitable value from the CSFII to assess sensitivity. Deterministic and probabilistic approaches to risk assessment are reviewed for noncarcinogenic health effects in Karlbelah, et al. 2003, with attention to quantifying sources of uncertainty. Kelly and Campbell (2000) review guidance for conducting Monte Carlo analysis and clarify the distinction between variability and uncertainty. This distinction is represented in two-stage Monte Carlo simulation, where a probability distribution represents variability in a population, while a separate distribution for uncertainty defines the degree of variation in the parameters of the population variability distribution (Figure 1). Price, et al. (1997) utilize a Monte Carlo approach to characterize uncertainties for a method aimed at estimating the probability of adverse, non-cancer health effects for exposures exceeding the Reference Dose (RfD). Their method relies on general toxicologic information for a compound, such as the no-observed-adverse-effect-level dose (NOAEL). Semple, et al. (2003) examine uncertainty arising in reconstructed exposure estimates using Monte Carlo methods. Uncertainty in PBPK models is evaluated in Simon (1997). Slob and Pieters (1998) propose replacing uncertainty factors with probabilistic uncertainty distributions and discuss how uncertainties may be quantified for animal NOAELs and extrapolation factors. Zheng and Frey (2005) demonstrate the use of Monte Carlo methods for characterizing uncertainty and emphasize that uncertainty estimates will be biased if contributions from sampling error and measurement error are not accounted for separately.

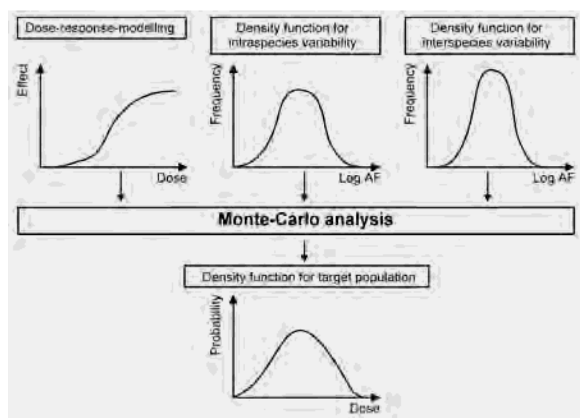

Figure 1. Illustration of probabilistic risk assessment methods: the probability of effects for a predefined low effect level for the target population is derived by mathematically combining (e.g., by Monte Carlo Analysis) the distributions of the assessment factors (AFs) which describe the dose–response curve and the individual extrapolation steps. (Adapted from Karlbelah, et al., 2003)

Distributional biometric data for probabilistic risk assessment are available for some exposure factors. Empirical distributions are provided in this handbook when available. If the data are unavailable or otherwise inadequate, expert judgment can be used to generate a subjective probabilistic representation. Such judgments should be developed in a consistent, well-documented manner. Morgan and Henrion (1990) and Rish (1988) describe techniques to solicit expert judgment, while Weiss (2001) demonstrates use of a web-based survey.

If there are enough data to support their use, standard statistical methods are preferred and may be less cumbersome than a probabilistic approach. Epidemiologic analyses may, for example, be used to estimate variability in human populations, as in Peretz, et al. (1997), who describe variation in exposure time. Sources of variation and uncertainty may also be explored and quantified using a linear regression modeling framework, as in Robinson and Hurst (1997). A general framework for statistical assessment of uncertainty and variance are given for additive and multiplicative models in Rai, et al. (1996) and Rai and Krewski (1998), respectively. Wallace and Williams (2005) describes a robust method for estimating long-term exposures based on short-term measurements.

In addition to the use of defaults and quantitative analysis, exposure and risk assessors often rely on expert judgment when information is insufficient to establish uncertainty bounds (NRC, 2009). There are, however, some biases introduced during expert elicitation. Some of these include availability, anchoring and adjustment, representativeness, disqualification, belief in "law of small numbers," and overconfidence (NRC, 2009). Availability refers to the tendency to assign greater probability to commonly encountered or frequently mentioned events (NRC, 2009). Anchoring and adjustment is the tendency to be over-influenced by the first information seen or provided (NRC, 2009). Representativeness is the tendency to judge and event by reference to another (NRC, 2009). Disqualification is the tendency to ignore data or evidence that contradicts strongly held convictions (NRC, 2009). The belief in the "law of small numbers" is the believe that small samples from a population are more representative than is justified (NRC, 2009). Overconfidence is the tendency of expert to belief that their answers are correct (NRC, 2009).

2.7 PRESENTING RESULTS OF VARIABILITY AND UNCERTAINTY ANALYSIS

Comprehensive qualitative analysis and rigorous quantitative analysis are of little value for use in the decision-making process if their results are not clearly presented. In this chapter, variability (differing levels of exposure among individuals) has been distinguished from uncertainty (the lack of knowledge about the correct value for a specific exposure measure or estimate). Most of the data are presented in this handbook deal with variability directly through inclusion of statistics that pertain to the probability distributions for various exposure factors.

Not all approaches historically used to construct measures or estimates of exposure have attempted to distinguish between variability and uncertainty. The assessor is advised to use a variety of exposure descriptors, and where possible, the full population distribution, when presenting the results. This information will provide risk managers with a better understanding of how exposures are distributed over the population and how variability in population activities influences this distribution.

Although incomplete analysis is essentially unquantifiable as a source of uncertainty, it should not be ignored. At a minimum, the assessor should describe the rationale for excluding particular exposure scenarios; characterize the uncertainty in these decisions as high, medium, or low; and state whether they were based on data, analogy, or professional judgment. Where uncertainty is high, a sensitivity analysis can be used to estimate upper limits on exposure by way of a series of "what if" questions.

Although assessors have always used descriptors (e.g., high-end, worst case, average) to communicate the kind of scenario being addressed, the 1992 Exposure Guidelines (U.S. EPA, 1992) establish clear quantitative definitions for these risk descriptors. Individual descriptors address risks borne by individuals within a population, including measures of central tendency (e.g., average or median), as well as risks at the higher end of the distribution. These definitions were established to ensure that consistent terminology is used throughout the Agency. The risk descriptors in the Exposure Guidelines include those for individual and population risk. Population risk descriptors refer to the extent of harm to the population as a whole. It can be either an estimate of the number of cases of a particular effect that might occur in a population (or population segment), or a description of what fraction of the population receives exposures, doses, or risks greater than a specified value. The data presented in this handbook are one of the tools available to exposure assessors to construct the various risk descriptors.

However, it is not sufficient to merely present the results using different exposure descriptors. Risk managers should also be presented with an analysis of the uncertainties surrounding these descriptors. Uncertainty may be presented using simple or very sophisticated techniques, depending on the requirements of the assessment and the amount of data available. It is beyond the scope of this handbook to discuss the mechanics of uncertainty analysis in detail. The assessor can address uncertainty qualitatively by answering questions such as:

- What is the basis or rationale for selecting these assumptions/parameters, such as data, modeling, scientific judgment, Agency policy, and "what if" considerations?

- What is the range or variability of the key parameters? How were the parameter values selected for use in the assessment? Were average, median, or upper-percentile values chosen? If other choices had been made, how would the results have differed?

- What is the assessor's confidence (including qualitative confidence aspects) in the key parameters and the overall assessment? What are the quality and the extent of the data base(s) supporting the selection of the chosen values?

Any exposure estimate developed by an assessor will have associated assumptions about the setting, chemical, population characteristics, and how contact with the chemical occurs through various exposure routes and pathways. The exposure assessor will need to examine many sources of information that bear either directly or indirectly on these components of the exposure assessment. In addition, the assessor may need to make many decisions regarding the use of existing information in constructing scenarios and setting up the exposure equations. In presenting the scenario results, the assessor should strive for a balanced and impartial treatment of the evidence bearing on the conclusions with the key assumptions highlighted. For these key assumptions, one should cite data sources and explain any adjustments of the data.

The exposure assessor also should qualitatively describe the rationale for selection of any conceptual or mathematical models that may have been used. This discussion should address their verification and validation status, how well they represent the situation being assessed (e.g., average versus high-end estimates), and any plausible alternatives in terms of their acceptance by the scientific community.

Table 2-2 summarizes the three types of uncertainty, associated sources, and examples. Table 2-3 summarizes four approaches to analyze uncertainty quantitatively. These are described further in the 1992 Exposure Guidelines (U.S. EPA, 1992).

To the extent possible, this handbook provides information that can be used to characterize the variability and uncertainty of data for the various exposure factors. In general, variability is addressed by providing probability distributions, where available, or qualitative discussions of the data sets used. Uncertainty is addressed by applying confidence rating to the recommendations provided for the various factors, along with detailed discussions of any limitations of the data presented.

2.8 REFERENCES FOR CHAPTER 2

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Table 2-1. Four Strategies for Coping With Variability		
Strategy	Example	Comment
Ignore variability	Assume that all adults weigh 70 kg	Works best when variability is small
Disaggregate the variability	Develop probability distributions of body weight for age/gender groups	Variability will be smaller in each group; it depends on availability of data
Use the average value	Use average body weight for adults	Can the average be estimated reliably given what is known about the variability of a specific population or group with potential exposures?
Use a maximum or minimum value	Use a lower-end value from the weight distribution	Conservative approach -- can lead to unrealistically high exposure estimate if taken for all factors. It may be useful as a screening method for eliminating pathways of exposure that are not significant.
Source: NRC, 1994.		

Table 2-2. Three Types of Uncertainty With Associated Sources and Examples		
Type of Uncertainty	Sources	Examples
Scenario Uncertainty	Descriptive errors	Incorrect or insufficient information
	Aggregation errors	Spatial or temporal approximations
	Judgment errors	Selection of an incorrect model
	Incomplete analysis	Overlooking an important pathway
Parameter Uncertainty	Measurement errors	Imprecise or biased measurements
	Sampling errors	Small or unrepresentative samples
	Variability	In time, space or activities
	Surrogate data	Structurally-related chemicals
Model Uncertainty	Relationship errors	Incorrect inference on the basis for correlations
	Modeling errors	Excluding relevant variables
Source: U.S. EPA, 1992.		

Table 2-3. Approaches to Quantitative Analysis of Uncertainty

Approach	Description	Example
Sensitivity Analysis	Changing one input variable at a time while leaving others constant, to examine effect on output	Fix each input at lower (then upper) bound while holding others at nominal values (e.g., medians)
Analytical Uncertainty Propagation	Examining how uncertainty in individual parameters affects the overall uncertainty of the exposure assessment	Analytically or numerically obtain a partial derivative of the exposure equation with respect to each input parameter
Probabilistic Uncertainty Analysis	Varying each of the input variables over various values of their respective probability distributions	Assign probability density function to each parameter; randomly sample values from each distribution and insert them in the exposure equation (Monte Carlo)
Classical Statistical Methods	Estimating the population exposure distribution directly, based on measured values from a representative sample	Compute confidence interval estimates for various percentiles of the exposure distribution

Source: U.S. EPA, 1992.

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3 INGESTION OF WATER AND OTHER SELECT LIQUIDS

3.1 INTRODUCTION

Water ingestion is another pathway of exposure to environmental chemicals. Contamination of water may occur at the water supply source (ground water or surface water); during treatment (for example toxic by-products may be formed during chlorination); or post-treatment (such as leaching of lead or other materials from plumbing systems). People may be exposed to contaminants in water when consuming water directly as a beverage, indirectly from foods and drinks made with water, or incidentally while swimming. Estimating the magnitude of the potential dose of toxics from water ingestion requires information on the quantity of water consumed. The purpose of this section is to describe key and relevant published studies that provide information on water ingestion for various populations and to provide recommended ingestion rate values for use in exposure assessments. The studies described in this section provide information on ingestion of water consumed as a beverage, ingestion of other select liquids, and ingestion of water while swimming.

Historically, the U.S. EPA has assumed a drinking water ingestion rate of 2 L per day for adults and 1 L per day for infants and children under 10 years of age (U.S. EPA, 2000). This rate includes water consumed in the form of juices and other beverages containing tapwater. The National Academy of Sciences (NAS, 1977) estimated that daily consumption of water may vary with levels of physical activity and fluctuations in temperature and humidity. It is reasonable to assume that people engaging in physically-demanding activities or living in warmer regions may have higher levels of water ingestion. However, there is limited information on the effects of activity level and climatic conditions on water ingestion.

The U.S. EPA selected Kahn and Stralka (2008a) as a key study of drinking water ingestion for the general population based on the applicability of the survey design to exposure assessments of the entire U.S. population. Kahn and Stralka (2008b) was selected as a key study of drinking water ingestion for pregnant and lactating women. In these studies, ingestion rates for direct and indirect ingestion of water are reported. *Direct ingestion* is defined as direct consumption of water as a beverage, while *indirect ingestion* includes water added during food preparation, but not water intrinsic to purchased foods (i.e. water that is naturally contained in foods) (Kahn and Stralka, 2008a). Data for consumption of water from various sources (i.e., the community water supply, bottled water, and other sources) are also presented. For the purposes of exposure assessments involving site-specific contaminated drinking water, ingestion rates based on the community supply are most appropriate. Given the assumption that bottled water, and purchased foods and beverages that contain water are widely distributed and less likely to contain source-specific water, the use of total water ingestion rates may overestimate the potential exposure to toxic substances present only in local water supplies; therefore, tapwater ingestion of community water, rather than total water ingestion, is emphasized in this section.

The studies on water ingestion that are currently available for the general population and the population of pregnant/lactating women are based on short-term survey data (two days). Although short-term data may be suitable for obtaining mean or median ingestion values that are representative of both short- and long-term ingestion distributions, upper and lower -percentile values may be different for short-term and long-term data. It should also be noted that most currently available water ingestion surveys are based on respondent recall. This may be a source of uncertainty in the estimated ingestion rates because of the subjective nature of this type of survey technique. Percentile distributions for water ingestion are presented in this handbook, where sufficient data are available. Data are not provided for the location of water consumption (i.e., home, school, day care center, etc.).

Limited information was available regarding incidental ingestion of water while swimming. A recent pilot study (Dufour et al., 2006) has provided some quantitative experimental data on water ingestion among swimmers. These data are provided in this chapter. The recommendations and confidence ratings for general water ingestion ingestion among pregnant and lactating women, and ingestion while swimming are found in Section 3.2. The recommended values are based on studies identified by U.S. EPA as key: Kahn and Stralka (2008a, 2008b), and supplemental data in Kahn (2008), and Dufour (2006). The key studies for general water ingestion rates are provided in Section 3.3.1, ingestion rates for pregnant and lactating women are provided in Section 3.4.1, and ingestion rates for swimming in Section 3.6.1. For water ingestion at high activity levels or hot climates, no recommendations are provided, but relevant studies are included in Section 3.5. Relevant studies on all subcategories of water ingestion are also presented to provide the reader with added perspective on the current state-of-knowledge pertaining to ingestion of water and select liquids.

3.2 RECOMMENDATIONS

3.2.1 Water Ingestion from Consumption of Water as a Beverage and from Food and Drink

The recommended water ingestion from the consumption of water as a beverage and from food and drink are based on Kahn and Stralka (2008a) and supplementary data prepared by Kahn (2008) for EPA. This study presents estimates of water ingestion by age range categories for the population of the United States using data collected in the U.S. Department of Agriculture's (USDA's) 1994-96 and 1998 Continuing Survey of Food Intakes by Individuals (CSFII) (USDA, 1998). A summary of the recommended values for water ingestion from the consumption of water as a beverage and from food and drink is presented in Table 3-1. Per capita mean and 95th percentile values range from 184 mL/day to 1,127 mL/day and 837 mL/day to 2,811 mL/day, respectively, depending on the age group. A characterization of the overall confidence in the accuracy and appropriateness of the recommendations for drinking water intake is presented in Table 3-2.

3.2.2 Pregnant and Lactating Women

Based upon the results of Kahn and Stralka (2008b), per capita mean and 95th percentile values for ingestion of drinking water among pregnant women were 819 mL/day and 2,503 mL/day, respectively. The per capita mean and 95th percentile values for lactating women were 1,379 mL/day and 3,434 mL/day, respectively. A summary of the recommended values for water ingestion rates is presented in Table 3-3. The confidence ratings for these recommendations are presented in Table 3-4.

3.2.3 Water Ingestion While Swimming

Based on the results of the Dufour et al. (2006) study, a mean water ingestion rate of 49 mL/hour for children under 18 years of age and 21 mL/hour for adults is recommended for exposure scenarios involving swimming activities. Although these estimates were derived from swimming pool experiments, Dufour et al. (2006) noted that swimming behavior of pool swimmers may be similar to freshwater swimmers. Estimates may be different for salt water swimmers. Because the data set is limited, the upper percentile water ingestion rate for swimming activities is based on the maximum value observed in the Dufour et al. (2006) study: 205 mL/hour for children (154 mL/0.75 hour) and 71 mL/hour for adults (53 mL/0.75 hour). A summary of the recommended values for water ingestion rates is presented in Table 3-5. The confidence ratings for these recommendations are presented in Table 3-6. Data on the amount of time spent swimming can be found in Chapter 16 of this handbook.

Table 3-1. Recommended Values for Drinking Water Ingestion Rates[a]

Age Group	Mean		95th Percentile		Multiple Percentiles
	mL/day	mL/kg-day	mL/day	mL/kg-day	
Per Capita					
Birth to <1 month	184	52	839[b]	232[b]	
1 to <3 months	227	48	896[b]	205[b]	
3 to <6 months	362	52	1,056	159	
6 to <12 months	360	41	1,055	126	
1 to <2 years	271	23	837	71	
2 to <3 years	317	23	877	60	
3 to <6 years	380	22	1,078	61	See Tables 3-7 and 3-12
6 to <11 years	447	16	1,235	43	
11 to <16 years	606	12	1,727	34	
16 to <18 years	731	11	1,983[b]	31[b]	
18 to <21 years	826	12	2,540[b]	35[b]	
≥ 21 years	1,104	15	2,811	39	
> 65 years[c]	1,127	16	2,551	37	
All ages	926	16	2,544	43	
Consumers Only					
Birth to <1 month	470[b]	137[b]	858[b]	238[b]	
1 to <3 months	552	119	1,053[b]	285[b]	
3 to <6 months	556	80	1,171[b]	173[b]	
6 to <12 months	467	53	1,147	129	
1 to <2 years	308	27	893	75	
2 to <3 years	356	26	912	62	
3 to <6 years	417	24	1,099	65	See Tables 3-17 and 3-22
6 to <11 years	480	17	1,251	45	
11 to <16 years	652	13	1,744	34	
16 to <18 years	792	12	2,002[b]	32[b]	
18 to <21 years	895	13	2,565[b]	35[b]	
≥ 21 years	1,183	16	2,848	39	
> 65 years[c]	1,242	18	2,604	37	
All ages	1,000	17	2,601	44	

[a] Ingestion rates for combined direct and indirect water from community water supply.

[b] The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

[c] U.S. EPA, 2004.

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-2. Confidence in Recommendations for Drinking Water Ingestion Rates

General Assessment Factors	Rationale	Rating
Soundness		Medium to High
Adequacy of Approach	The survey methodology and data analysis was adequate. The survey sampled approximately 20,000 individuals; sample size varied with age.	
Minimal (or defined) Bias	No physical measurements were taken. The method relied on recent recall of standardized volumes of drinking water containers.	
Applicability and Utility		Medium
Exposure Factor of Interest	The key study was directly relevant to water ingestion.	
Representativeness	The data were demographically representative (based on stratified random sample).	
Currency	Data were collected between 1994 and 1998.	
Data Collection Period	Data were collected for two non-consecutive days. However, long term variability may be small. Use of a short-term average as a chronic ingestion measure can be assumed.	
Clarity and Completeness		High
Accessibility	The CSFII data are publicly available. The Kahn and Stralka (2008a) analysis of the CSFII 1994-96, 1998 data was published in a peer-reviewed journal.	
Reproducibility	The methodology was clearly presented; enough information was included to reproduce the results.	
Quality Assurance	Quality assurance of the CSFII data was good; quality control of the secondary data analysis was not well described.	
Variability and Uncertainty		High
Variability in Population	Full distributions were given in a separate document (Kahn, 2008).	
Uncertainty	Except for data collection based on recall, sources of uncertainty were minimal.	
Evaluation and Review		Medium
Peer Review	The USDA CSFII survey received high level of peer review. The Kahn and Stralka (2008a) study was published in a peer-reviewed journal.	
Number and Agreement of Studies	There was 1 key study for drinking water ingestion.	
Overall Rating		**Medium to High**

Table 3-3. Recommended Values for Water Ingestion Rates of Community Water for Pregnant and Lactating Women[a]

Group	Mean		95th Percentile	
Per Capita				
	mL/day	mL/kg-day	mL/day	mL/kg-day
Pregnant women	819 [b]	13 [b]	2,503 [b]	43 [b]
Lactating women	1,379 [b]	21 [b]	3,434 [b]	55 [b]
Consumers Only				
	mL/day	mL/kg-day	mL/day	mL/kg-day
Pregnant women	872[b]	14 [b]	2,589 [b]	43 [b]
Lactating women	1,665 [b]	26 [b]	3,588 [b]	55 [b]

[a] Ingestion rates for combined direct and indirect water from community water supply.

[b] The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn and Stralka, 2008b.

Table 3-4. Confidence in Recommendations for Water Ingestion for Pregnant/Lactating Women		
General Assessment Factors	Rationale	Rating
Soundness		Low
Adequacy of Approach	The survey methodology and data analysis was adequate. The sample size was small, approximately 99 pregnant and lactating women.	
Minimal (or defined) Bias	No physical measurements were taken. The method relied on recent recall of standardized volumes of drinking water containers.	
Applicability and Utility		Low to Medium
Exposure Factor of Interest	The key study was directly relevant to water ingestion.	
Representativeness	The data were demographically representative (based on stratified random sample).	
Currency	Data were collected between 1994 and 1998.	
Data Collection Period	Data were collected for two non-consecutive days. However, long term variability may be small. Use of a short-term average as a chronic ingestion measure can be assumed.	
Clarity and Completeness		Medium
Accessibility	The CSFII data are publicly available. The Kahn and Stralka (2008b) analysis of the CSFII 1994-96, 1998 data was published in a peer-reviewed journal.	
Reproducibility	The methodology was clearly presented; enough information was included to reproduce the results.	
Quality Assurance	Quality assurance of the CSFII data was good; quality control of the secondary data analysis was not well described.	
Variability and Uncertainty		Low
Variability in Population	Full distributions were given in a separate document (Kahn, 2008).	
Uncertainty	Except for data collection based on recall, sources of uncertainty were minimal.	
Evaluation and Review		Medium
Peer Review	The USDA CSFII survey received high level of peer review. The Kahn and Stralka (2008b) study was published in a peer-reviewed journal.	
Number and Agreement of Studies	There was 1 key study for pregnant/lactating women water ingestion.	
Overall Rating		**Low**

Table 3-5. Recommended Values for Water Ingestion While Swimming				
Age Group	Mean		95th Percentile	
	mL/event[a]	mL/hour	mL/event[a]	mL/hour
Children	37	49	154	205
Adults	16	21	53	71
All	NR	NR	NR	90

[a] Participants swam for 45 minutes.
NR Not reported.

Source: Dufour et al., 2006.

Table 3-6. Confidence in Recommendations for Water Ingestion While Swimming		
General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	The approach appears to be appropriate given that cyanuric acid (a tracer used in treated pool water) is not metabolized, but the sample size was small (41 children and 12 adults). The Dufour et al. (2006) study analyzed primary data on water ingestion during swimming.	
Minimal (or defined) Bias	Data were collected over a period of 45 minutes; this may not accurately reflect the time spent by a recreational swimmer.	
Applicability and Utility		Low to Medium
Exposure Factor of Interest	The key study was directly relevant to water ingestion while swimming.	
Representativeness	The sample was not representative of the U.S. population. Data cannot be broken out by age categories	
Currency	It appears that the study was conducted in 2005.	
Data Collection Period	Data were collected over a period of 45 minutes.	
Clarity and Completeness		Medium
Accessibility	The Dufour et al. (2006) study was published in a peer-reviewed journal.	
Reproducibility	The methodology was clearly presented; enough information was included to reproduce the results.	
Quality Assurance	Quality assurance methods were not described in the study.	
Variability and Uncertainty		Low
Variability in Population	Full distributions were not available.. Data were not broken out by age groups	
Uncertainty	There were multiple sources of uncertainty (e.g., sample population may not reflect swimming practices for all swimmers, rates based on swimming duration of 45 minutes, differences by age group not defined).	
Evaluation and Review		Medium
Peer Review	Dufour et al. (2006) was published in a peer-reviewed journal.	
Number and Agreement of Studies	There was 1 key study for ingestion of water when swimming.	
Overall Rating		**Low**

3.3 DRINKING WATER INGESTION STUDIES

3.3.1 Key Drinking Water Ingestion Study

3.3.1.1 *Kahn and Stralka, 2008a - Estimated Daily Average Per Capita Water Ingestion by Child and Adult Age Categories Based on USDA's 1994-96 and 1998 Continuing Survey of Food Intakes by Individuals and Supplemental Data, Kahn 2008*

Kahn and Stralka (2008a) analyzed the combined 1994-96 and 1998 Continuing Survey of Food Intakes by Individuals (CSFII) data sets to examine water ingestion rates of more than 20,000 individuals surveyed, including approximately 10,000 under age 21 and 9,000 under age 11. USDA surveyed households in the United States and District of Columbia and collected food and beverage recall data as part of the CSFII (USDA, 1998). Data were collected by an in-home interviewer. The day two interview was conducted 3 to 10 days later and on a different day of the week. Each individual in the survey was assigned a sample weight based on his or her demographic data. These weights were taken into account when calculating mean and percentile water ingestion rates from various sources.

Kahn and Stralka (2008a) derived mean and percentile estimates of daily average water ingestion for the following age categories: <1 month, 1 to <3 months, 3 to <6 months, 6 to <12 months, 1 to <2 years of age, 2 to <3 years, 3 to <6 years, 6 to <11 years, 11 to <16 years, 16 to <18 years, and 18 to <21 years of age, 21 years and older, 65 years and older, and all ages. The increased sample size for children younger than 11 years of age (from 4,339 in the initial 1994-96 survey to 9,643 children in the combined 1994-96, 1998 survey) enabled water ingestion estimates to be categorized into the finer age categories recommended by U.S. EPA (2005). Per capita and consumers only water ingestion estimates were reported in the Kahn and Stralka (2008a) study for two water source categories: all sources and community water. "All sources" included water from all supply sources such as community water supply (i.e., tap water), bottled water, other sources, and missing sources. "Community water" included tap water from a community or municipal water supply. Other sources included wells, springs, and cisterns; missing sources represented water sources that the survey respondent was unable to identify. The water ingestion estimates included both water ingested directly as a beverage (direct water) and water added to foods and beverages during final preparation at home or by local food service establishments such as school cafeterias and restaurants (indirect water). Commercial water added by a manufacturer (i.e., water contained in soda or beer) and intrinsic water in foods and liquids (i.e., milk and natural undiluted juice) were not included in the estimates. Kahn and Stralka (2008a) only reported the mean, 90th and 95th percentile estimates of per capita and consumers only ingestion. The full distribution of ingestion estimates for various water source categories (all sources, community water, bottled water, and other sources) were provided by the author (Kahn, 2008). Tables 3-7 to 3-10 provide mean and percentile per capita ingestion estimates of total water (combined direct and indirect water) in mL/day for the various water source categories (i.e., community, bottled, other, and all sources). The 90 percent confidence intervals around the estimated means and the 90 percent bootstrap intervals around the 90th and 95th percentiles of total water ingestion from all water sources are presented in Table 3-11. Tables 3-12 to 3-16 present the same information as Tables 3-7 to 3-11 but in units of mL/kg-day. Consumers only combined direct and indirect water ingestion estimates in mL/day for the various source categories are provided in Tables 3-17 to 3-20. Table 3-21 presents confidence and bootstrap intervals for total water ingestion estimates by consumers only from all sources. Tables 3-22 to 3-26 present the same information as Tables 3-17 to 3-21 but in units of mL/kg-day. The data show that the total quantity of water ingested per unit mass of body weight is at a maximum in the first month of life and decreases with increasing age. The per capita ingestion rate of water from all sources combined for children under 1 month of age is approximately four times higher than that adults, and consumers younger than 1 month of age ingest approximately 8 times the amount of water (all sources combined) as adults (Kahn and Stralka, 2008a). The pattern of decreasing water ingestion per unit of body weight is also observed in per capita and consumers only estimates of community water (Tables 3-12 and 3-22), bottled water (Table 3-13 and 3-23), other sources (Tables 3-14 and 3-24) and all sources (Tables 3-15 and 3-25). For adults (age $\geq$21 years), the mean and 95th percentile per capita ingestion rates are 1.1 and 2.8 L/day, respectively.

The CSFII 1994-96, 1998 data have both strengths and limitations with regard to estimating water ingestion. These are discussed in detail in U.S. EPA (2004) and Kahn and Stralka (2008a). The principal advantages of this survey are (1) that the survey was designed to obtain a statistically valid sample of the entire United States population that included children and low income groups; (2) sample weights were provided that facilitated proper analysis of the data and accounted for non-response; and (3) the number of individuals sampled (more than

20,000) is sufficient to allow categorization within narrowly defined age categories. Over sampling of children enhanced the precision and accuracy of the estimates for the child population subsets. One limitation of this survey is that data were collected for only 2 days and does not necessarily represent “usual intake.” “Usual dietary intake” refers to the long-term average of daily intakes by an individual. Thus, upper percentile water ingestion estimates based on short-term data may differ from long-term rates because short-term consumption data tend to be inherently more variable. However, Kahn and Stralka (2008a) noted that variability due to short term duration of the survey does not result in bias of estimates of overall mean. In addition, the survey was conducted on non-consecutive days, which improves the variance over consecutive days of consumption. However, the two non-consecutive days of data collection, although an advantage over two consecutive days, provide limited information on individual respondents. The two-day mean for an individual can easily be skewed for numerous reasons. Estimation at the individual respondent level was not, however, an objective of the survey. The large sample provides useful information on the overall distribution of ingestion by the population, and should adequately reflect the range among respondent variability. Another limitation of these data is that the survey design, while being well-tailored for the overall population of the United States and conducted throughout the year to account for seasonal variation, is of limited utility for assessing small and potentially at-risk subpopulations based on ethnicity, medical status, geography/climate, or other factors such as activity level.

3.3.2 Relevant Drinking Water Ingestion Studies

3.3.2.1 *Wolf, , 1958 - Body water content*

Wolf (1958) provided information on the water content of human bodies. Wolf (1958) stated that a newborn baby is about 77% water while an adult male is about 60% water by weight. An adult male gains and loses about 2,750 mL of water each day. Water intake in dissimilar mammals varies according to 0.88 power of body weight.

3.3.2.2 *National Academy of Sciences, 1977 – Drinking Water and Health*

NAS (1977) calculated the average per capita water (liquid) consumption per day to be 1.63 L. This figure was based on a survey of the following literature sources: Evans (1941); Bourne and Kidder (1953); Walker et al. (1957); Wolf (1958); Guyton (1968); McNall and Schlegel (1968); Randall (1973); NAS (1974); and Pike and Brown (1975), as cited in NAS (1977) Although the calculated average intake rate was 1.63 L per day, NAS (1977) adopted a larger rate (2 L per day) to represent the intake of the majority of water consumers. This value is relatively consistent with the total tapwater intakes rate estimated from the key study presented previously. However, the use of the term "liquid" was not clearly defined in this study, and it is not known whether the populations surveyed are representative of the adult U.S. population. Consequently, the results of this study are of limited use in recommending total tapwater intake rates and this study is not considered a key study.

3.3.2.3 *Hopkins and Ellis, 1980 – Drinking Water Consumption in Great Britain*

A study conducted in Great Britain over a 6-week period during September and October 1978, estimated the drinking water consumption rates of 3,564 individuals from 1,320 households in England, Scotland, and Wales (Hopkins and Ellis, 1980). The participants were selected randomly and were asked to complete a questionnaire and a diary indicating the type and quantity of beverages consumed over a 1-week period. Total liquid intake included total tapwater taken at home and away from home; purchased alcoholic beverages; and non-tapwater-based drinks. Total tapwater included water content of tea, coffee, and other hot water drinks; homemade alcoholic beverages; and tapwater consumed directly as a beverage. The assumed tapwater contents for these beverages are presented in Table 3-27. Based on responses from 3,564 participants, the mean intake rates and frequency distribution data for various beverage categories were estimated by Hopkins and Ellis (1980). These data are listed in Table 3-28. The mean per capita total liquid intake rate for all individuals surveyed was 1.59 L/day, and the mean per capita total tapwater intake rate was 0.96 L/day, with a 90th percentile value of about 1.57 L/day. Liquid intake rates were also estimated for males and females in various age groups. Table 3-29 summarizes the total liquid and total tapwater intake rates for 1,758 males and 1,800 females grouped into six age categories (Hopkins and Ellis, 1980). The mean and 90th percentile total tapwater intake values for adults over age 18 years are, respectively, 1.07 L/day and 1.87 L/day, as determined by pooling data for males and females for the three adult age ranges in Table 3-29. This calculation assumes, as does Table 3-28 and 3-29, that the underlying distribution is normal and not lognormal.

The advantage of these data is that the responses were not generated on a recall basis, but by recording daily intake in diaries. The latter approach may result in more accurate responses being generated. Diaries were maintained for one week, which is longer than other surveys (e.g., CSFII). The use of total liquid and total tapwater was well defined in this study. Also, these data were based on the population of Great Britain and not the United States. Drinking patterns may differ among these populations as a result of varying weather conditions and socio-economic factors. For these reasons this study is not considered a key study in this document.

3.3.2.4 *Canada Department of Health and Welfare, 1981 – Tapwater Consumption in Canada*

In a study conducted by the Canadian Department of Health and Welfare, 970 individuals from 295 households were surveyed to determine the per capita total tapwater intake rates for various age/sex groups during winter and summer seasons (Canadian Ministry of National Health and Welfare, 1981). Intake rate was also evaluated as a function of physical activity. The population that was surveyed matched the Canadian 1976 census with respect to the proportion in different age, regional, community size and dwelling type groups. Participants monitored water intake for a 2-day period (1 weekday, and 1 weekend day) in both late summer of 1977 and winter of 1978. All 970 individuals participated in both the summer and winter surveys. The amount of tapwater consumed was estimated based on the respondents' identification of the type and size of beverage container used, compared to standard sized vessels. The survey questionnaires included a pictorial guide to help participants in classifying the sizes of the vessels. For example, a small glass of water was assumed to be equivalent to 4.0 ounces of water, and a large glass was assumed to contain 9.0 ounces of water. The study also accounted for water derived from ice cubes and popsicles, and water in soups, infant formula, and juices. The survey did not attempt to differentiate between tapwater consumed at home and tapwater consumed away from home. The survey also did not attempt to estimate intake rates for fluids other than tapwater. Consequently, no intake rates for total fluids were reported.

Daily consumption distribution patterns for various age groups are presented in Table 3-30. For adults (over 18 years of age) only, the average total tapwater intake rate was 1.38 L/day, and the 90th percentile rate was 2.41 L/day as determined by graphical interpolation. These data follow a lognormal distribution. The intake data for males, females, and both sexes combined as a function of age and expressed in the units of milliliters per kilogram body weight are presented in Table 3-31. The tapwater survey did not include body weights of the participants, but the body weight information was taken from a Canadian health survey dated 1981; it averaged 65.1 kg for males and 55.6 kg for females. Intake rates for specific age groups and seasons are presented in Table 3-32. The average daily total tapwater intake rates for all ages and seasons combined was 1.34 L/day, and the 90th percentile rate was 2.36 L/day. The summer intake rates are nearly the same as the winter intake rates. The authors speculate that the reason for the small seasonal variation is that in Canada, even in the summer, the ambient temperature seldom exceeded 20 degrees C and marked increase in water consumption with high activity levels has been observed in other studies only when the ambient temperature has been higher than 20 degrees. Average daily total tapwater intake rates as a function of the level of physical activity, as estimated subjectively, are presented in Table 3-33. The amounts of tapwater consumed that are derived from various foods and beverages are presented in Table 3-34. Note that the consumption of direct "raw" tapwater is almost constant across all age groups from school-age children through the oldest ages. The increase in total tapwater consumption beyond school age is due to coffee and tea consumption.

This survey may be more representative of total tapwater consumption than some other less comprehensive surveys because it included data for some tapwater-containing items not covered by other studies (i.e., ice cubes, popsicles, and infant formula). One potential source of error in the study is that estimated intake rates were based on identification of standard vessel sizes; the accuracy of this type of survey data is not known. The cooler climate of Canada may have reduced the importance of large tapwater intakes resulting from high activity levels, therefore making the study less applicable to the United States. The authors were not able to explain the surprisingly large variations between regional tapwater intakes; the largest regional difference was between Ontario (1.18 liters/day) and Quebec (1.55 liters/day).

3.3.2.5 *Gillies and Paulin, 1983 – Variability of Mineral Intakes from Drinking Water*

Gillies and Paulin (1983) conducted a study to evaluate variability of mineral intake from drinking water. A study population of 109 adults (75 females; 34 males) ranging in age from 16 to 80 years (mean age = 44 years) in New Zealand was asked to collect duplicate samples of water consumed directly from the tap or used in beverage preparation during a 24-hour period. Participants were asked to collect the samples on a day when all of the water consumed would be from their own home. Individuals were selected based on their willingness to participate and their ability to comprehend the collection procedures. The mean total tapwater intake rate for this population was 1.25 (±0.39) L/day, and the 90th percentile rate was 1.90 L/day. The median total tapwater intake rate (1.26 L/day) was very similar to the mean intake rate. The reported range was 0.26 to 2.80 L/day.

The advantage of these data is that they were generated using duplicate sampling techniques. Because this approach is more objective than recall methods, it may result in more accurate responses. However, these data are based on a short-term survey that may not be representative of long-term behavior, the population surveyed is small and the procedures for selecting the survey population were not designed to be representative of the New Zealand population, and the results may not be applicable to the United States. For these reasons the study is not regarded as a key study in this document.

3.3.2.6 *Pennington, 1983 – Revision of the Total Diet Study Food List and Diets*

Based on data from the U.S. Food and Drug Administration's (FDA's) Total Diet Study, Pennington (1983) reported average intake rates for various foods and beverages for five age groups of the population. The Total Diet Study is conducted annually to monitor the nutrient and contaminant content of the U.S. food supply and to evaluate trends in consumption. Representative diets were developed based on 24-hour recall and 2-day diary data from the 1977-1978 U.S. Department of Agriculture (USDA) Nationwide Food Consumption Survey (NFCS) and 24-hour recall data from the Second National Health and Nutrition Examination Survey (NHANES II). The number of participants in NFCS and NHANES II was approximately 30,000 and 20,000, respectively. The diets were developed to "approximate 90 percent or more of the weight of the foods usually consumed" (Pennington, 1983). The source of water (bottled water as distinguished from tapwater) was not stated in the Pennington study. For the purposes of this report, the consumption rates for the food categories defined by Pennington (1983) were used to calculate total fluid and total water intake rates for five age groups. Total water includes water, tea, coffee, soft drinks, and soups and frozen juices that are reconstituted with water. Reconstituted soups were assumed to be composed of 50 percent water, and juices were assumed to contain 75 percent water. Total fluids include total water in addition to milk, ready-to-use infant formula, milk-based soups, carbonated soft drinks, alcoholic beverages, and canned fruit juices. These intake rates are presented in Table 3-35. Based on the average intake rates for total water for the two adult age groups, 1.04 and 1.26 L/day, the average adult intake rate is about 1.15 L/day. These rates should be more representative of the amount of source-specific water consumed than are total fluid intake rates. Because this study was designed to measure food intake, and it used both USDA 1978 data and NHANES II data, there was not necessarily a systematic attempt to define tapwater intake per se, as distinguished from bottled water. For this reason, it is not considered a key tapwater study in this document.

3.3.2.7 *U.S. EPA, 1984 – An Estimation of the Daily Average Food Intake by Age and Sex for Use in Assessing the Radionuclide Intake of the General Population*

Using data collected by USDA in the 1977-78 NFCS, U.S. EPA (1984) determined daily food and beverage intake levels by age to be used in assessing radionuclide intake through food consumption. Tapwater, water-based drinks, and soups were identified subcategories of the total beverage category. Daily intake rates for tapwater, water-based drinks, soup, and total beverage are presented in Table 3-36. As seen in Table 3-36, mean tapwater intake for different adult age groups (age 20 years and older) ranged from 0.62 to 0.76 L/day, water-based drinks intake ranged from 0.34 to 0.69 L/day, soup intake ranged from 0.04 to 0.06 L/day, and mean total beverage intake levels ranged from 1.48 to 1.73 L/day. Total tapwater intake rates were estimated by combining the average daily intakes of tapwater, water-based drinks, and soups for each age group. For adults (ages 20 years and older), mean total tapwater intake rates range from 1.04 to 1.47 L/day, and for children (ages <1 to 19 years), mean intake rates range from 0.19 to 0.90 L/day. The total tapwater intake rates, derived by combining data on tapwater, water-based drinks, and soup should be more representative of source-specific drinking water intake than the total beverage intake rates reported in this study. The chief limitation of the study is that the data were collected in 1978 and do not reflect the expected increase in the U.S. consumption of soft drinks and bottled water or changes in the diet within the last two decades. Since the data were collected for only a three-day period, the extrapolation to chronic intake is uncertain. Also, these intake rates do not include reconstituted infant formula.

3.3.2.8 *Cantor et al., 1987 – Bladder Cancer, Drinking Water Source, and Tapwater Consumption*

The National Cancer Institute (NCI), in a population-based, case control study investigating the possible relationship between bladder cancer and drinking water, interviewed approximately 8,000 adult white individuals, 21 to 84 years of age (2,805 cases and 5,258 controls) in their homes, using a standardized questionnaire (Cantor et al., 1987). The cases and controls resided in one of five metropolitan areas (Atlanta, Detroit, New Orleans, San Francisco, and Seattle) and five States (Connecticut, Iowa, New Jersey, New Mexico, and Utah). The individuals interviewed were asked to recall the level of intake of tapwater and other beverages in a typical week during the winter prior to the interview. Total beverage intake was divided into the following two components: 1) beverages derived from tapwater; and 2) beverages from other sources. Tapwater used in cooking foods and in ice cubes was apparently not considered. Participants also supplied information on the primary source of the water consumed (i.e., private well, community supply, bottled water, etc.). The control population was randomly selected from the general population and frequency matched to the bladder cancer case population in terms of age, sex, and geographic location of residence. The case population consisted of Whites only, had no people under the age of 21 years and 57 percent were over the age of 65 years. The fluid intake rates for the bladder cancer cases were not used because their participation in the study was based on selection factors that could bias the intake estimates for the general population. Based on responses from 5,258 White controls (3,892 males; 1,366 females), average tapwater intake rates for a "typical" week were compiled by sex, age group, and geographic region. These rates are listed in Table 3-37. The average total fluid intake rate was 2.01 L/day for men of which 70 percent (1.4 L/day) was derived from tapwater, and 1.72 L/day for women of which 79 percent (1.35 L/day) was derived from tapwater. Frequency distribution data for the 5,081 controls, for which the authors had information on both tapwater consumption and cigarette smoking habits, are presented in Table 3-37. These data follow a lognormal distribution having an average value of 1.30 L/day and an upper 90th percentile value of approximately 2.40 L/day. These values were determined by graphically interpolating the data of Table 3-38 after plotting it on log probability graph paper. These values represent the usual level of intake for this population of adults in the winter.

Limitations associated with this data set are that the population surveyed was older than the general population and consisted exclusively of Whites. Also, the intake data are based on recall of behavior during the winter only. Extrapolation of the data to other seasons is difficult.

The authors presented data on person-years of residence with various types of water supply sources (municipal versus private, chlorinated versus nonchlorinated, and surface versus well water). Unfortunately, these data cannot be used to draw conclusions about the national average apportionment of surface versus groundwater since a large fraction (24 percent) of municipal water intake in this survey could not be specifically attributed to either ground or surface water.

3.3.2.9 *Ershow and Cantor, 1989 – Total Water and Tapwater Intake in the United States: Population-Based Estimates of Quantities and Sources*

Ershow and Cantor (1989) estimated water intake rates based on data collected by the USDA 1977-1978 Nationwide Food Consumption Survey (NFCS). The survey was conducted through interview and diary. Daily intake rates for tapwater and total water were calculated for various age groups for males, females, and both sexes combined. Tapwater was defined as "all water from the household tap consumed directly as a beverage or used to prepare foods and beverages." Total water was defined as tapwater plus "water intrinsic to foods and beverages" (i.e., water contained in purchased food and beverages). The authors showed that the age, sex, and racial distribution of the surveyed population closely matched the estimated 1977 U. S. population.

Daily total tapwater intake rates, expressed as mL per day by age group are presented in Table 3-39. These data follow a lognormal distribution. The same data, expressed as mL per kg body weight per day are presented in Table 3-40. A summary of these tables, showing the mean, the 10th and 90th percentile intakes, expressed as both mL/day and mL/kg-day as a function of age, is presented in Table 3-41. This shows that the mean and 90th percentile intake rates for adults (ages 20 to 65+) are approximately 1,410 mL/day and 2,280 mL/day and for all ages the mean and 90th percentile intake rates are 1,193 mL/day and 2,092 mL/day. Note that older adults have greater intakes than do adults between age 20 and 65, an observation bearing on the interpretation of the Cantor et al. (1987) study which surveyed a population that was older than the national average (see Section 3.3.2.8).

Ershow and Cantor (1989) also measured total water intake for the same age groups and concluded that it averaged 2,070 mL/day for all groups combined and that tapwater intake (1,190 mL/day) is 55 percent of the total water intake. (The detailed intake data for various age groups are presented in Table 3-42). Ershow and Cantor (1989) also concluded that, for all age groups combined, the proportion of tapwater consumed as drinking water, or used to prepare foods and beverages is 54 percent, 10 percent and 36 percent, respectively. (The detailed data on proportion of tapwater consumed for various age groups are presented in Table 3-43). Ershow and Cantor (1989) also observed that males of all age groups had higher total water and tapwater consumption rates than females; the variation of each from the combined-sexes mean was about 8 percent.

With respect to region of the country, the northeast states had slightly lower average tapwater intake (1,200 mL/day) than the three other regions (which were approximately equal at 1,400 mL/day).

This survey has an adequately large size (26,446 individuals) and it is a representative sample of the United States population with respect to age distribution and residential location. The data are more than 20 years old and may not be entirely representative of current patterns of water intake, but in general, the rates are similar to those presented in the key drinking water study in this chapter.

3.3.2.10 *Roseberry and Burmaster, 1992 – Lognormal Distributions for Water Intake*

Roseberry and Burmaster (1992) fit lognormal distributions to the water intake data population-wide distributions for total fluid and total tapwater intake based on proportions of the population in each age group. Their publication shows the data and the fitted log-normal distributions graphically. The mean was estimated as the zero intercept, and the standard deviation was estimated as the slope of the best fit line for the natural logarithm of the intake rates plotted against their corresponding z-scores (Roseberry and Burmaster, 1992). Least squares techniques were used to estimate the best fit straight lines for the transformed data. Summary statistics for the best-fit lognormal distribution are presented in Table 3-44. In this table, the simulated balanced population represents an adjustment to account for the different age distribution of the United States population in 1988 from the age distribution in 1978 when Ershow and Cantor (1989) collected their data. Table 3-45 summarizes the quantiles and means of tapwater intake as estimated from the best-fit distributions. The mean total tapwater intake rates for the two adult populations (age 20 to 65 years, and 65+ years) were estimated to be 1.27 and 1.34 L/day.

These intake rates were based on the data originally presented by Ershow and Cantor (1989). Consequently, the same advantages and disadvantages associated with the Ershow and Cantor (1989) study apply to this data set.

3.3.2.11 *Levy et al., 1995 - Infant Fluoride Intake From Drinking Water Added to Formula, Beverages, and Food*

Levy et al. (1995) conducted a study to determine fluoride intake by infants through drinking water and other beverages prepared with water and baby foods. The study was longitudinal and covered the ages from birth to 9 months old. A total of 192 mothers, recruited from the *post partum* wards of two hospitals in Iowa City, completed mail questionnaires and three-day beverage and food diaries for their infants at ages 6 weeks, and 3, 6, and 9 months of age (Levy et al., 1995). The questionnaire addressed feeding habits, water sources and ingestion, and the use of dietary fluoride supplements during the preceding week (Levy et al., 1995). Data on the quantity of water consumed by itself or as an additive to infant formula, other beverages, or foods were obtained. In addition, the questionnaire addressed the infants' ingestion of cow's milk, breast-milk, ready-to-feed infant products (formula, juices, beverages, baby food), and table foods.

Mothers were contacted for any clarifications of missing data and discrepancies (Levy et al., 1995). Levy et al. (1995) assessed non-response bias and found no significant differences in the reported number of adults or children in the family, water sources, or family income at 3, 6, or 9 months. Table 3-46 provides the range of water ingestion from water by itself and from addition to selected foods and beverages. The percentage of infants ingesting water by itself increased from 28 percent at 6 weeks to 66 percent at 9 months, respectively, and the mean intake increased slightly over this time frame. During this time frame, the largest proportion of the infants' water ingestion (i.e., 36 percent at 9 months to 48 percent at 6 months) came from the addition of water to formula. Levy et al. (1995) noted that 32 percent of the infants at age 6 weeks and 23 percent of the infants at age 3 months did not receive any water from any of the sources studied. Levy et al. (1995) also noted that the proportion of children ingesting some water from all sources gradually increased with age.

The advantages of this study are that it provides information on water ingestion of infants starting at 6 weeks old and the data are for water only and for water added to beverages and foods. The limitations of the study are that the sample size was small for each age group, it captured information from a select geographical location, and data were collected through self reporting. The authors noted, however, that the three-day diary has been shown to be a valid assessment tool. Levy et al. (1995) also stated that (1) for each time period, the ages of the infants varied by a few days to a few weeks, and are, therefore, not exact and could, at early ages, have an effect on age-specific intake patterns, and (2) the same number of infants were not available at each of the four time periods.

3.3.2.12 *USDA, 1995 – Food and Nutrient Intakes by Individuals in the United States, 1 Day 1989-91*

USDA (1995) collected data on the quantity of "plain drinking water" and various other beverages consumed by individuals in 1 day during 1989 through 1991. The data were collected as part of USDA's Continuing Survey of Food Intakes by Individuals (CSFII). The data used to estimate mean per capita intake rates combined one-day dietary recall data from 3 survey years: 1989, 1990, and 1991 during which 15,128 individuals supplied one-day intake data. Individuals from all income levels in the 48 conterminous states and Washington D.C. were included in the sample. A complex three-stage sampling design was employed and the overall response rate for the study was 58 percent. To minimize the biasing effects of the low response rate and adjust for the seasonality, a series of weighting factors was incorporated into the data analysis. The intake rates based on this study are presented in Table 3-47. Table 3-47 includes data for: a) "plain drinking water", which might be assumed to mean tapwater directly consumed rather than bottled water; b) coffee and tea, which might be assumed to be constituted from tapwater; and c) fruit drinks and ades, which might be assumed to be reconstituted from tapwater rather than canned products; and d) the total of the three sources. With these assumptions, the mean per capita total intake of water is estimated to be 1,416 mL/day for adult males (i.e., 20 years of age and older), 1,288 mL/day for adult females (i.e., 20 years of age and older) and 1,150 mL/day for all ages and both sexes combined. Although these assumptions appear reasonable, a close reading of the definitions used by USDA (1995) reveals that the word "tapwater" does not occur, and this uncertainty prevents the use of this study as a key study of tapwater intake.

The advantages of using these data are that; 1) the survey had a large sample size; and 2) the authors attempted to represent the general United States population by oversampling low-income groups and by weighting the data to compensate for low response rates. The disadvantages are that: 1) the word "tapwater" was not defined and the assumptions that must be used in order to compare the data with the other tapwater studies might not be valid; 2) the data collection period reflects only a one-day intake period, and may not reflect long-term drinking water intake patterns; 3) data on the percentiles of the distribution of intakes were not given; and 4) the data are almost 20 years old are may not be entirely representative of current intake patterns.

3.3.2.13 *Tsang and Klepeis, 1996 – National Human Activity Pattern Survey (NHAPS)*

The U.S. EPA collected information on the number of glasses of drinking water and juice reconstituted with tapwater consumed by the general population as part of the National Human Activity Pattern Survey (Tsang and Klepeis, 1996). NHAPS was conducted between October 1992 and September 1994. Over 9,000 individuals in the 48 contiguous United States provided data on the duration and frequency of selected activities and the time spent in selected microenvironments via 24-hour diaries. Over 4,000 NHAPS respondents also provided information on the number of 8-ounce glasses of water and the number of 8-ounce glasses of juice reconstituted with water than they drank during the 24-hour survey period (Tables 3-48 and 3-49). The median number of glasses of tapwater consumed was 1-2 and the median number of glasses of juice with tapwater consumed was 1-2.

For both individuals who drank tapwater and individuals who drank juices reconstituted with tapwater, the number of glasses consumed in a day ranged from 1 to 20 glasses. The highest percentage of the population (37.1 percent) who drank tapwater, consumed in the range of 3-5 glasses a day and the highest percentage of the population (51.5 percent) who consumed juice reconstituted with tapwater consumed 1-2 glasses in a day. Based on the assumption that each glass contained 8 ounces of water (226.4 mL), the total volume of tapwater and juice with tapwater consumed would range from 0.23 L/day (1 glass) to 4.5 L/day (20 glasses) for respondents who drank tapwater. Using the same assumption, the volume of tapwater consumed for the population who consumed 3-5 glasses would be 0.68 L/day to 1.13 L/day and the volume of juice with tapwater consumed for the population who consumed 1-2 glasses would be 0.23 L/day to 0.46 L/day. Assuming that the average individual consumes 3-5 glasses of tapwater plus 1-2 glasses of juice with tapwater, the range of total tapwater intake for this individual would range from 0.9 L/day to 1.64 L/day. These values are consistent with the average intake rates observed in other studies.

The advantages of NHAPS is that the data were collected for a large number of individuals and that the data are representative of the U.S. population. However, evaluation of drinking water intake rates was not the primary purpose of the study and the data do not reflect the total volume of tapwater consumed. In addition, using the assumptions described above, the estimated drinking water intake rates from this study are within the same ranges observed for other drinking water studies.

3.3.2.14 *Heller et al., 2000 - Water Consumption and Nursing Characteristics of Infants by Race and Ethnicity*

Heller et al. (2000) analyzed data from the 1994-96 CSFII to evaluate racial/ethnic differences in the ingestion rates of water in children younger than 2 years old. Using data from 946 children in this age group, the mean amounts of water consumed from eight sources were determined for various racial/ethnic groups, including black non-Hispanic, white non-Hispanic, Hispanic and "other" (Asian, Pacific Islander, American Indian, Alaskan Native, and other non-specified racial/ethnic groups). The sources analyzed included: (1) plain tap water, (2) milk and milk drinks, (3) reconstituted powdered or liquid infant formula made from drinking water, (4) ready-to-feed and other infant formula, (5) baby food, (6) carbonated beverages, (7) fruit and vegetable juices and other noncarbonated drinks, and (8) other foods and beverages. In addition, Heller et al. (2000) calculated mean plain water and total water ingestion rates for children by age, sex, region, urbanicity, and poverty category. Ages were defined as less than 12 months and 12 to 24 months. Region was categorized as Northeast, Midwest, South, and West. The states represented by each of these regions was not reported in Heller et al. (2000). However, it is likely that these regions were defined in the same way as in Sohn et al. (2001). See Section 3.3.2.16 for a discussion on the Sohn et al. (2001) study. Urbanicity of the residence was defined as urban (i.e., being in a Metropolitan Statistical Area [MSA], suburban [outside of an MSA], or rural [being in a non-MSA]). Poverty category was derived from the poverty income ratio. In this study, a poverty income ratio was calculated by dividing the family's annual income by the federal poverty threshold for that size household. The poverty categories used were 0-1.30, 1.31 to 3.50, and greater than 3.50 times the federal poverty level (Heller et al., 2000).

Table 3-50 provides water ingestion estimates for the eight water sources evaluated, for each of the race/ethnic groups. Heller et al. (2000) reported that black non-Hispanic children had the highest mean plain tap water intake (21 mL/kg-day), and white non-Hispanic children had the lowest mean plain tap water intake (13 mL/kg-day). The only statistically significant difference between the racial/ethnic groups was found to be in plain tap water consumption and total water consumption. Reconstituted baby formula made up the highest proportion of total water intake for all race/ethnic groups. Table 3-51 presents tap water and total water ingestion by age, sex, region, urbanicity, and poverty category. On average, children younger than 12 months of age consumed less plain tap water (11 mL/kg-day) than children aged 12-24 months (18 mL/kg-day). There were no significant differences in plain tap water consumption by sex, region, or urbanicity. Heller et al. (2000) reported a significant association between higher income and lower plain tap water consumption. For total water consumption, ingestion per kg body weight was lower for the 12-24-month-old children than for those younger than 12 months of age. Urban children consumed more plain tap water and total water than suburban and rural children. In addition, plain tap water and total water ingestion was found to decrease with increasing poverty category (i.e., higher wealth).

A major strength of the Heller et al. (2000) study is that it provides information on tap water and total water consumption by race, age, sex, region, urbanicity, and family income. The weaknesses in the CSFII data set have been discussed under Kahn and Stralka (2008a) and U.S. EPA (2004) and include surveying participants for only two days.

3.3.2.15 *Sichert-Hellert et al., 2001 - Fifteen Year Trends in Water Intake in German Children and Adolescents: Results of the DONALD Study*

Water and beverage consumption was evaluated by Sichert-Hellert et al. (2001) using 3-day dietary records of 733 children, ages 2 to 13 years, enrolled in the Dortmund Nutritional and Anthropometric Longitudinally Designed Study (DONALD study). The DONALD study is a cohort study, conducted in Germany, that collects data on diet, metabolism, growth and development from healthy subjects between infancy and adulthood (Sichert-Hellert et al., 2001). Beginning in 1985, approximately 40 to 50 infants were enrolled in the study annually. Mothers of the participants were recruited in hospital maternity wards. Older children and parents of younger children were asked to keep dietary records for three days by recording and weighing (to the nearest 1 gram) all foods and fluids, including water, consumed.

Sichert-Hellert et al. (2001) evaluated 3,736 dietary records from 733 subjects (354 males and 379 females) collected between 1985 and 1999. Total water ingestion was defined as the sum of water content from food (intrinsic water), beverages and oxidation. Beverages included milk, mineral water, tap water, juice, soft drinks, and coffee and tea. Table 3-52 presents the mean water ingestion rates for these different sources, as well as mean total water ingestion rates for three age ranges of children (age 2 to 3 years, age 4 to 8 years, and age 9 to 13 years). According to Sichert-Hellert et al. (2001), mean total water ingestion increased with age from 1,114 mL/day in the 2 to 3 year old subjects to 1,891 and 1,676 mL/day in 9 to 13-year-old boys and girls, respectively. However, mean total water intake per body weight decreased with age. Sichert-Hellert et al. (2001) observed that the most important source of total water ingestion was mineral water for all children, except the 2 to 3 year olds. For these children, the most important source of total water ingestion was milk.

One of the limitations of this study is that it evaluated water and beverage consumption in German children and, as such, it may not be representative of consumption patterns of U.S. children.

3.3.2.16 *Sohn et al., 2001 - Fluid Consumption Related to Climate Among Children in the United States*

Sohn et al. (2001) investigated the relationship between fluid consumption among children aged l to 10 years and local climate using data from the third National Health and Nutrition Examination Survey (NHANES III, 1988-94). Children aged 1 to 10 years who completed the 24-hour dietary interview (or proxy interview for the younger children) during the NHANES III survey were selected for the analysis. Breast-fed children were excluded from the analysis. Among 8,613 children who were surveyed, 688 (18 percent) were excluded due to incomplete data. A total of 7,925 eligible children remained. Since data for climatic conditions were not collected in the NHANES III survey, the mean daily maximum temperature from 1961 to 1990, averaged for the month during which the NHANES III survey was conducted, was obtained for each survey location from the U.S. Local Climate Historical Database. Of the 7,925 eligible children with complete dietary data, temperature information was derived for only 3,869 children (48.8 percent) since detailed information on survey location, in terms of county and state, was released only for counties with a population of more than a half million.

Sohn et al. (2001) calculated the total amount of fluid intake for each child by adding the fluid intake from plain drinking water and the fluid intake from foods and beverages other than plain drinking water provided by NHANES III. Sohn et al. (2001) identified major fluid sources as milk (and milk drinks), juice (fruit and vegetable juices and other noncarbonated drinks), carbonated drinks, and plain water. Fluid intake from sources other than these major sources were all grouped into other foods and beverages. Other foods and beverages included bottled water, coffee, tea, baby food, soup, water-based beverages, and water used for dilution of food. Mean fluid ingestion rates of selected fluids for the total sample population and for the subsets of the sample population with and without temperature information are presented in Table 3-53. The estimated mean total fluid and plain water ingestion rates for the 3,869 children for whom temperature information was obtained are presented in Table 3-54 according to age (years), sex, race/ethnicity, poverty/income ratio, region, and urban or rural. Poverty/income ratio was defined as the ratio of the reported family income to the federal poverty level. The following categories were assigned: low socioeconomic status (SES) = 0.000 to 1.300 times the poverty/income ratio; medium SES = 1.3.01 to 3.500 times the poverty/income level; and high SES = 3.501 or greater times the poverty/income level. Regions were as Northeast, Midwest, South, and West, as defined by the U.S. Census (see Table 3-54). Sohn et al. (2001) did not find significant association between mean daily maximum temperature and total fluid or plain water ingestion, either before or after controlling for sex, age, SES and race or ethnicity. However, significant associations between fluid ingestion and age, sex, socioeconomic status and race and ethnicity were reported.

The main strength of the Sohn et al. (2001) study is the evaluation of water intake as it relates to weather data. The main limitations of this study were that northeast and western regions were over represented since temperature data was only available for counties with populations in excess of a half million. In addition, whites were under-represented compared to other racial or ethnic groups. Other limitations include lack of data for children from extremely cold or hot weather conditions.

3.3.2.17 *Hilbig et al., 2002 - Measured Consumption of Tap Water in German Infants and Young Children as Background for Potential Health Risk Assessment: Data of the DONALD Study*

Hilbig et al. (2002) estimated tap water ingestion rates based on 3-day dietary records of 504 German children aged 3, 6, 9, 12, 18, 24 and 36 months. The data were collected between 1990 and 1998 as part of the DONALD study. Details of data collection for the DONALD study have been provided previously under the Sichert-Hellert et al. (2001) study in Section 3.3.2.15 of this handbook. Tap water ingestion rates were calculated for three subgroups of children: (1) breast-fed infants ≤12 months of age (exclusive and partial breast-fed infants) (2) formula-fed infants ≤12 months of age (no human milk, but including weaning food) and (3) mixed-fed young children aged 18 to 36 months. Hilbig et al. (2002) defined "total tap water from household" as water from the tap consumed as a beverage or used in food preparation. "Tap water from food manufacturing" was defined as water used in industrial production of foods, and "Total Tap Water" was defined as tap water consumed from both the household and that used in manufacturing.

Table 3-55 summarizes total tap water ingestion (in mL/day and mL/kg-day) and tap water ingestion from household and manufacturing sources (in mL/kg-day) for breastfed, formula fed and mixed-fed children. Mean total tap water intake was higher in formula-fed infants (53 mL/kg-day) than in breast-fed infants (17 g/kg-day) and mixed-fed young children (19 g/kg-day). Tap water from household sources constituted 66 to 97 percent of total tap water ingestion in the different age groups.

The major limitation of this study is that the study sample consists of families from an upper social background in Germany (Hilbig et al., 2002). Because the study was conducted in Germany, the data may not be directly applicable to the U.S. population.

3.3.2.18 *Marshall et al., 2003a - Patterns of Beverage Consumption during the Transition Stage of Infant Nutrition*

Marshall et al. (2003a) investigated beverage ingestion during the transition stage of infant nutrition. Mean ingestion of infant formula, cow's milk, combined juice and juice drinks, water, and other beverages were estimated using a frequency questionnaire. A total of 701 children, ages six months through 24 months, participated in the Iowa Fluoride Study (IFS). Mothers of newborns were recruited from 1992 through 1995. The parents were sent questionnaires when the children were 6, 9, 12, 16, 20, and 24 months old. Of the 701 children, 470 returned all six questionnaires, 162 returned five, 58 returned four and 11 returned three, with the minimum criteria being three questionnaires to be included in the data set (Marshall et al., 2003a). The questionnaire was designed to assess the type and quantity of the beverages consumed during the previous week. The validity of the questionnaire was assessed using a three-day food diary for reference (Marshall et al., 2003a). The percentage of subjects consuming beverages and mean daily beverage ingestion for children with returned questionnaires are presented in Table 3-56. Human milk ingestion was not quantified, but the percent of children consuming human milk was provided at each age category (Table 3-56). Juice (100 percent) and juice drinks were not distinguished separately, but categorized as juice and juice drinks. Water used to dilute beverages beyond normal dilution and water consumed alone were combined. Based on Table 3-56, 97 percent of the children consumed human milk, formula, or cow's milk throughout the study period, and the percentage of infants consuming human milk decreased with age, while the percent consuming water increased (Marshall et al., 2003a). Marshall et al. (2003a) observed that in general, lower family incomes were associated with less breastfeeding and increased ingestion of other beverages.

The advantage of this study is that it provides mean ingestion data for various beverages. Limitations of the study are that it is based on samples gathered in one geographical area and may not be reflective of the general population. The authors also noted the following limitations: the parents were not asked to differentiate between 100 percent juice and juice drinks; the data are parent-reported and could reflect perceptions of appropriate ingestion instead of actual ingestion, and a substantial number of the infants from well educated, economically secure households dropped out during the initial phase.

3.3.2.19 *Marshall et al., 2003b - Relative Validation of a Beverage Frequency Questionnaire in Children Ages 6 Months through 5 Years Using 3-day Food and Beverage Diaries*

Marshall et al. (2003b) conducted a study based on data taken from 700 children in the IFS. This study compared estimated beverage ingestion rates reported in questionnaires for the preceding week and dairies for the following week. Packets were sent periodically (every 4 to 6 months) to parents of children aged 6 weeks through 5 years of age. This study analyzed data from children, ages 6 and 12 months, and 2 and 5 years of age. Beverages were categorized as human milk, infant formula, cow's milk, juice and juice drinks, carbonated and rehydration beverages, prepared drinks (from powder) and water. The beverage questionnaire was completed by parents and summarized the average amount of each beverage consumed per day by their children. The data collection for the diaries maintained by parents included 1 weekend day and 2 week days and included detailed information about beverages consumed. Table 3-57 presents the mean ingestion rates of all beverages for children aged 6 and 12 months and 3 and 5 years. Marshall et al. (2003b) concluded that estimates of beverage ingestion derived from quantitative questionnaires are similar to those derived from diaries. They found that it is particularly useful to estimate ingestion of beverages consumed frequently using quantitative questionnaires.

The advantage of this study is that the survey was conducted in two different forms (questionnaire and diary) and that diaries for recording beverage ingestion were maintained by parents for three days. The main limitation is the lack of information regarding whether the diaries were populated on consecutive or non-consecutive days. The IFS survey participants may not be representative of the general population of the U.S. since participants were primarily white, and from affluent and well-educated families in one geographic region of the country.

3.3.2.20 *Skinner et al., 2004 - Transition in Infants' and Toddlers' Beverage Patterns*

Skinner et al. (2004) investigated the pattern of beverage consumption by infants and children participating in the Feeding Infant and Toddlers Study (FITS) sponsored by Gerber Products Company. The FITS is a cross-sectional study designed to collect and analyze data on feeding practices, food consumption, and usual nutrient intake of U.S. infants and toddlers (Devaney et al., 2004). It included a stratified random sample of 3,022 infants and toddlers between 4 and 24 months of age. Parents or primary caregivers of sampled infants and toddlers completed a single 24-hour dietary recall of all foods and beverages consumed by the child on the previous day by telephone interview. All recalls were completed between March and July 2002. Detailed information on data collection, coding and analyses related to FITS are provided in Devaney et al. (2004).

Beverages consumed by FITS participants were identified as total milks (i.e., human milk, infant formulas, cows milk, soy milk, goat milk), 100 percent juices, fruit drinks, carbonated beverages, water and "other" drinks (i.e., tea, cocoa, dry milk mixtures, and electrolyte replacement beverages). There were six age groupings in the FITS study: 4 to 6, 7 to 8, 9 to 11, 12 to 14, 15 to 18, and 19 to 24 months. Skinner et al. (2004) calculated the percentage of children in each age group consuming any amount in a beverage category and the mean amounts consumed. Table 3-58 provides the mean beverage consumption rates in mL/day for the six age categories. Skinner et al. (2004) found that some form of milk beverage was consumed by almost all children at each age; however, total milk ingestion decreased with increasing age. Water consumption also doubled with age, from 163 mL/day in children aged 4 to 6 months old to 337 mL/day at 19 to 24 months old. The percentages of children consuming water increased from 34 percent at 4 to 6 months of age to 77 percent at 19 to 24 months of age.

A major strength of the Skinner et al. (2004) study is the large sample size (3,022 children). However, beverage ingestion estimates are based on one day of dietary recall data and human milk quantity derived from studies that weighed infants before and after each feeding to determine the quantity of human milk consumed (Devaney et al., 2004); therefore, estimates of total milk ingestion may not be accurate.

3.4 PREGNANT AND LACTATING WOMEN

3.4.1 Key Study on Pregnant and Lactating Women

3.4.1.1 *Kahn and Stralka, 2008b - Estimates of Water Ingestion for Women in Pregnant, Lactating and Non-Pregnant and Non-Lactating Child Bearing Age Groups Based on USDA's 1994-1996,1998 CSFII*

The combined 1994-96 and 1998 Continuing Survey of Food Intake by Individuals (CSFII) data sets were analyzed to examine the ingestion of water by various segments of the U.S. population as described in Section 3.2. This study provided water intake data for pregnant, lactating, and child-bearing age women. Mean and upper percentile distribution data are provided. Lactating women had an estimated per capita mean community water ingestion of 1.38 L/day, the highest water ingestion rates of any identified subpopulation. The mean consumer only population was 1.67 L/day. Tables 3-59 through 3-66 provide estimated drinking water intake for pregnant and lactating women, and non-pregnant, non-lactating women 15-44 years old. The same advantages and disadvantages discussed in

Section 3.2 apply to these data.

3.4.2 Relevant Studies on Pregnant and Lactating Women

3.4.2.1 *Ershow et al., 1991 - Intake of Tapwater and Total Water by Pregnant and Lactating Women*

Ershow et al. (1991) used data from the 1977-78 USDA NFCS to estimate total fluid and total tapwater intake among pregnant and lactating women (ages 15-49 years). Data for 188 pregnant women, 77 lactating women, and 6,201 non-pregnant, non-lactating control women were evaluated. The participants were interviewed based on 24 hour recall, and then asked to record a food diary for the next 2 days. "Tapwater" included tapwater consumed directly as a beverage and tapwater used to prepare food and tapwater-based beverages. "Total water" was defined as all water from tapwater and non-tapwater sources, including water contained in food. Estimated total fluid and total tapwater intake rates for the three groups are presented in Tables 3-67 and 3-68, respectively. Lactating women had the highest mean total fluid intake rate (2.24 L/day) compared with both pregnant women (2.08 L/day) and control women (1.94 L/day). Lactating women also had a higher mean total tapwater intake rate (1.31 L/day) than pregnant women (1.19 L/day) and control women (1.16 L/day). The tapwater distributions are neither normal nor lognormal, but lactating women had a higher mean tapwater intake than controls and pregnant women. Ershow et al. (1991) also reported that rural women (n=1,885) consumed more total water (1.99 L/day) and tapwater (1.24 L/day) than urban/suburban women (n=4,581, 1.93 and 1.13 L/day, respectively). Total water and tapwater intake rates were lowest in the northeastern region of the United States (1.82 and 1.03 L/day) and highest in the western region of the United States (2.06 L/day and 1.21 L/day). Mean intake per unit body weight was highest among lactating women for both total fluid and total tapwater intake. Total tapwater intake accounted for over 50 percent of mean total fluid in all three groups of women (Table 3-68). Drinking water accounted for the largest single proportion of the total fluid intake for control (30 percent), pregnant (34 percent), and lactating women (30 percent) (Table 3-69). All other beverages combined accounted for approximately 46 percent, 43 percent, and 45 percent of the total water intake for control, pregnant, and lactating women, respectively. Food accounted for the remaining portion of total water intake. The same advantages and limitations associated with the Ershow and Cantor (1989) data also apply to these data sets (Section 3.3.2.9). A further advantage of this study is that it provides information on estimates of total water and tapwater intake rates for pregnant and lactating women. This topic has rarely been addressed in the literature.

3.4.2.2 *Forssen et al., 2007 - Predictors of Use and Consumption of Public Drinking Water Among Pregnant Women*

Forssen et al. (2007) evaluated the demographic and behavioral characteristics that would be important in predicting water consumption among pregnant women in the United States. Data were collected through telephone interviews with 2,297 pregnant women in three geographical areas. Women 18 years old and 12 weeks pregnant were recruited from the local communities and from both private and public prenatal care facilities in the southern United States. Variables studied included demographic, health status and history (e.g., diabetes, pregnancy history), behavioral (e.g., exercise, smoking, caffeine consumption), and some physiological characteristics (e.g., pre-pregnancy weight). Daily amount of water ingestion was estimated based on cup sizes defined in the interview. Water consumption was reported as cold tapwater (filtered and unfiltered) and bottled water. Other behavioral information on water use such as showering and bathing habits, use of swimming pools, hot tubs, and jacuzzis was collected. The overall mean tapwater ingested was 1.7 L/day (percentiles: 25^{th} = 0.5 L/day, 50^{th} = 1.4 L/day, 75^{th} = 2.4 L/day, and 90^{th} = 3.8 L/day). The overall mean bottled water ingested was 0.6 L/day (percentiles: 25^{th} = 0.1 L/day, 50^{th} = 0.2 L/day, 75^{th} = 0.6 L/day, and 90^{th} = 1.8 L/day. Table 3-70 presents water ingestion by the different variables studied and Table 3-71 presents the percentage of ingested tapwater that is filtered and unfiltered by various variables.

3.5 HIGH ACTIVITY LEVELS/HOT CLIMATES

3.5.1 Relevant Studies on High Activity Levels/Hot Climates

3.5.1.1 *McNall and Schlegel, 1968 - Practical Thermal Environmental Limits for Young Adult Males Working in Hot, Humid Environments*

McNall and Schlegel (1968) conducted a study that evaluated the physiological tolerance of adult males working under varying degrees of physical activity. Subjects were required to pedal pedal-driven propeller fans for 8-hour work cycles under varying environmental conditions. The activity pattern for each individual was: cycled at 15 minute pedaling and 15 minute rest for each 8-hour period. Two groups of eight subjects each were used. Work rates were divided into three categories as follows: high activity level [0.15 horsepower (hp) per person], medium activity level (0.1 hp per person), and low activity level (0.05 hp per person). Evidence of physical stress (i.e., increased body temperature, blood pressure, etc.) was recorded, and individuals were eliminated from further testing if certain stress criteria were met. The amount of water consumed by the test subjects during the work cycles was also recorded. Water was provided to the individuals on request.

The water intake rates obtained at the three different activity levels and the various environmental temperatures are presented in Table 3-72. The data presented are for test subjects with continuous data only (i.e. those test subjects who were not eliminated at any stage of the study as a result of stress conditions). Water intake was the highest at all activity levels when environmental temperatures were increased. The highest intake rate was observed at the low activity level at 100°F (0.65 L/hour) however, there were no data for higher activity levels at 100°F. It should be noted that this study estimated intake on an hourly basis during various levels of physical activity. These hourly intake rates cannot be converted to daily intake rates by multiplying by 24 hours/day because they are only representative of intake during the specified activity levels and the intake rates for the rest of the day are not known. Therefore, comparison of intake rate values from this study cannot be made with values from the previously described studies on drinking water intake.

3.5.1.2 *United States Army, 1983 - Water Consumption Planning Factors Study*

The U.S. Army has developed water consumption planning factors to enable them to transport an adequate amount of water to soldiers in the field under various conditions (U.S. Army, 1983). Both climate and activity levels were used to determine the appropriate water consumption needs. Consumption factors have been established for the following uses: 1) drinking, 2) heat treatment, 3) personal hygiene, 4) centralized hygiene, 5) food preparation, 6) laundry, 7) medical treatment, 8) vehicle and aircraft maintenance, 9) graves registration, and 10) construction. Only personal drinking water consumption factors are described here. Drinking water consumption planning factors are based on the estimated amount of water needed to replace fluids lost by urination, perspiration, and respiration. It assumes that water lost to urinary output averages one quart/day (0.9 L/day) and perspiration losses range from almost nothing in a controlled environment to 1.5 quarts/day (1.4 L/day) in a very hot climate where individuals are performing strenuous work. Water losses to respiration are typically very low except in extreme cold where water losses can range from 1 to 3 quarts/day (0.9 to 2.8 L/day). This occurs when the humidity of inhaled air is near zero, but expired air is 98 percent saturated at body temperature (U.S. Army, 1983).

Drinking water is defined by the U.S. Army (1983) as "all fluids consumed by individuals to satisfy body needs for internal water." This includes soups, hot and cold drinks, and tapwater. Planning factors have been established for hot, temperate, and cold climates based on the following mixture of activities among the work force: 15 percent of the force performing light work, 65 percent of the force performing medium work, and 20 percent of the force performing heavy work. Hot climates are defined as tropical and arid areas where the temperature is greater than 80°F. Temperate climates are defined as areas where the mean daily temperature ranges from 32°F to 80°F. Cold regions are areas where the mean daily temperature is less than 32°F. Drinking water consumption factors for these three climates are presented in Table 3-73. These factors are based on research on individuals and small unit training exercises. The estimates are assumed to be conservative because they are rounded up to account for the subjective nature of the activity mix and minor water losses that are not considered (U.S. Army, 1983).

The advantage of using these data is that they provide a conservative estimate of drinking water intake among individuals performing at various levels of physical activity in hot, temperate, and cold climates. However, the planning factors described here are based on assumptions about water loss from urination, perspiration, and respiration, and are not based on survey data or actual measurements.

3.6 WATER INGESTION WHILE SWIMMING

3.6.1 Key Study on Water Ingestion While Swimming

3.6.1.1 *Dufour et al., 2006 - Water Ingestion During Swimming Activities in a Pool: A Pilot Study*

Dufour et al. (2006) estimated the amount of water ingested while swimming, using cyanuric acid as an indicator of pool water ingestion exposure. Cyanuric acid is a breakdown product of chloroisocyanates which are commonly used as disinfectant stabilizers in recreational water treatment. Because ingested cyanuric acid passes through the body unmetabolized, the volume of water ingested can be estimated based on the amount of cyanuric acid measured in the pool water and in the urine of swimmers, as follows:

$$V_{pool\ water\ ingested} = V_{urine} \times CA_{urine}/CA_{pool} \qquad \text{(Eqn. 3-1)}$$

where:

$V_{pool\ water\ ingested}$	=	volume of pool water ingested (mL)
V_{urine}	=	volume of urine collected over a 24-hour period (mL)
CA_{urine}	=	concentration of cyanuric acid in urine (mg/L)
CA_{pool}	=	concentration of cyanuric acid in pool water (mg/L)

Dufour et al. (2006) estimated pool water intake among 53 swimmers that participated in a pilot study at an outdoor swimming pool treated with chloroisocyanate. This pilot study population included 12 adults (4 males and 8 females) and 41 children under 18 years of age (20 males and 21 females). The study participants were asked not to swim for 24 hours before or after a 45 minute period of active swimming in the pool. Pool water samples were collected prior to the start of swimming activities and swimmers' urine was collected for 24 hours after the swimming event ended. The pool water and urine sample were analyzed for cyanuric acid.

The results of this pilot study are presented in Table 3-74. The mean volume of water ingested over a 45-minute period was 16 mL for adults and 37 mL for children. The maximum volume of water ingested by adults was 53 mL and by children was 154 mL/45 minutes, as found in the recommendations table for water ingestion while swimming (Table 3-5). The 95th percentile volume of water ingested by all participants combined was approximately 90 mL/hour (Table 3-5).

The advantage of this study is that it is one of the first attempts to measure water ingested while swimming. However, the number of study participants was low and data cannot be broken out by the recommended age categories. As noted by the Dufour et al. (2006), swimming behavior of pool swimmers may be similar to freshwater swimmers, but may differ from salt water swimmers.

Based on the results of the Dufour et al. (2006) study, the recommended mean water ingestion rate for exposure scenarios involving swimming activities is 21 mL/hour for adults and 50 mL/hour for children under 18 years of age. Because the data set is limited, upper percentile water ingestion rates for swimming is based on the maximum values observed in the Dufour et al. (2006) study: 71 mL/hour for adults and 200 mL/hour for children (Table 3-5).

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Table 3-7. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion: Community Water (mL/day)

Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	91	184	-	-	-	322	687*	839*	860*
1 to <3 months	253	227	-	-	-	456	804	896*	1,165*
3 to <6 months	428	362	-	-	148	695	928	1,056	1,424*
6 to <12 months	714	360	-	17	218	628	885	1,055	1,511*
1 to <2 years	1,040	271	-	60	188	402	624	837	1,215*
2 to <3 years	1,056	317	-	78	246	479	683	877	1,364*
3 to <6 years	4,391	380	4	98	291	547	834	1,078	1,654
6 to <11 years	1,670	447	22	133	350	648	980	1,235	1,870*
11 to <16 years	1,005	606	30	182	459	831	1,387	1,727	2,568*
16 to <18 years	363	731	16	194	490	961	1,562	1,983*	3,720*
18 to <21 years	389	826	24	236	628	1,119	1,770	2,540*	3,889*
>21 years	9,207	1,104	69	422	928	1,530	2,230	2,811	4,523
>65 years[c]	2,170	1,127	16	545	1,067	1,601	2,139	2,551	4,242
All ages	20,607	926	30	263	710	1,311	2,014	2,544	4,242

a Includes all participants whether or not they ingested any water from the source during survey period.
b Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
- = Zero.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-8. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion: Bottled Water (mL/day)

Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	91	104	-	-	-	18	437*	556*	1,007*
1 to <3 months	253	106	-	-	-	-	541	771*	1,056*
3 to <6 months	428	120	-	-	-	-	572	774	1,443*
6 to <12 months	714	120	-	-	-	53	506	761	1,284*
1 to <2 years	1,040	59	-	-	-	-	212	350	801*
2 to <3 years	1,056	76	-	-	-	-	280	494	1,001*
3 to <6 years	4,391	84	-	-	-	-	325	531	1,031*
6 to <11 years	1,670	84	-	-	-	-	330	532	1,079*
11 to <16 years	1,005	111	-	-	-	-	382	709	1,431*
16 to <18 years	363	109	-	-	-	-	426	680*	1,605*
18 to <21 years	389	185	-	-	-	-	514	1,141*	2,364*
>21 years	9,207	189	-	-	-	-	754	1,183	2,129
>65 years[c]	2,170	136	-	-	-	-	591	1,038	1,957
All ages	20,607	163	-	-	-	-	592	1,059	2,007

[a] Includes all participants whether or not they ingested any water from the source during survey period.
[b] Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
- = Zero.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-9. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion: Other Sources (mL/day)

Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	91	13	-	-	-	-	-	-	393*
1 to <3 months	253	35	-	-	-	-	-	367*	687*
3 to <6 months	428	45	-	-	-	-	-	365	938*
6 to <12 months	714	45	-	-	-	-	31	406	963*
1 to <2 years	1,040	22	-	-	-	-	-	118	482*
2 to <3 years	1,056	39	-	-	-	-	52	344	718*
3 to <6 years	4,391	43	-	-	-	-	58	343	830
6 to <11 years	1,670	61	-	-	-	-	181	468	1,047*
11 to <16 years	1,005	102	-	-	-	-	344	786	1,698*
16 to <18 years	363	97	-	-	-	-	295	740*	1,760*
18 to <21 years	389	47	-	-	-	-	-	246*	1,047*
>21 years	9,207	156	-	-	-	-	541	1,257	2,381
>65 years[c]	2,170	171	-	-	-	-	697	1,416	2,269
All ages	20,607	128	-	-	-	-	345	1,008	2,151

a Includes all participants whether or not they ingested any water from the source during survey period.
b Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
\- = Zero.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-10. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion: All Sources (mL/day)

Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	91	301	-	-	135	542	846*	877*	1,088*
1 to <3 months	253	368	-	-	267	694	889	1,020*	1,265*
3 to <6 months	428	528	-	89	549	812	1,025	1,303	1,509*
6 to <12 months	714	530	37	181	505	771	1,029	1,278	1,690*
1 to <2 years	1,040	358	68	147	287	477	735	961	1,281*
2 to <3 years	1,056	437	104	211	372	588	825	999	1,662*
3 to <6 years	4,391	514	126	251	438	681	980	1,200	1,794
6 to <11 years	1,670	600	169	304	503	803	1,130	1,409	2,167*
11 to <16 years	1,005	834	224	401	663	1,099	1,649	1,960	3,179*
16 to <18 years	363	964	236	387	742	1,273	1,842	2,344*	3,854*
18 to <21 years	389	1,075	189	406	803	1,394	2,117	2,985*	4,955*
>21 years	9,207	1,466	500	828	1,278	1,871	2,553	3,195	5,174
>65 years[c]	2,170	1,451	651	935	1,344	1,832	2,323	2,708	3,747
All ages	20,607	1,233	285	573	1,038	1,633	2,341	2,908	4,805

[a] Includes all participants whether or not they ingested any water from the source during survey period.
[b] Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
- = Zero.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn,2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-11. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion, Mean Confidence Intervals and Bootstrap Intervals for 90th and 95th Percentiles: All Sources (mL/day)

Age	Sample size	Mean			90th percentile			95th percentile		
			90% C.I.			90% B.I.			90% B.I.	
		Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Birth to <1 month	91	301	215	387	846*	638*	859*	839*	638*	859*
1 to <3 months	253	368	304	432	889	862	896	896*	878*	1,022*
3 to <6 months	428	528	485	571	1,025	955	1,083	1,056	1,043	1,170
6 to <12 months	714	530	495	564	1,029	973	1,100	1,055	1,008	1,254
1 to <2 years	1,040	358	338	377	735	686	778	837	754	925
2 to <3 years	1,056	437	418	455	825	784	857	877	828	939
3 to <6 years	4,391	514	494	533	980	953	1,004	1,078	1,053	1,109
6 to <11 years	1,670	600	571	629	1,130	1,065	1,162	1,235	1,148	1,317
11 to <16 years	1,005	834	770	898	1,649	1,567	1,775	1,727	1,615	1,780
16 to <18 years	363	964	870	1,057	1,842	1,743	1,988	1,983*	1,843*	2,128*
18 to <21 years	389	1,075	980	1,171	2,117	1,952	2,299	2,540*	1,908*	2,934*
>21 years	9,207	1,466	1,427	1,506	2,553	2,511	2,607	2,811	2,732	2,924
>65 years[c]	2,170	1,451	1,412	1,489	2,323	2,279	2,388	2,708	2,632	2,760
All ages	20,607	1,233	1,200	1,265	2,341	2,303	2,377	2,908	2,812	2,975

a Includes all participants whether or not they ingested any water from the source during survey period.

b Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.

c U.S. EPA, 2004.

* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

CI = Confidence Interval.

BI = Bootstrap Interval.

Source: Kahn,2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-12. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion: Community Water (mL/kg-day)

Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	88	52	-	-	-	101	196*	232*	253*
1 to <3 months	245	48	-	-	-	91	151	205*	310*
3 to <6 months	411	52	-	-	20	98	135	159	216*
6 to <12 months	678	41	-	2	24	71	102	126	185*
1 to <2 years	1,002	23	-	5	17	34	53	71	106*
2 to <3 years	994	23	-	6	17	33	50	60	113*
3 to <6 years	4,112	22	-	6	17	31	48	61	93
6 to <11 years	1,553	16	1	5	12	22	34	43	71*
11 to <16 years	975	12	1	4	9	16	25	34	54*
16 to <18 years	360	11	-	3	8	15	23	31*	55*
18 to <21 years	383	12	1	4	10	16	17	35*	63*
>21 years	9,049	15	1	6	12	21	31	39	62
>65 years[c]	2,139	16	-	7	15	23	31	37	52
All ages	19,850	16	1	5	12	21	32	43	75

a Includes all participants whether or not they ingested any water from the source during survey period.
b Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
- = Zero.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-13. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion: Bottled Water (mL/kg-day)

Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	88	33	-	-	-	6	131*	243*	324*
1 to <3 months	245	22	-	-	-	-	97	161*	242*
3 to <6 months	411	16	-	-	-	-	74	117	193*
6 to <12 months	678	13	-	-	-	4	52	87	139*
1 to <2 years	1,002	5	-	-	-	-	18	28	67*
2 to <3 years	994	5	-	-	-	-	19	35	84*
3 to <6 years	4,112	5	-	-	-	-	18	30	59
6 to <11 years	1,553	3	-	-	-	-	10	18	41*
11 to <16 years	975	2	-	-	-	-	8	14	26*
16 to <18 years	360	2	-	-	-	-	6	10*	27*
18 to <21 years	383	3	-	-	-	-	8	19*	34*
>21 years	9.049	3	-	-	-	-	10	17	32
>65 years[c]	2,139	2	-	-	-	-	9	15	27
All ages	19,850	3	-	-	-	-	10	18	39

[a] Includes all participants whether or not they ingested any water from the source during survey period.
[b] Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
\- = Zero.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-14. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion: Other Sources (mL/kg-day)

Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	88	4	-	-	-	-	-	-	122*
1 to <3 months	245	7	-	-	-	-	-	52*	148*
3 to <6 months	411	7	-	-	-	-	-	55	155*
6 to <12 months	678	5	-	-	-	-	3	35	95*
1 to <2 years	1,002	2	-	-	-	-	-	11	45*
2 to <3 years	994	3	-	-	-	-	4	23	61*
3 to <6 years	4,112	2	-	-	-	-	3	19	48
6 to <11 years	1,553	2	-	-	-	-	7	16	36*
11 to <16 years	975	2	-	-	-	-	7	14	34*
16 to <18 years	360	2	-	-	-	-	5	11*	27*
18 to <21 years	383	1	-	-	-	-	-	4*	14*
>21 years	9,049	2	-	-	-	-	7	17	33
>65 years[c]	2,139	2	-	-	-	-	10	20	35
All ages	19,850	2	-	-	-	-	6	16	35

a Includes all participants whether or not they ingested any water from the source during survey period.
b Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
\- = Zero.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-15. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion: All Sources (mL/kg-day)

Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	88	89	-	-	21	168	235*	269*	338*
1 to <3 months	245	77	-	-	46	134	173	246*	336*
3 to <6 months	411	75	-	9	73	118	156	186	225*
6 to <12 months	678	59	4	20	53	86	118	148	194*
1 to <2 years	1,002	31	6	13	24	39	63	85	122*
2 to <3 years	994	31	7	15	26	41	59	73	130*
3 to <6 years	4,112	29	7	14	25	38	56	69	102
6 to <11 years	1,553	21	6	10	18	27	39	50	76*
11 to <16 years	975	16	4	8	13	20	31	39	60*
16 to <18 years	360	15	4	6	12	18	28	37*	59*
18 to <21 years	383	16	3	6	12	21	32	41*	73*
>21 years	9,049	20	7	11	17	26	36	44	68
>65 years[c]	2,139	21	9	13	19	27	34	39	54
All ages	20,850	21	6	10	17	26	38	50	87

a Includes all participants whether or not they ingested any water from the source during survey period.
b Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
\- = Zero.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-16. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion, Mean Confidence Intervals and Bootstrap Intervals for 90th and 95th Percentiles: All Sources (mL/kg-day)

Age	Sample size	Mean			90th percentile			95th percentile		
			90% C.I.			90% B.I.			90% B.I.	
		Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Birth to <1 month	88	89	64	114	235*	198*	269*	269*	236*	332*
1 to <3 months	245	77	62	91	173	164	217	246*	187*	295*
3 to <6 months	411	75	68	82	156	145	162	186	176	199
6 to <12 months	678	59	54	63	118	112	128	148	134	166
1 to <2 years	1,002	31	29	32	63	59	68	85	73	95
2 to <3 years	994	31	30	33	59	57	62	73	69	81
3 to <6 years	4,112	29	28	30	56	54	56	69	66	72
6 to <11 years	1,553	21	20	22	39	36	41	50	47	52
11 to <16 years	975	16	15	17	31	29	34	39	36	41
16 to <18 years	360	15	13	16	28	27	32	37*	33*	44*
18 to <21 years	383	16	14	17	32	29	35	41*	36*	44*
> 21 years	9,049	20	19	21	36	35	37	44	43	45
> 65 years[c]	2,139	21	20	21	34	34	35	39	37	41
All ages	19,850	21	20	21	38	38	39	50	48	51

[a] Includes all participants whether or not they ingested any water from the source during survey period.
[b] Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).
CI = Confidence Interval.
BI = Bootstrap Interval.
Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-17. Consumers Only[a] Estimates of Combined Direct and Indirect[b] Water Ingestion: Community Water (mL/day)									
Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	40	470*	32*	215*	482*	692*	849*	858*	919*
1 to <3 months	114	552	67*	339	533	801	943*	1,053*	1,264*
3 to <6 months	281	556	44	180	561	837	1,021	1,171*	1,440*
6 to <12 months	562	467	44	105	426	710	971	1,147	1,586*
1 to <2 years	916	308	43	107	229	428	674	893	1,248*
2 to <3 years	934	356	49	126	281	510	700	912	1,388*
3 to <6 years	3,960	417	57	146	336	581	867	1,099	1,684
6 to <11 years	1,555	480	74	177	373	682	994	1,251	2,024*
11 to <16 years	937	652	106	236	487	873	1,432	1,744	2,589*
16 to <18 years	341	792	106	266	591	987	1,647	2,002*	3,804*
18 to <21 years	364	895	114	295	674	1,174	1,860	2,565*	3,917*
>21 years	8,505	1,183	208	529	1,006	1,582	2,289	2,848	4,665
>65 years[c]	1,958	1,242	310	704	1,149	1,657	2,190	2,604	3,668
All ages	18,509	1,000	127	355	786	1,375	2,069	2,601	4,274

a Excludes individuals who did not ingest water from the source during the survey period.

b Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.

c U.S. EPA, 2004.

* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-18. Consumers Only[a] Estimates of Combined Direct and Indirect[b] Water Ingestion: Bottled Water (mL/day)

Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	25	-	-	-	-	-	-	-	-
1 to <3 months	64	450*	31*	62*	329*	743*	886*	1,045*	1,562*
3 to <6 months	103	507	48*	88	493	747	1,041*	1,436*	1,506*
6 to <12 months	200	425	47	114	353	630	945*	1,103*	1,413*
1 to <2 years	229	262	45	88	188	324	600	709*	1,083*
2 to <3 years	232	352	57	116	241	471	736	977*	1,665*
3 to <6 years	1,021	380	72	149	291	502	796	958	1,635*
6 to <11 years	332	430	88	168	350	557	850	1,081*	1,823*
11 to <16 years	192	570	116*	229	414	719	1,162*	1,447*	2,705*
16 to <18 years	63	615*	85*	198*	446*	779*	1,365*	1,613*	2,639*
18 to <21 years	97	769	118*	236	439	943	1,788*	2,343*	3,957*
>21 years	1,893	831	167	354	650	1,071	1,773	2,093	3,505
>65 years[c]	302	910	234	465	785	1,182	1,766	2,074	2,548
All ages	4,451	736	118	266	532	975	1,567	1,964	3,312

[a] Excludes individuals who did not ingest water from the source during the survey period.
[b] Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
- Insufficient sample size to estimate mean and percentiles.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-19. Consumers Only[a] Estimates of Combined Direct and Indirect[b] Water Ingestion: Other Sources (mL/day)

Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	3	-	-	-	-	-	-	-	-
1 to <3 months	19	-	-	-	-	-	-	-	-
3 to <6 months	38	562*	59*	179*	412*	739*	983*	1,205*	2,264*
6 to <12 months	73	407*	31*	121*	300*	563*	961*	1,032*	1,144*
1 to <2 years	98	262	18*	65	143	371	602*	899*	1,204*
2 to <3 years	129	354	56*	134	318	472	704*	851*	1,334*
3 to <6 years	533	396	59	148	314	546	796	1,019	1,543*
6 to <11 years	219	448	89	177	347	682	931	1,090*	1,596*
11 to <16 years	151	687	171*	296	482	947	1,356*	1,839*	2,891*
16 to <18 years	53	657*	152*	231*	398*	823*	1,628*	1,887*	2,635*
18 to <21 years	33	569*	103*	142*	371*	806*	1,160*	1,959*	1,962*
>21 years	1,386	1,137	236	503	976	1,533	2,161	2,739	4,673
>65 years[c]	323	1,259	360	680	1,188	1,660	2,136	2,470	3,707*
All ages	2,735	963	148	347	741	1,344	1,970	2,468	3,814

[a] Excludes individuals who did not ingest water from the source during the survey period.
[b] Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
\- Insufficient sample size to estimate means and percentiles.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-20. Consumers Only[a] Estimates of Combined Direct and Indirect[b] Water Ingestion: All Sources (mL/day)

Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	58	511*	51*	266*	520*	713*	858*	986*	1,274*
1 to <3 months	178	555	68*	275	545	801	946*	1,072*	1,470*
3 to <6 months	363	629	69	384	612	851	1,064	1,330*	1,522*
6 to <12 months	667	567	90	250	551	784	1,050	1,303	1,692*
1 to <2 years	1,017	366	84	159	294	481	735	978	1,281*
2 to <3 years	1,051	439	105	213	375	589	825	1,001	1,663*
3 to <6 years	4,350	518	134	255	442	682	980	1,206	1,796
6 to <11 years	1,659	603	177	310	506	805	1,131	1,409	2,168*
11 to <16 years	1,000	837	229	404	665	1,105	1,649	1,961	3,184*
16 to <18 years	357	983	252	395	754	1,276	1,865	2,346*	3,866*
18 to <21 years	383	1,094	219	424	823	1,397	2,144	3,002*	4,967*
>21 years	9,178	1,472	506	829	1,282	1,877	2,559	3,195	5,175
>65 years[c]	2,167	1,453	651	939	1,345	1,833	2,324	2,708	3,750
All ages	20,261	1,242	296	585	1,047	1,642	2,345	2,923	4,808

[a] Excludes individuals who did not ingest water from the source during the survey period.
[b] Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-21. Consumers Only[a] Estimates of Combined Direct and Indirect[b] Water Ingestion, Mean Confidence Intervals and Bootstrap Intervals for 90th and 95th Percentiles: All Sources (mL/day)

Age	Sample size	Mean			90th percentile			95th percentile		
			90% C.I.			90% B.I.			90% B.I.	
		Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Birth to <1 month	58	511*	417*	606*	858*	856*	993*	986*	974*	1,076*
1 to <3 months	178	555	487	622	946*	891*	1,042*	1,072*	1,022*	1,183*
3 to <6 months	363	629	587	672	1,064	1,011	1,177	1,330*	1,183*	1,431*
6 to <12 months	667	567	534	600	1,050	1,001	1,141	1,303	1,181	1,372
1 to <2 years	1,017	366	346	385	735	715	765	978	915	1,001
2 to <3 years	1,051	439	420	457	825	784	857	1,001	944	1,075
3 to <6 years	4,350	518	499	537	980	961	1,000	1,206	1,171	1,253
6 to <11 years	1,659	603	574	632	1,131	1,075	1,162	1,409	1,336	1,468
11 to <16 years	1,000	837	773	901	1,649	1,568	1,749	1,961	1,873	2,104
16 to <18 years	357	983	896	1,071	1,865	1,774	1,982	2,346*	2,129*	2,599*
18 to <21 years	383	1,094	999	1,189	2,144	1,951	2,299	3,002*	2,576*	3,785*
>21 years	9,178	1,472	1,472	1,432	2,559	2,522	2,602	3,195	3,121	3,363
>65 years[c]	2,167	1,453	1,415	1,491	2,324	2,279	2,388	2,708	2,636	2,789
All ages	20,261	1,242	1,210	1,274	2,345	2,284	2,403	2,923	2,842	2,997

[a] Excludes individuals who did not ingest water from the source during the survey period.
[b] Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
* The sample size does not meet minimum requirements as described in the Third *Report on Nutrition Monitoring in the United States* (LSRO, 1995).
CI = Confidence Interval.
BI = Bootstrap Interval.

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-22. Consumers Only[a] Estimates of Direct and Indirect[b] Water Ingestion: Community Water (mL/kg-day)

Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	37	137*	11*	65*	138*	197*	235*	238*	263*
1 to <3 months	108	119	12*	71	107	151	228*	285*	345*
3 to <6 months	269	80	7	27	77	118	148	173*	222*
6 to <12 months	534	53	5	12	47	81	112	129	186*
1 to <2 years	880	27	4	9	20	36	56	75	109*
2 to <3 years	879	26	4	9	21	36	52	62	121*
3 to <6 years	3,703	24	3	8	19	33	49	65	97
6 to <11 years	1,439	17	3	6	13	23	35	45	72*
11 to <16 years	911	13	2	5	10	17	26	34	54*
16 to <18 years	339	12	1	4	9	16	24	32*	58*
18 to <21 years	361	13	2	5	10	17	29	35*	63*
>21 years	8,355	16	3	7	13	22	32	39	63
>65 years[c]	1,927	18	5	10	16	24	34	37	53
All ages	17,815	17	3	7	13	22	33	44	77

[a] Excludes individuals who did not ingest water from the source during the survey period.
[b] Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-23. Consumers Only[a] Estimates of Direct and Indirect[b] Water Ingestion: Bottled Water (mL/kg-day)

Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	25	-	-	-	-	-	-	-	-
1 to <3 months	64	92*	7*	12*	76*	151*	164*	220*	411*
3 to <6 months	95	72	6*	15	69	100	149*	184*	213*
6 to <12 months	185	47	5*	11	34	73	104*	120*	166*
1 to <2 years	216	22	5	8	16	27	49	66*	103*
2 to <3 years	211	25	4	8	17	35	54	81*	91*
3 to <6 years	946	21	4	8	16	29	45	57	90*
6 to <11 years	295	15	3	5	11	19	30	42*	69*
11 to <16 years	180	11	2*	4	8	14	24*	27*	44*
16 to <18 years	63	10*	1*	3*	7*	11*	23*	27*	37*
18 to <21 years	93	11	2*	3	6	14	27*	30*	54*
>21 years	1,861	12	2	5	9	16	25	31	45
>65 years[c]	297	13	3	7	12	17	26	30	42*
All ages	4,234	13	2	5	9	17	27	36	72

[a] Excludes individuals who did not ingest water from the source during the survey period.
[b] Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
\- Insufficient sample size to estimate means and percentiles.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-24. Consumers Only[a] Estimates of Direct and Indirect[b] Water Ingestion: Other Sources (mL/kg-day)

Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	3	-	-	-	-	-	-	-	-
1 to <3 months	19	-	-	-	-	-	-	-	-
3 to <6 months	38	80*	10*	23*	59*	106*	170*	200*	246*
6 to <12 months	68	44*	4*	10*	33*	65*	95*	106*	147*
1 to <2 years	95	23	1*	5	13	28	46*	84*	125*
2 to <3 years	124	26	4*	10	21	34	55*	66*	114*
3 to <6 years	505	22	3	8	17	30	46	56	79*
6 to <11 years	208	16	3	6	12	23	32	39*	62*
11 to <16 years	148	13	3*	6	9	18	27*	36*	56*
16 to <18 years	52	10*	2*	4*	7*	12*	24*	29*	43*
18 to <21 years	33	8*	1*	2*	6*	10*	16*	27*	31*
>21 years	1,365	15	3	6	13	21	30	39	58
>65 years[c]	322	18	5	9	16	24	31	37	50*
All ages	2,657	16	3	6	12	21	32	41	67

a Excludes individuals who did not ingest water from the source during the survey period.
b Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
\- Indicates insufficient sample size to estimate distribution percentiles.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-25. Consumers Only[a] Estimates of Direct and Indirect[b] Water Ingestion: All Sources (mL/kg-day)									
Age	Sample size	Mean	Percentiles						
			10	25	50	75	90	95	99
Birth to <1 month	55	153*	13*	83*	142*	208*	269*	273*	400*
1 to <3 months	172	116	12*	50	107	161	216*	291*	361*
3 to <6 months	346	90	9	52	86	125	161	195*	233*
6 to <12 months	631	63	10	27	58	88	120	152	198*
1 to <2 years	980	31	7	14	25	40	64	86	122*
2 to <3 years	989	31	7	15	27	41	59	73	130*
3 to <6 years	4,072	29	7	15	25	38	56	70	102*
6 to <11 years	1,542	21	6	10	18	27	39	50	76*
11 to <16 years	970	16	4	8	13	20	31	39	60*
16 to <18 years	354	15	4	7	12	18	29	37*	60*
18 to <21 years	378	16	3	6	12	21	32	41*	73*
>21 years	9,020	20	7	11	17	26	36	44	68
>65 years[c]	2,136	21	9	13	19	27	34	39	54
All ages	19,509	21	6	11	17	26	38	50	87

a Excludes individuals who did not ingest water from the source during the survey period.
b Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-26. Consumer Only[a] Estimates of Direct and Indirect[b] Water Ingestion, Mean Confidence Intervals and Bootstrap Intervals for 90th and 95th Percentiles (mL/kg-day)

Age	Sample size	Mean			90th percentile			95th percentile		
			90% C.I.			90% B.I.			90% B.I.	
		Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Birth to <1 month	55	153*	125*	181*	269*	234*	273*	273*	263*	332*
1 to <3 months	172	116	100	132	216*	176*	259*	291*	214*	316*
3 to <6 months	346	90	83	97	161	145	178	195*	174*	212*
6 to <12 months	631	63	59	67	120	117	127	152	137	166
1 to <2 years	980	31	30	33	64	57	67	86	70	89
2 to <3 years	989	31	30	33	59	56	61	73	67	81
3 to <6 years	4,072	29	28	30	56	54	57	70	67	73
6 to <11 years	1,542	21	20	22	39	37	41	50	46	52
11 to <16 years	970	16	15	17	31	29	33	39	38	42
16 to <18 years	354	15	14	16	29	27	32	37*	33v	44*
18 to <21 years	378	16	15	18	32	29	35	41*	36*	56*
>21 years	9,020	20	20	21	36	34	37	44	42	46
>65 years[c]	1,025	22	21	22	35	34	37	50	48	52
All ages	19,509	21	21	22	38	38	39	50	49	51

[a] Excludes individuals who did not ingest water from the source during the survey period.
[b] Direct water defined as water ingested directly as a beverage; indirect water defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).
CI = Confidence Interval.
BI = Bootstrap Interval.

Source: Kahn, 2008 (Based on 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII).

Table 3-27. Assumed Tapwater Content of Beverages in Great Britain

Beverage	% Tapwater
Cold Water	100
Home-made Beer/Cider/Lager	100
Home-made Wine	100
Other Hot Water Drinks	100
Ground/Instant Coffee:[a]	
Black	100
White	80
Half Milk	50
All Milk	0
Tea	80
Hot Milk	0
Cocoa/Other Hot Milk Drinks	0
Water-based Fruit Drink	75
Fizzy Drinks	0
Fruit Juice 1[b]	0
Fruit Juice 2[b]	75
Milk	0
Mineral Water[c]	0
Bought cider/beer/lager	0
Bought Wine	0

[a] Black - coffee with all water, milk not added; White - coffee with 80% water, 20% milk; Half Milk - coffee with 50% water, 50% milk; All Milk - coffee with all milk, water not added.

[b] Fruit juice: individuals were asked in the questionnaire if they consumed ready-made fruit juice (type 1 above), or the variety that is diluted (type 2).

[c] Information on volume of mineral water consumed was obtained only as "number of bottles per week." A bottle was estimated at 500 mL, and the volume was split so that 2/7 was assumed to be consumed on weekends, and 5/7 during the week.

Source: Hopkins and Ellis, 1980.

Table 3-28. Intake of Total Liquid, Total Tapwater, and Various Beverages (L/day) by the British Population

Beverage	All Individuals					Consumers Only[a]			
	Mean Intake	Approx. Std. Error of Mean	Approx. 95% Confidence Interval for Mean	10 and 90 Percentiles	1 and 99 Percentiles	Percentage of Total Number of Individuals	Mean Intake	Approx. Std. Error of Mean	Approx. 95% Confidence Interval for Mean
Total Liquid	1.589	0.0203	1.547-1.629	0.77-2.57	0.34-4.50	100	1.589	0.0203	1.547-1.629
Total Liquid Home	1.104	0.0143	1.075-1.133	0.49-1.79	0.23-3.10	100	1.104	0.0143	1.075-1.133
Total Liquid Away	0.484	0.0152	0.454-0.514	0.00-1.15	0.00-2.89	89.9	0.539	0.0163	0.506-0.572
Total Tapwater	0.955	0.0129	0.929-0.981	0.39-1.57	0.10-2.60	99.8	0.958	0.0129	0.932-0.984
Total Tapwater Home	0.754	0.0116	0.731-0.777	0.26-1.31	0.02-2.30	99.4	0.759	0.0116	0.736-0.782
Total Tapwater Away	0.201	0.0056	0.190-0.212	0.00-0.49	0.00-0.96	79.6	0.253	0.0063	0.240-0.266
Tea	0.584	0.0122	0.560-0.608	0.01-1.19	0.00-2.03	90.9	0.643	0.0125	0.618-0.668
Coffee	0.19	0.0059	0.178-0.202	0.00-0.56	0.00-1.27	63	0.302	0.0105	0.281-0.323
Other Hot Water Drinks	0.011	0.0015	0.008-0.014	0.00-0.00	0.00-0.25	9.2	0.12	0.0133	0.093-0.147
Cold Water	0.103	0.0049	0.093-0.113	0.00-0.31	0.00-0.85	51	0.203	0.0083	0.186-0.220
Fruit Drinks	0.057	0.0027	0.052-0.062	0.00-0.19	0.00-0.49	46.2	0.123	0.0049	0.113-0.133
Non Tapwater	0.427	0.0058	0.415-0.439	0.20-0.70	0.06-1.27	99.8	0.428	0.0058	0.416-0.440
Home-brew	0.01	0.0017	0.007-0.013	0.00-0.00	0.00-0.20	7	0.138	0.0209	0.096-0.180
Bought Alcoholic Beverages	0.206	0.0123	0.181-0.231	0.00-0.68	0.00-2.33	43.5	0.474	0.025	0.424-0.524

[a] "Consumers only" is defined as only those individuals who reported consuming the beverage during the survey period.

Source: Hopkins and Ellis, 1980.

Table 3-29. Summary of Total Liquid and Total Tapwater Intake for Males and Females (L/day) in Great Britian

Beverage	Age Group (years)	Number		Mean Intake		Approx. Std. Error of Mean		Approx 95% Confidence Interval for Mean		10 and 90 Percentiles	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Total Liquid Intake	1-4	88	75	0.853	0.888	0.0557	0.066	0.742-0.964	0.756-1.020	0.38-1.51	0.39-1.48
	5-11	249	201	0.986	0.902	0.0296	0.0306	0.917-1.045	0.841-0.963	0.54-1.48	0.51-1.39
	12-17	180	169	1.401	1.198	0.0619	0.0429	1.277-1.525	1.112-1.284	0.75-2.27	0.65-1.74
	18-30	333	350	2.184	1.547	0.0691	0.0392	2.046-2.322	1.469-1.625	1.12-3.49	0.93-2.30
	31-54	512	551	2.112	1.601	0.0526	0.0215	2.007-2.217	1.558-1.694	1.15-3.27	0.95-2.36
	≥55	396	454	1.83	1.482	0.0498	0.0356	1.730-1.930	1.411-1.553	1.03-2.77	0.84-2.17
Total Tapwater Intake	1-4	88	75	0.477	0.464	0.0403	0.0453	0.396-0.558	0.373-0.555	0.17-0.85	0.15-0.89
	5-11	249	201	0.55	0.533	0.0223	0.0239	0.505-0.595	0.485-0.581	0.22-0.90	0.22-0.93
	12-17	180	169	0.805	0.725	0.0372	0.0328	0.731-0.8790	0.659-0.791	0.29-1.35	0.31-1.16
	18-30	333	350	1.006	0.991	0.0363	0.0304	0.933-1.079	0.930-1.052	0.45-1.62	0.50-1.55
	31-54	512	551	1.201	1.091	0.0309	0.024	1.139-1.263	1.043-1.139	0.64-1.88	0.62-1.68
	≥55	396	454	1.133	1.027	0.0347	0.0273	1.064-1.202	0.972-1.082	0.62-1.72	0.54-1.57

Source: Hopkins and Ellis, 1980.

Table 3-30. Daily Total Tapwater Intake Distribution for Canadians, by Age Group
(Approx. 0.20 L increments, both sexes, combined seasons)

Amount Consumed[a] L/day	Age Group (years)					
	5 and Under		6-17		18 and Over	
	%	Number	%	Number	%	Number
0.00 - 0.21	11.1	9	2.8	7	0.5	3
0.22 - 0.43	17.3	14	10.0	25	1.9	12
0.44 - 0.65	24.8	20	13.2	33	5.9	38
0.66 - 0.86	9.9	8	13.6	34	8.5	54
0.87 - 1.07	11.1	9	14.4	36	13.1	84
1.08 - 1.29	11.1	9	14.8	37	14.8	94
1.30 - 1.50	4.9	4	9.6	24	15.3	98
1.51 - 1.71	6.2	5	6.8	17	12.1	77
1.72 - 1.93	1.2	1	2.4	6	6.9	44
1.94 - 2.14	1.2	1	1.2	3	5.6	36
2.15 - 2.36	1.2	1	4.0	10	3.4	22
2.37 - 2.57	-	0	0.4	1	3.1	20
2.58 - 2.79	-	0	2.4	6	2.7	17
2.80 - 3.00	-	0	2.4	6	1.4	9
3.01 - 3.21	-	0	0.4	1	1.1	7
3.22 - 3.43	-	0	-	0	0.9	6
3.44 - 3.64	-	0	-	0	0.8	5
3.65 - 3.86	-	0	-	0	-	0
>3.86	-	0	1.6	4	2.0	13
TOTAL	100.0	81	100.0	250	100.0	639

[a] Includes tapwater and foods and beverages derived from tapwater.

Source: Canadian Ministry of National Health and Welfare, 1981.

Table 3-31. Average Daily Tapwater Intake of Canadians (expressed as milliliters per kilogram body weight)			
Age Group (years)	Average Daily Intake (mL/kg)		
	Females	Males	Both Sexes
<3	53	35	45
3 to 5	49	48	48
6 to 17	24	27	26
18 to 34	23	19	21
35 to 54	25	19	22
≥ 55	24	21	22
Total Population	24	21	22

Source: Canadian Ministry of National Health and Welfare, 1981.

Table 3-32. Average Daily Total Tapwater Intake of Canadians, by Age and Season (L/day)[a]							
	Age (years)						
	<3	3 to 5	6 to 17	18 to 34	35 to 54	≤55	All Ages
Average							
Summer	0.57	0.86	1.14	1.33	1.52	1.53	1.31
Winter	0.66	0.88	1.13	1.42	1.59	1.62	1.37
Summer/Winter	0.61	0.87	1.14	1.38	1.55	1.57	1.34
90th Percentile							
Summer/Winter	1.5	1.5	2.21	2.57	2.57	2.29	2.36

[a] Includes tapwater and foods and beverages derived from tapwater.

Source: Canadian Ministry of National Health and Welfare, 1981.

Table 3-33. Average Daily Total Tapwater Intake of Canadians as a Function of Level of Physical Activity at Work and in Spare Time (16 years and older, combined seasons, L/day)

Activity Level[a]	Work		Spare Time	
	Consumption[b] L/day	Number of Respondents	Consumption[b] L/day	Number of Respondents
Extremely Active	1.72	99	1.57	52
Very Active	1.47	244	1.51	151
Somewhat Active	1.47	217	1.44	302
Not Very Active	1.27	67	1.52	131
Not At All Active	1.3	16	1.35	26
Did Not State	1.3	45	1.31	26
TOTAL		688		688

a The levels of physical activity listed here were not defined any further by the survey report, and categorization of activity level by survey participants is assumed to be subjective.
b Includes tapwater and foods and beverages derived from tapwater.

Source: Canadian Ministry of National Health and Welfare, 1981.

Table 3-34. Average Daily Tapwater Intake by Canadians, Apportioned Among Various Beverages (Both sexes, by age, combined seasons, L/day)[a]

	Age Group (years)					
	< 3	3 to 5	6 to 17	18 to 34	35 to 54	≥ 55
Total Number in Group	34	47	250	232	254	153
Water	0.14	0.31	0.42	0.39	0.38	0.38
Ice/Mix	0.01	0.01	0.02	0.04	0.03	0.02
Tea	*	0.01	0.05	0.21	0.31	0.42
Coffee	0.01	*	0.06	0.37	0.5	0.42
"Other Type of Drink"	0.21	0.34	0.34	0.2	0.14	0.11
Reconstituted Milk	0.1	0.08	0.12	0.05	0.04	0.08
Soup	0.04	0.08	0.07	0.06	0.08	0.11
Homemade Beer/Wine	*	*	0.02	0.04	0.07	0.03
Homemade Popsicles	0.01	0.03	0.03	0.01	*	*
Baby Formula, etc.	0.09	*	*	*	*	*
TOTAL	0.61	0.86	1.14	1.38	1.55	1.57

a Includes tapwater and foods and beverages derived from tapwater.
* Less than 0.01 L/day.

Source: Canadian Ministry of National Health and Welfare, 1981.

Table 3-35. Intake Rates of Total Fluids and Total Tapwater by Age Group		
	Average Daily Consumption Rate (L/day)	
Age Group	Total Fluids[a]	Total Tapwater[b]
6 to 11 months	0.80	0.20
2 years	0.99	0.50
14 to 16 years	1.47	0.72
25 to 30 years	1.76	1.04
60 to 65 years	1.63	1.26

[a] Includes milk, "ready-to-use" formula, milk-based soup, carbonated soda, alcoholic beverages, canned juices, water, coffee, tea, reconstituted juices, and reconstituted soups. Does not include reconstituted infant formula.

[b] Includes water, coffee, tea, reconstituted juices, and reconstituted soups.

Source: Derived from Pennington, 1983.

Table 3-36. Mean and Standard Error for the Daily Intake of Beverages and Tapwater by Age				
Age (years)	Tapwater Intake (mL)	Water-Based Drinks (mL)[a]	Soups (mL)	Total Beverage Intake[b] (mL)
All ages	662.5 ± 9.9	457.1 ± 6.7	45.9 ± 1.2	1,434.0 ± 13.7
< 1	170.7 ± 64.5	8.3 ± 43.7	10.1 ± 7.9	307.0 ± 89.2
1 to 4	434.6 ± 31.4	97.9 ± 21.5	43.8 ± 3.9	743.0 ± 43.5
5 to 9	521.0 ± 26.4	116.5 ± 18.0	36.6 ± 3.2	861.0 ± 36.5
10 to 14	620.2 ± 24.7	140.0 ± 16.9	35.4 ± 3.0	1,025.0 ± 34.2
15 to 19	664.7 ± 26.0	201.5 ± 17.7	34.8 ± 3.2	1,241.0 ± 35.9
20 to 24	656.4 ± 33.9	343.1 ± 23.1	38.9 ± 4.2	1,484.0 ± 46.9
25 to 29	619.8 ± 34.6	441.6 ± 23.6	41.3 ± 4.2	1,531.0 ± 48.0
30 to 39	636.5 ± 27.2	601.0 ± 18.6	40.6 ± 3.3	1,642.0 ± 37.7
40 to 59	735.3 ± 21.1	686.5 ± 14.4	51.6 ± 2.6	1,732.0 ± 29.3
≥60	762.5 ± 23.7	561.1 ± 16.2	59.4 ± 2.9	1,547.0 ± 32.8

[a] Includes water-based drinks such as coffee, etc. Reconstituted infant formula does not appear to be included in this group.

[b] Includes tapwater and water-based drinks such as coffee, tea, soups, and other drinks such as soft drinks, fruitades, and alcoholic drinks.

Source: U.S. EPA, 1984.

Table 3-37. Average Total Tapwater Intake Rate by Sex Age, and Geographic Area

Group/Subgroup	Number of Respondents	Average Total Tapwater Intake,[a,b] L/day
Total group	5,258	1.39
Sex		
Males	3,892	1.40
Females	1,366	1.35
Age, years		
21 to 44	291	1.30
45 to 64	1,991	1.48
65 to 84	2,976	1.33
Geographic area		
Atlanta	207	1.39
Connecticut	844	1.37
Detroit	429	1.33
Iowa	743	1.61
New Jersey	1,542	1.27
New Mexico	165	1.49
New Orleans	112	1.61
San Francisco	621	1.36
Seattle	316	1.44
Utah	279	1.35

[a] Standard deviations not reported in Cantor et al. (1987).
[b] Total tapwater defined as all water and beverages derived from tapwater.

Source: Cantor et al., 1987.

Table 3-38. Frequency Distribution of Total Tapwater Intake Rates[a]

Consumption Rate (L/day)	Frequency[b] (%)	Cumulative Frequency[b] (%)
≤0.80	20.6	20.6
0.81-1.12	21.3	41.9
1.13-1.44	20.5	62.4
1.45-1.95	19.5	81.9
≥1.96	18.1	100.0

[a] Represents consumption of tapwater and beverages derived from tapwater in a "typical" winter week.
[b] Extracted from Table 3 in the article by Cantor et al. (1987).

Source: Cantor, et al., 1987.

Table 3-39. Total Tapwater Intake (mL/day) for Both Sexes Combined[a]													
Age (years)	Number of Observations	Mean	SD	S.E. of Mean	Percentile Distribution								
					1	5	10	25	50	75	90	95	99
<0.5	182	272	247	18	*	0	0	80	240	332	640	800	*
0.5 to 0.9	221	328	265	18	*	0	0	117	268	480	688	764	*
1 to 3	1,498	646	390	10	33	169	240	374	567	820	1,162	1,419	1,899
4 to 6	1,702	742	406	10	68	204	303	459	660	972	1,302	1,520	1,932
7 to 10	2,405	787	417	9	68	241	318	484	731	1,016	1,338	1,556	1,998
11 to 14	2,803	925	521	10	76	244	360	561	838	1,196	1,621	1,924	2,503
15 to 19	2,998	999	593	11	55	239	348	587	897	1,294	1,763	2,134	2,871
20 to 44	7,171	1,255	709	8	105	337	483	766	1,144	1,610	2,121	2,559	3,634
45 to 64	4,560	1,546	723	11	335	591	745	1,057	1,439	1,898	2,451	2,870	3,994
65 to 74	1,663	1,500	660	16	301	611	766	1,044	1,394	1,873	2,333	2,693	3,479
≥75	878	1,381	600	20	279	568	728	961	1,302	1,706	2,170	2,476	3,087
Infants (ages <1)	403	302	258	13	0	0	0	113	240	424	649	775	1,102
Children (ages 110)	5,605	736	410	5	56	192	286	442	665	960	1,294	1,516	1,954
Teens (ages 11-19)	5,801	965	562	7	67	240	353	574	867	1,246	1,701	2,026	2,748
Adults (ages 20-64)	11,731	1,366	728	7	148	416	559	870	1,252	1,737	2,268	2,707	3,780
Adults (ages ≥65)	2,541	1,459	643	13	299	598	751	1,019	1,367	1,806	2,287	2,636	3,338
All	26,081	1,193	702	4	80	286	423	690	1,081	1,561	2,092	2,477	3,415

[a] Total tapwater is defined as "all water from the household tap consumed directly as a beverage or used to prepare foods and beverages."
* Value not reported due to insufficient number of observations.

Source: Ershow and Cantor, 1989.

Table 3-40. Total Tapwater Intake (mL/kg-day) for Both Sexes Combined[a]

Age (years)	Number of Observations		Mean	SD	S.E. of Mean	Percentile Distribution								
	Actual Count	Weighted Count				1	5	10	25	50	75	90	95	99
<0.5	182	201.2	52.4	53.2	3.9	*	0	0	14.8	37.8	66.1	128.3	155.6	*
0.5 to 0.9	221	243.2	36.2	29.2	2	*	0	0	15.3	32.2	48.1	69.4	102.9	*
1 to 3	1,498	1,687.7	46.8	28.1	0.7	2.7	11.8	17.8	27.2	41.4	60.4	82.1	101.6	140.6
4 to 6	1,702	1,923.9	37.9	21.8	0.5	3.4	10.3	14.9	21.9	33.3	48.7	69.3	81.1	103.4
7 to 10	2,405	2,742.4	26.9	15.3	0.3	2.2	7.4	10.3	16	24	35.5	47.3	55.2	70.5
11 to 14	2,803	3,146.9	20.2	11.6	0.2	1.5	4.9	7.5	11.9	18.1	26.2	35.7	41.9	55
15 to 19	2,998	3,677.9	16.4	9.6	0.2	1	3.9	5.7	9.6	14.8	21.5	29	35	46.3
20 to 44	7,171	13,444.5	18.6	10.7	0.1	1.6	4.9	7.1	11.2	16.8	23.7	32.2	38.4	53.4
45 to 64	4,560	8,300.4	22	10.8	0.2	4.4	8	10.3	14.7	20.2	27.2	35.5	42.1	57.8
65 to 74	1,663	2,740.2	21.9	9.9	0.2	4.6	8.7	10.9	15.1	20.2	27.2	35.2	40.6	51.6
≥75+	878	1,401.8	21.6	9.5	0.3	3.8	8.8	10.7	15	20.5	27.1	33.9	38.6	47.2
Infants (ages <1)	403	444.3	43.5	42.5	2.1	0	0	0	15.3	35.3	54.7	101.8	126.5	220.5
Children (ages 1-10)	5,605	6,354.1	35.5	22.9	0.3	2.7	8.3	12.5	19.6	30.5	46.0	64.4	79.4	113.9
Teens (ages 11-19)	5,801	6,824.9	18.2	10.8	0.1	1.2	4.3	6.5	10.6	16.3	23.6	32.3	38.9	52.6
Adults (ages 20-64)	11,731	21,744.9	19.9	10.8	0.1	2.2	5.9	8.0	12.4	18.2	25.3	33.7	40.0	54.8
Adults (ages ≥65)	2,541	4,142.0	21.8	9.8	0.2	4.5	8.7	10.9	15.0	20.3	27.1	34.7	40.0	51.3
All	26,081	39,510.2	22.6	15.4	0.1	1.7	5.8	8.2	13.0	19.4	28.0	39.8	50.0	79.8

[a] Total tapwater is defined as "all water from the household tap consumed directly as a beverage or used to prepare foods and beverages."
* Value not reported due to insufficient number of observations.

Source: Ershow and Cantor, 1989.

Table 3-41. Summary of Tapwater Intake by Age				
Age Group	Intake (mL/day)		Intake (mL/kg-day)	
	Mean	10th-90th Percentiles	Mean	10th-90th Percentiles
Infants (<1 year)	302	0-649	43.5	0 - 100
Children (1 to 10 years)	736	286-1,294	35.5	12.5 - 64.4
Teens (11 to 19 years)	965	353-1,701	18.2	6.5 - 32.3
Adults (20 to 64 years)	1,366	559-2,268	19.9	8.0 - 33.7
Adults (≥65 years)	1,459	751-2,287	21.8	10.9 - 34.7
All ages	1,193	423-2,092	22.6	8.2 - 39.8

Source: Ershow and Cantor, 1989.

Table 3-42. Total Tapwater Intake (as percent of total water intake) by Broad Age Category[a,b]										
Age (years)	Mean	Percentile Distribution								
		1	5	10	25	50	75	90	95	99
<1	26	0	0	0	12	22	37	55	62	82
1 to 10	45	6	19	24	34	45	57	67	72	81
11 to 19	47	6	18	24	35	47	59	69	74	83
20 to 64	59	12	27	35	49	61	72	79	83	90
≥65	65	25	41	47	58	67	74	81	84	90

[a] Does not include pregnant women, lactating women, or breast-fed children.

[b] Total tapwater is defined as "all water from the household tap consumed directly as a beverage or used to prepare foods and beverages."

0 = Less than 0.5 percent.

Source: Ershow and Cantor, 1989.

Table 3-43. General Dietary Sources of Tapwater for Both Sexes[a,b]

Age (years)	Source	% of Tapwater							
		Mean	Standard Deviation	5	25	50	75	95	99
<1	Food[c]	11	24	0	0	0	10	70	100
	Drinking Water	69	37	0	39	87	100	100	100
	Other Beverages	20	33	0	0	0	22	100	100
	All Sources	100							
1 to 10	Food[c]	15	16	0	5	10	19	44	100
	Drinking Water	65	25	0	52	70	84	96	100
	Other Beverages	20	21	0	0	15	32	63	93
	All Sources	100							
11 to 19	Food[c]	13	15	0	3	8	17	38	100
	Drinking Water	65	25	0	52	70	85	98	100
	Other Beverages	22	23	0	0	16	34	68	96
	All Sources	100							
20 to 64	Food[c]	8	10	0	2	5	11	25	49
	Drinking Water	47	26	0	29	48	67	91	100
	Other Beverages	45	26	0	25	44	63	91	100
	All Sources	100							
≥65	Food[c]	8	9	0	2	5	11	23	38
	Drinking Water	50	23	0	36	52	66	87	99
	Other Beverages	42	23	3	27	40	57	85	100
	All Sources	100							
All	Food[c]	10	13	0	2	6	13	31	64
	Drinking Water	54	27	0	36	56	75	95	100
	Other Beverages	36	27	0	14	34	55	87	100
	All Sources	100							

[a] Does not include pregnant women, lactating women, or breast-fed children.
[b] Individual values may not add to totals due to rounding.
[c] Food category includes soups.
0 = Less than 0.5 percent.

Source: Ershow and Cantor, 1989.

Table 3-44. Summary Statistics for Best-Fit Lognormal Distributions for Water Intake Rates[a]

Group (Age in Years)	In Total Fluid Intake Rate		
	Φ	σ	R^2
0 < age < 1	6.979	0.291	0.996
1 # age <11	7.182	0.340	0.953
11 # age <20	7.490	0.347	0.966
20 # age <65	7.563	0.400	0.977
≥ age 65	7.583	0.360	0.988
All ages	7.487	0.405	0.984
Simulated balanced population	7.492	0.407	1.000
Group (Age in Years)	In Total Fluid Intake Rate		
	Φ	σ	R^2
0 < age < 1	5.587	0.615	0.970
1 # age <11	6.429	0.498	0.984
11 # age <20	6.667	0.535	0.986
20 # age <65	7.023	0.489	0.956
≥ age 65	7.088	0.476	0.978
All ages	6.870	0.530	0.978
Simulated balanced population	6.864	0.575	0.995

[a] These values (mL/day) were used in the following equations to estimate the quantiles and averages for total tapwater intake shown in Table 3-13.

97.5 percentile intake rate = exp [$\Phi + (1.96 \cdot \sigma)$]
75 percentile intake rate = exp [$\Phi + (0.6745 \cdot \sigma)$]
50 percentile intake rate = exp [Φ]
25 percentile intake rate = exp [$\Phi - (0.6745 \cdot \sigma)$]
2.5 percentile intake rate = exp [$\Phi - (1.96 \cdot \sigma)$]
Mean intake rate - exp [$\Phi + 0.5 \cdot \sigma^2$)]

Source: Roseberry and Burmaster, 1992.

Table 3-45. Estimated Quantiles and Means for Total Tapwater Intake Rates (mL/day)[a]

Age Group (years)	Percentile 2.5	25	50	75	97.5	Arithmetic Average
0 <age < 1	80	176	267	404	891	323
1 ≤ age < 11	233	443	620	867	1,644	701
11 ≤ age < 20	275	548	786	1,128	2,243	907
20 ≤ age < 65	430	807	1,122	1,561	2,926	1,265
≥ age 65	471	869	1,198	1,651	3,044	1,341
All ages	341	674	963	1,377	2,721	1,108
Simulated Balanced Population	310	649	957	1,411	2,954	1,129

[a] Total tapwater is defined as "all water from the household tap consumed directly as a beverage or used to prepare foods and beverages."

Source: Roseberry and Burmaster, 1992.

Table 3-46. Water Ingested (mL/day)[a] from Water By Itself and Water Added to Other Beverages and Foods					
Category		6 Weeks (N = 124)	3 Months (N = 120)	6 Months (N = 99)	9 Months (N = 77)
Water by Itself	Range	0-355	0-355	0-266	0-473
	Per capita mean[b] ± SD	30 ± 89	30 ± 59	30 ± 59	89 ± 89
	Consumer only mean[c]	89	89	118	118
	Percent consuming[d]	28	24	42	66
Water Added to Formula Powdered Concentrate	Range	0-1,242	0-1,242	0-1,124	0-1,064
	Per capita mean ± SD	177 ± 296	266 ± 384	266 ± 355	207 ± 325
	Consumer only me an	473	621	562	562
	Percent consuming	39	42	48	36
Liquid Concentrate	Range	0-621	0-680	0-710	0-532
	Per capita mean SD	89 ± 148	237 ± 207	148 ± 207	59 ± 148
	Consumer only mean	355	384	414	325
	Percent consuming	23	30	35	21
All Concentrated Formula	Range	0-1,242	0-1,242	0-1,123	0-1,064
	Per capita mean ± SD	266 ± 296	384 ± 355	414 ± 325	266 ± 296
	Consumer only mean	444	562	532	503
	Percent consuming	60	68	81	56
Water Added to Juices and Other Beverages	Range	0-118	0-710	0-473	0-887
	Per capita mean ± SD	<30 ± 30	30 ± 89	30 ± 89	59 ± 148
	Consumer only mean	89	207	148	207
	Percent consuming	3	9	18	32
Water Added to Powdered Baby Foods and Cereals	Range	0-30	0-177	0-266	0-177
	Per capita mean ± SD	<30 ± 30	<30 ± 30	59 ± 59	30 ± 59
	Consumer only mean	30	59	89	89
	Percent consuming	2	17	64	43
Water Added to Other Foods (Soups, Jell-o, Puddings)	Range	-	0-118	0-118	0-355
	Per capita mean ± SD	-	30 ± 30	<30 ± 30	30 ± 59
	Consumer only mean	-	89	59	118
	Percent consuming	0	2	8	29
ALL SOURCES OF WATER	Range	0-1,242	0-1,419	0-1,123	0-1,745
	Per capita mean ± SD	296 ± 325	414 ± 414	473 ± 325	444 ± 355
	Consumer only mean	414	562	503	473
	Percent consuming	68	77	94	97

[a] Converted from ounces/day; 1 fluid ounce = 29.57 mL.
[b] Mean intake among entire sample.
[c] Mean intake for only those ingesting water from the particular category.
[d] Percentage of infants receiving water from that individual source.
N = Number of observations.
SD = Standard Deviation.
\- Indicates there is insufficient sample size to estimate means

Source: Levy et al., 1995.

Table 3-47. Mean Per Capita Drinking Water Intake Based on USDA, CSFII Data From 1989-91 (mL/day)					
Sex and Age (years)	Plain Drinking Water	Coffee	Tea	Fruit Drinks and Ades[a]	Total
Males and Females:					
<1	194	0	<0.5	17	211.5
1 to 2	333	<0.5	9	85	427.5
3 to 5	409	2	26	100	537
≤ 5	359	1	17	86	463
Males:					
6 to 11	537	2	44	114	697
12 to 19	725	12	95	104	936
20 to 29	842	168	136	101	1,247
30 to 39	793	407	136	50	1,386
40 to 49	745	534	149	53	1,481
50 to 59	755	551	168	51	1,525
60 to 69	946	506	115	34	1,601
70 to79	824	430	115	45	1,414
≥80	747	326	165	57	1,295
≥20	809	408	139	60	1,416
Females:					
6 to 11	476	1	40	86	603
12 to 19	604	21	87	87	799
20 to 29	739	154	120	61	1,074
30 to 39	732	317	136	59	1,244
40 to 49	781	412	174	36	1,403
50 to 59	819	438	137	37	1,431
60 to 69	829	429	124	36	1,418
70 to 79	772	324	161	34	1,291
≥80 and over	856	275	149	28	1,308
≥ 20 and over	774	327	141	46	1,288
All individuals	711	260	114	65	1,150

[a] Includes regular and low calorie fruit drinks, punches, and ades, including those made from powdered mix and frozen concentrate. Excludes fruit juices and carbonated drinks.

Source: USDA, 1995.

Table 3-48. Number of Respondents that Consumed Tapwater at a Specified Daily Frequency

Population Group	Total N	None	Number of Glasses in a Day					
			1-2	3-5	6-9	10-19	20+	DK
Overall	4,663	1,334	1,225	1,253	500	151	31	138
Gender								
Male	2,163	604	582	569	216	87	25	65
Female	2,498	728	643	684	284	64	6	73
Refused	2	2	-	-	-	-	-	-
Age (years)								
1 to 4	263	114	96	40	7	1	0	5
5 to 11	348	90	127	86	15	7	2	20
12 to 17	326	86	109	88	22	7	-	11
18 to 64	2,972	908	751	769	334	115	26	54
> 64	670	117	127	243	112	20	2	42
Race								
White	3,774	1,048	1,024	1,026	416	123	25	92
Black	463	147	113	129	38	9	1	21
Asian	77	25	18	23	6	1	-	4
Some Others	96	36	18	22	6	7	2	5
Hispanic	193	63	42	40	28	10	2	7
Refused	60	15	10	13	6	1	1	9
Hispanic								
No	4,244	1,202	1,134	1,162	451	129	26	116
Yes	347	116	80	73	41	18	4	13
DK	26	5	6	7	4	3	-	1
Refused	46	11	5	11	4	1	1	8
Employment								
Full-time	2,017	637	525	497	218	72	18	40
Part-time	379	90	94	120	50	13	7	5
Not Employed	1,309	313	275	413	188	49	3	54
Refused	32	6	4	11	1	2	1	4
Education								
< High School	399	89	95	118	51	14	2	28
High School Graduate	1,253	364	315	330	132	52	13	37
< College	895	258	197	275	118	31	5	9
College Graduate	650	195	157	181	82	19	4	6
Post Graduate	445	127	109	113	62	16	3	12
Census Region								
Northeast	1,048	351	262	266	95	32	7	28
Midwest	1,036	243	285	308	127	26	9	33
South	1,601	450	437	408	165	62	11	57
West	978	290	241	271	113	31	4	20
Day of Week								
Weekday	3,156	864	840	862	334	96	27	106
Weekend	1,507	470	385	391	166	55	4	32
Season								
Winter	1,264	398	321	336	128	45	5	26
Spring	1,181	337	282	339	127	33	10	40
Summer	1,275	352	323	344	155	41	9	40
Fall	943	247	299	234	90	32	7	32
Asthma								
No	4,287	1,232	1,137	1,155	459	134	29	115
Yes	341	96	83	91	40	16	1	13
DK	35	6	5	7	1	1	1	10
Angina								
No	4,500	1,308	1,195	1,206	470	143	29	123
Yes	125	18	25	40	27	6	1	6
DK	38	8	5	7	3	2	1	9
Bronchitis/Emphysema								
No	4,424	1,280	1,161	1,189	474	142	29	124
Yes	203	48	55	58	24	9	1	5
DK	36	6	9	6	2	-	1	9

- = Missing Data
DK = Don't know
N = sample size
Refused = respondent refused to answer

Source: Tsang and Klepeis, 1996.

Table 3-49. Number of Respondents that Consumed Juice Reconstituted with Tapwater at a Specified Daily Frequency

Population Group	Total N	Number of Glasses in a Day						
		None	1-2	3-5	6-9	10-19	20+	DK
Overall	4,663	1,877	1,418	933	241	73	21	66
Gender								
Male	2,163	897	590	451	124	35	17	33
Female	2,498	980	826	482	117	38	4	33
Refused	2	-	2	-	-	-	-	-
Age (years)								
1 to 4	263	126	71	48	11	4	1	2
5 to 11	348	123	140	58	12	2	1	11
12 to 17	326	112	118	63	18	7	1	4
18 to 64	2,972	1,277	817	614	155	46	16	30
> 64	670	206	252	133	43	12	2	14
Race								
White	3,774	1,479	1,168	774	216	57	16	44
Black	463	200	142	83	15	9	1	7
Asian	77	33	27	15	1	-	-	0
Some Others	96	46	19	24	2	1	3	1
Hispanic	193	95	51	30	5	5	1	5
Refused	60	24	11	7	2	1	-	9
Hispanic								
No	4,244	1,681	1,318	863	226	64	17	49
Yes	347	165	87	61	14	7	4	7
DK	26	11	6	5	-	1	-	3
Refused	46	20	7	4	1	1	-	7
Employment								
Full-time	2,017	871	559	412	103	32	9	20
Part-time	379	156	102	88	19	7	2	5
Not Employed	1,309	479	426	265	75	20	7	21
Refused	32	15	4	4	2	1	-	3
Education								
< High School	399	146	131	82	25	7	2	4
High School Graduate	1,253	520	355	254	68	21	7	17
< College	895	367	253	192	47	18	5	11
College Graduate	650	274	201	125	31	7	1	5
Post Graduate	445	182	130	92	26	5	3	4
Census Region								
Northeast	1,048	440	297	220	51	13	4	15
Midwest	1,036	396	337	200	63	17	4	14
South	1,601	593	516	332	84	26	10	28
West	978	448	268	181	43	17	3	9
Day of Week								
Weekday	3,156	1,261	969	616	162	51	11	46
Weekend	1,507	616	449	307	79	22	10	20
Season								
Winter	1,264	529	382	245	66	23	4	10
Spring	1,181	473	382	215	54	19	8	17
Summer	1,275	490	389	263	68	18	6	28
Fall	943	385	265	210	53	13	3	11
Asthma								
No	4,287	1,734	1,313	853	216	69	20	55
Yes	341	130	102	74	25	3	1	5
DK	35	13	3	6	-	1	-	6
Angina								
No	4,500	1,834	1,362	900	231	67	20	59
Yes	125	31	53	25	7	5	1	1
DK	38	12	3	8	3	1	-	6
Bronchitis/Emphysema								
No	4,424	1,782	1,361	882	230	65	21	57
Yes	203	84	53	44	10	6	-	3
DK	36	11	4	7	1	2	-	6

- = Missing Data
DK = Don't know
N = sample size
Refused = Respondent refused to answer

Source: Tsang and Klepeis, 1996.

Table 3-50. Mean and (Standard Error) Water Consumption (mL/kg-day) by Race/Ethnicity										
Race/Ethnic Group	N	Plain Tap Water	Milk and Milk Drinks	Reconstituted Formula	RTF Formula	Baby Food	Juices and Carbonated Drinks	Non-carbonated Drinks	Other	Total[a]
Black non-Hispanic	121	21 (1.7)	24 (4.6)	35 (6.0)	4 (2.0)	8 (1.6)	2 (0.7)	14 (1.3)	21 (1.7)	129 (5.7)
White non-Hispanic	620	13 (0.8)	23 (1.2)	29 (2.7)	8 (1.5)	10 (1.2)	1 (0.2)	11 (0.7)	18 (0.8)	113 (2.6)
Hispanic	146	15 (1.2)	23 (2.4)	38 (7.3)	12 (4.0)	10 (1.4)	1 (0.3)	10 (1.6)	16 (1.4)	123 (5.2)
Other	59	21 (2.4)	19 (3.7)	31 (9.1)	19 (11.2)	7 (4.0)	1 (0.5)	8 (2.0)	19 (3.2)	124 (10.6)

[a] Totals may be slightly different from the sums of all categories due to rounding.
N = Number of observations.
RTF = Ready-to-Feed.
Note: Standard Error shown in parentheses.

Source: Heller et al., 2000.

Table 3-51. Plain Tap Water and Total Water Consumption by Age, Sex, Region, Urbanicity, and Poverty Category

		Plain Tap Water (mL/kg-day)		Total Water (mL/kg-day)	
Variable	N	Mean	SE	Mean	SE
Age					
<12 months	296	11	1.0	130	4.6
12 to 24 months	650	18	0.8	108	1.7
Sex					
Male	475	15	1.0	116	4.1
Female	471	15	0.8	119	3.2
Region					
Northeast	175	13	1.4	121	6.3
Midwest	197	14	1.0	120	3.1
South	352	15	1.3	113	3.7
West	222	17	1.1	119	4.6
Urbanicity					
Urban	305	16	1.5	123	3.5
Suburban	446	13	0.9	117	3.1
Rural	195	15	1.2	109	3.9
Poverty category[a]					
0-1.30	289	19	1.5	128	2.6
1.31-3.50	424	14	1.0	117	4.2
>3.50	233	12	1.3	109	3.5
Total	946	15	0.6	118	2.3

[a] Poverty category represents family's annual incomes of 0-1.30, 1.31-3.50, and greater than 3.50 times the federal poverty level.

N = Number of observations.

SE = Standard Error.

Source: Heller et al., 2000.

Table 3-52. Intake of Water from Various Sources in 2-13-y-old Participants of the DONALD Study 1985-1999				
Water Intake from:	Boys and girls 2 to 3 years N = 858[b]	Boys and girls 4 to 8 years N = 1,795[b]	Boys 9 to 13 years N = 541[b]	Girls 9 to 13 years N = 542[b]
	Mean			
Water in Food (mL/day)[a]	365 (33)[c]	487 (36)	673 (36)	634 (38)
Beverages (mL/day)[a]	614 (55)	693 (51)	969 (51)	823 (49)
Milk (mL/day)[a]	191 (17)	177 (13)	203 (11)	144 (9)
Mineral water (mL/day)[a]	130 (12)	179 (13)	282 (15)	242 (15)
Tap water (mL/day)[a]	45 (4)	36 (3)	62 (3)	56 (3)
Juice (mL/day)[a]	114 (10)	122 (0)	133 (7)	138 (8)
Soft drinks (mL/day)[a]	57 (5)	111 (8)	203 (11)	155 (9)
Coffee/tea (mL/day)[a]	77 (7)	69 (5)	87 (4)	87 (5)
	Mean ± SD			
Total water intake[a,d] (mL/day)	1,114 ± 289	1,363 ± 333	1,891 ± 428	1,676 ± 386
Total water intake[a,d] (mL/kg-day)	78 ± 22	61 ± 13	49 ± 11	43 ± 10
Total water intake[a,d] (mL/kcal-day)	1.1 ± 0.3	0.9 ± 0.2	1.0 ± 0.2	1.0 ± 0.2

[a] Converted from g/day, g/kg-day, or g/kcal-day; 1 g = 1 mL.
[b] N = Number of records.
[c] Percent of total water shown in parentheses.
[d] Total water = water in food + beverages + oxidation.
SD = Standard deviation.

Source: Sichert-Hellert et al., 2001.

Table 3-53. Mean (± Standard Error) Fluid Intake (mL/kg/day) by Children Aged 1 to 10 years, NHANES III, 1988-94			
	Total Sample (N = 7,925)	Sample with Temperature Information (N = 3,869)	Sample without Temperature Information (N = 4,056)
Total fluid	84 ± 1.0	84 ± 1.0	85 ± 1.4
Plain water	27 ± 0.8	27 ± 1.0	26 ± 1.1
Milk	18 ± 0.3	18 ± 0.6	18 ± 0.4
Carbonated drinks	6 ± 0.2	5 ± 0.3	6 ± 0.3
Juice	12 ± 0.3	11 ± 0.6	12 ± 0.4

N = Number of observations.

Source: Sohn et al., 2001.

Table 3-54. Estimated Mean (± Standard Error) Amount of Total Fluid and Plain Water Intake among Children[a] Aged 1 to 10 Years by Age, Sex, Race/Ethnicity, Poverty Income Ratio, Region, and Urbanicity (NHANES III, 1988-94)

		Total Fluid		Plain Water	
	N	mL/day	mL/kg-day	mL/day	mL/kg-day
Age (years)					
1	578	1,393 ± 31	124 ± 2.9	298 ± 19	26 ± 1.8
2	579	1,446 ± 31	107 ± 2.3	430 ± 26	32 ± 1.9
3	502	1,548 ± 75	100 ± 4.6	482 ± 27	31 ± 1.8
4	511	1,601 ± 41	91 ± 2.8	517 ± 23	29 ± 1.3
5	465	1,670 ± 54	84 ± 2.3	525 ± 36	26 ± 1.7
6	255	1,855 ± 125	81 ± 4.9	718 ± 118	31 ± 4.7
7	235	1,808 ± 66	71 ± 2.3	674 ± 46	26 ± 1.9
8	247	1,792 ± 37	61 ± 1.8	626 ± 37	21 ± 1.2
9	254	2,113 ± 78	65 ± 2.1	878 ± 59	26 ± 1.4
10	243	2,051 ± 97	58 ± 2.4	867 ± 74	24 ± 2.0
Sex					
Male	1,974	1,802 ± 30	86 ± 1.8	636 ± 32	29 ± 1.3
Female	1,895	1,664 ± 24	81 ± 1.5	579 ± 26	26 ± 1.0
Race/ethnicity					
White	736	1,653 ± 26	79 ± 1.8	552 ± 34	24 ± .3
African American	1,122	1,859 ± 42	88 ± 1.8	795 ± 36	36 ± 1.5
Mexican American	1,728	1,817 ± 25	89 ± 1.7	633 ± 23	29 ± 1.1
Other	283	1,813 ± 47	90 ± 4.2	565 ± 39	26 ± 1.7
Poverty income ratio[b]					
Low	1,868	1,828 ± 32	93 ± 2.6	662 ± 27	32 ± 1.3
Medium	1,204	1,690 ± 31	80 ± 1.6	604 ± 35	26 ± 1.4
High	379	1,668 ± 54	76 ± 2.5	533 ± 41	22 ± 1.7
Region[c,d]					
Northeast	679	1,735 ± 31	87 ± 2.3	568 ± 52	26 ± 2.1
Midwest	699	1,734 ± 45	84 ± 1.5	640 ± 54	29 ± 1.8
South	869	1,739 ± 31	83 ± 2.2	613 ± 24	28 ± 1.3
West	1,622	737 ± 25	81 ± 1.7	624 ± 44	27 ± 1.9
Urban/rural[d]					
Urban	3,358	1,736 ± 18	84 ± 1.0	609 ± 29	27 ± 1.1
Rural	511	1,737 ± 19	84 ± 4.3	608 ± 20	28 ± 1.2
Total	3,869	1,737 ± 15	84 ± 1.1	609 ± 24	27 ± 1.0

[a] Children for whom temperature data were obtained.
[b] Based on ratio of household income to federal poverty threshold. Low: <u><</u>1.300; medium: 1.301-3.500; high <u>></u>3.501.
[c] All variables except for Region and Urban/rural showed statistically significant differences for both total fluid and plain water intake by Bonferroni multiple comparison method.
[d] Northeast = Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont; Midwest = Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin; South = Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia; West = Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming.
N = Number of observations.

Source: Sohn et al., 2001.

Table 3-55. Tap Water Intake in Breastfed and Formula-fed Infants and Mixed-fed Young Children at Different Age Points

Age	N[a]	Tapwater Intake[b] (mL/day)					Tapwater Intake[b] (mL/kg-day)											
		Total					Total						From Household[c]			From Manufacturing[d]		
		Mean	SD	Median	P95	Max	Mean	SD	Median	P95	Max	%[e]	Mean	SD	%[f]	Mean	SD	%[f]
Breastfed																		
#1 year, total	300	130	180	50	525	1,172	17	24**	6	65	150	17	15	23**	85	2.4	4.7**	15
3 months	111	67	167	0	493	746	10	25**	0	74	125	10	10	25**	97	0.3	1.9**	3
6 months	124	136	150	68	479	634	18	20**	8	5`8	85	18	14	19**	79	3.8	6.3*	21
9 months	47	254	218	207	656	1,172	30	27**	23	77	150	28	26	27**	87	3.7	3.4	13
12 months	18	144	170	85	649	649	15	18**	9	66	66	19	13	18**	86	2.2	2.1	14
Formula fed																		
#1 year, total	758	441	244	440	828	1,603	53	33	49	115	200	51	49	33	92	4.0	8.0	8
3 months	78	662	154	673	874	994	107	23	107	147	159	93	103	28	97	3.4	17.9	3
6 months	141	500	178	519	757	888	63	23	65	99	109	64	59	25	92	4.8	8.0	8
9 months	242	434	236	406	839	1,579	49	27	45	94	200	50	44	27	91	4.5	6.3	9
12 months	297	360	256	335	789	1,603	37	26	32	83	175	39	33	25	91	3.3	3.7	9
Mixed - Breast and Formula																		
1 to 3 years, total	904	241	243	175	676	2,441	19	20	14	56	203	24	15	20	78	3.9	5.5	22
18 months	277	280	264	205	828	1,881	25	23	18	70	183	28	22	23	88	3.0	4.1	12
24 months	292	232	263	158	630	2,441	18	21	12	49	203	23	15	21	80	3.7	5.0	20
36 months	335	217	199	164	578	1,544	14	13	11	36	103	22	9	12	66	4.9	6.6	34

[a] Numbers of 3-day diet records.
[b] Total tap water = tap water from the household and tap water from food manufacturing. Converted from g/day and g/kg-day; 1 g = 1 mL.
[c] Tap water from household = tap water from the household tap consumed directly as a beverage or used to prepare foods and beverages.
[d] Tap water from food = manufacturing tap water from the industrial food production used for the preparation of foods (bread, butter/margarine, tinned fruit, vegetables and legumes, ready to serve meals, commercial weaning food) and mixed beverages (lemonade, soft drinks).
[e] Mean as a percentage of total water.
[f] Mean as a percentage of total tap water.
* Significantly different from formula-fed infants, $p<0.05$.
** Significantly different from formula-fed infants, $p<0.0001$.
SD = Standard Deviation.
P95 = 95th percentile.

Source: Hilbig et al., 2002.

Table 3-56. Percentage of Subjects Consuming Beverages and Mean Daily Beverage Intakes (mL/day) for Children With Returned Questionnaires

Age at Questionnaire	6 Months	9 Months	12 Months	16 Months	20 Months	24 Months	6 to 24 Months[a]
Actual Age (Months)	6.29 ± 0.35	9.28 ± 0.35	12.36 ± 0.46	16.31 ± 0.49	20.46 ± 0.57	24.41 ± 0.53	-
N[b]	677	681	659	641	632	605	585[c]
Human Milk[d]	30	19	11	5	3	0	-
Infant Formula[e]							
%[d]	68	69	29	4	2	0	67[g]
mL/day[f]	798 ± 234	615 ± 328	160 ± 275	12 ± 77	9 ± 83	-	207 ± 112
Cows' Milk[e]							
%[d]	5	25	79	91	93	97	67[g]
mL/day[f]	30 ± 145	136 ± 278	470 ± 310	467 ± 251	402 ± 237	358 ± 225	355 ± 163
Formula and Cows' Milk[e]							
%[d]	70	81	88	92	94	98	67[g]
mL/day[f]	828 ± 186	751 ± 213	630 ± 245	479 ± 248	411 ± 237	358 ± 228	562 ± 154
Juice and Juice Drinks							
%[d]	55	73	89	94	95	93	99[h]
mL/day[f]	65 ± 95	103 ± 112	169 ± 151	228 ± 166	269 ± 189	228 ± 172	183 ± 103
Water							
%[d]	36	59	75	87	90	94	99[h]
mL/day[f]	27 ± 47	53 ± 71	92 ± 109	124 ± 118	142 ± 127	145 ± 148	109 ± 74
Other Beverages[i]							
%[d]	1	9	23	42	62	86	80[h]
mL/day[f]	3 ± 18	6 ± 27	27 ± 71	53 ± 109	83 ± 121	89 ± 133	44 ± 59
Total Beverages mL/day[e,f,j]	934 ± 219	917 ± 245	926 ± 293	887 ± 310	908 ± 310	819 ± 299	920 ± 207

a Cumulative number of children and percentage of children consuming beverage and beverage intakes for the 6 through 24 month period.
b Number of children with returned questionnaires at each time period.
c Number of children with cumulative intakes for six-through 24 month period.
d Percentage of children consuming beverage.
e Children are not included when consuming human milk.
f Mean   standard deviation of beverage intake. Converted from ounces/day; 1 fluid ounce = 29.57 mL.
g Percentage of children consuming beverage during six-through 24 month period. Children who consumed human milk are not included.
h Percentage of children consuming beverage during six-through 24 month period.
i Other beverages include non juice beverages (e.g., carbonated beverages, Kool-Aid).
j Total beverages includes all beverages except human milk.
\- Indicates there is insufficient data

Source: Marshall et al., 2003a.

Table 3-57. Mean (± Standard Deviation) Daily Beverage Intakes Reported on Beverage Frequency Questionnaire and 3-day Food and Beverage Dairies

Beverage	Age											
	6 months (N = 240)			12 months (N = 192)			3 years (N = 129)			5 years (N = 112)		
	Questionnaire	Diary		Questionnaire	Diary		Questionnaire	Diary		Questionnaire	Diary	
	mL/day[a]		%[b]	mL/day[a]		%[b]	mL/day[a]		%[b]	mL/day[a]		%[b]
Human Milk	204 ± 373	195 ± 358	28.0	9 ± 21	56 ± 225	12.6	NA[c]	NA	-	NA	NA	-
Infant formula	609 ± 387	603 ± 364	85.8	180 ± 290	139 ± 251	37.0	NA	NA	-	NA	NA	-
Cow's milk	24 ± 124	24 ± 124	6.7	429 ± 349	408 ± 331	90.4	316 ± 216	358 ± 216	100	319 ± 198	325 ± 177	98.2
Juice/juice drinks	56 ± 124	33 ± 59	57.5	151 ± 136	106 ± 101	92.2	192 ± 169	198 ± 169	96.9	189 ± 169	180 ± 163	95.5
Liquid soft drinks	6 ± 68	0 ± 0	1.3	9 ± 30	3 ± 15	20.9	62 ± 71	74 ± 101	74.2	74 ± 95	101 ± 121	82.1
Powdered soft drinks	0 ± 18	0 ± 0	0.4	12 ± 47	3 ± 18	10.5	62 ± 115	47 ± 101	51.2	74 ± 124	47 ± 95	52.7
Water	44 ± 80	30 ± 53	61.7	127 ± 136	80 ± 109	84.9	177 ± 204	136 ± 177	95.3	240 ± 242	169 ± 183	99.1
Total	940 ± 319	896 ± 195	100	905 ± 387	804 ± 284	100	795 ± 355	816 ± 299	100	896 ± 399	819 ± 302	100

[a] Mean standard deviation of all subjects. Converted from ounces/day; 1 fluid ounce = 29.57 mL.
[b] Percent of subjects consuming beverage on either questionnaire or diary.
[c] NA = not applicable.
N = Number of observations.
\- Indicates there is insufficient data to calculate percentage

Source: Marshall et al., 2003b.

Table 3-58. Consumption of Beverages by Infants and Toddlers (Feeding Infants and Toddlers Study)												
Beverage Category	Age (months)											
	4 to 6 Months (N=862)		7 to 8 Months (N=483)		9 to 11 Months (N=679)		12 to 14 Months (N=374)		15 to 18 Months (N=308)		19 to 24 Months (N=316)	
	Consumers %[a]	Mean ± SD mL/day[b]	Consumers %[a]	Mean ± SD mL/day[b]	Consumers %[a]	Mean ± SD mL/day[b]	Consumers %[a]	Mean ± SD mL/day[b]	Consumers %[a]	Mean ± SD mL/day[b]	Consumers %[a]	Mean ± SD mL/day[b]
Total milks[c]	100	778 ± 257	100	692 ± 257	99.7	659 ± 284	98.2	618 ± 293	94.2	580 ± 305	93.4	532 ± 281
100% Juice[d]	21.3	121 ± 89	45.6	145 ± 109	55.3	160 ± 127	56.2	186 ± 145	57.8	275 ± 189	61.6	281 ± 189
Fruit Drinks[e]	1.6	101 ± 77	7.1	98 ± 77	12.4	157 ± 139	29.1	231 ± 186	38.6	260 ± 231	42.6	305 ± 308
Carbonated	0.1	86 ± 0	1.1	6 ± 9	1.7	89 ± 92	4.5	115 ± 83	11.2	157 ± 106	11.9	163 ± 172
Water	33.7	163 ± 231	56.1	174 ± 219	66.9	210 ± 234	72.2	302 ± 316	74.0	313 ± 260	77.0	337 ± 245
Other[f]	1.4	201 ± 192	2.2	201 ± 219	3.5	169 ± 166	6.6	251 ± 378	12.2	198 ± 231	11.2	166 ± 248
Total beverages	100	863 ± 254	100	866 ± 310	100	911 ± 361	100	1,017 ± 399	100	1,079 ± 399	100	1,097 ± 482

a Weighted percentages, adjusted for over sampling, nonresponse, and under representation of some racial and ethnic groups.
b Amounts consumed only by those children who had a beverage from this beverage category. Converted from ounces/day; 1 fluid ounce = 29.57 mL.
c Includes human milk, infant formula, cow's milk, soy milk, and goat's milk.
d Fruit or vegetable juices with no added sweeteners.
e Includes beverages with less than 100% juice and often with added sweeteners; some were fortified with one or more nutrients.
f "Other" beverages category included tea, cocoa and similar dry milk beverages, and electrolyte replacement beverages for infants.
N = Number of observations.
SD = Standard deviation.

Source: Skinner et al., 2004.

Table 3-59. Per Capita Estimates of Direct and Indirect Water Intake from All Sources by Pregnant, Lactating, and Childbearing Age Women (mL/kg-day)

Women Categories	Sample Size	Mean			90th Percentile			95th Percentile		
			90% C.I.			90% B.I.			90% B.I.	
		Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	69	21*	19*	22*	39*	33*	46*	44*	38*	46*
Lactating	40	21*	15*	28*	53*	44*	55*	55*	52*	57*
Non-Pregnant, Non-Lactating Age 15 to 44	2,166	19	19	20	35	35	36	36	46	47

NOTE: Source of data: 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII0; (2) Estimates are based on 2-day averages; (3) Interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; (4) All estimates exclude commercial and biological water.

90% C.I 90% confidence intervals for estimated means; 90% B.I.: 90% Bootstrap intervals for percentile estimates using boot strap method with 1,000 replications;

* The sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States, 1994-96" (LSRO, 1995).

Source: Kahn and Stralka, 2008b (Based on CSFH 1994-96 and 1998).

Table 3-60. Per Capita Estimates of Direct and Indirect Water Intake from All Sources by Pregnant, Lactating, and Childbearing Age Women (mL/day)

		Mean			90th Percentile			95th Percentile		
			90% C.I.			90% B.I.			90% B.I.	
Women Categories	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	70	1,318*	1,199*	1,436*	2,336*	1,851*	3,690*	2,674*	2,167*	3,690*
Lactating	41	1,806*	1,374*	2,238*	3,021*	2,722*	3,794*	3,767*	3,452*	3,803*
Non-Pregnant, Non-Lactating Age 15 to 44	2,221	1,243	1,193	1,292	2,336	2,222	2,488	2,937	2,774	3,211

NOTE: Source of data: 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII0; (2) Estimates are based on 2-day averages; (3) Interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; (4) All estimates exclude commercial and biological water.

90% C.I. 90% confidence intervals for estimated means; 90% B.I.: 90% Bootstrap intervals for percentile estimates using boot strap method with 1,000 replications;

* The sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States, 1994-96" (LSRO, 1995).

Source: Kahn and Stralka, 2008b (Based on CSFH 1994-96 and 1998).

Table 3-61. Per Capita Estimated Direct and Indirect Community Water Ingestion by Pregnant, Lactating, and Childbearing Age Women (mL/kg-day)

		Mean			90th Percentile			95th Percentile		
			90% C.I.			90% B.I.			90% B.I.	
Women Categories	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	69	13*	11*	14*	31*	28*	46*	43*	33*	46*
Lactating	40	21*	15*	28*	53*	44*	55*	55*	52*	57*
Non-Pregnant, Non-Lactating Age 15 to 44	2,166	14	14	15	31	30	32	38	36	39

NOTE: Source of data: 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII0; (2) Estimates are based on 2-day averages; (3) Interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; (4) All estimates exclude commercial and biological water.

90% C.I. 90% confidence intervals for estimated means; 90% B.I.: 90% Bootstrap intervals for percentile estimates using boot strap method with 1,000 replications;

* The sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States, 1994-96" (LSRO, 1995).

Source: Kahn and Stralka, 2008b (Based on CSFH 1994-96 and 1998).

Table 3-62. Per Capita Estimated Direct and Indirect Community Water Ingestion by Pregnant, Lactating, and Childbearing Age Women (mL/day)

		Mean			90th Percentile			95th Percentile		
			90% C.I.			90% B.I.			90% B.I.	
Women Categories	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	70	819*	669*	969*	1,815*	1,479*	2,808*	2,503*	2,167*	3,690*
Lactating	41	1,379*	1,021*	1,737*	2,872*	2,722*	3,452*	3,434*	2,987*	3,803*
Non-Pregnant, Non-Lactating Age 15 to 44	2,221	916	882	951	1,953	1,854	2,065	2,575	2,403	2,908

NOTE: Source of data: 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII0; (2) Estimates are based on 2-day averages; (3) Interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; (4) All estimates exclude commercial and biological water.

90% C.I. 90% confidence intervals for estimated means; 90% B.I.: 90% Bootstrap intervals for percentile estimates using boot strap method with 1,000 replications;

* The sample size does not meet minimum reporting requirements as described in the *Third Report on Nutrition Monitoring in the United States, 1994-96* (LSRO, 1995).

Source: Kahn and Stralka, 2008b (Based on CSFH 1994-96 and 1998).

Table 3-63. Estimates of Consumers Only Direct and Indirect Water Intake from All Sources by Pregnant, Lactating, and Childbearing Age Women (mL/kg-day)

		Mean			90th Percentile			95th Percentile		
			90% C.I.			90% B.I.			90% B.I.	
Women Categories	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	69	21*	19*	22*	39*	33*	46*	44*	38*	46*
Lactating	40	28*	19*	38*	53*	44*	57*	57*	52*	58*
Non-Pregnant, Non-Lactating Age 15 to 44	2,149	19	19	20	35	34	37	46	42	48

NOTE: Source of data: 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII0; (2) Estimates are based on 2-day averages; (3) Interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; (4) All estimates exclude commercial and biological water.

90% C.I 90% confidence intervals for estimated means; 90% B.I.: 90% Bootstrap intervals for percentile estimates using boot strap method with 1,000 replications;

* The sample size does not meet minimum reporting requirements as described in the *Third Report on Nutrition Monitoring in the United States, 1994-96* (LSRO, 1995).

Source: Kahn and Stralka, 2008b (Based on CSFH 1994-96 and 1998).

Table 3-64. Estimates of Consumers Only Direct and Indirect Water Intake from All Sources by Pregnant, Lactating, and Childbearing Age Women (mL/day)

		Mean			90th Percentile			95th Percentile		
			90% C.I.			90% B.I.			90% B.I.	
Women Categories	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	70	1,318*	1,199*	1,436*	2,336*	1,851*	3,690*	2,674*	2,167*	3,690*
Lactating	41	1,806*	1,374*	2,238*	3,021*	2,722*	3,794*	3,767*	3,452*	3,803*
Non-Pregnant, Non-Lactating Age 15 to 44	2,203	1,252	1,202	1,303	2,338	2,256	2,404	2,941	2,834	3,179

NOTE: Source of data: 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII0; (2) Estimates are based on 2-day averages; (3) Interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; (4) All estimates exclude commercial and biological water.

90% C.I. 90% confidence intervals for estimated means; 90% B.I.: 90% Bootstrap intervals for percentile estimates using boot strap method with 1,000 replications;

* The sample size does not meet minimum reporting requirements as described in the *Third Report on Nutrition Monitoring in the United States, 1994-96* (LSRO, 1995).

Source: Kahn and Stralka, 2008b (Based on CSFH 1994-96 and 1998).

Table 3-65. Consumers Only Estimated Direct and Indirect Community Water Ingestion by Pregnant, Lactating, and Childbearing Age Women (mL/kg/day)

		Mean			90th Percentile			95th Percentile		
			90% C.I.			90% B.I.			90% B.I.	
Women Categories	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	65	14*	12*	15*	33*	29*	46*	43*	33*	46*
Lactating	33	26*	18*	18*	54*	44*	55*	55*	53*	57*
Non-Pregnant, Non-Lactating Age 15 to 44	2,028	15	14	16	32	31	33	38	36	42

NOTE: Source of data: 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII0; (2) Estimates are based on 2-day averages; (3) Interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; (4) All estimates exclude commercial and biological water.

90% C.I. 90% confidence intervals for estimated means; 90% B.I.: 90% Bootstrap intervals for percentile estimates using boot strap method with 1,000 replications;

* The sample size does not meet minimum reporting requirements as described in the *Third Report on Nutrition Monitoring in the United States, 1994-96* (LSRO, 1995).

Source: Kahn and Stralka, 2008b (Based on CSFH 1994-96 and 1998).

Table 3-66. Consumers Only Estimated Direct and Indirect Community Water Ingestion by Pregnant, Lactating, and Childbearing Age Women (mL/day)

Women Categories	Sample Size	Mean Estimate	Mean 90% C.I. Lower Bound	Mean 90% C.I. Upper Bound	90th Percentile Estimate	90th Percentile 90% B.I. Lower Bound	90th Percentile 90% B.I. Upper Bound	95th Percentile Estimate	95th Percentile 90% B.I. Lower Bound	95th Percentile 90% B.I. Upper Bound
Pregnant	65	872*	728*	1,016*	1,844*	1,776*	3,690*	2,589*	2,167*	3,690*
Lactating	34	1,665*	1,181*	2,148*	2,959*	2,722*	3,452*	3,588*	2,987*	4,026*
Non-Pregnant, Non-Lactating Age 15 to 44	2,077	976	937	1,014	2,013	1,893	2,065	2,614	2,475	2,873

NOTE: Source of data: 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII0; (2) Estimates are based on 2-day averages; (3) Interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; (4) All estimates exclude commercial and biological water.

90% C.I. 90% confidence intervals for estimated means; 90% B.I.: 90% Bootstrap intervals for percentile estimates using boot strap method with 1,000 replications;

* The sample size does not meet minimum reporting requirements as described in the *Third Report on Nutrition Monitoring in the United States, 1994-96* (LSRO, 1995).

Source: Kahn and Stralka, 2008b (Based on CSFH 1994-96 and 1998).

Table 3-67. Total Fluid Intake of Women 15 to 49 Years Old

Reproductive Status[a]	Mean	Standard Deviation	Percentile Distribution 5	10	25	50	75	90	95
mL/day									
Control	1,940	686	995	1,172	1,467	1,835	2,305	2,831	3,186
Pregnant	2,076	743	1,085	1,236	1,553	1,928	2,444	3,028	3,475
Lactating	2,242	658	1,185	1,434	1,833	2,164	2,658	3,169	3,353
mL/kg/day									
Control	32.3	12.3	15.8	18.5	23.8	30.5	38.7	48.4	55.4
Pregnant	32.1	11.8	16.4	17.8	17.8	30.5	40.4	48.9	53.5
Lactating	37.0	11.6	19.6	21.8	21.8	35.1	45.0	53.7	59.2

[a] Number of observations: nonpregnant, nonlactating controls (n = 6,201); pregnant (n = 188); lactating (n = 77).

Source: Ershow et al., 1991.

Table 3-68. Total Tapwater Intake of Women 15 to 49 Years Old

Reproductive Status[a]	Mean	Standard Deviation	Percentile Distribution 5	10	25	50	75	90	95
mL/day									
Control	1,157	635	310	453	709	1,065	1,503	1,983	2,310
Pregnant	1,189	699	274	419	713	1,063	1,501	2,191	2,424
Lactating	1,310	591	430	612	855	1,330	1,693	1,945	2,191
mL/kg/day									
Control	19.1	10.8	5.2	7.5	11.7	17.3	24.4	33.1	39.1
Pregnant	18.3	10.4	4.9	5.9	10.7	16.4	23.8	34.5	39.6
Lactating	21.4	9.8	7.4	9.8	14.8	20.5	26.8	35.1	37.4
Fraction of daily fluid intake that is tapwater (%)									
Control	57.2	18.0	24.6	32.2	45.9	59.0	70.7	79.0	83.2
Pregnant	54.1	18.2	21.2	27.9	42.9	54.8	67.6	76.6	83.2
Lactating	57.0	15.8	27.4	38.0	49.5	58.1	65.9	76.4	80.5

a Number of observations: nonpregnant, nonlactating controls (n = 6,201); pregnant (n = 188); lactating (n = 77).

Source: Ershow et al., 1991.

Table 3-69. Total Fluid (mL/Day) Derived from Various Dietary Sources by Women Aged 15 to 49 Years[a]

Sources	Control Women Mean[b]	Control Women Percentile 50	Control Women Percentile 95	Pregnant Women Mean[b]	Pregnant Women Percentile 50	Pregnant Women Percentile 95	Lactating Women Mean[b]	Lactating Women Percentile 50	Lactating Women Percentile 95
Drinking Water	583	480	1,440	695	640	1,760	677	560	1,600
Milk and Milk Drinks	162	107	523	308	273	749	306	285	820
Other Dairy Products	23	8	93	24	9	93	36	27	113
Meats, Poultry, Fish, Eggs	126	114	263	121	104	252	133	117	256
Legumes, Nuts, and Seeds	13	0	77	18	0	88	15	0	72
Grains and Grain Products	90	65	257	98	69	246	119	82	387
Citrus and Noncitrus Fruit Juices	57	0	234	69	0	280	64	0	219
Fruits, Potatoes, Vegetables, Tomatoes	198	171	459	212	185	486	245	197	582
Fats, Oils, Dressings, Sugars, Sweets	9	3	41	9	3	40	10	6	50
Tea	148	0	630	132	0	617	253	77	848
Coffee and Coffee Substitutes	291	159	1,045	197	0	955	205	80	955
Carbonated Soft Drinks[c]	174	110	590	130	73	464	117	57	440
Noncarbonated Soft Drinks[c]	38	0	222	48	0	257	38	0	222
Beer	17	0	110	7	0	0	17	0	147
Wine Spirits, Liqueurs, Mixed Drinks	10	0	66	5	0	25	6	0	59
All Sources	1,940	NA	NA	2,076	NA	NA	2,242	NA	NA

a Number of observations: nonpregnant, nonlactating controls (n = 6,201); pregnant (n = 188); lactating (n = 77).

b Individual means may not add to all-sources total due to rounding.

c Includes regular, low-calorie, and noncalorie soft drinks.

NA: Not appropriate to sum the columns for the 50th and 95th percentiles of intake.

Source: Ershow et al., 1991.

Table 3-70. Total Tapwater and Bottled Water Intake by Pregnant Women (L/day)

Variables	Cold Tapwater		Bottled Water	
	N	Mean (SD)	N	Mean (SD)
Demographics				
Home	2,293	1.3 (1.2)	[c]	[c]
Work	2,295	0.4 (0.6)	[c]	[c]
Total	2,293	1.7 (1.4)	2,284	0.6 (0.9)
Geographic Region				
Site 1	1,019	1.8 (1.4)	1,016	0.5 (0.9)
Site 2	864	1.9 (1.4)	862	0.4 (0.7)
Site 3	410	1.1 (1.3)	406	1.1 (1.2)
Season				
Winter	587	1.6 (1.3)	584	0.6 (1.0)
Spring	622	1.7 (1.4)	622	0.6 (1.0)
Summer	566	1.8 (1.6)	560	0.6 (0.9)
Fall	518	1.8 (1.5)	518	0.5 (0.9)
Age at LMP[a]				
17 – 25	852	1.6 (1.4)	848	0.6 (1.0)
26 – 30	714	1.8 (1.5)	710	0.6 (1.0)
31 – 35	539	1.7 (1.3)	538	0.5 (0.8)
≥ 36	188	1.8 (1.4)	188	0.5 (0.9)
Education				
≤ High school	691	1.5 (1.5)	687	0.6 (1.0)
Some college	498	1.7 (1.5)	496	0.6 (1.0)
≥ 4-year college	1,103	1.8 (1.3)	1,100	0.5 (0.9)
Race/ethnicity				
White, non Hispanic	1,276	1.8 (1.4)	1,273	0.5 (0.9)
Black, non Hispanic	727	1.6 (1.5)	722	0.6 (0.9)
Hispanic, any race	204	1.1 (1.3)	202	1.1 (1.2)
Other	84	1.9 (1.5)	85	0.5 (0.9)
Marital Status				
Single, never married	719	1.6 (1.5)	713	0.6 (1.0)
Married	1,497	1.8 (1.4)	1,494	0.5 (0.9)
Other	76	1.7 (1.9)	76	0.5 (0.9)
Annual Income ($)				
≤ 40,000	967	1.6 (1.5)	962	0.6 (1.0)
40,000 - 80,000	730	1.8 (1.4)	730	0.5 (0.9)
> 80,000	501	1.7 (1.3)	499	0.5 (0.9)
Employment				
No	681	1.7 (1.5)	679	0.5 (0.9)
Yes	1,611	1.7 (1.4)	1,604	0.6 (0.9)
BMI				
Low	268	1.6 (1.3)	267	0.6 (1.0)
Normal	1,128	1.7 (1.4)	1,123	0.5 (0.9)
Overweight	288	1.7 (1.5)	288	0.6 (0.9)
Obese	542	1.8 (1.6)	540	0.6 (1.0)

Table 3-70. Total Tapwater and Bottled Water Intake by Pregnant Women (L/day) (continued)

Variables	Cold Tapwater		Bottled Water	
	N	Mean (SD)	N	Mean (SD)
Diabetes				
No diabetes	2,221	1.7 (1.4)	2,213	0.6 (0.9)
Regular diabetes	17	2.6 (2.1)	17	0.4 (0.8)
Gestational diabetes	55	1.6 (1.6)	54	0.6 (1.0)
Nausea during pregnancy				
No	387	1.6 (1.4)	385	0.6 (1.0)
Yes	1,904	1.7 (1.4)	1,897	0.6 (0.9)
Pregnancy history				
No prior pregnancy	691	1.7 (1.4)	685	0.6 (1.0)
Prior pregnancy with no SAB[b]	1,064	1.7 (1.4)	1,063	0.5 (0.9)
Prior pregnancy with SAB	538	1.8 (1.5)	536	0.6 (1.0)
Caffeine				
0 mg/day	578	1.8 (1.5)	577	0.6 (1.0)
1 - 150 mg/day	522	1.6 (1.3)	522	0.5 (0.8)
151 - 300 mg/day	433	1.6 (1.4)	433	0.6 (0.9)
> 300 mg/day	760	1.7 (1.5)	752	0.6 (1.0)
Vitamin use				
No	180	1.4 (1.4)	176	0.5 (0.8)
Yes	2,113	1.7 (1.4)	2,108	0.6 (0.9)
Smoking				
Nonsmoker	2,164	1.7 (1.4)	2,155	0.6 (0.9)
< 10 cigarettes/day	84	1.8 (1.5)	84	0.8 (1.3)
≥ 10 cigarettes/day	45	1.8 (1.6)	45	0.4(0.7)
Alcohol use				
No	2,257	1.7 (1.4)	2,247	0.6 (0.9)
Yes	36	1.6 (1.2)	37	0.6 (0.8)
Recreational exercise				
No	1,061	1.5 (1.4)	1,054	0.6 (0.9)
Yes	1,232	1.8 (1.4)	1,230	0.6 (1.0)
Illicit drug use				
No	2,024	1.7 (1.4)	2,017	0.6 (0.9)
Yes	268	1.7 (1.5)	266	0.6 (1.0)

[a] LMP - Age of Last Menstrual Period
[b] SAB - spontaneous abortion
[c] Data is not reported in the source document.

Source: Forssen et al., 2007.

Table 3-71. Percentage of Mean Water Intake Consumed as Unfiltered and Filtered Tapwater by Pregnant Women				
Variables		Cold Unfiltered Tapwater	Cold Filtered Tapwater	Bottled Water
	N	Percent	Percent	Percent
Total	2,280	52	19	28
Geographic Region				
Site 1	1,014	46	28	26
Site 2	860	67	13	19
Site 3	406	37	10	53
Season				
Winter	583	52	19	29
Spring	621	53	19	28
Summer	559	50	20	29
Fall	517	54	19	26
Age at LMP[a]				
≤ 25	845	55	11	33
26 - 30	709	49	22	28
31 - 35	538	51	27	22
≥ 36	188	53	22	25
Education				
≤ High school	685	56	8	34
Some college	495	53	16	30
≥ 4-year college	1,099	49	27	23
Race/ethnicity				
White, non Hispanic	1,272	50	26	23
Black, non Hispanic	720	60	9	30
Hispanic, any race	202	37	9	54
Other	84	48	27	25
Marital Status				
Single, never married	711	57	9	33
Married	1,492	50	25	25
Other	76	57	9	34
Annual Income ($)				
≤ 40,000	960	56	11	33
40,000 - 80,000	728	51	24	24
> 80,000	499	45	29	25
Employment				
No	678	52	21	27
Yes	1,601	52	19	29
BMI				
Low	266	50	21	29
Normal	1,121	51	22	27
Overweight	287	53	18	28

Table 3-71. Percentage of Mean Water Intake Consumed as Unfiltered and Filtered Tapwater by Pregnant Women (continued)

Variables	N	Cold Unfiltered Tapwater Percent	Cold Filtered Tapwater Percent	Bottled Water Percent
Obese	540	56	14	29
Diabetes				
No diabetes	2,209	52	19	28
Regular diabetes	17	69	15	16
Gestational diabetes	54	50	22	27
Nausea during pregnancy				
No	385	54	18	28
Yes	1,893	52	20	28
Pregnancy history				
No prior pregnancy	685	48	21	31
Prior pregnancy with no SAB[b]	1,060	54	18	27
Prior pregnancy with SAB	535	53	20	26
Caffeine				
0 mg/day	577	50	22	27
1 - 150 mg/day	520	53	17	29
151 - 300 mg/day	432	52	17	30
> 300 mg/day	751	53	19	27
Vitamin use				
No	176	57	8	34
Yes	2,104	52	20	28
Smoking				
Nonsmoker	2,151	51	20	28
< 10 cigarettes/day	84	60	10	28
≥ 10 cigarettes/day	45	66	7	22
Alcohol use				
No	2,244	52	19	28
Yes	36	58	19	23
Recreational exercise				
No	1,053	54	14	31
Yes	1,227	51	24	26
Illicit drug use				
No	2,013	51	20	28
Yes	266	56	12	31

[a] LMP - Age of Last Menstrual Period
[b] SAB - spontaneous abortion

Source: Forssen et al., 2007.

Table 3-72. Water Intake at Various Activity Levels (L/hr)[a]

Room Temperature[b] (°F)	Activity Level					
	High (0.15 hp/man)[c]		Medium (0.10 hp/man)[c]		Low (0.05 hp/man)[c]	
	No.[d]	Intake	No.	Intake	No.	Intake
100	-	-	-	-	15	0.653 (0.75)
95	18	0.540 (0.31)	12	0.345 (0.59)	6	0.50 (0.31)
90	7	0.286 (0.26)	7	0.385 (0.26)	16	0.23 (0.20)
85	7	0.218 (0.36)	16	0.213 (0.20)	-	-
80	16	0.222 (0.14)	-	-	-	-

a Data expressed as mean intake with standard deviation in parentheses.
b Humidity = 80 percent; air velocity = 60 ft/min.
c The symbol "hp" refers to horsepower.
d Number of subjects with continuous data.
\- Data not reported in the source document.

Source: McNall and Schlegel, 1968.

Table 3-73. Planning Factors for Individual Tapwater Consumption

Environmental Condition	Recommended Planning Factor (gal/day)[a]	Recommended Planning Factor (L/day)[a,b]
Hot	3.0[c]	11.4
Temperate	1.5[d]	5.7
Cold	2.0[e]	7.6

a Based on a mix of activities among the work force as follows: 15% light work; 65% medium work; 20% heavy work. These factors apply to the conventional battlefield where no nuclear, biological, or chemical weapons are used.
b Converted from gal/day to L/day.
c This assumes 1 quart/12-hour rest period/man for perspiration losses and 1 quart/day/man for urination plus 6 quarts/12-hours light work/man, 9 quarts/12-hours moderate work/man, and 12 quarts/12-hours heavy work/man.
d This assumes 1 quart/12-hour rest period/man for perspiration losses and 1 quart/day/man for urination plus 1 quart/12-hours light work/man, 3 quarts/12-hours moderate work/man, and 6 quarts/12-hours heavy work/man.
e This assumes 1 quart/12-hour rest period/man for perspiration losses, 1 quart/day/man for urination, and 2 quarts/day/man for respiration losses plus 1 quart/12-hours light work/man, 3 quarts/12-hours moderate work/man, and 6 quarts/6-hours heavy work/man.

Source: U.S. Army, 1983.

Table 3-74. Pool Water Ingestion by Swimmers

Study Group	Number of Participants	Average Water Ingestion Rate (mL/45-minute interval)	Average Water Ingestion Rate (mL/hour)[a]
Children < 16 years old	41	37	49
Males < 16 years old	20	45	60
Females <16 years old	21	30	43
Adults (>18 years)	12	16	21
Men	4	22	29
Women	8	12	16

[a] Converted from mL/45 minute interval.

Source: Dufour et al., 2006.

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4 NON-DIETARY INGESTION FACTORS

4.1 INTRODUCTION

Adults and children have the potential for exposure to toxic substances through non-dietary ingestion pathways other than soil and dust ingestion (e.g., ingesting pesticide residues that have been transferred from treated surfaces to the hands or objects that are mouthed). Adults mouth objects such as cigarettes, pens/pencils, or their hands. Young children mouth objects, surfaces or their fingers as they explore their environment. Mouthing behavior includes all activities in which objects, including fingers, are touched by the mouth or put into the mouth except for eating and drinking, and includes licking, sucking, chewing, and biting (Groot et al., 1998). Videotaped observations of children's mouthing behavior demonstrate the intermittent nature of hand to mouth and object to mouth behaviors in terms of the number of contacts recorded per unit of time (e.g., Ko et al., 2007).

Adult and children's mouthing behavior can potentially result in ingestion of toxic substances (Lepow et al., 1975). Although no studies were located that provided data on mouthing frequency or duration for adults, adults with developmental disabilities frequently exhibit excessive hand-mouthing behavior (Cannella et al., 2005). In a large non-random sample of children born in Iowa, non-nutritive sucking behaviors were reported by parents to be very common in infancy, and to continue for a substantial proportion of children up to the third and fourth birthdays (Warren et al., 2000). Hand-to-mouth behavior has been observed in both pre-term and full term infants (Rochat et al., 1988, Blass et al., 1989, Takaya et al., 2003). Infants are born with a sucking reflex for breast feeding, and within a few months, they begin to use sucking or mouthing as a means to explore their surroundings. Sucking also becomes a means of comfort when a child is tired or upset. In addition, teething normally causes substantial mouthing behavior (i.e., sucking or chewing) to alleviate discomfort in the gums (Groot et al., 1998).

There are three general approaches to gather data on children's mouthing behavior: real-time hand recording, in which trained observers manually record information (e.g., Davis et al., 1995); video-transcription, in which trained videographers tape a child's activities and subsequently extract the pertinent data manually or with computer software (e.g., Black et al., 2005); and questionnaire, or survey response, techniques (e.g., Stanek et al., 1998). With real-time hand recording, observations made by trained professionals (rather than parents) may offer the advantage of consistency in interpreting visible behaviors and may be less subjective than observations made by someone who maintains a care giving relationship to the child. On the other hand, young children's behavior may be influenced by the presence of unfamiliar people (e.g., Davis et al., 1995). Groot et al. (1998) indicated that parent observers perceived that deviating from their usual care giving behavior by observing and recording mouthing behavior appeared to have influenced the children's behavior. With video-transcription methodology, an assumption is made that the presence of the videographer or camera does not influence the child's behavior. This assumption may result in minimal biases introduced when filming newborns, or when the camera and videographer are not visible to the child. However, if the children being studied are older than newborns and can see the camera or videographer, biases may be introduced. Ferguson et al. (2006) described apprehension caused by videotaping and described situations where a child's awareness of the videotaping crew caused "play-acting" to occur, or parents indicated that the child was behaving differently during the taping session. Another possible source of measurement error may be introduced when children's movements or positions cause their mouthing not to be captured by the camera. Data transcription errors can bias results in either the negative or positive direction. Finally, measurement error can occur if situations arise in which care givers are absent during videotaping and researchers must stop videotaping and intervene to prevent risky behaviors (Zartarian et al., 1995). Survey response studies rely on responses to questions about a child's mouthing behavior posed to parents or care givers. Measurement errors from these studies could occur for a number of different reasons, including language/dialect differences between interviewers and respondents, question wording problems and lack of definitions for terms used in questions, differences in respondents' interpretation of questions, and recall/memory effects.

Some researchers express mouthing behavior as the frequency of occurrence (e.g., contacts per hour or contacts per minute). Others describe the duration of specific mouthing events, expressed in units of seconds or minutes. This handbook does not address issues related to contaminant transfer from thumbs, fingers, or objects or surfaces, into the mouth, and subsequent ingestion. The recommendations for mouthing frequency and duration are provided in the next section for children only, along with a summary of the confidence ratings for these recommendations. The recommended values for children are based on key studies identified by U.S. EPA for this factor. Although some studies in Sections 4.3.1 and 4.4.1 are classified as key, they were not directly used to provide the recommendations. They are included as key because they were used by Xue et al., 2007 or Xue et al., 2009 in meta analyses, which are the primary sources of the recommendations provided in this chapter for hand-to-mouth and object-to-mouth frequency, respectively. Following the recommendations, key and relevant studies on mouthing frequency (Section 4.3) and duration (Section 4.4) are summarized and the methodologies used in the key and relevant studies are described. Information on the prevalence of mouthing behavior is presented in Section 4.5.

4.2 RECOMMENDATIONS

The key studies described in Section 4.3 and Section 4.4 were used to develop recommended values for mouthing frequency and duration, respectively, among children. No studies were located that provided data on mouthing frequency or duration for adults. In several cases, key studies pre-dated the recommendations on age groups in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* U.S. EPA (2005), and were performed on groups of children of varying ages. For cases in which age groups of children in the key studies did not correspond exactly to U.S. EPA's recommended age groups, the closest age group was used.

Table 4-1 shows recommended mouthing frequencies, expressed in units of contacts per hour, between either any part of the hand (including fingers and thumbs) and the mouth, or between an object or surface and the mouth. The recommended hand-to-mouth frequencies are based on data from Xue et al. (2007). Xue et al. (2007) conducted a secondary analysis of data from several of the studies summarized in this chapter, as well as data from unpublished studies. Xue et al. (2007) provided data for the age groups of interest to U.S. EPA and categorized the data according to indoor and outdoor contacts. The recommendations for frequency of object-to-mouth contact are based on data from Xue et al. (2009). Xue et al. (2009) conducted a secondary analysis of data from several of the studies summarized in this chapter. Recommendations for duration of object-to-mouth contacts are based on data from Juberg et al. (2001) and Greene (2002). Recommendations for hand-to-mouth duration are not provided since those estimates may not be relevant to environmental exposures. Table 4-2 presents the confidence ratings for the recommended values. The overall confidence rating is low for both frequency and duration of hand-to-mouth and object-to-mouth.

Table 4-1. Summary of Recommended Mouthing Frequency and Duration

Age Group	Hand-to-Mouth: Indoor Frequency (contacts/hour)		Outdoor Frequency (contacts/hour)		Source
	Mean	95th Percentile	Mean	95th Percentile	
Birth to <1 month	-	-	-	-	Xue et al., 2007
1 to <3 months	-	-	-	-	
3 to <6 months	28	65	-	-	
6 to <12 months	19	52	15	47	
1 to <2 years	20	63	14	42	
2 to <3 years	13	37	5	20	
3 to <6 years	15	54	9	36	
6 to <11 years	7	21	3	12	
11 to <16 years	-	-	-	-	
16 to <21 years	-	-	-	-	
	Object-to-mouth				
	Indoor Frequency (contacts/hour)		Outdoor Frequency (contacts/hour)		
	Mean	95th Percentile	Mean	95th Percentile	
Birth to <1 month	-	-	-	-	Xue et al., 2009
1 to <3 months	-	-	-	-	
3 to <6 months	11	32	-	-	
6 to <12 months	28	84	-	-	
1 to <2 years	27	82	8.8	21	
2 to <3 years	15	36	8.1	40	
3 to <6 years	10	39	8.3	30	
6 to <11 years	1.3	3.7	1.9	9.1	
11 to <16 years	-	-	-	-	
16 to <21 years	-	-	-	-	
	Mean Duration (minutes/hour)		95th Percentile Duration (minutes/hour)		
Birth to <1 month	-		-		Juberg et al., 2001, Greene, 2002, and Beamer et al., 2008
1 to <3 months	-		-		
3 to <6 months	11[a]		26[b]		
6 to <12 months	9[c]		19[d]		
1 to <2 years	7[e]		22[e]		
2 to <3 years	10[f]		11[g]		
3 to <6 years	-		-		
6 to <11 years	-		-		
11 to <16 years	-		-		
16 to <21 years	-		-		

[a] Mean calculated from Juberg et al., 2001 (0 to 18 months) and Greene, 2002 (3 to 12 months).
[b] Calculated 95th percentile from Greene, 2002 (3 to 12 months).
[c] Mean calculated from Juberg, et al., 2001 (0 to 18 months) and Greene, 2002 (3 to 12 months), and Beamer et al., 2008 (6 to 13 months).
[d] Calculated 95th percentile from Greene, 2002 (3 to 12 months) and Beamer et al., 2008 (6 to 13 months).
[e] Mean and 95th percentile from Greene, 2002 (12 to 24 months).
[f] Mean calculated from Juberg, et al., 2001 (19 to 36 months) and Greene, 2002 (24 to 36 months), and Beamer et al., 2008 (20 to 26 months).
[g] Calculated 95th percentile from Greene, 2002 (24 to 36 months) and Beamer et al., 2008 (20 to 26 months).
\- = No data.

Table 4-2. Confidence in Mouthing Frequency and Duration Recommendations

General Assessment Factors	Rationale	Rating
Soundness		Low
Adequacy of Approach	The approaches for data collection and analysis used were adequate for providing estimates of children's mouthing frequencies and durations. Sample sizes were very small relative to the population of interest. Almost all key studies published primary data; in cases where secondary data were used, U.S. EPA judged the secondary data to be of suitable utility for the purposes for developing recommendations.	
Minimal (or defined) Bias	Bias in either direction likely exists in both frequency and duration estimates; the magnitude of bias is unknown.	
Applicability and Utility		Low
Exposure Factor of Interest	Key studies for older children focused on mouthing behavior while the infant studies were designed to research developmental issues.	
Representativeness	Most key studies were of samples of U.S. children, but due to the small sample sizes and small number of locations under study, the study subjects may not be representative of the overall U.S. child population.	
Currency	The studies were conducted over a wide range of dates. However, the currency of the data is not expected to affect mouthing behavior recommendations.	
Data Collection Period	Extremely short data collection periods may not represent behaviors over longer time periods.	
Clarity and Completeness		Low
Accessibility	The journal articles are in the public domain, but in many cases, primary data were unavailable.	
Reproducibility	Data collection methodologies were capable of providing results that were reproducible within a certain range, when compared with results obtained using alternate data collection techniques (e.g., Smith and Norris, 2003).	
Quality Assurance	Several of the key studies applied and documented quality assurance/quality control measures.	
Variability and Uncertainty		Low
Variability in Population	The key studies characterized inter-individual variability to a limited extent, and did not characterize intra-individual variability over diurnal or longer term time frames.	
Description of Uncertainty	The study authors typically did not attempt to quantify uncertainties inherent in data collection methodology (such as the influence of observers on behavior), although some described these uncertainties qualitatively. The study authors typically did attempt to quantify uncertainties in data analysis methodologies (if video-transcription methods were used). Uncertainties arising from short data collection periods typically were unaddressed either qualitatively or quantitatively.	
Evaluation and Review		Medium
Peer Review	All key studies appear in peer review journals.	
Number and Agreement of Studies	Several key studies were available for both frequency and duration, but data were not available for all age groups. The results of studies from different researchers are generally in agreement.	
Overall rating		**Low**

4.3 NON-DIETARY INGESTION - MOUTHING FREQUENCY STUDIES

4.3.1 Key Studies of Mouthing Frequency

4.3.1.1 *Zartarian et al., 1997a - Quantifying Videotaped Activity Patterns: Video Translation Software and Training Technologies/Zartarian et al., 1997b - Quantified Dermal Activity Data From a Four-Child Pilot Field Study/Zartarian et al., 1998 - Quantified Mouthing Activity Data From a Four-Child Pilot Field Study*

Zartarian et al. (1997a, 1997b, 1998) conducted a pilot study of the video-transcription methodology to investigate the applicability of using videotaping for gathering information related to children's activities, dermal exposures and mouthing behaviors. The researchers had conducted studies using the real-time hand recording methodology, resulting in poor inter-observer reliability and observer fatigue when attempted for long periods of time, prompting the investigation into using videotaping with transcription of the children's activities at a point in time after the observations (videotaping) occurred.

Four Mexican-American farm worker children in the Salinas Valley of California each were videotaped with a hand-held videocamera during their waking hours, excluding time spent in the bathroom, over one day in September 1993. The boys were 2 years 10 months old and 3 years, 9 months old; the girls were 2 years 5 months old and 4 years 2 months old. Time of videotaping was 6.0 hours for the younger girl, 6.6 hours for the older girl, 8.4 hours for the younger boy and 10.1 hours for the older boy. The videotaping gathered information on detailed micro-activity patterns of children to be used to evaluate software for videotaped activities and translation training methods. The researchers reported measures taken to assess inter-observer reliability and several problems with the video-transcription process.

The hourly data showed that non-dietary object mouthing occurred in 30 of the 31 hours of tape time, with one child eating during the hour in which no non-dietary object mouthing occurred. Average object to mouth contacts for the four children were reported to be 9 contacts per hour, with the average per child ranging from 1 to 19 contacts per hour (Zartarian et al., 1997a). Objects mouthed included bedding/towels, clothes, dirt, grass/vegetation, hard surfaces, hard toys, paper/card, plush toy, and skin (Zartarian et al., 1997a). Average hand to mouth contacts for the four children were reported to be 13 contacts per hour (averaging the sum of left hand and right hand to mouth contacts and averaging across children, from Zartarian et al., 1997b), with the average per child ranging from 9 to 19 contacts per hour.

This study's primary purpose was to develop and evaluate the video-transcription methodology; a secondary purpose was collection of mouthing behavior data. The sample of children studied was very small and not likely to be representative of the national population. As with other video-transcription studies, the presence of non-family-member videographers, and a video camera may have influenced the children's behavior.

4.3.1.2 *Reed et al., 1999 - Quantification of Children's Hand and Mouthing Activities Through a Videotaping Methodology*

In this study, Reed et al. (1999) used a video-transcription methodology to quantify the frequency and type of children's hand and mouth contacts, as well as a survey response methodology, and compared the videotaped behaviors with parents' perceptions of those behaviors. Twenty children ages 3 to 6 years old selected randomly at a day care center in New Brunswick, New Jersey, and ten children ages 2 to 5 years old at residences in Newark and Jersey City, New Jersey who were not selected randomly, were studied (gender not specified). For the video-transcription methodology, inter-observer reliability tests were performed during observer training and at four points during the two years of the study. The researchers compared the results of videotaping the ten children in the residences with their parents' reports of the children's daily activities. Mouthing behaviors studied included hand to mouth and hand bringing object to mouth.

The video-transcription mouthing contact frequency results are presented in Table 4-3. The authors analyzed parents' responses on frequencies of their children's mouthing behaviors and compared those responses with the children's videotaped behaviors, which revealed certain discrepancies. Parents' reported hand to mouth contact of "almost never" corresponded to overall somewhat lower videotaped hand to mouth frequencies than those of children whose parents reported "sometimes," but there was little correspondence between parents' reports of object to mouth frequency and videotaped behavior.

The advantages of this study were that it compared the results of video-transcription with the survey response methodology results, and described quality assurance steps taken to assure reliability of transcribed videotape data. However, only a small number of children were studied, some were not selected for observation randomly, and the sample of children studied may not be representative of either the locations studied or the national population. Due to the children's ages, the presence of unfamiliar persons following the children with a video camera may influence the video-transcription results. The parents' survey responses may also be influenced by recall/memory effects and other limitations of survey methodologies.

4.3.1.3 *Freeman et al., 2001 - Quantitative Analysis of Children's Microactivity Patterns: The Minnesota Children's Pesticide Exposure Study*

Freeman et al. (2001) conducted a survey response and video-transcription study of some of the respondents in a phased study of children's pesticide exposures in the summer and early fall of 1997. A probability-based sample of 168 families with children ages 3 to <14 years old in urban (Minneapolis/St. Paul) and non-urban (Rice and Goodhue Counties) areas of Minnesota answered questions about children's mouthing of paint chips, food-eating without utensils, eating of food dropped on the floor, mouthing of non-food items, and mouthing of thumbs/fingers. For the survey response portion of the study, parents provided the responses for children ages 3 and 4 years, and collaborated with or assisted older children with their responses. Of the 168 families responding to the survey, 102 were available, selected, and agreed to measurements of pesticide exposure. Of these 102 families, 19 agreed to videotaping of the study children's activities for a period of four consecutive hours.

Based on the survey responses for 168 children, the 3 year olds had significantly more positive responses for all reported behavior compared to the other age groups. The authors stated that they did not know whether parent reporting of 3 year olds' behavior influenced the responses given. Table 4-4 shows the percent of children, grouped by age, who were reported to exhibit non-food related mouthing behaviors. Table 4-5 presents the mean and median number of mouthing contacts by age for the 19 videotaped children. Among the four age categories of these children, object to mouth activities were significantly greater for the 3 and 4 year olds than any other age group, with a median of 3 and a mean of 6 contacts per hour (P = 0.002, Kruskal Wallis test comparison across four age groups). Hand to mouth contacts had a median of 3.5 and mean of 4 contacts per hour for the three 3 and 4 year olds observed, median of 2.5 and mean of 8 contacts per hour for the seven 5 and 6 year olds observed, median of 3 and mean of 5 contacts per hour for the four 7 and 8 year olds observed, and median of 2 and mean of 4 for the five 10, 11 and 12 year olds observed. Gender differences were observed for some of the activities, with boys spending significantly more time outdoors than girls. Hand to mouth and object to mouth activities were less frequent outdoors than indoors for both boys and girls.

For the 19 children in the video-transcription portion of the study, inter-observer reliability checks and quality control checks were performed on randomly sampled tapes. For four children's tapes, comparison of the manual video-transcription with a computerized transcription method (Zartarian et al., 1995) was also performed; no significant differences were found in the frequency of events recorded using the two techniques. The frequency of six behaviors (hand to mouth, hand to object, object to mouth, hand to smooth surface, hand to textured surface, and hand to clothing) was recorded. The amount of time each child spent indoors, outdoors, in contact with soil or grass, and whether the child was barefoot was also recorded. For the four children whose tapes were analyzed with the computerized transcription method, which calculates event durations, the authors stated that most hand to mouth and object to mouth activities were observed during periods of lower physical activity, such as television viewing.

An advantage to this study is that it included results from two separate methodologies, and included quality assurance steps taken to assure reliability of transcribed videotape data. However, the children in this study may not be representative of all children in the U.S. Variation in who provided the survey responses (sometimes parents only, sometimes children with parents) may have influenced the responses given. Children studied using the video-transcription methodology were not chosen randomly from the survey response group. The presence of unfamiliar persons following the children with a video camera may have influenced the video-transcription methodology results.

4.3.1.4 *Tulve et al., 2002 - Frequency of Mouthing Behavior in Young Children*

Tulve et al. (2002) coded the unpublished Davis et al. (1995) data for location (indoor and outdoor) and activity type (quiet or active) and analyzed the subset of the data that consisted of indoor mouthing behavior during quiet activity (72 children, ranging in age from 11 to 60 months). A total of 186 15-minute observation periods were included in the study, with the number of observation periods per child ranging from 1 to 6.

Results of the data analyses indicated that there was no association between mouthing frequency and gender, but a clear association between mouthing frequency and age was observed. The analysis indicated that children ≤24 months had the highest frequency of mouthing behavior (81 events/hour) and children >24 months had the lowest (42 events/hour) (Table 4-6). Both groups of children were observed to mouth toys and hands more frequently than household surfaces or body parts other than hands.

An advantage of this study is that the randomized design may mean that the children studied were relatively representative of young children living in the study area, although they may not be representative of the U.S. population. Due to the ages of the children studied, the observers' use of headphones and manual recording of mouthing behavior on observation sheets may have influenced the children's behavior.

4.3.1.5 *AuYeung et al., 2004 - Young Children's Mouthing Behavior: An Observational Study via Videotaping in a Primarily Outdoor Residential Setting*

AuYeung et al. (2004) used a video-transcription methodology to study a group of 38 children (20 females and 18 males; ages 1 to 6 years), 37 of whom were selected randomly via a telephone screening survey of a 300 to 400 square mile portion of the San Francisco, California peninsula, along with one child selected by convenience due to time constraints. Families who lived in a residence with a lawn and whose annual income was >$35,000 were asked to participate. Videotaping took place between August 1998 and May 1999 for approximately two hours per child. Videotaping by one researcher was supplemented with field notes taken by a second researcher who was also present during taping. Most of the videotaping took place during outdoor play, however, data were included for several children (one child <2 years old and 8 children >2 years old) who had more than 15 minutes of indoor play during their videotaping sessions.

The videotapes were translated into ASCII computer files using VirtualTimingDevice™ software described in Zartarian et al. (1997a). Both frequency and duration (see Section 4.4.2.5 of this Chapter) were analyzed. Between 5 and 10 percent of the data files translated were randomly chosen for quality control checks for inter-observer agreement. Ferguson et al. (2006) described quality control aspects of the study in detail.

For analysis, the mouthing contacts were divided into indoor and outdoor locations, and 16 object/surface categories. Mouthing frequency was analyzed by age and gender separately, and in combination. Mouthing contacts were defined as contact with the lips, inside of the mouth, and/or the tongue; dietary contacts were ignored. Mouthing frequencies for indoor locations are shown in Table 4-7. For the one child observed that was ≤24 months of age, the total mouthing frequency was 84.8 contacts/hour; for children >24 months, the median indoor mouthing frequency was 19.5 contacts/hour. Outdoor median mouthing frequencies (Table 4-8) were very similar for children ≤24 months of age (13.9 contacts/hour) and >24 months (14.6 contacts/hour).

Nonparametric tests, such as the Wilcoxon rank sum test were used for the data analyses. Both age and gender were found to be associated with differences in mouthing behavior. Girls had significantly higher frequencies of mouthing contacts with the hands and non-dietary objects than boys (p = 0.01 and p = 0.008, respectively).

This study provides distributions of outdoor mouthing frequencies with a variety of objects and surfaces. Although indoor mouthing data were also included in this study, the results were based on a small number of children (N=9) and a limited amount of indoor play. The sample of children may be representative of certain socioeconomic strata in the study area, but is not likely to be representative of the national population. Due to the children's ages, the presence of unfamiliar persons following the children with a video camera may have influenced the video-transcription methodology results.

4.3.1.6 *Black et al., 2005 - Children's Mouthing and Food-Handling Behavior in an Agricultural Community on the U.S./Mexico Border*

Black et al. (2005) studied mouthing behavior of children in a Mexican-American community along the Rio Grande River in Texas, in the spring and summer of 2000, using a survey response and a video-transcription methodology. A companion study of this community (Shalat et al., 2003) identified 870 occupied households during the April 2000 U.S. census and contacted 643 of these via in-person interview to determine presence of children under the age of 3 years. Of the 643 contacted, 91 had at least one child under the age of 3 years (Shalat et al., 2003). Of these 91 households, the mouthing and food-handling behavior of 52 children (26 boys and 26 girls) from 29 homes was videotaped, and the children's parents answered questions about children's hygiene, mouthing and food-handling activities (Black et al., 2005). The study was of children ages 7 to 53 months, grouped into four age categories: infants (7 to 12 months), 1 year olds (13 to 24 months), 2 year olds (25 to 36 months), and preschoolers (37 to 53 months).

The survey asked questions about children's ages, genders, reported hand-washing, mouthing and food-handling behavior (N=52), and activities (N=49). Parental reports of thumb/finger placement in the mouth showed decreases with age. The researchers attempted to videotape each child for four hours. The children were followed by the videographers through the house and yard, except for times when they were napping or using the bathroom. Virtual Timing Device™ software, mentioned earlier, was used to analyze the videotapes.

Based on the results of videotaping, most of the children (49 of 52) spent the majority of their time indoors. Of the 39 children who spent time both indoors and outdoors, all three behaviors (hand to mouth, object to mouth and food handling) were more frequent and longer while the child was indoors. Hand to mouth activity was recorded during videotaping for all but one child, a 30 month old girl.

For the four age groups, the mean hourly hand to mouth frequency ranged from 11.9 (2 year olds) to 22.1 (preschoolers), and the mean hourly object to mouth frequency ranged from 7.8 (2 year olds) to 24.4 (infants). No significant linear trends were seen with age or gender for hand to mouth hourly frequency. A significant linear trend was observed for hourly object to mouth frequency, which decreased as age increased (adjusted $R^2 = 0.179$; $P = 0.003$). Results of this study are shown in Table 4-9.

One advantage of this study is that it compared survey responses with videotaped information on mouthing behavior. A limitation is that the sample was fairly small and was from a limited area (mid-Rio Grande Valley) and is not likely to be representative of the national population. Due to the children's ages, the presence of unfamiliar persons following the children with a video camera may have influenced the video-transcription methodology results.

4.3.1.7 *Xue et al., 2007 - A Meta-analysis of Children's Hand-to-Mouth Frequency Data for Estimating Nondietary Ingestion Exposure*

Xue et al. (2007) gathered hand-to-mouth frequency data from 9 available studies representing 429 subjects and more than 2,000 hours of behavior observation. The studies used in this analysis included several of the studies summarized in this chapter (Zartarian et al.,1998; Reed et al., 1999; Freeman et al., 2001; Greene, 2002; Tulve et al., 2002; Black et al., 2005, and Beamer et al., 2008). These data were used to conduct a meta-analysis to study differences in hand-to-mouth behavior. The purpose of the analysis was to:

1) examine differences across studies by age (using the new U.S. EPA recommended age groupings (U.S. EPA, 2005)), gender, and indoor/outdoor location;
2) fit variability distributions to the available hand-to-mouth frequency data for use in one dimensional Monte Carlo exposure assessments;
3) fit uncertainty distributions to the available hand-to-mouth frequency data for use in two dimensional Monte Carlo exposure assessments; and
4) assess hand-to-mouth frequency data needs using the new U.S. EPA recommended age groupings (U.S. EPA, 2005).

The data were sorted into age groupings. Visual inspection of the data and statistical methods (method of moments and maximum likelihood estimation) were used, and goodness-of-fit tests were applied to verify the selection among lognormal, Weibull, and normal distributions (Xue et al., 2007). Analyses to study inter- and intra- individual variability of indoor and outdoor hand to mouth frequency were conducted. There were 894 hours of behavior observation data for the 429 children, ages 0.3 to 12 years, across all available studies. It was found that age and location (indoor vs. outdoor) were important factors contributing to hand to mouth frequency, but study and gender were not (Xue et al., 2007). Distributions of hand to mouth frequencies were developed for both indoor and outdoor activities. Distributions are presented in Table 4-10 for indoor settings and Table 4-11 for outdoor settings. Hand to mouth frequencies decreased for both indoor and outdoor activity as age increased, and were higher indoors than outdoors for all age groups (Xue et al., 2007).

A strength of this study is that it is the first effort to fit hand to mouth distributions using U.S. EPA's recommended age groups using available data on mouthing behavior from studies using different methodologies, of children in different locations. Limitations of the studies used in this meta-analysis apply to the results from the meta-analysis as well; the uncertainty analysis in this study does not account for uncertainties arising out of differences in approaches used in the various studies used in the meta-analysis.

4.3.1.8 *Beamer et al. (2008) - Quantified Activity Pattern Data From 6 to 27-Month-Old Farmworker Children for Use in Exposure Assessment*

Beamer et al. (2008) conducted a follow-up to the pilot study performed by Zartarian et al. (1997a, 1997b, 1998) and described in Sections 4.3.1.1 and 4.4.2.2. For this study, a convenience sample of 23 children residing in the farmworker community of Salinas Valley, CA was enrolled. Participants were 6-13 month old infants or 20-26 month old toddlers. Two researchers videotaped each child's activities for a minimum of 4 hours, and kept a detailed written log of locations visited and objects and surfaces contacted by the child. A questionnaire was administered to an adult in the household to acquire demographic data, housing and cleaning characteristics, eating patterns, and other information pertinent to the child's potential pesticide exposure.

The mean and median object/surface contact frequency in events/hour are presented in Table 4-12. The mean frequency of hand contact of all objects/surfaces for both hands combined was 686.3 events/hour. The mean hand-to-mouth frequency was 18.4 events/hour. The mean mouthing frequency of non-dietary objects was 29.2 events/hour. Table 4-13 presents the distributions for the mouthing of non-dietary objects for both infants and toddlers. Toddlers had higher mouthing frequencies with non-dietary items associated with pica (i.e., paper) while infants had higher mouthing frequencies with other non-dietary objects. In addition, boys had higher mouthing frequencies than girls. The advantage of this study is that it included both infants and toddlers. Differences between the two age groups, as well as gender differences, could be observed. As with other video-transcription studies, the presence of non-family-member videographers and a video camera may have influenced the children's behavior.

4.3.1.9 *Xue et al., 2009 - A Meta-analysis of Children's Object-to-Mouth Frequency Data for Estimating Nondietary Ingestion Exposure*

Xue et al. (2009) gathered object-to-mouth frequency data from 7 available studies representing 438 subjects and approximately 1,500 hours of behavior observation. The studies used in this analysis included several of the studies summarized in this chapter (Reed et al., 1999; Freeman et al., 2001; Greene, 2002; Tulve et al., 2002; Au Yeung et al., 2004, and Beamer et al., 2008) as well as Hore 2003. These data were used to conduct a meta-analysis to study differences in object-to-mouth behavior. The purpose of the analysis was to:

1) examine differences across studies by age (using the new U.S. EPA recommended age groupings (U.S. EPA, 2005)), gender, and indoor/outdoor location;
2) fit variability distributions to the available object to-mouth frequency data for use in one dimensional Monte Carlo exposure assessments;
3) fit uncertainty distributions to the available object-to-mouth frequency data for use in two dimensional Monte Carlo exposure assessments; and
4) assess object-to-mouth frequency data needs using the new U.S. EPA recommended age groupings (U.S. EPA, 2005).

The data were sorted into age groupings. Visual inspection of the data and statistical methods (method of moments and maximum likelihood estimation) were used, and goodness-of-fit tests were applied to verify the selection among lognormal, Weibull, and normal distributions (Xue et al., 2009). Analyses to study inter- and intra- individual variability of indoor and outdoor object-to-mouth frequency were conducted. It was found that age, location (indoor vs. outdoor), and study were important factors contributing to object-to-mouth frequency, but study and gender were not (Xue et al., 2009). Distributions of object-to-mouth frequencies were developed for both indoor and outdoor activities. Distributions are presented in Table 4-14 for indoor settings and Table 4-15 for outdoor settings. Object-to-mouth frequencies decreased for both indoor and outdoor activity as age increased (i.e., after age <6 to 12 months for indoor activity; and after <3 to 6 years for outdoor activity), and were higher indoors than outdoors for all age groups (Xue et al., 2009).

A strength of this study is that it is the first effort to fit object-to-mouth distributions using U.S. EPA's recommended age groups using available data on mouthing behavior from studies using different methodologies, of children in different locations. Limitations of the studies used in this meta-analysis apply to the results from the meta-analysis as well; the uncertainty analysis in this study does not account for uncertainties arising out of differences in approaches used in the various studies used in the meta-analysis.

4.3.2 Relevant Studies of Mouthing Frequency

4.3.2.1 *Davis et al., 1995 - Soil Ingestion in Children with Pica: Final Report*

In 1992, under a Cooperative Agreement with U.S. EPA, the Fred Hutchinson Cancer Research Center conducted a survey response and real-time hand recording study of mouthing behavior data. The study included 92 children (46 males, 46 females) ranging in age from <12 months to 60 months, from Richland, Kennewick, and Pasco, Washington. The children were selected randomly based on date of birth through a combination of birth certificate records and random digit dialing of residential telephone numbers. For each child, data were collected during a seven day period in January to April, 1992. Eligibility included residence within the city limits, residence duration >1 month, and at least one parent or guardian who spoke English. Most of the adults who responded to the survey reported their marital status as being married (90 percent), their race as Caucasian (89 percent), their household income in the >$30,000 range (56 percent) or their housing status as single-family home occupants (69 percent).

The survey asked questions about thumb-sucking and frequency questions about pacifier use, placing fingers, hands and feet in the mouth, and mouthing of furniture, railings, window sills, floor, dirt, sand, grass, rocks, mud, clothes, toys, crayons, pens, and other items. Table 4-16 shows the survey responses for the 92 study children. For most of the children in the study, the mouthing behavior real-time hand recording data were collected simultaneously by parents and by trained observers who described and quantified the mouthing behavior of the children in their home environment. The observers recorded mouth and tongue contacts with hands, other body parts, natural objects, surfaces, and toys every 15 seconds during 15 minute observation periods spread over 4 days. Parents and trained observers wore headphones that indicated elapsed time (Davis et al., 1995). If all attempted observation periods were successful, each child would have a total of 16 15 minute observation periods with 60 15-second intervals per 15-minute observation period, or 960 15-second intervals in all. The number of successful intervals of observation ranged from 0 to 840 per child. Comparisons of the inter-observer reliability between the trained observers and parents showed "a high degree of correlation between the overall degree of both mouth and tongue activity recorded by parents and observers. For total mouth activity, there was a significant correlation between the rankings obtained according to parents and observers, and parents were able to identify the same individuals as observers as being most and least oral in 60 percent of the cases."

One advantage of this study is the simultaneous observations by both parents and trained observers that allows comparisons to be made regarding the consistency of the recorded observations. The random nature in which the population was selected may provide a representative population of the study area, within certain limitations, but not of the national population. Simultaneous collection of food, medication, fecal, and urine samples that occurred as part of the overall study (not described in this summary) may have contributed a degree of deviation from normal routines within the households during the 7 days of data collection and may have influenced children's usual behaviors. Wearing of headphones by parents and trained observers during mouthing observations, presence of non-family-member observers, and parents' roles as observers as well as care givers may also have influenced the results; the authors state "Having the child play naturally while being observed was challenging. Usually the first day of observation was the most difficult in this respect, and by the third or fourth day of observation the child generally paid little attention to the observers."

4.3.2.2 *Lew and Butterworth, 1997 - The Development of Hand-Mouth Coordination in 2- to 5-Month-Old Infants: Similarities With Reaching and Grasping*

Lew and Butterworth (1997) studied 14 mostly first-born infants (10 males, 4 females) in Stirling, United Kingdom, in 1990 using a video-transcription methodology. Attempts were made to study each infant within a week of the infant's 2-month, 3-month, 4-month and 5-month birthdays. After becoming accustomed to the testing laboratory, and with their mothers present, infants were placed in semi-reclining seats and filmed during an experimental protocol in which researchers placed various objects into the infants' hands. Infants were observed for two baseline periods of 2 minutes each. The researchers coded all contacts to the face and mouth that occurred during baseline periods (prior to and after the object handling period) as well as contacts occurring during the object handling period. Hand to mouth contacts included contacts that landed directly in or on the mouth as well as those in which the hand landed on the face first and then moved to the mouth. The researchers assessed inter-observer agreement using a rater not involved with the study, for a random proportion (approximately 10 percent) of the movements documented during the object handling period, and reported inter-observer agreement of 0.90 using Cohen's kappa for the location of contacts. The frequency of contacts ranged between 0 and 1 contacts per minute.

The advantages of this study were that use of video cameras could be expected to have minimal impact on infant behavior for infants of these ages, and the researchers performed tests of inter-observer reliability. A disadvantage is that the study included baseline observation periods of only 2 minutes' duration, during which spontaneous hand to mouth movements could be observed. The extent to which these infants' behavior is representative of other infants of these ages is unknown.

4.3.2.3 *Tudella et al., 2000 - The Effect of Oral-Gustatory, Tactile-Bucal, and Tactile-Manual Stimulation on the Behavior of the Hands in Newborns*

Tudella et al. (2000) studied the frequency of hand to mouth contact, as well as other behaviors, in 24 full-term Brazilian newborns (10 to 14 days old) using a video-transcription methodology. Infants were in an alert state, in their homes in silent and previously heated rooms in a supine position and had been fed between 1 and 1 1/2 hours before testing. Infants were studied for a four minute baseline period without stimuli before experimental stimuli were administered. Results from the four minute baseline period, without stimuli, indicated that the mean frequency of hand to mouth contact (defined as right hand or left hand touching the lips or entering the buccal cavity, either with or without rhythmic jaw movements) was almost 3 right hand contacts and slightly more than 1.5 left hand contacts, for a total hand to mouth contact frequency of about 4 contacts in the four minute period. The researchers performed inter-observer reliability tests on the videotape data and reported an inter-coder Index of Concordance of 93 percent.

The advantages of this study were that use of video cameras could be expected to have virtually no impact on newborns' behavior, and inter-observer reliability tests were performed. However, the study data may not represent newborn hand to mouth contact during non-alert periods such as sleep. The extent to which these infants' behavior is representative of other full-term 10 to 14 day old infants' behavior is unknown.

4.3.2.4 *Ko et al., 2007 - Relationships of Video Assessments of Touching and Mouthing Behaviors During Outdoor Play in Urban Residential Yards to Parental Perceptions of Child Behaviors and Blood Lead Levels*

Ko et al. (2007) compared parent survey responses with results from a video-transcription study of children's mouthing behavior in outdoor settings, as part of a study of relationships between children's mouthing behavior and other variables with blood lead levels. A convenience sample of 37 children (51 percent males, 49 percent females) 14 to 69 months old was recruited via an urban health center and direct contacts in the surrounding area, apparently in Chicago, Illinois. Participating children were primarily Hispanic (89 percent). The mouth area was defined as within 1 inch of the mouth, including the lips. Items passing beyond the lips were defined as in the mouth. Placement of an object or food item in the mouth along with part of the hand was counted as both hand and food or object in mouth. Mouthing behaviors included hand-to-mouth area both with and not with food, hand- in-mouth with or without food, and object-in-mouth including food, drinks, toys or other objects.

Survey responses for the 37 children who were also videotaped included parents reporting children's inserting hand, toys or objects in mouth when playing outside, and inserting dirt, stones or sticks in mouth. Video-transcription results of outdoor play for these 37 children indicated 0 to 27 hand-in-mouth, and 3 to 69 object-in-mouth touches per hour for the 13 children reported to frequently insert hand, toys or objects in mouth when playing outside; 0 to 67 hand in mouth, and 7 to 40 object-in-mouth touches per hour for the 10 children reported to "sometimes" perform this behavior; 0 to 30 hand-in-mouth, and 0 to 125 object in mouth touches per hour for the 12 children reported to "hardly ever" perform this behavior, and 1 to 8 hand-in-mouth, and 3 to 6 object-in-mouth touches per hour for the 2 children reported to "never" perform this behavior.

Videotaping was attempted for two hours per child over two or more play sessions, with videographers trying to avoid interacting with the children. Children played with their usual toys and partners, and no instructions were given to parents regarding their supervision of the children's play. The authors stated that during some portion of the videotape time, children's hands and mouths were out of camera view. Videotape transcription was performed manually, according to a modified version of the protocol used in the Reed et al. (1999) study. Inter-observer reliability between three video-transcribers was checked with seven 30 minute video segments.

One strength of this study is its comparison of survey responses with results from the video-transcription methodology. A limitation is that the non-randomly selected sample of children studied is unlikely to be representative of the national population. Comparing results from this study with results from other video-transcription studies may be problematic due to inclusion of food handling with hand to mouth and object to mouth frequency counts. Due to the children's ages, their behavior may have differed from normal patterns due to the presence of strangers who videotaped them.

4.4 NON-DIETARY INGESTION - MOUTHING DURATION STUDIES

4.4.1 Key Mouthing Duration Studies

4.4.1.1 *Juberg et al., 2001 - An Observational Study of Object Mouthing Behavior by Young Children*

Juberg et al. (2001) studied 385 children ages 0 to 36 months in western New York state, with parents collecting real-time hand-recording mouthing behavior data, primarily in children's own home environments. The study consisted of an initial pilot study conducted in February 1998, a second phase conducted in April 1998, and a third phase conducted at an unspecified later time. The study's sample was drawn from families identified in a child play research center database or whose children attended a child care facility in the same general area; some geographic variation within the local area was obtained by selecting families with different zip codes in the different study phases. The pilot phase had 30 children who participated out of 150 surveys distributed; the second phase had 187 children out of approximately 300 surveys distributed, and the third phase had 168 participants out of 300 surveys distributed.

Parents were asked to observe their child's mouthing of objects only; hand to mouth behavior was not included. Data were collected on a single day (pilot and second phases) or five days (third phase); parents recorded the insertion of objects into the mouth by noting the "time in" and "time out" and the researchers summed the recorded data to tabulate total times spent mouthing the various objects during the day(s) of observation. Thus, the study data were presented as minutes per day of object mouthing time. Mouthed items were classified as pacifiers, teethers, plastic toys, or other objects.

The results of the combined pilot and second phase II data are shown in Table 4-17. For both age groups, mouthing time for pacifiers greatly exceeded mouthing time for non-pacifiers, with the difference more acute for the older age group than for the younger age group. Histograms of the observed data show a peak in the low end of the distribution (0 to 100 minutes per day) and a rapid decline at longer durations.

A third phase of the study focused on children between the ages of 3 and 18 months and included only non-pacifier objects. Subjects were observed for 5 non-consecutive days over a 2 month period. A total of 168 participants returned surveys for at least one day, providing a total of 793 person-days of data. The data yielded a mean non-pacifier object mouthing duration of 36 minutes per day; the mean was the same when calculated on the basis of 793 person-days of data as on the basis of 168 daily average mouthing times.

One advantage of this study is the large sample size (385 children); however, the children apparently were not selected randomly, although some effort was made to obtain local geographic variation among study participants. There is no description of the socioeconomic status or racial and ethnic identities of the study participants. The authors do not describe the methodology (such as stopwatches, analog or digital clocks, or guesses) parents used to record mouthing event durations. The authors stated that using mouthing event duration units of minutes, rather than seconds, may have yielded observations rounded to the nearest minute.

4.4.1.2 *Greene, 2002 - A Mouthing Observation Study of Children Under Six Years of Age*

The U.S. Consumer Product Safety Commission (CPSC) conducted a survey response and real-time hand recording study between December 1999 and February 2001 to quantify the cumulative time per day that young children spend awake, not eating, and mouthing objects. "Mouthing" was defined as sucking, chewing, or otherwise putting an object on his/her lips or into his/her mouth. Participants were recruited via a random digit dialing telephone survey in urban and nearby rural areas of Houston, Texas and Chicago, Illinois. Of the 115,289 households surveyed, 1,745 households had a child under the age of 6 years and were willing to participate. In the initial phase of the study, 491children ages 3 to 81 months participated. Parents were instructed to use watches with second hands, or count seconds to estimate mouthing event durations. Parents also were to record mouthing frequency and types of objects mouthed. Parents collected data in four separate, non-consecutive 15-minute observation periods. Initially, parents were called back by the researchers and asked to provide their data over the telephone. Of the 491 children, 43 children (8.8 percent) had at least one 15-minute observation period with mouthing event durations recorded as exceeding 15 minutes. Due to this data quality problem, the researchers excluded the parent observation data from further analysis.

In a second phase, trained observers used stopwatches to record the mouthing behaviors and mouthing event durations of the subset of 109 of these children ages 3 to 36 months, and an additional 60 children (total in second phase, 169), on two hours of each of two days. The observations were done at different times of the day at the child's home and/or child care facility. Table 4-18 shows the prevalence of observed mouthing among the 169 children in the second phase. All children were observed to mouth during the four hours of observation time; 99 percent mouthed the category defined as "anatomy." Pacifiers were mouthed by 27 percent in an age-declining pattern ranging from 47 percent of children less than 12 months old to 10 percent of the 2 to <3 year olds.

Table 4-19 provides the average mouthing time by object category and age in minutes per hour. The average mouthing time for all objects ranged from 5.3 to 10.5 minutes per hour, with the highest mouthing time corresponding to children <1 year of age and the lowest to the 2 to <3 years of age category. Among the objects mouthed, pacifiers represented about one third of the total mouthing time, with 3.4 minutes per hour for the youngest children, 2.6 minutes per hour for the children between 1 and 2 years and 1.8 minutes per hour for children 2 to <3 years old. The next largest single item category was anatomy. In this category, children under 1 year of age spent 2.4 minutes per hour mouthing fingers and thumbs; this behavior declined with age to 1.2 minutes per hour for children 2 to <3 years old.

Of the 169 children in the second phase, there were usable data on the time awake and not eating (or "exposure time") for only 109; data for the remaining 60 children were missing. Thus, in order to develop extrapolated estimates of daily mouthing time, from the 2 hours of observation per day for two days, for the 109 children, the researchers developed a statistical model that accounted for the children's demographic characteristics, in order to estimate exposure times for the 60 children for whom exposure time data were missing, and then computed statistics for the extrapolated daily mouthing times for all 169 children, using a "bootstrap" procedure. Using this method, the estimated mean daily mouthing time of objects other than pacifiers ranged from 37 minutes/day to 70 minutes/day with the lowest number corresponding to the 2 to <3 year old children and the largest number corresponding to the 3 to <12 month old children.

The 551 child participants were 55 percent males, 45 percent females. The study's sample was drawn in an attempt to duplicate the overall U.S. demographic characteristics with respect to race, ethnicity, socioeconomic status and urban/suburban/rural settings. The sample families' reported annual incomes were generally higher than those of the overall U.S. population.

This study's strength was that it consisted of a randomly selected sample of children from both urban and non-urban areas in two different geographic areas within the U.S. However, the observers' presence and use of a stopwatch to time mouthing durations may have affected the children's behavior.

4.4.1.3 *Beamer et al. (2008) - Quantified Activity Pattern Data From 6 to 27-Month-Old Farmworker Children for Use in Exposure Assessment*

Beamer et al. (2008) conducted a follow-up to the pilot study performed by Zartarian et al. (1997a, 1997b, 1998) and described in Sections 4.3.1.1 and 4.4.2.2. For this study, a convenience sample of 23 children residing in the farmworker community of Salinas Valley, CA was enrolled. Participants were 6-13 month old infants or 20-26 month old toddlers. Two researchers videotaped each child's activities for a minimum of 4 hours, and kept a detailed written log of locations visited and objects and surfaces contacted by the child. A questionnaire was administered to an adult in the household to acquire demographic data, housing and cleaning characteristics, eating patterns, and other information pertinent to the child's potential pesticide exposure.

The object/surface hourly contact duration in minutes/hour are presented in Table 4-20. The mean hourly mouthing duration for hands and non-dietary objects was 1.4 and 3.5 minutes/hour, respectively. Infants had higher hourly mouthing duration with toys and all non-dietary objects than toddlers. Girls had higher contact durations than boys.

The advantage of this study is that it included both infants and toddlers. Differences between the two age groups, as well as gender differences, could be observed. As with other video-transcription studies, the presence of non-family-member videographers and a video camera may have influenced the children's behavior.

4.4.2 Relevant Mouthing Duration Studies

4.4.2.1 *Barr et al., 1994 - Effects of Intra-Oral Sucrose on Crying, Mouthing and Hand-Mouth Contact in Newborn and Six Week Old Infants*

Barr et al. (1994) studied hand to mouth contact, as well as other behaviors, in 15 newborn (8 males, 7 females) and 15 five to seven week old (8 males, 7 females) full-term Canadian infants using a video-transcription methodology. The newborns were 2 to 3 days old, in a quiet, temperature-controlled room at the hospital, in a supine position and had been fed between 2 1/2 and 3 1/2 hours before testing. Barr et al. (1994) analyzed a one minute baseline period, with no experimental stimuli, immediately before a sustained crying episode lasting 15 seconds. For the newborns, reported durations of hand to mouth contact during 10 second intervals of the one minute baseline period were in the range of 0 to 2 percent. The five to seven week old infants apparently were studied at primary care pediatric facilities when they were in bassinets inclined at an angle of 10 degrees. For these slightly older infants, the baseline periods analyzed were less than 20 seconds in length, but Barr et al. (1994) reported similarly low mean percentages of the 10 second intervals (approximately 1 percent of the time with hand to mouth contact). Hand to mouth contact was defined as "any part of the hand touching the lips and/or the inside of the mouth." The researchers performed inter-observer reliability tests on the videotape data and reported a mean inter-observer reliability of 0.78 by Cohen's kappa.

The advantages of this study were that use of video cameras could be expected to have virtually no impact on newborns' or five to seven week old infants' behavior, and inter-observer reliability tests were performed. The study data did not represent newborn or five to seven week old infant hand to mouth contact during periods in which infants of these ages were in a sleeping or other non-alert state, and may only represent behavior immediately prior to a state of distress (sustained crying episode). The extent to which these infants' behavior is representative of other full-term infants of these ages is unknown.

4.4.2.2 *Zartarian et al., 1997a - Quantifying Videotaped Activity Patterns: Video Translation Software and Training Technologies/Zartarian et al., 1997b - Quantified Dermal Activity Data From a Four-Child Pilot Field Study/Zartarian et al., 1998 - Quantified Mouthing Activity Data From a Four-Child Pilot Field Study*

As described in Section 4.3.1.1, Zartarian et al. (1997a, 1997b, 1998) conducted a pilot study of the video-transcription methodology to investigate the applicability of using videotaping for gathering information related to children's activities, dermal exposures and mouthing behaviors. The researchers had conducted studies using the real-time hand recording methodology, resulting in poor inter-observer reliability and observer fatigue when attempted for long periods of time, prompting the investigation into using videotaping with transcription of the children's activities at a point in time after the observations (videotaping) occurred.

Four Mexican-American farm worker children in the Salinas Valley of California each were videotaped with a hand-held videocamera during their waking hours, excluding time spent in the bathroom, over one day in September 1993. The boys were 2 years 10 months old and 3 years, 9 months old; the girls were 2 years 5 months old and 4 years 2 months old. Time of videotaping was 6.0 hours for the younger girl, 6.6 hours for the older girl, 8.4 hours for the younger boy and 10.1 hours for the older boy. The videotaping gathered information on detailed micro-activity patterns of children to be used to evaluate software for videotaped activities and translation training methods.

The four children mouthed non-dietary objects an average of 4.35 percent (range 1.41 to 7.67 percent) of the total observation time, excluding the time during which the children were out of the camera's view (Zartarian et al., 1997a). Objects mouthed included bedding/towels, clothes, dirt, grass/vegetation, hard surfaces, hard toys, paper/card, plush toy, and skin (Zartarian et al., 1997a). Frequency distributions for the four children's non-dietary object contact durations were reported to be similar in shape. Reported hand to mouth contact presumably is a subset of the object to mouth contacts described in Zartarian et al., 1997a, and is described in Zartarian et al., 1997b. The four children mouthed their hands an average of 2.35 percent (range 1.0 to 4.4 percent) of observation time. The researchers reported measures taken to assess inter-observer reliability and several problems with the video-transcription process.

This study's primary purpose was to develop and evaluate the video-transcription methodology; a secondary purpose was collection of mouthing behavior data. The sample of children studied was very small and not likely to be representative of the national population. Thus, U.S. EPA did not judge it to be suitable for consideration as a key study of children's mouthing behavior. As with other video-transcription studies, the presence of non-family-member videographers, and a video camera may have influenced the children's behavior.

4.4.2.3 *Groot et al., 1998 - Mouthing Behavior of Young Children: An Observational Study*

In this study, Groot et al. (1998) examined the mouthing behavior of 42 Dutch children (21 boys and 21 girls) between the ages of 3 and 36 months in late July and August 1998. Parent observations were made of children in 36 families. Parents were asked to observe their children ten times per day for 15 minute intervals (i.e., 150 minutes total per day) for two days and measure mouthing times with a stopwatch. In this study, mouthing was defined as "all activities in which objects are touched by mouth or put into the mouth except for eating and drinking. This term includes licking as well as sucking, chewing and biting."

For the study, a distinction was made between toys meant for mouthing (e.g., pacifiers, teething rings) and those not meant for mouthing. Inter-observer and intra-observer reliability was measured by trained observers who co-observed a portion of observation periods in three families, and who co-observed and repeatedly observed some video-transcriptions made of one child. Another quality assurance procedure performed for the extrapolated total mouthing time data was to select 12 times per hour randomly during the entire waking period of four children during one day, in which the researchers recorded activities and total mouthing times.

Although the sample size was relatively small, the results provided estimates of mouthing times, other than pacifier use, during a day. The results were extrapolated to the entire day based on the 150 minutes of observation per day, and the mean value for each child for the two days of observations was interpreted as the estimate for that child. Summary statistics are shown in Table 4-21. The standard deviation in all four age categories except the 3 to 6 month old children exceeded the estimated mean. The 3 to 6 month children (N=5) were estimated to have mean non-pacifier mouthing durations of 36.9 minutes per day, with toys as the most frequently mouthed product category, and the 6 to 12 month children (N=14) 44 minutes per day (fingers most frequently mouthed). The 12 to 18 month olds' (N=12) estimated mean non-pacifier mouthing time was 16.4 minutes per day, with fingers most frequently mouthed, and 18 to 36 month olds' (N=11) estimated mean non-pacifier mouthing time was 9.3 minutes per day (fingers most frequently mouthed).

One strength of this study is that the researchers recognized that observing children might affect their behavior, and emphasized to the parents the importance of making observations under conditions that were as normal as possible. In spite of these efforts, many parents perceived that their children's behavior was affected by being observed, and observation interfered with care giving responsibilities such as comforting children when they were upset. Other limitations included a small sample size that was not representative of the Dutch population and that also may not be representative of U.S. children. Technical problems with the stopwatches affected at least 14 of 36 parents' data.

4.4.2.4 *Smith and Norris, 2003 - Reducing the Risk of Choking Hazards: Mouthing Behavior of Children Aged 1 Month to 5 Years/Norris and Smith, 2002 - Research Into the Mouthing Behaviour of Children up to 5 Years Old*

Smith and Norris (2003) conducted a real-time hand recording study of mouthing behavior among 236 children (111 males, 125 females) in the United Kingdom (exact locations not specified) who were from 1 month to 5 years old. Children were observed at home by parents, who used stopwatches to record the time that mouthing began, the type of mouthing, the type of object being mouthed, and the time that mouthing ceased. Children were observed for a total of 5 hours over a two week period; the observation time consisted of twenty 15 minute periods spread over different times and days during the child's waking hours. Parents also recorded the times each child was awake and not eating meals so that the researchers could extrapolate estimates of total daily mouthing time from the shorter observation periods. Mouthing was defined as licking/lip touching, sucking/trying to bite, biting or chewing, with a description of each category, together with pictures, given to parents as guidance for what to record.

The results of the study are shown in Table 4-22. While no overall pattern could be found in the different age groups tested, a Kruskal-Wallis test on the data for all items mouthed indicated that there was a significant difference between the age groups. Across all age groups and types of items, licking and sucking accounted for 64 percent of all mouthing behavior. Pacifiers and fingers exhibited less variety on mouthing behavior (principally sucking), while other items had a higher frequency of licking, biting, or other mouthing.

The researchers selected 25 of the 236 children randomly for a single 15 minute observation of each child (total observation time across all children: 375 minutes), in order to compare the mouthing frequency and duration data obtained according to the real-time hand recording and the video-transcription methodologies, as well as the reliability of parent observations versus those made by trained professionals. For this group of 25 children, the total number of mouthing behavior events recorded by video (160) exceeded those recorded by parents (114) and trained observers (110). Similarly, the total duration recorded by video (24 minutes and 15 seconds) exceeded that recorded by observers (parents and trained observers both recorded identical totals of 19 minutes and 44 seconds). The mean and standard deviation of observed mouthing time were both lower when recorded by video versus real-time hand recording. The maximum observed mouthing time was also lower (6 minutes and 7 seconds by video versus 9 minutes and 43 seconds for both parents and trained observers).

The strengths of this study were its comparison of three types of observation (parents, trained professional observers, and videotaping), and its detailed reporting of mouthing behaviors by type, object/item mouthed, and age group. However, the children studied may not be representative of the study population, and may not be representative of U.S. children.

4.4.2.5 *AuYeung et al, 2004 - Young Children's Mouthing Behavior: An Observational Study via Videotaping in a Primarily Outdoor Residential Setting*

As described in Section 4.3.2.4, AuYeung et al. (2004) used a video-transcription methodology to study a group of 38 children (20 females and 18 males; ages 1 to 6 years), 37 of whom were selected randomly via a telephone screening survey of a 300 to 400 square mile portion of the San Francisco, California peninsula, along with one child selected by convenience due to time constraints. Families who lived in a residence with a lawn and whose annual income was >$35,000 were asked to participate. Videotaping took place between August 1998 and May 1999 for approximately two hours per child. Videotaping by one researcher was supplemented with field notes taken by a second researcher who was also present during taping. Most of the videotaping took place during outdoor play, however, data were included for several children (one child <2 years old and 8 children >2 years old) who had more than 15 minutes of indoor play during their videotaping sessions.

The videotapes were translated into ASCII computer files using VirtualTimingDevice™ software described in Zartarian et al. (1997a). Both frequency (see Section 4.3.2.4 of this Chapter) and duration were analyzed. Between 5 and 10 percent of the data files translated were randomly chosen for quality control checks for inter-observer agreement. Ferguson et al. (2006) described quality control aspects of the study in detail.

For analysis, the mouthing contacts were divided into indoor and outdoor locations, and 16 object/surface categories. Mouthing durations were analyzed by age and gender separately, and in combination. Mouthing contacts were defined as contact with the lips, inside of the mouth, and/or the tongue; dietary contacts were ignored. Mouthing durations are shown in Table 4-23 (outdoor locations). For the children in all age groups, the median duration of each mouthing contact was 1 to 2 seconds, confirming the observations of other researchers that children's mouthing contacts are of very short duration. For the one child observed that was ≤24 months, the total indoor mouthing duration was 11.1 minutes/hour; for children >24 months, the median indoor mouthing duration was 0.9 minutes/hour (Table 4-24). For outdoor environments, median contact durations for these age groups decreased to 0.8 and 0.6 minutes/hour, respectively (Table 4-25).

Nonparametric tests, such as the Wilcoxon rank sum test were used for the data analyses. Both age and gender were found to be associated with differences in mouthing behavior. Girls' hand to mouth contact durations were significantly shorter than for boys ($p = 0.04$).

This study provides distributions of outdoor mouthing durations with a variety of objects and surfaces. Although indoor mouthing data were also included in this study, the results were based on a small number of children (N=9) and a limited amount of indoor play. The sample of children may be representative of certain socioeconomic strata in the study area, but is not likely to be representative of the national population. Due to the children's ages, the presence of unfamiliar persons following the children with a video camera may have influenced the video-transcription methodology results.

4.5 MOUTHING PREVALENCE

4.5.1 Stanek et al., 1998 - Prevalence of Soil Mouthing/Ingestion Among Healthy Children Aged 1 to 6

Stanek et al. (1998) characterized the prevalence of mouthing behavior among healthy children based on a survey response study of parents or guardians of 533 children (289 females, 244 males) ages 1 to 6 years old. Study participants were attendees at scheduled well-child visits at three clinics in Western Massachusetts in August through October, 1992. Participants were questioned about the frequency of 28 mouthing behaviors of the children over the preceding month in addition to exposure time (e.g., time outdoors, play in sand or dirt) and children's characteristics (e.g., teething).

Table 4-27 presents the prevalence of reported non-food ingestion/mouthing behaviors by child's age as the percent of children whose parents reported the behavior in the preceding month. The table includes a column of data for the 3 to <6 year age category; this column was calculated by U.S. EPA as a weighted mean value of the individual data for 3, 4, and 5 year olds in order to conform to the standardized age categories used in this handbook. Among all the age groups, 1 year olds had the highest reported daily sucking of fingers/thumb; the proportion dropped for two year olds, but rose slightly for three and four year olds and declined again after age 4. A similar pattern was reported for more than weekly finger/thumb sucking, while more than monthly finger/thumb sucking showed a very slight increase for 6 year olds. Reported pacifier use was highest for one year olds and declined with age for daily and more than weekly use; for more than monthly use of a pacifier several six year olds were reported to use pacifiers, which altered the age-declining pattern for the daily and more than weekly reported pacifier use. A pattern similar to pacifier use existed with reported mouthing of teething toys, with highest reported use for one year olds, a decline with age until age 6 when reported use for daily, more than weekly, and more than monthly use of teething toys increased.

The authors developed an outdoor mouthing rate for each child as the sum of rates for responses to four questions on mouthing specific outdoor objects. Survey responses were converted to mouthing rates per week, using values of 0, 0.25, 1, and 7 for responses of never, monthly, weekly, and daily ingestion. Reported outdoor soil mouthing behavior prevalence was found to be higher than reported indoor dust mouthing prevalence, but both behaviors had the highest reported prevalence among 1 year old children and decreased for children 2 years and older. The investigators conducted principal component analyses on responses to four questions relating to ingestion/mouthing of outdoor objects in an attempt to characterize variability. Outdoor ingestion/mouthing rates constructed from the survey responses were that children 1 year of age were reported to mouth or ingest outdoor objects 4.73 times per week while 2 to 6 year olds were reported to mouth or ingest outdoor objects 0.44 times per week. The authors developed regression models to identify factors related to high outdoor mouthing rates. The authors found that children who were reported to play in sand or dirt had higher outdoor object ingestion/mouthing rates.

A strength of this study is that it was a large sample obtained in an area with urban and semi-urban residents within various socioeconomic categories and with varying racial/ethnic identities. However, difficulties with parents' recall of past events may have caused either over-estimates or under-estimates of the behaviors studied.

4.5.2 Warren et al., 2000 - Non-nutritive Sucking Behaviors in Preschool Children: A Longitudinal Study

Warren et al. (2000) conducted a survey response study of a non-random cohort of children born in certain Iowa hospitals from early 1992 to early 1995, as part of a study of children's fluoride exposure. For this longitudinal study of children's non-nutritive sucking behaviors, 1,374 mothers were recruited at the time of their newborns' birth, and over 600 were active in the study until the children were at least 3 years old. Survey questions on non-nutritive sucking behaviors were administered to the mothers when the children were 6 weeks, 3, 6, 9, 12, 16 and 24 months old, and yearly after age 24 months. Questions were posed regarding the child's sucking behavior over the previous 3 to 12 months.

The authors reported that nearly all children sucked non-nutritive items, including pacifiers, thumbs or other fingers, and/or other objects, at some point in their early years. The parent-reported sucking behavior prevalence peaked at 91 percent for 3 month old children. At 2 years of age, a majority (53 percent) retained a sucking habit, while 29 percent retained the habit at age 3 years and 21 percent at age 4 years. Parent-reported pacifier use was 28% for 1 year olds, 25% for 2 year olds, and 10% for 3 year olds. The authors cautioned against generalizing the results to other children due to study design limitations.

Strengths of this study were its longitudinal design and the large sample size. A limitation is that the non-random selection of original study participants and the self-selected nature of the cohort of survey respondents who participated over time means that the results may not be representative of other U.S. children of these ages.

4.6 REFERENCES FOR CHAPTER 4

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Table 4-3. New Jersey Children's Mouthing Frequency (contacts/hour) from Video-transcription					
Category	Minimum	Mean	Median	90th Percentile	Maximum
Hand to mouth	0.4	9.5	8.5	20.1	25.7
Object to mouth	0	16.3	3.6	77.1	86.2

Source: Reed et al., 1999.

Table 4-4. Survey-Reported Percent of 168 Minnesota Children Exhibiting Behavior, by Age			
Age Group	Thumbs/fingers in Mouth	Toes in Mouth	Non-food Items in Mouth
3 years	71	29	71
4 years	63	0	31
5 years	33	-	20
6 years	30	-	29
7 years	28	-	28
8 years	33	-	40
9 years	43	-	38
10 years	38	-	38
11 years	33	-	48
12 years	33	-	17

- = No data.

Source: Freeman et al., 2001.

Table 4-5. Video-transcription Median (Mean) Observed Mouthing in 19 Minnesota Children (contacts/hour)			
Age Group	N	Object-to-mouth[a]	Hand-to-mouth
3 to 4 years	3	3 (6)	3.5 (4)
5 to 6 years	7	0 (1)	2.5 (8)
7 to 8 years	4	0 (1)	3 (5)
10 to 12 years	5	0 (1)	2 (4)

[a] Kruskal Wallis test comparison across four age groups, *P*=0.002.
N = Number of observations.

Source: Freeman et al., 2001.

Table 4-6. Variability in Objects Mouthed by Washington State Children (contacts/hour)												
Variable	All Subjects				≤24 Months				>24 Months			
	N[a]	Mean[b]	Median	95% CI[c]	N[a]	Mean[b]	Median	95% CI[c]	N[a]	Mean[b]	Median	95% CI[c]
Mouth-body	186	8	2	2-3	69	10	4	3-6	117	7	1	0.8-1.3
Mouth-hand	186	16	11	9-14	69	18	12	9-16	117	16	9	7-12
Mouth-surface	186	4	1	0.8-1.2	69	7	5	3-8	117	2	1	0.9-1.1
Mouth-toy	186	27	18	14-23	69	45	39	31-48	117	17	9	7-12
Total events	186	56	44	36-52	69	81	73	60-88	117	42	31	25-39

[a] Number of observations.
[b] Arithmetic mean.
[c] The 95% confidence intervals (CI) apply to median. Values were calculated in logs and converted to original units.

Source: Tulve et al., 2002.

Table 4-7. Indoor Mouthing Frequency (Contacts per hour), Video-transcription of 9 Children with >15 minutes in View Indoors

Age Group	N	Statistic	Hands	Total non-dietary[a]
		Mean	20.5	29.6
		Median	14.8	22.1
13 to 84 months	9	Range	2.5 - 70.4	3.2 - 82.2
≤24 months	1	-	73.5	84.8
		Mean	13.9	22.7
		Median	13.3	19.5
>24 months	8	Range	2.2 - 34.1	2.8 - 51.3

[a] Object/surface categories mouthed indoors included: Clothes/towels, hands, metal, paper/wrapper, plastic, skin, toys, and wood.
N = Number of subjects.

Source: AuYeung et al., 2004.

Table 4-8. Outdoor Mouthing Frequency (Contacts per hour), Video-transcription of 38 Children

Age Group	N	Statistic	Hands	Total non-dietary[a]
		Mean	11.7	18.3
		5th percentile	0.4	0.8
		25th percentile	4.4	9.2
		50th percentile	8.4	14.5
		75th percentile	14.8	22.4
		95th percentile	31.5	51.7
13 to 84 months	38	99th percentile	47.6	56.6
		Mean	13.0	20.4
		Median	7.0	13.9
≤24 months	8	Range	1.3 - 47.7	6.2 - 56.4
		Mean	11.3	17.7
		5th percentile	0.2	0.6
		25th percentile	4.7	7.6
		50th percentile	8.6	14.6
		75th percentile	14.8	22.4
		95th percentile	27.7	43.8
>24 months	30	99th percentile	39.5	53.0

[a] Object/surface categories mouthed outdoors included: animal, clothes/towels, fabric, hands, metal, non-dietary water, paper/wrapper, plastic, skin, toys, vegetation/grass, and wood.
N = Number of subjects.

Source: AuYeung et al., 2004.

Table 4-9. Videotaped Mouthing Activity of Texas Children, Median Frequency (Mean ± SD)			
Age	N	Hand to mouth	Object to Mouth
		Frequency (contacts/hour)	Frequency (contacts/hour)
7-12 months	13	14 (19.8 ± 14.5)	18.1 (24.4 ± 11.6)
13-24 months	12	13.3 (15.8 ± 8.7)	8.4 (9.8 ± 6.3)
25-36 months	18	9.9 (11.9 ± 9.3)	5.5 (7.8 ± 5.8)
37-53 months	9	19.4 (22.1 ± 22.1)	8.4 (10.1 ± 12.4)

N = Number of subjects.
SD = Standard deviation.

Source: Black et al., 2005.

Table 4-10. Indoor Hand-to-Mouth Frequency (contacts/hour) Weibull Distributions from Various Studies											
Age Group	Weibull scale parameter	Weibull shape parameter	Chi-Square	N	Mean	SD	Percentiles				
							5	25	50	75	95
3 to <6 months	1.28	30.19	Fail	23	28.0	21.7	3.0	8.0	23.0	48.0	65.0
6 to <12 months	1.02	19.01	pass	119	18.9	17.4	1.0	6.6	14.0	26.4	52.0
1 to <2 years	0.91	18.79	fail	245	19.6	19.6	0.1	6.0	14.0	27.0	63.0
2 to <3 years	0.76	11.04	fail	161	12.7	14.2	0.1	2.9	9.0	17.0	37.0
3 to <6 years	0.75	12.59	pass	169	14.7	18.4	0.1	3.7	9.0	20.0	54.0
6 to <11 years	1.36	7.34	pass	14	6.7	5.5	1.7	2.4	5.7	10.2	20.6

N = Number of subjects.
SD = Standard deviation.

Source: Xue et al., 2007.

Table 4-11. Outdoor Hand-to-Mouth Frequency (contacts/hour) Weibull Distributions from Various Studies											
Age Group	Weibull scale parameter	Weibull shape parameter	Chi-Square	N	Mean	SD	Percentiles				
							5	25	50	75	95
6 to <12 months	1.39	15.98	pass	10	14.5	12.3	2.4	7.6	11.6	16.0	46.7
1 to <2 years	0.98	13.76	pass	32	13.9	13.6	1.1	4.2	8.0	19.2	42.2
2 to <3 years	0.56	3.41	fail	46	5.3	8.1	0.1	0.1	2.6	7.0	20.0
3 to <6 years	0.55	5.53	fail	55	8.5	10.7	0.1	0.1	5.6	11.0	36.0
6 to <11 years	0.49	1.47	fail	15	2.9	4.3	0.1	0.1	0.5	4.7	11.9

N = Number of subjects.
SD = Standard deviation.

Source: Xue et al., 2007.

Table 4-12. Object/Surface Hands and Mouth Contact Frequency (events/hour)

Object/Surface	Mouth			Both Hands		
	Range	Mean	Median	Range	Mean	Median
Animal	-	-	-	0.0-4.3	0.2	0.0
Body	0.0-5.0	1.5	0.8	16.6-147.1	76.8	70.5
Clothes/towel	0.3-13.6	5.4	3.6	39.2-237.9	113.8	100.9
Fabric	0.0-5.7	1.1	0.3	0.0-134.4	45.6	37.6
Floor	0.0-1.3	0.2	0.0	0.0-594.5	96.0	41.5
Food	2.3-68.3	28.9	28.2	0.0-170.7	51.8	42.7
Footwear	0.0-8.9	0.7	0.0	0.0-47.0	7.8	2.4
Hand/mouth[a]	2.0-62.1	18.4	15.2	2.0-62.1	18.2	14.5
Metal	0.0-2.1	0.3	0.0	0.0-52.4	17.3	14.5
Non-dietary water	-	-	-	0.0-2.6	0.2	0.0
Paper/wrapper	0.0-13.6	2.1	0.8	0.0-75.3	18.1	18.7
Plastic	0.0-14.3	2.0	1.4	10.9-294.9	87.1	76.1
Rock/brick	-	-	-	0.0-17.4	3.4	1.6
Toys	0.3-48.4	14.7	12.5	28.3-300.4	121.2	98.8
Vegetation	0.0-18.2	0.8	0.0	0.0-16.3	3.8	0.3
Wood	0.0-3.9	0.5	0.0	0.0-65.4	24.9	27.2
Non-dietary objects	6.2-82.3	29.2	27.2	266.8-1,180.0	600.8	568.7
All objects/surfaces	24.4-145.9	76.5	77.4	303.1-1,206.0	686.3	689.4

[a] Mouth for contacts with both hands.

\- No mouth contact with these objects/surfaces occurred.

Source: Beamer et al., 2008.

Table 4-13. Distributions Mouthing Frequency and Duration of Non-Dietary Objects for Infants and Toddlers

Object/Surface	Infants (6- 13 months) Mouthing Frequency (contacts/hr)									Infants (6- 13 months) Mouthing Duration (minutes/hr)							
	N	Range	Mean	5th	25th	50th	75th	95th	99th	Range	Mean	5th	25th	50th	75th	95th	99th
Clothes/towel	13	2-13.3	6.8	2.7	4.8	6.3	7.2	12.7	12.1	-	-	-	-	-	-	-	-
Paper/wrapper	13	0.0-7.2	1.1	0.0	0.2	0.7	0.8	4.3	6.6	0.0-0.7	0.1	0.0	0.0	0.0	0.1	0.4	0.6
Toys	13	6.5-48.4	21.1	7.3	14.4	20.2	25.5	40.8	46.9	0.7-17.9	3.6	0.8	1.2	1.7	2.8	11.6	16.6
Non-dietary objects	13	14-82.3	37.8	20.0	28.3	35.2	38.6	72.8	64.0	1.1-18.4	4.5	1.2	2.2	2.8	4.1	12.6	17.2
	Toddlers (20-26 months)Mouthing Frequency (contacts/hr)									Toddlers (20-26 months)Mouthing Duration (minutes/hr)							
	N	Range	Mean	5th	25th	50th	75th	95th	99th	Range	Mean	5th	25th	50th	75th	95th	99th
Clothes/towel	10	0.3-13.6	3.5	0.6	2.0	2.6	3.6	9.1	12.7	-	-	-	-	-	-	-	-
Paper/wrapper	10	0.3-12.6	6.3	1.0	2.8	5.4	9.6	12.5	12.6	0.0-0.8	0.2	0.0	0.0	0.1	0.2	0.6	0.7
Toys	10	0.3-13.6	3.5	0.6	2.0	2.6	3.6	9.1	12.7	0.0-6.8	1.5	0.1	0.2	0.5	0.7	6.1	6.6
Non-dietary objects	10	6.2-41.2	18.0	7.0	9.4	15.9	22.0	35.2	40.5	0.3-6.9	2.1	0.4	0.7	1.3	1.8	6.3	6.7

- No mouth contact with these objects/surfaces occurred.

Source: Beamer et al., 2008 supplemental data.

Table 4-14. Indoor Object-to-Mouth Frequency (contacts/hour) Weibull Distributions from Various Studies

Age Group	Weibull scale parameter	Weibull shape parameter	Chi-Square	N	Mean	SD	Percentiles				
							5	25	50	75	95
3 to <6 months	9.83	0.74	Pass	19	11.2	10.0	0.1	1.7	9.3	17.3	31.8
6 to <12 months	29.91	1.31	Fail	102	27.5	23.0	3.7	13.3	23.7	32.3	84.0
1 to <2 years	26.82	1.02	Pass	228	26.6	27.4	2.0	9.5	18.2	33.7	82.0
2 to <3 years	13.03	0.80	Fail	136	15.0	26.3	0.1	3.9	9.5	17.1	36.0
3 to <6 years	6.90	0.58	Pass	167	10.1	14.8	0.1	1.0	5.0	13.0	39.0
6 to <11 years	1.20	0.84	Pass	15	1.3	1.2	0.1	0.1	1.0	2.5	3.7

N = Number of subjects.
SD = Standard deviation.

Source: Xue et al., 2009.

Table 4-15. Outdoor Object-to-Mouth Frequency (contacts/hour) Weibull Distributions from Various Studies

Age Group	Weibull scale parameter	Weibull shape parameter	Chi-Square	N	Mean	SD	Percentiles				
							5	25	50	75	95
1 to <2 years	8.58	0.93	Pass	21	8.8	8.8	0.1	3.8	6.0	10.8	21.3
2 to <3 years	6.15	0.64	Fail	29	8.1	10.5	0.1	1.5	4.6	11.0	40.0
3 to <6 years	5.38	0.55	Pass	53	8.3	12.4	0.1	0.1	5.0	10.6	30.3
6 to <11 years	1.10	0.55	Fail	29	1.9	2.8	0.1	0.1	0.8	2.0	9.1

N = Number of subjects.
SD = Standard deviation.

Source: Xue et al., 2009.

Table 4-16. Survey Reported Mouthing Behaviors for 92 Washington State Children

Behavior	Never		Seldom		Occasionally		Frequently		Always		Unknown	
	N	%	N	%	N	%	N	%	N	%	N	%
Hand/Foot in Mouth	4	4	27	30	23	25	31	34	4	4	3	3
Pacifier	74	81	6	7	2	2	9	10	1	1	0	0
Mouth on Object	14	15	30	33	25	27	19	21	1	1	3	3
Non-Food in Mouth	5	5	25	27	33	36	24	26	5	5	0	0
Eat Dirt/Sand	37	40	39	43	11	12	4	4	1	1	0	0

N = Number of subjects.

Source: Davis et al., 1995.

Table 4-17. Estimated Daily Mean Mouthing Times of New York State Children, for Pacifiers and Other Objects

	Age 0 to 18 months		Age 19 to 36 months	
Object Type	All Children	Only Children Who Mouthed Object [a]	All Children	Only Children Who Mouthed Object [a]
	Minutes	Minutes	Minutes	Minutes
Pacifier	108 (N = 107)	221 (N=52)	126 (N=110)	462 (N=52)
Teether	6 (N=107)	20 (N=34)	0 (N=110)	30 (N=1)
Plastic Toy	17 (N=107)	28 (N=66)	2 (N=110)	11 (N=21)
Other Objects	9 (N=107)	22 (N=46)	2 (N=110)	15 (N=18)

[a] Refers to means calculated for the subset of the sample children who mouthed the object stated (zeroes are eliminated from the calculation of the mean).

N = Number of children.

Source: Juberg et al., 2001.

Table 4-18. Percent of Houston-area and Chicago-area Children Observed Mouthing, by Category and Child's Age

Object Category	All ages	<1 year	1 to 2 years	2 to 3 years
All Objects	100	100	100	100
Pacifiers	27	43	27	10
Non-pacifiers	100	100	100	100
Soft Plastic Food Content Items	28	13	30	41
Anatomy	99	100	97	100
Non-soft Plastic Toys, Teethers, and Rattles	91	94	91	86
Other Items	98	98	97	98

Source: Greene, 2002.

Table 4-19. Estimates of Mouthing Time for Various Objects (minutes/hour)

Age Group	Mean (SD)	Median	95th Percentile	99th Percentile
All Items[a]				
3 to <12 months	10.5 (7.3)	9.6	26.2	39.8
12 to <24 months	7.3 (6.8)	5.5	22.0	28.8
24 to <36 months	5.3 (8.2)	2.4	15.6	47.8
Non Pacifiers[b]				
3 to <12 months	7.1 (3.6)	6.9	13.1	14.4
12 to <24 months	4.7 (3.7)	3.6	12.8	18.9
24 to <36 months	3.5 (3.6)	2.3	12.8	15.6
All Soft Plastic Items				
3 to <12 months	0.5 (0.6)	0.1	1.8	2.5
12 to <24 months	0.4 (0.4)	0.2	1.3	1.9
24 to <36 months	0.4 (0.6)	0.1	1.6	2.9
Soft Plastic Items Not Food Contact				
3 to <12 months	0.4 (0.6)	0.1	1.8	2.0
12 to <24 months	0.3 (0.4)	0.1	1.1	1.5
24 to <36 months	0.2 (0.4)	0.0	1.3	1.8
Soft Plastic Toys, Teethers, and Rattles				
3 to <12 months	0.3 (0.5)	0.1	1.8	2.0
12 to <24 months	0.2 (0.3)	0.0	0.9	1.3
24 to <36 months	0.1 (0.2)	0.0	0.2	1.6
Soft Plastic Toys				
3 to <12 months	0.1 (0.3)	0.0	0.7	1.1
12 to <24 months	0.2 (0.3)	0.0	0.9	1.3
24 to <36 months	0.1 (0.2)	0.0	0.2	1.6
Soft Plastic Teethers and Rattles				
3 to <12 months	0.2 (0.4)	0.0	1.0	2.0
12 to <24 months	0.0 (0.1)	0.0	0.1	0.6
24 to <36 months	0.0 (0.1)	0.0	0.0	1.0
Other Soft Plastic Items				
3 to <12 months	0.1 (0.2)	0.0	0.8	1.0
12 to <24 months	0.1 (0.1)	0.0	0.4	0.6
24 to <36 months	0.1 (0.3)	0.0	0.5	1.4
Soft Plastic Food Contact Items				
3 to <12 months	0.0 (0.2)	0.0	0.3	0.9
12 to <24 months	0.1 (0.2)	0.0	0.7	1.2
24 to <36 months	0.2 (0.4)	0.0	1.2	1.9
Anatomy				
3 to <12 months	2.4 (2.8)	1.5	10.1	12.2
12 to <24 months	1.7 (2.7)	0.8	8.3	14.8
24 to <36 months	1.2 (2.3)	0.4	5.1	13.6

Table 4-19. Estimates of Mouthing Time for Various Objects (minutes/hour) (continued)

Age Group	Mean (SD)	Median	95th Percentile	99th Percentile
Non Soft Plastic Toys, Teethers, and Rattles				
3 to <12 months	1.8 (1.8)	1.3	6.5	7.7
12 to <24 months	0.6 (0.8)	0.3	1.8	4.6
24 to <36 months	0.2 (0.4)	0.1	0.9	2.3
Other Items				
3 to <12 months	2.5 (2.1)	2.1	7.8	8.1
12 to <24 months	2.1 (2.0)	1.4	6.6	9.0
24 to <36 months	1.7 (2.6)	0.7	7.1	14.3
Pacifiers				
3 to <12 months	3.4 (6.9)	0.0	19.5	37.3
12 to <24 months	2.6 (6.5)	0.0	19.9	28.6
24 to <36 months	1.8 (7.9)	0.0	4.8	46.3

[a] Object category "all items" is subdivided into pacifiers and non-pacifiers.
[b] Object category "non-pacifiers" is subdivided into all soft plastic items, anatomy (which includes hair, skin, fingers and hands), non-soft plastic toys/teethers/rattles, and other items.
[c] Object category "all soft plastic items" is subdivided into food contact items, nonfood contact items (toys, teethers and rattles) and other soft plastic.
SD = Standard Deviation.

Source: Greene, 2002.

Table 4-20. Object/Surface Hands and Mouth Contact Duration (minutes/hour)

Object/Surface	Mouth			Both Hands[a]		
	Range	Mean	Median	Range	Mean	Median
Animal	0.0-0.0	0.0	0.0	0.0-0.2	0.0	0.0
Body	0.0-0.3	0.1	0.0	1.6-21.9	7.5	5.9
Clothes/towel	0.0-0.9	0.3	0.2	4.5-31.0	13.1	12.4
Fabric	0.0-0.2	0.0	0.0	2.1-21.6	10.3	9.1
Floor	0.0-0.1	0.0	0.0	0.0-32.2	7.0	4.3
Food	0.3-15.0	4.7	3.8	0.0-37.1	14.2	12.1
Footwear	0.0-1.4	0.1	0.0	0.0-7.7	1.1	0.3
Hand/mouth[b]	0.2-5.4	1.4	1.2	0.1-7.4	1.8	1.5
Metal	0.0-0.2	0.0	0.0	0.0-5.2	2.0	1.9
Non-dietary water	0.0-0.0	0.0	0.0	0.0-0.0	0.0	0.0
Paper/wrapper	0.0-0.8	0.1	0.0	0.0-13.9	3.7	3.1
Plastic	0.0-0.6	0.1	0.1	0.9-50.6	13.5	10.9
Rock/brick	0.0-0.0	0.0	0.0	0.0-1.8	0.3	0.1
Toys	0.0-17.9	2.7	1.2	9.8-54.1	25.2	9.8
Vegetation	0.0-0.2	0.0	0.0	0.0-2.2	0.3	0.0
Wood	0.0-0.3	0.0	0.0	0.0-10.6	3.5	3.9
Non-dietary objects	0.3-18.4	3.5	2.2	62.6-106.2	83.1	83.2
All objects/surfaces	2.2-33.6	9.6	8.8	76.4-124.1	99.1	100.5

[a] Hourly contact duration for both hands is the sum of the hourly contact durations for the left and right hands independently.
[b] Mouth for contacts with both hands.

Source: Beamer et al., 2008.

Table 4-21. Mouthing Times of Dutch Children Extrapolated to Total Time While Awake, Without Pacifier, in Minutes per Day

Age Group	N	Mean	SD	Minimum	Maximum
3 to 6 months	5	36.9	19.1	14.5	67
6 to 12 months	14	44	44.7	2.4	171.5
12 to 18 months	12	16.4	18.2	0	53.2
18 to 36 months	11	9.3	9.8	0	30.9

Note: The object most mouthed in all age groups was the fingers, except for the 6 to 12 month group which mostly mouthed toys.
N = Number of children.
SD = Standard deviation.

Source: Groot et al., 1998.

Table 4-22. Estimated Mean Daily Mouthing Duration by Age Group for Pacifiers, Fingers, Toys, and Other Objects (hours:minutes:seconds)

Item Mouthed	Age Group											
	1 to 3 months	3 to 6 months	6 to 9 months	9 to 12 months	12 to 15 months	15 to 18 months	18 to 21 months	21 to 24 months	2 years	3 years	4 years	5 years
N =	9	14	15	17	16	14	16	12	39	31	29	24
Dummy (Pacifier)	0:47:13	0:27:45	0:14:36	0:41:39	1:00:15	0:25:22	1:09:02	0:25:12	0:32:55	0:48:42	0:16:40	0:00:20
Fingers	0:18:22	0:49:03	0:16:54	0:14:07	0:08:24	0:10:07	0:18:40	0:35:34	0:29:43	0:34:42	0:19:26	0:44:06
Toys	0:00:14	0:28:20	0:39:10	0:23:04	0:15:18	0:16:34	0:11:07	0:15:46	0:12:23	0:11:37	0:03:11	0:01:53
Other Objects	0:05:14	0:12:29	0:24:30	0:16:25	0:12:02	0:23:01	0:19:49	0:12:53	0:21:46	0:15:16	0:10:44	0:10:00
Not Recorded	0:00:45	0:00:24	0:00:00	0:00:01	0:00:02	0:00:08	0:00:11	0:14:13	0:02:40	0:00:01	0:00:05	0:02:58
Total (all objects)	1:11:48	1:57:41	1:35:11	1:35:16	1:36:01	0:15:13	1:58:49	1:43:39	1:39:27	1:50:19	0:50:05	0:59:17

N = Number of children in sample.

Source: Smith and Norris, 2003.

Table 4-23. Outdoor Median Mouthing Duration (seconds per contact), Video-transcription of 38 Children				
Age Group	N	Statistic	Hands	Total non-dietary[a]
13 to 84 months	38	Mean	3.5	3.4
		5th percentile	0	0
		25th percentile	1	1
		50th percentile	1	1
		75th percentile	2	3
		95th percentile	12	11
		99th percentile	41.6	40
≤24 months	8	Mean	9	2
		Median	3	1
		Range	0 to 136	0 to 40
>24 months	30	Mean	3.5	3.4
		5th percentile	0	0
		25th percentile	1	1
		50th percentile	1	1
		75th percentile	2	3
		95th percentile	12	11
		99th percentile	41.6	40

[a] Object/surface categories mouthed outdoors included: animal, clothes/towels, fabric, hands, metal, non-dietary water, paper/wrapper, plastic, skin, toys, vegetation/grass, and wood.
N = Number of subjects.

Source: AuYeung et al., 2004.

Table 4-24. Indoor Mouthing Duration (minutes per hour), Video-transcription of 9 Children with >15 minutes in View Indoors				
Age Group	N	Statistic	Hands	Total non-dietary[a]
13 to 84 months	9	Mean	1.8	2.3
		Median	0.7	0.9
		Range	0-10.7	0-11.1
≤24 months	1	Observation	10.7	11.1
>24 months	8	Mean	0.7	1.2
		Median	0.7	0.9
		Range	0-1.9	0-3.7

[a] Object/surface categories mouthed indoors included: Clothes/towels, hands, metal, paper/wrapper, plastic, skin, toys, and wood.
N = Number of subjects.

Source: AuYeung et al., 2004.

Table 4-25. Outdoor Mouthing Duration (minutes per hour), Video-transcription of 38 Children				
Age Group	N	Statistic	Hands	Total non-dietary[a]
13 to 84 months	38	Mean	0.9	1.2
		5th percentile	0	0
		25th percentile	0.1	0.2
		50th percentile	0.2	0.6
		75th percentile	0.6	1.2
		95th percentile	2.6	2.9
		99th percentile	11.2	11.5
		Range	0-15.5	0-15.8
≤24 months	8	Mean	2.7	3.1
		5th percentile	0	0.2
		25th percentile	0.2	0.2
		50th percentile	0.4	0.8
		75th percentile	1.5	3.1
		95th percentile	11.5	11.7
		99th percentile	14.7	15
		Range	0-15.5	0.2-15.8
>24 months	30	Mean	0.4	0.7
		5th percentile	0	0
		25th percentile	0.1	0.2
		Median	0.2	0.6
		75th percentile	0.4	1
		95th percentile	1.2	2.1
		99th percentile	2.2	2.5
		Range	0-2.4	0-2.6

[a] Object/surface categories mouthed outdoors included: animal, clothes/towels, fabric, hands, metal, non-dietary water, paper/wrapper, plastic, skin, toys, vegetation/grass, and wood.

N = Number of subjects.

Source: AuYeung et al., 2004.

Table 4-26. 95th Percentile Object-to-Mouth Duration for Key Studies Combined (minutes/hour)

Age Group	Greene, 2002		Beamer et al., 2008		Combined Studies	
	N		N		N	
Birth to 1 month	-	-	-	-	-	-
1 to <3 months	-	-	-	-	-	-
3 to < 6 months	54	26.2				26
6 to < 12 months	54	26.2	10	12.6	64	19
1 to < 2 years	66	22			66	22
2 to < 3 years	43	15.6	10	6.3	53	11
3 to < 6 years	-	-	-	-	-	-
6 to < 11 years	-	-	-	-	-	-
11 to <16 years	-	-	-	-	-	-
16 to < 21 years	-	-	-	-	-	-

N Sample size.
\- No data available.

Table 4-27. Reported Daily Prevalence of Massachusetts Children's Non-Food Mouthing/Ingestion Behaviors

Object or substance mouthed or ingested	Percent of children reported to mouth/ingest daily				
	1 year N=171	2 years N=70	3 to <6 years[a] N=265	6 years N=22	All years N=528
Grass, leaves, flowers	16	0	1	0	6
Twigs, sticks, woodchips	12	0	0	0	4
Teething toys	44	6	2	9	17
Other toys	63	27	12	5	30
Blankets, cloth	29	11	10	5	16
Shoes, Footwear	20	1	0	0	7
Clothing	25	7	9	14	14
Crib, chairs, furniture	13	3	1	0	5
Paper, cardboard, tissues	28	9	5	5	13
Crayons, pencils, erasers	19	17	5	18	12
Toothpaste	52	87	89	82	77
Soap, detergent, shampoo	15	14	2	0	8
Plastic, plastic wrap	7	4	1	0	3
Cigarette butts, tobacco	4	0	1	0	2
Suck fingers/thumb	44	21	24	14	30
Suck feet or toes	8	1	0	0	3
Bite nails	2	7	10	14	7
Use pacifier	20	6	2	0	9

[a] Weighted mean of 3, 4, and 5 year-olds' data calculated by U.S. EPA to conform to standardized age categories used in this Handbook.

Source: Stanek et al. (1998).

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5 SOIL AND DUST INGESTION

5.1 INTRODUCTION

The ingestion of soil and dust is a potential route of exposure for both adults and children to environmental chemicals. Children, in particular, may ingest significant quantities of soil, due to their tendency to play on the floor indoors and on the ground outdoors and their tendency to mouth objects or their hands. Children may ingest soil and dust through deliberate hand to mouth movements, or unintentionally by eating food that has dropped on the floor. Adults may also ingest soil or dust particles that adhere to food, cigarettes, or their hands. Thus, understanding soil and dust ingestion patterns is an important part of estimating overall exposures to environmental chemicals.

At this point in time, knowledge of soil and dust ingestion patterns within the United States is somewhat limited. Only a few researchers have attempted to quantify soil and dust ingestion patterns in U.S. adults or children. This chapter explains the concepts of soil ingestion, soil pica, and geophagy, defines these terms for the purpose of this handbook's exposure factors, and presents available data from the literature on the amount of soil and dust ingested.

The Centers for Disease Control and Prevention's Agency for Toxic Substances and Disease Registry (ATSDR) held a workshop in June 2000 in which a panel of soil ingestion experts developed definitions for soil ingestion, soil-pica, and geophagy, to distinguish aspects of soil ingestion patterns that are important from a research perspective (ATSDR, 2001). This chapter uses the definitions that are based on those developed by participants in that workshop:

> **Soil ingestion** is the consumption of soil. This may result from various behaviors including, but not limited to, mouthing, contacting dirty hands, eating dropped food, or consuming soil directly.
>
> **Soil-pica** is the recurrent ingestion of unusually high amounts of soil (i.e., on the order of 1,000 - 5,000 mg/day or more).
>
> **Geophagy** is the intentional ingestion of earths and is usually associated with cultural practices.

Some studies are of a behavior known as "pica," and the subset of "pica" that consists of ingesting soil. A general definition of the concept of pica is that of ingesting non-food substances, or ingesting large quantities of certain particular foods. Definitions of pica often include references to recurring or repeated ingestion of these substances. Soil-pica is pica that is specific to ingesting materials that are defined as soil, such as clays, yard soil, and flower-pot soil. Researchers in many different disciplines have hypothesized motivations for human soil-pica or geophagy behavior, including alleviating nutritional deficiencies, a desire to remove toxins or self-medicate, and other physiological or cultural influences (e.g., Danford, 1982). Bruhn and Pangborn (1971) and Harris and Harper (1997) suggest a religious context for certain geophagy or soil ingestion practices. Some researchers have investigated populations that may be more likely than others to exhibit soil-pica behavior on a recurring basis. These populations might include pregnant women who exhibit soil-pica behavior (Simpson et al., 2000), adults and children who practice geophagy (Vermeer and Frate, 1979), institutionalized children (Wong, 1988), and children with developmental delays (Danford, 1983), autism (Kinnell, 1985), or celiac disease (Korman, 1990). However, identifying specific soil-pica and geophagy populations remains difficult due to limited research on this topic.

In this handbook, soil, indoor settled and outdoor settled dust, and dust ingestion are defined generally as:

> **Soil**. Particles of unconsolidated mineral and/or organic matter from the earth's surface that are located outdoors, or are used indoors to support plant growth. It includes particles that have settled onto outdoor objects and surfaces (outdoor settled dust).
>
> **Indoor Settled Dust**. Particles in building interiors that have settled onto objects, surfaces, floors, and carpeting. These particles may include soil particles that have been tracked into the indoor environment from outdoors as well as organic matter.
>
> **Outdoor Settled Dust**. Particles that have settled onto outdoor objects and surfaces due to either wet or dry deposition. Note that it is not possible to distinguish between soil and outdoor settled dust, since outdoor settled dust generally would be present on the uppermost surface layer of soil.

For the purposes of this handbook, soil ingestion includes both soil and outdoor settled dust, and dust ingestion includes indoor settled dust only.

There are several methodologies represented in the literature related to soil and dust ingestion. Three methodologies combine biomarker measurements with measurements of the biomarker substance's presence in environmental media. A fourth methodology offers indirect evidence of soil/dust ingestion behaviors from the responses of adults, caregivers, and/or children to survey questions.

The first of the biomarker methodologies measures quantities of specific elements present in feces, urine, food and medications, yard soil, house dust, and sometimes also community soil and dust, and combines this information using certain assumptions about the elements' behavior in the gastrointestinal tract to produce estimates of soil and dust quantities ingested (e.g., Davis et al., 1990). In this chapter, this methodology is referred to as the "tracer element" methodology. The second biomarker methodology compares results from a biokinetic model of lead exposure and uptake that predict blood lead levels, with biomarker measurements of lead in blood (e.g., von Lindern et al., 2003). The model predictions are made using assumptions about ingested soil and dust quantities that are based, in part, on results from early versions of the first methodology. Therefore, the comparison with actual measured blood lead levels serves to confirm, to some extent, the assumptions about ingested soil and dust quantities used in the biokinetic model. In this chapter, this methodology is referred to as the "biokinetic model comparison" methodology. The third biomarker methodology, the "lead isotope ratio" methodology, involves measurements of different lead isotopes in blood and/or urine, food, water, and house dust and compares the ratio of different lead isotopes to infer sources of lead exposure that may include dust or other environmental exposures (e.g., Manton et al., 2000). In the fourth, "survey response" methodology, responses to survey questions regarding soil and dust ingestion are analyzed. This methodology includes questions asked about soil and dust ingestion behaviors, frequency, and sometimes quantity (e.g., Barltrop, 1966).

Although not directly evaluated in this chapter, a fifth methodology uses assumptions regarding ingested quantities of soil and dust that are based on a general knowledge of human behavior, and potentially supplemented or informed by data from other methodologies (e.g., Hawley, 1985; Kissel et al., 1998; Wong et al., 2000).

The recommendations for soil, dust, and soil + dust ingestion rates are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values are based on key studies identified by U.S. EPA for this factor. Following the recommendations, key studies on soil and dust ingestion are summarized. Summaries of the relevant studies, methodology descriptions and methodological strengths and limitations are also provided.

5.2 RECOMMENDATIONS

The key studies described in Section 5.3 were used to recommend values for soil and dust ingestion for adults and children. Table 5-1 shows the central tendency recommendations for daily ingestion of soil, dust, or soil + dust, in mg/day. It also shows the soil-pica or geophagy recommendations for daily ingestion of soil, in mg/day. No data are available on which to base comparable upper percentile recommendations for "dust" or "soil + dust" for adults or children. Due to the current state of research on soil and dust ingestion, the upper percentile recommendations are called "soil-pica" or "geophagy" recommendations that are likely to represent high soil ingestion episodes or behaviors at an unknown point on the high end of the distribution of soil ingestion. Published estimates from the key studies have been rounded to one significant figure.

The soil ingestion recommendations in Table 5-1 are intended to represent ingestion of a combination of soil and outdoor settled dust, without distinguishing between these two sources. The source of the soil in these recommendations could be outdoor soil, indoor containerized soil used to support growth of indoor plants, or a combination of both outdoor soil and containerized indoor soil. These recommendations are called "soil." The dust ingestion recommendations in Table 5-1, provided for children only, include soil tracked into the indoor setting, indoor settled dust and air-suspended particulate matter that is inhaled and swallowed. Central tendency "dust" recommendations are provided, in the event that assessors need recommendations for an indoor or inside a transportation vehicle scenario in which dust, but not outdoor soil, is the exposure medium of concern. The soil + dust recommendations would include soil, either from outdoor or containerized indoor sources, dust that is a combination of outdoor settled dust, indoor settled dust, and air-suspended particulate matter that is inhaled, subsequently trapped in mucous and moved from the respiratory system to the gastrointestinal tract, and a soil-origin material located on indoor floor surfaces that was tracked indoors by building occupants. Soil and dust recommendations exclude the soil or dust's moisture content. In other words, recommended values represent mass of ingested soil or dust that is represented on a dry weight basis.

Studies estimating adult soil ingestion are extremely limited, and only two of these are considered to be key studies (Vermeer and Frate, 1979 and Davis and Mirick, 2006). In the Davis and Mirick (2006) study, soil ingestion for adults and children in the same family was calculated using a mass-balance approach. The adult data were seen to be more variable than for the children in the study, possibly indicating an important occupational contribution of soil ingestion in some of the adults. For the aluminum and silicon tracers, soil ingestion rates ranged from 23-92 mg/day (mean), 0-23 mg/day (median), and 138-814 mg/day (maximum), with an overall mean value of 52 mg/day for the adults in the study. Based on this value, the recommended mean value from the Davis and Mirick (2006) study is estimated to be 50 mg/day for adult soil ingestion (Table 5-1). There are no available studies estimating the ingestion of dust by adults, therefore, no recommended values are provided for adults for either dust or soil + dust ingestion.

The key studies pre-dated the age groups recommended for children by U.S. EPA (2005) and were performed on groups of children of varying ages. As a result, central tendency recommendations can be used for the life stage categories of 6 to <12 months, 1 to <2 years, 2 to <3 years, 3 to <6 years, and part of the 6 to <11 years categories. Upper percentile recommendations can be used for the life stage categories of 1 to <2 years, 2 to <3 years, 3 to <6 years, 6 to <11 years, and part or all of the 11 to <16 years category.

The recommended central tendency soil + dust ingestion estimate for infants from 6 months up to their first birthday is 60 mg/day. If an estimate is needed for soil only, from outdoor or indoor sources, or both outdoor and indoor sources, the recommendation is 30 mg/day. If an estimate for indoor dust only is needed, that would include a certain quantity of tracked-in soil from outside, the recommendation is 30 mg/day. The confidence rating for this recommendation is low due to the small numbers of study subjects in the study on which the recommendation is based and the inferences needed to develop a quantitative estimate. Examples of these inferences include: an assumption that the relative proportions of soil and dust ingested by 6 to <12 month old children is the same as the central tendency assumption for older children (45 percent soil, 55 percent dust, based on U.S. EPA (1994a)), and the assumption that pre-natal or non-soil, non-dust sources of lead exposure do not dominate these children's blood lead levels.

When assessing risks for individuals who are not expected to exhibit soil-pica or geophagy behavior, the recommended central tendency soil + dust ingestion estimate is 100 mg/day for children ages 1 to <21 years. If an estimate for soil only is needed, for exposure to soil such as manufactured topsoil or potted-plant soil that could occur in either an indoor or outdoor setting, or when the risk assessment is not considering children's ingestion of indoor dust (in an indoor setting) as well, the recommendation is 50 mg/day. If an estimate for indoor dust only is needed, the recommendation is 60 mg/day. Although these quantities add up to 110 mg/day, the sum is rounded to one significant figure. Although there were no tracer element studies or biokinetic model comparison studies performed for children 6 to <21 years, as a group, their mean or central tendency soil ingestion would not be zero. In the absence of data that can be used to develop specific central tendency soil and dust ingestion recommendations for children aged 6 to <11 years, 11 to <16 years and 16 to <21 years, U.S. EPA recommends using the same central tendency soil and dust ingestion rates that are recommended for children in the 1 to <6 year old age range.

No key studies are available estimating soil-pica behavior in adults, therefore, no recommended value is provided. When assessing risks for children who may exhibit soil-pica behavior, or a group of children that includes individual children who may exhibit soil-pica behavior, the soil-pica ingestion estimate in the literature for children up to age 14 ranges from 400 to 41,000 mg/day. Due to the definition of soil-pica used in this chapter, that sets a lower bound on the quantity referred to as "soil-pica" at 1,000 mg/day, and due to the significant number of observations in the U.S. tracer element studies that are at or exceed that quantity, the recommended soil-pica ingestion rate is 1,000 mg/day. Currently, no data are available for upper percentile, soil-pica behavior for children ages 6 to <21 years. Because pica behavior may occur among some children ages ~1 to 21 years old (Hyman et al., 1990), it is prudent to assume that, for some children, soil-pica behavior may occur at any age up to 21 years.

The recommended geophagy soil estimate is 50,000 mg/day (50 grams) for both adults and children (Vermeer and Frate, 1979). Risk assessors should use this value for soil ingestion in areas where residents are known to exhibit geophagy behaviors.

These recommendations are not robust enough for use in probabilistic risk assessments.

Table 5-2 shows the confidence ratings for these recommendations. Section 5.4 gives a more detailed explanation of the basis for the confidence ratings.

An important factor to consider when using these recommendations is that they are limited to estimates of soil and dust quantities ingested. The scope of this chapter is limited to quantities of soil and dust taken into the gastrointestinal tract, and does not extend to issues regarding bioavailability of environmental contaminants present in that soil and dust. Information from other sources is needed to address bioavailability. In addition, as more information becomes available regarding gastrointestinal absorption of environmental contaminants, adjustments to the soil and dust ingestion exposure equations may need to be made, to better represent the direction of movement of those contaminants within the gastrointestinal tract.

To place these recommendations into context, it is useful to compare these soil ingestion rates to common measurements. The bulk densities of surface soils are often in the range of 1.3 to 1.7 g/cm^3. U.S. EPA (1996) recommends using 1.5 g/cm^3 as a default value for dry soil bulk density. The central tendency recommendation of 50 mg/day, or 0.050 g/day, dry weight basis, with a 1.5 g/cm^3 bulk density would be equivalent to approximately 0.03 cm^3. A teaspoon is approximately 5 cm^3 in volume, so the 50 mg/day quantity would be roughly equivalent to seven thousandths of a teaspoon per day. The 50 g/day ingestion rate recommended to represent geophagy behavior would be roughly equivalent to 5 to 7 teaspoons per day in volume.

Indoor settled dust could be expected to have a lower dry bulk density than the surface soil bulk density cited above (for example, bulk densities of five grain dusts are reported by Parnell et al. (1986) to be 0.15-0.31 g/cm^3, “specific density” of Danish office building dust is reported by Mølhave et al. (2000) to be 1.0 gm/cm^3). Thus, volumes of indoor settled dust could be expected to weigh less than comparable volumes of surface soil. The central tendency “dust” recommendation for children of 60 mg/day, or 0.060 g/day, dry weight basis, with a 1.0 g/cm^3 bulk density would be equivalent to approximately 0.06 cm^3, or roughly equivalent to twelve thousandths of a teaspoon per day.

Table 5-1. Recommended Values for Daily Soil, Dust, and Soil + Dust Ingestion

	Soil[a]			Dust[b]	Soil + Dust
		Upper Percentile			
Age Group	Central Tendency (mg/day)	Soil-Pica (mg/day)	Geophagy (mg/day)	Central Tendency (mg/day)	Central Tendency (mg/day)
6 to <12 months	30	-	-	30	60
1 to < 6 years	50	1,000	50,000	60	100[c]
6 to <21 years	50	1,000	50,000	60	100[c]
Adult	50	-	50,000	-	-

- No recommendation.
[a] Includes soil and outdoor settled dust.
[b] Includes indoor settled dust only.
[c] Total soil and dust ingestion rate is 110 mg/day; rounded to one significant figure it is 100 mg/day.

Table 5-2. Confidence in Recommendations for Ingestion of Soil and Dust

General Assessment Factors	Rationale	Rating
Soundness		Low
Adequacy of Approach	The methodologies have significant limitations. The studies did not capture all of the information needed (quantities ingested, frequency of high soil ingestion episodes, prevalence of high soil ingestion). Four of the 9 key studies were of census or randomized design. Sample selection may have introduced some bias in the results (i.e., children near smelter or Superfund sites, volunteers in nursery schools). The total number of adults and children in key studies were 122 and 1,203 (859 U.S. children, 292 Dutch, and 52 Jamaican children), respectively, while the target population currently numbers more than 74 million (U.S. DOC, 2008). The response rates for in-person interviews and telephone surveys were often not stated in published articles. Primary data were collected for 381 U.S. children and 292 Dutch children; secondary data for 478 U.S. children and 52 Jamaican children. Two key studies provided data for adults.	
Minimal (or defined) Bias	Numerous sources of measurement error exist in the tracer element studies. Biokinetic model comparison study may contain less measurement error than tracer element studies. Survey response study may contain measurement error.	
Applicability and Utility		Low
Exposure Factor of Interest	Eight of the 9 key studies focused on the soil exposure factor, with no or less focus on the dust exposure factor. The biokinetic model comparison study did not focus exclusively on soil and dust exposure factors.	
Representativeness	The study samples may not be representative of the U.S. in terms of race, ethnicity, socio-economics, and geographical location; studies focused on specific areas.	
Currency	Studies results are likely to represent current conditions.	
Data Collection Period	Tracer element studies' data collection periods may not represent long-term behaviors. Biokinetic model comparison and survey response studies do represent longer term behaviors.	
Clarity and Completeness		Low
Accessibility	Observations for individual children are available for only 3 of the 9 key studies.	
Reproducibility	For the methodologies used by more than one research group, reproducible results were obtained in some instances. Some methodologies have been used by only one research group and have not been reproduced by others.	
Quality Assurance	For some studies, information on quality assurance/quality control was limited or absent.	
Variability and Uncertainty		Low
Variability in Population	Tracer element studies characterized variability among study sample members; biokinetic model comparison and survey response studies did not. Day-to-day and seasonal variability was not very well characterized. Numerous factors that may influence variability have not been explored in detail.	
Minimal Uncertainty	Estimates are highly uncertain. Tracer element studies' design appears to introduce biases in the results.	
Evaluation and Review		Medium
Peer Review	All key studies appeared in peer review journals.	
Number and Agreement of Studies	9 key studies. Researchers using similar methodologies obtained generally similar results; somewhat general agreement between researchers using different methodologies.	
Overall Rating		**Low**

5.3 KEY AND RELEVANT STUDIES

The key tracer element, biokinetic model comparison, and survey response studies are summarized in the following sections. Certain studies were considered "key" and were used as a basis for developing the recommendations, using judgment about the study's design features, applicability, and utility of the data to U.S. soil and dust ingestion rates, clarity and completeness, and characterization of uncertainty and variability in ingestion estimates. Because the studies often were performed for reasons unrelated to developing soil and dust ingestion recommendations, their attributes that were characterized as "limitations" in this chapter might not be limitations when viewed in the context of the study's original purpose. However, when studies are used for developing a soil or dust ingestion recommendation, U.S. EPA has categorized some studies' design or implementation as preferable to others. In general, U.S. EPA chose studies designed either with a census or randomized sample approach over studies that used a convenience sample, or other non-randomized approach, as well as studies that more clearly explained various factors in the study's implementation that affect interpretation of the results. However, in some cases, studies that used a non-randomized design contain information that is useful for developing exposure factor recommendations (for example, if they are the only studies of children in a particular age category), and thus may have been designated as "key" studies. Other studies were considered "relevant" but not "key" because they provide useful information for evaluating the reasonableness of the data in the key studies, but in U.S. EPA's judgment they did not meet the same level of soundness, applicability and utility, clarity and completeness, and characterization of uncertainty and variability that the key studies did. In addition, studies that did not contain information that can be used to develop a specific recommendation for mg/day soil and dust ingestion were classified as relevant rather than key.

Some studies are re-analyses of data previously published. For this reason, the sections that follow are organized into key and relevant studies of primary analysis (that is, studies in which researchers have developed primary data pertaining to soil and dust ingestion) and key and relevant studies of secondary analysis (that is, studies in which researchers have interpreted previously published results, or data that were originally collected for a different purpose).

5.3.1 Methodologies Used in Key Studies

5.3.1.1 *Tracer Element Methodology*

The tracer element methodology attempts to quantify the amounts of soil ingested by analyzing samples of soil and dust from residences and/or children's play areas, and feces or urine. The soil, dust, fecal, and urine samples are analyzed for the presence and quantity of tracer elements - typically, aluminum, silicon, titanium, and other elements. A key underlying assumption is that these elements are not metabolized into other substances in the body or absorbed from the gastrointestinal tract in significant quantities, and thus their presence in feces and urine can be used to estimate the quantity of soil ingested by mouth. Although they are sometimes called mass balance studies, none of the studies attempt to quantify amounts excreted in perspiration, tears, glandular secretions, or shed skin, hair or finger- and toe-nails, nor do they account for tracer element exposure via the dermal or inhalation into the lung routes, and thus they are not a complete "mass balance" methodology. Early studies using this methodology did not always account for the contribution of tracer elements from non-soil substances (food, medications, and non-food sources such as toothpaste) that might be swallowed. U.S. studies using this methodology in or after the mid to late 1980s account for, or attempt to account for, tracer element contributions from these non-soil sources. Some study authors adjust their soil ingestion estimate results to account for the potential contribution of tracer elements found in household dust as well as soil.

The general algorithm that is used to calculate the quantity of soil or dust estimated to have been ingested is as follows: the quantity of a given tracer element, in milligrams, present in the feces and urine, minus the quantity of that tracer element, in milligrams, present in the food and medicine, the result of which is divided by the tracer element's soil concentration, in milligrams of tracer per gram of soil, to yield an estimate of ingested soil, in grams.

The U.S. tracer element researchers have all assumed a certain offset, or lag time between ingestion of food, medication and soil, and the resulting fecal and urinary output. The lag times used are typically 24 or 28 hours; thus, these researchers subtract the previous day's food and medication tracer element quantity ingested from the current day's fecal and urinary tracer element quantity that was excreted. When compositing food, medication, fecal and urine samples across the entire study period, daily estimates can be obtained by dividing the total estimated soil ingestion by the number of days in which fecal and/or urine samples were collected. A variation of the algorithm that provides slightly higher estimates of soil ingestion is to divide the total estimated soil ingestion by the number of days on which feces were produced, which by definition would be equal to or less than the total number of days of the study period's fecal sample collection.

Substituting tracer element dust concentrations for tracer element soil concentrations yields a dust ingestion estimate. Because the actual non-food, non-medication quantity ingested is a combination of soil and dust, the unknown true soil and dust ingestion is likely to be somewhere between the estimates that are based on soil concentrations and estimates that are based on dust concentrations. Tracer element researchers have described ingestion estimates for soil that actually represent a combination of soil and dust, but were calculated based on tracer element concentrations in soil. Similarly, they have described ingestion estimates for dust that are actually for a combination of soil and dust but were calculated based on tracer element concentrations in dust. Other variations on these general soil and dust ingestion algorithms have been published, in attempts to account for time spent indoors, time spent away from the house, etc. that could be expected to influence the relative proportion of soil vs. dust.

Each individual's soil and dust ingestion can be represented as an unknown constant in a set of simultaneous equations of soil or dust ingestion represented by different tracer elements. To date, only one of the U.S. research teams (Lásztity et al., 1989) has published estimates calculated for pairs of tracer elements using simultaneous equations.

The U.S. tracer element studies have been performed for only short-duration study periods, and only for 33 adults (Davis and Mirick, 2006) and 241 children (101 in Davis et al., 1990, 12 of whom were studied again in Davis and Mirick, 2006; 64 in Calabrese et al., 1989/Barnes 1990; 64 in Calabrese et al., 1997a; and 12 in Calabrese et al., 1997b). They provide information on quantities of soil and dust ingested for the studied groups for short time periods, but provide limited information on overall prevalence of soil ingestion by U.S. adults and children, and limited information on the frequency of higher soil ingestion episodes.

The tracer element studies appear to contain numerous sources of error that influence the estimates upward and downward. Sometimes the error sources cause individual soil or dust ingestion estimates to be negative, which is not physically possible. In some studies, for some of the tracers, so many individual "mass balance" soil ingestion estimates were negative that median or mean estimates based on that tracer were negative. For soil and dust ingestion estimates based on each particular tracer, or averaged across tracers, the net impact of these competing upward and downward sources of error is unclear.

5.3.1.2 *Biokinetic Model Comparison Methodology*

The Biokinetic Model Comparison methodology compares direct measurements of a biomarker, such as blood or urine levels of a toxicant, with predictions from a biokinetic model of oral, dermal and inhalation exposure routes with air, food, water, soil, and dust toxicant sources. An example is to compare measured children's blood lead levels with predictions from the Integrated Exposure and Uptake Biokinetic (IEUBK) model. Where environmental contamination of lead in soil, dust, and drinking water has been measured and those measurements can be used as model inputs for the children in a specific community, the model's assumed soil and dust ingestion values can be confirmed or refuted by comparing the model's predictions of blood lead levels with those children's measured blood lead levels. It should be noted, however, that such confirmation of the predicted blood lead levels would be confirmation of the net impact of all model inputs, and not just soil and dust ingestions. Under the assumption that the actual measured blood lead levels of various groups of children studied have minimal error, and those measured blood lead levels roughly match the biokinetic model predictions for those groups of children, then the model's default assumptions may be roughly accurate for the central tendency, or typical, children in an assessed group of children. The model's default assumptions likely are not as useful for predicting outcomes for highly exposed children.

5.3.1.3 *Survey Response Methodology*

The survey response methodology includes studies that survey adults, children's caretakers, or children themselves, via in-person or mailed surveys that ask about mouthing behavior and ingestion of various non-food items. Sometimes, questions about amounts ingested are included in the survey instrument. There could be either false positive or false negative responses to these questions, for various reasons.

5.3.2 Key Studies of Primary Analysis

5.3.2.1 *Vermeer and Frate, 1979 - Geophagia in Rural Mississippi: Environmental and Cultural Contexts and Nutritional Implications*

Vermeer and Frate (1979) performed a survey response study in Holmes County, Mississippi in the 1970s (date unspecified). Questions about geophagy (defined as regular consumption of clay over a period of weeks) were asked of household members (N=229 in 50 households; 56 were women, 33 were men, and 140 were children or adolescents) of a subset of a random sample of nutrition survey respondents. Caregiver responses to questions about 115 children under 13 indicate that geophagy was likely to be practiced by a minimum of 18 (16%) of these children; however, 16 of these 18 children were 1 to 4 years old, and only 2 of the 18 were older than 4 years. Of the 56 women, 32 (57%) reported eating clay. There was no reported geophagy among 33 men or 25 adolescent study subjects questioned.

In a separately administered survey, geophagy and pica data were obtained from 142 pregnant women over a period of 10 months. Geophagy was reported by 40 of these women (28%), and an additional 27 respondents (19%) reported other pica behavior, including the consumption of laundry starch, dry powdered milk and baking soda.

The average daily amount of clay consumed was reported to be about 50 grams, for the adult and child respondents who acknowledged practicing geophagy. Quantities were usually described as either portions or multiples of the amount that could be held in a single, cupped hand. Clays for consumption were generally obtained from the B soil horizon, or subsoil rather than an uppermost layer, at a depth of 50 to 130 centimeters.

5.3.2.2 *Calabrese et al., 1989 - How Much Soil Do Young Children Ingest: An Epidemiologic Study/Barnes, 1990 - Childhood Soil Ingestion: How Much Dirt Do Kids Eat?/Calabrese et al., 1991 - Evidence of Soil-Pica Behaviour and Quantification of Soil Ingested*

Calabrese et al. (1989) and Barnes (1990) studied soil ingestion among children using eight tracer elements—aluminum, barium, manganese, silicon, titanium, vanadium, yttrium, and zirconium. A non-random sample of 30 male and 34 female 1, 2 and 3 year-olds from the greater Amherst, Massachusetts area were studied, presumably in 1987. The children were predominantly from two-parent households where the parents were highly educated. The study was conducted over a period of eight days spread over two weeks. During each week, duplicate samples of food, beverages, medicines, and vitamins were collected on Monday through Wednesday, while excreta were collected for four 24-hour cycles running from Monday/Tuesday through Thursday/Friday. Soil and dust samples were also collected from the child's home and play area. Study participants were supplied with toothpaste, baby cornstarch, diaper rash cream, and soap with low levels of most of the tracer elements. Fecal and urine samples, excluding wipes and toilet paper, were also collected and analyzed for tracer elements.

Table 5-3 shows the published mean soil ingestion estimates ranging from -294 mg/day based on manganese to 459 mg/day based on vanadium, median soil ingestion estimates ranging from -261 mg/day based on manganese to 96 mg/day based on vanadium, and 95th percentile estimates ranged from 106 mg/day based on yttrium to 1,903 mg/day based on vanadium. Maximum daily soil ingestion estimates ranged from 1,391 mg/day based on zirconium to 7,281 mg/day based on manganese. Dust ingestions calculated using tracer concentrations in dust were often, but not always, higher than soil ingestions calculated using tracer concentrations in soil.

Data for the uppermost 23 subject-weeks (the highest soil ingestion estimates, averaged over the four days of excreta collection during each of the two weeks) were published in Calabrese et al. (1991). One child's soil-pica behavior was estimated in Barnes (1990) using both the subtraction/division algorithm and the simultaneous equations method. On two particular days during the second week of the study period, the child's aluminum-based soil ingestion estimates were 19 g/day (18,700 mg/day) and 36 g/day (35,600 mg/day), silicon-based soil ingestion estimates were 20 g/day (20,000 mg/day) and 24 g/day (24,000), and simultaneous-equation soil ingestion estimates were 20 g/day (20,100 mg/day) and 23 g/day (23,100 mg/day) (Barnes 1990). By tracer, averaged across the entire week, this child's estimates ranged from approximately 10 to 14 g/day during the second week of observation (Calabrese et al., 1991, shown in Table 5-4), and averaged 6 g/day across the entire study period. Additional information about this child's apparent ingestion of soil vs. dust during the study period, shown in Table 5-5, was published in Calabrese and Stanek (1992a).

5.3.2.3 *Van Wïjnen et al., 1990 - Estimated Soil Ingestion by Children*

In a tracer element study by Van Wïjnen et al. (1990), soil ingestion among Dutch children ranging in age from 1 to 5 years was evaluated using a tracer element methodology. Van Wïjnen et al. (1990) measured three tracers (titanium, aluminum, and acid insoluble residue (AIR)) in soil and feces. The authors estimated soil ingestion based on an assumption called the Limiting Tracer Method (LTM), which assumed that soil ingestion could not be higher than the lowest value of the three tracers. LTM values represented soil ingestion estimates that were not corrected for dietary intake.

An average daily feces dry weight of 15 g was assumed. A total of 292 children attending daycare centers were studied during the first of two sampling periods and 187 children were studied in the second sampling period; 162 of these children were studied during both periods (i.e., at the beginning and near the end of the summer of 1986). A total of 78 children were studied at campgrounds. The authors reported geometric mean LTM values because soil ingestion rates were found to be skewed and the log transformed data were approximately normally distributed. Geometric mean LTM values were estimated to be 111 mg/day for children in daycare centers and 174 mg/day for children vacationing at campgrounds (Table 5-6). For the 162 daycare center children studied during both sampling periods the arithmetic mean LTM was 162 mg/day, and the median was 114 mg/day.

Fifteen hospitalized children were studied and used as a control group. These children's LTM soil ingestion estimates were 74 (geometric mean), 93 (mean), and 110 (median) mg/day. The authors assumed the hospitalized children's soil ingestion estimates represented dietary intake of tracer elements, and used rounded 95 percent confidence limits on the arithmetic mean, 70 to 120 mg/day, to correct the day-care and campground children's LTM estimates for dietary intake of tracers. Corrected soil ingestion rates were 69 mg/day (162 mg/day minus 93 mg/day) for daycare children and 120 mg/day (213 mg/day minus 93 mg/day) for campers. Corrected geometric mean soil ingestion was estimated to range from 0 to 90 mg/day, with a 90th percentile value of up to 190 mg/day for the various age categories within the daycare group and 30 to 200 mg/day, with a 90th percentile value of up to 300 mg/day for the various age categories within the camping group.

AIR was the limiting tracer in about 80 percent of the samples. Among children attending daycare centers, soil ingestion was also found to be higher when the weather was good (i.e., <2 days/week precipitation) than when the weather was bad (i.e., >4 days/week precipitation (Table 5-7).

5.3.2.4 *Davis et al., 1990 - Quantitative Estimates of Soil Ingestion in Normal Children between the Ages of 2 and 7 Years: Population-based Estimates Using Aluminum, Silicon, and Titanium as Soil Tracer Elements*

Davis et al. (1990) used a tracer element technique to estimate soil ingestion among children. In this study, 104 children between the ages of 2 and 7 years were randomly selected from a three-city area in southeastern Washington State. Soil and dust ingestion was evaluated by analyzing soil and house dust, feces, urine, and duplicate food, dietary supplement, medication and mouthwash samples for aluminum, silicon, and titanium. Data were collected for 101 of the 104 children during July, August or September, 1987. In each family, data were collected over a seven day period, with four days of excreta sample collection. Participants were supplied with toothpaste with known tracer element content. In addition, information on dietary habits and demographics was collected in an attempt to identify behavioral and demographic characteristics that influence soil ingestion rates among children. The amount of soil ingested on a daily basis was estimated using equation 5-1:

$$S_{i,e} = \frac{((DW_f + DW_P) \times E_f) + 2E_u) - (DW_{fd} \times E_{fd})}{E_{soil}} \qquad \text{(Eq. 5-1)}$$

where:

$S_{i,e}$ = soil ingested for child *i* based on tracer *e* (g);
DW_f = feces dry weight (g);
DW_p = feces dry weight on toilet paper (g);
E_f = tracer concentration in feces (μg/g);
E_u = tracer amount in urine (μg);
DW_{fd} = food dry weight (g);
E_{fd} = tracer concentration in food (μg/g); and
E_{soil} = tracer concentration in soil (μg/g).

The soil ingestion rates were corrected by adding the amount of tracer in vitamins and medications to the amount of tracer in food, and adjusting the food, fecal and urine sample weights to account for missing samples. Food, fecal and urine samples were composited over a 4-day period, and estimates for daily soil ingestion were obtained by dividing the 4 day composited tracer quantities by 4.

Soil ingestion rates were highly variable, especially those based on titanium. Mean daily soil ingestion estimates were 38.9 mg/day for aluminum, 82.4 mg/day for silicon and 245.5 mg/day for titanium (Table 5-8). Median values were 25 mg/day for aluminum, 59 mg/day for silicon, and 81 mg/day for titanium. The investigators also evaluated the extent to which differences in tracer concentrations in house dust and yard soil impacted estimated soil ingestion rates. The value used in the denominator of the soil ingestion estimate equation was recalculated to represent a weighted average of the tracer concentration in yard soil and house dust based on the proportion of time the child spent indoors and outdoors, using an assumption that the likelihood of ingesting soil outdoors was the same as that of ingesting dust indoors. The adjusted mean soil/dust ingestion rates were 64.5 mg/day for aluminum, 160.0 mg/day for silicon, and 268.4 mg/day for titanium. Adjusted median soil/dust ingestion rates were: 51.8 mg/day for aluminum, 112.4 mg/day for silicon, and 116.6 mg/day for titanium. The authors investigated whether nine behavioral and demographic factors could be used to predict soil ingestion, and found family income less than $15,000/year and swallowing toothpaste to be significant predictors with silicon-based estimates; residing in one of the three cities to be a significant predictor with aluminum-based estimates, and washing the face before eating significant for titanium-based estimates.

5.3.2.5 *Calabrese et al. 1997a - Soil Ingestion Estimates for Children Residing on a Superfund Site*

Calabrese et al. (1997a) estimated soil ingestion rates for children residing on a Superfund site using a methodology in which eight tracer elements were analyzed. The methodology used in this study is similar to that employed in Calabrese et al. (1989), except that rather than using barium, manganese, and vanadium as three of the eight tracers, the researchers replaced them with cerium, lanthanum and neodymium. A total of 64 children ages 1-3 years (36 male, 28 female) were selected for this study of the Anaconda, Montana area. The study was conducted for seven consecutive days during September or September and October, apparently in 1992, shortly after soil was removed and replaced in some residential yards in the area. Duplicate samples of meals, beverages, and over-the-counter medicines and vitamins were collected over the seven day period, along with fecal samples. In addition, soil and dust samples were collected from the children's home and play areas. Toothpaste containing nondetectable levels of the tracer elements, with the exception of silica, was provided to all of the children. Infants were provided with baby cornstarch, diaper rash cream, and soap which were found to contain low levels of tracer elements. Calabrese et al. (1997a) estimated soil ingestion by each tracer element, as shown in Table 5-9.

5.3.2.6 *Stanek et al. 1998 - Prevalence of Soil Mouthing/Ingestion among Healthy Children Aged 1 to 6/Calabrese et al. 1997b - Soil Ingestion Rates in Children Identified by Parental Observation as Likely High Soil Ingesters*

Stanek et al. (1998) conducted a survey response study using in-person interviews of parents of children attending well visits at three western Massachusetts medical clinics in August, September and October of 1992. Of 528 children ages 1 to 7 with completed interviews, parents reported daily mouthing or ingestion of sand and stones in 6 percent, daily mouthing or ingestion of soil and dirt in 4 percent, and daily mouthing or ingestion of dust, lint and dustballs in 1 percent. Parents reported more than weekly mouthing or ingestion of sand and stones in 16 percent, more than weekly mouthing or ingestion of soil and dirt in 10 percent, and more than weekly mouthing or ingestion of dust, lint and dustballs in 3 percent. Parents reported more than monthly mouthing or ingestion of sand and stones in 27 percent, more than monthly mouthing or ingestion of soil and dirt in 18 percent, and more than monthly mouthing or ingestion of dust, lint and dustballs in 6 percent.

Calabrese and colleagues performed a follow-up tracer element study (Calabrese et al. 1997b) for a subset (n=12) of the Stanek et al. (1998) children whose caregivers had reported daily sand/soil ingestion (n=17). The time frame of the follow-up tracer study relative to the original survey response study was not stated; the study duration was 7 days. Of the 12 children in Calabrese et al. 1997b, one exhibited behavior that the authors believed was clearly soil pica; Table 5-10 shows estimated soil ingestion rates for this child during the study period. Estimated average daily soil ingestion estimates (calculated based on soil tracer element concentrations only) ranged from -0.015 to +1.783 g/day based on aluminum, -0.046 to +0.931 g/day based on silicon, and -0.047 to +3.581 g/day based on titanium. Estimated average daily dust ingestion estimates (calculated based on dust tracer element concentrations only) ranged from -0.039 to +2.652 g/day based on aluminum, -0.028 to +3.145 g/day based on silicon, and -0.098 to +3.632 g/day based on titanium. Calabrese et al. (1997b) question the validity of retrospective caregiver reports of soil pica on the basis of the tracer element results.

5.3.2.7 *Davis and Mirick, 2006 - Soil ingestion in children and adults in the same family*

Davis and Mirick (2006) calculated soil ingestion for children and adults in the same family using a tracer element approach. Data were collected in 1988, one year after the Davis et al. (1990) study was conducted. Samples were collected and prepared for laboratory analysis and then stored for a 12-year period prior to tracer element quantification with laboratory analysis. The 20 families in this study were a nonrandom subset of the 104 families who participated in the soil ingestion study by Davis et al. (1990). Data collection issues resulted in sufficiently complete data for only 19 of the 20 families consisting of a child participant from the Davis et al. (1990) study ages 3 to 7, inclusive, and a female and male parent or guardian living in the same house. Duplicate samples of all food and medication items consumed, and all feces excreted, were collected for 11 consecutive days. Urine samples were collected twice daily for 9 of the 11 days; for the remaining 2 days, attempts were made to collect full 24-hour urine specimens. Soil and house dust samples were also collected. Only 12 children had sufficiently complete data for use in the soil and dust ingestion estimates.

Tracer elements for this study included aluminum, silicon and titanium. Toothpaste was supplied for use by study participants. In addition, parents completed a daily diary of activities for themselves and the participant child for 4 consecutive days during the study period.

Soil ingestion rates are shown for all three family member participants in Table 5-11. The mean and median estimates for children for all three tracers ranged from 36.7 to 206.9 mg/day and 26.4 to 46.7 mg/day, respectively, and fall within the range of those reported by Davis *et al.*, 1990. Adult soil ingestion estimates ranged from 23.2 to 624.9 mg/day for mean values and from 0 to 259.5 mg/day for median values. Adult soil ingestion estimates were more variable than those of children in the study regardless of the tracer. The authors believed that this higher variability may have indicated an important occupational contribution of soil ingestion in some, but not all, of the adults. Similar to previous studies, the soil ingestion estimates were the highest for titanium. Although toothpaste is a known source of titanium, the titanium content of the toothpaste used by study participants was not determined.

Only three of a number of behaviors examined for their relationship to soil ingestion were found to be associated with increased soil ingestion in this study:

- reported eating of dirt (for children);
- occupational contact with soil (for adults); and
- hand washing before meals (for both children and adults).

Several typical childhood behaviors, however, including thumb-sucking, furniture licking, and carrying around a blanket or toy were not associated with increased soil ingestion for the participating children. Among both parents and children, neither nail-biting nor eating unwashed fruits or vegetables was correlated with increased soil ingestion. When investigating correlations within the same family, a child's soil ingestion was not found to be associated with either parent's soil ingestion, nor did the mother and father's soil ingestion appear to be correlated.

5.3.3 Key Studies of Secondary Analysis

5.3.3.1 *Wong, 1988 - The Role of Environmental and Host Behavioural Factors in Determining Exposure to Infection with Ascaris lumbricoides and Trichuris Trichiura/Calabrese and Stanek, 1993 - Soil Pica: Not a Rare Event*

Calabrese and Stanek (1993) reviewed a tracer element study that was conducted by Wong (1988) to estimate the amount of soil ingested by two groups of children. Wong (1988) studied a total of 52 children in two government institutions in Jamaica. The younger group included 24 children with an average age of 3.1 years (range of 0.3 to 7.5 years). The older group included 28 children with an average age of 7.2 years (range of 1.8 to 14 years). One fecal sample was collected each month from each subject over the four-month study period. The amount of silicon in dry feces was measured to estimate soil ingestion.

An unspecified number of daily fecal samples were collected from a hospital control group of 30 children with an average age of 4.8 years (range of 0.3 to 12 years). Dry feces were observed to contain 1.45 percent silicon, or 14.5 mg Si per gram of dry feces. This quantity was used to correct measured fecal silicon from dietary sources. Fecal silicon quantities greater than 1.45 percent in the 52 studied children were interpreted as originating from soil ingestion.

For the 28 children in the older group, soil ingestion was estimated to be 58 mg/day, based on the mean minus one outlier, and 1,520 mg/day, based on the mean of all the children. The outlier was a child with an estimated average soil ingestion rate of 41 g/day over the 4 months.

Estimates of soil ingestion were higher in the younger group of 24 children. The mean soil ingestion of all the children was 470 ± 370 mg/day. Due to some sample losses, of the 24 children studied, only 15 had samples for each of the 4 months of the study. Over the entire 4-month study period, 9 of 84 samples (or 10.5 percent) yielded soil ingestion estimates in excess of 1 g/day.

Of the 52 children studied, 6 had one-day estimates of more than 1,000 mg/day. The estimated soil ingestion for these six children is shown in Table 5-12. The article describes 5 of 24 (or 20.8 percent) in the younger group of children as having a >1,000 mg/day estimate on at least one of the four study days; in the older group one child is described in this manner. A high degree of daily variability in soil ingestion was observed among these six children; three showed soil-pica behavior on 2, 3, and 4 days, respectively, with the most consistent (4 out of 4 days) soil-pica child having the highest estimated soil ingestion, 3.8 to 60.7 g/day.

5.3.3.2 *Hogan et al., 1998 - Integrated Exposure Uptake Biokinetic Model for Lead in Children: Empirical Comparisons with Epidemiologic Data*

Hogan et al. (1998) used the biokinetic model comparison methodology to review the measured blood lead levels of 478 children. These children were a subset of the entire population of children living in three historic lead smelting communities, whose environmental lead exposures (soil and dust lead levels) had been collected as part of public health evaluations in these communities.

The Integrated Exposure and Uptake Biokinetic (IEUBK) model is a biokinetic model for predicting children's blood lead levels that uses measurements of lead content in house dust, soil, drinking water, food and air, and child-specific estimates of intake for each exposure medium (dust, soil, drinking water, food and air). Model users can also use default assumptions for the lead contents and intake rates for each exposure medium when they do not have specific information for each child.

Hogan et al. (1998) compared children's measured blood lead levels with biokinetic model predictions (IEUBK version 0.99d) of blood lead levels, using the children's measured drinking water, soil, and dust lead contamination levels together with default IEUBK model inputs for soil and dust ingestion, relative proportions of soil and dust ingestion, lead bioavailability from soil and dust, and other model parameters. Thus, the default soil and dust ingestion rates in the model, and other default assumptions in the model, were tested by comparing measured blood lead levels with the model's predictions for those children's blood lead levels.

For Palmerton, Pennsylvania (n=34), the community-wide geometric mean measured blood lead levels (6.8 ug/dl) were slightly over-predicted by the model (7.5 ug/dl); for southeastern Kansas/southwestern Missouri (n=111), the blood lead levels (5.2 ug/dl) were slightly under-predicted (4.6 ug/dl), and for Madison County, Illinois (n=333), the geometric mean measured blood lead levels matched the model predictions (5.9 ug/dl measured and predicted), with very slight differences in the 95 percent confidence interval. These results suggest that the default soil and dust ingestion rates used in this version of the IEUBK model (approximately 50 mg/day soil and 60 mg/day dust for a total soil + dust ingestion of 110 mg/day, averaged over children ages 1 through 6) may be roughly accurate in representing the central tendency soil and dust ingestion rates of residence-dwelling children in the three locations studied.

5.3.4 Relevant Studies of Primary Analysis

The following studies are classified as relevant rather than key. The tracer element studies described in this section are not designated as key because the methodology to account for non-soil tracer exposures was not as well-developed as the methodology in the U.S. tracer element studies described in Sections 5.3.2 and 5.3.3, or because they do not provide a quantitative estimate of soil ingestion. However, the method of Clausing et al. (1987) was used in developing the biokinetic model default soil and dust ingestion rates (U.S. EPA 1994a) used in the Hogan et al. (1998) study, which was designated as key. In the survey response studies, in most cases the studies were of a non-randomized design, insufficient information was provided to determine important details regarding study design, or no data were provided to allow quantitative estimates of soil and/or dust ingestion rates.

5.3.4.1 *Dickins and Ford, 1942 - Geophagy (Dirt Eating) Among Mississippi Negro School Children*

Dickens and Ford conducted a survey response study of rural black school children (4th grade and above) in Oktibbeha County, Mississippi in September 1941. A total of 52 of 207 children (18 of 69 boys and 34 of 138 girls) studied gave positive responses to questions administered in a test-taking format regarding having eaten dirt in the previous 10 to 16 days. The authors stated that the study sample likely was more representative of the higher socioeconomic levels in the community, because older children from lower socioeconomic levels sometimes left school in order to work, and because children in the lower grades, who were more socioeconomically representative of the overall community, were excluded from the study. Clay was identified as the predominant type of soil eaten.

5.3.4.2 *Ferguson and Keaton, 1950 - Studies of the Diets of Pregnant Women in Mississippi: Ingestion of Clay and Laundry Starch*

Ferguson and Keaton (1950) conducted a survey response study of a group of 361 pregnant women receiving health care at the Mississippi State Board of Health, who were interviewed regarding their diet, including the consumption of clay or starch. All of the women were from the lowest economic and educational level in the area, and 92% were black. Of the black women, 27% reported clay-eating and 41% starch-eating. In the group of white women, 7 and 10% reporting clay- and starch-eating, respectively. The amount of starch eaten ranged from 2-3 small lumps to 3 boxes (24 ounces) per day. The amount of clay eaten ranged from 1 tablespoon to 1 cup per day.

5.3.4.3 *Cooper, 1957 - Present Study*

Cooper (1957) conducted a non-randomized survey response study in the 1950s of children age 7 months or older referred to a Baltimore, Maryland mental hygiene clinic. For 86 out of 784 children studied, parents or caretakers gave positive responses to the question, “Does your child have a habit, or did he ever have a habit, of eating dirt, plaster, ashes, etc.?” and identified dirt, or dirt combined with other substances, as the substance ingested. Cooper (1957) described a pattern of pica behavior, including ingesting substances other than soil, being most common between ages 2 and 4 or 5 years, with one of the 86 children ingesting clay at age 10 years and 9 months.

5.3.4.4 *Barltrop, 1966 - The Prevalence of Pica*

Barltrop (1966) conducted a randomized survey response study of children born in Boston, Massachusetts between 1958 and 1962, inclusive, whose parents resided in Boston and who were neither illegitimate nor adopted. A stratified random subsample of 500 of these children were contacted for in-person caregiver interviews, in which a total of 186 families (37 percent) participated. A separate stratified subsample of 1,000 children was selected for a mailed survey, in which 277 (28 percent) of the families participated. Interview-obtained data regarding care- giver reports of pica (in this study is defined as placing nonfood items in the mouth and swallowing them) behavior in all children ages 1 to 6 in the 186 families (n=439) indicated 19 had ingested dirt (defined as yard dirt, house dust, plant-pot soil, pebbles, ashes, cigarette ash, glass fragments, lint, and hair combings) in the preceding 14 days. It does not appear that these data were corrected for unequal selection probability in the stratified random sample, nor were they corrected for non-response bias. Interviews were conducted in the March/April time frame, presumably in 1964. Mail-survey obtained data regarding caregiver reports of pica in the preceding 14 days indicated that 39 of 277 children had ingested dirt, presumably using the same definition as above. Barltrop (1966) mentions several possible limitations of the study, including non-participation bias and respondents’ memory, or recall, effects.

5.3.4.5 *Bruhn and Pangborn, 1971 - Reported Incidence of Pica among Migrant Families*

Bruhn and Pangborn (1971) conducted a survey among 91 low income families of migrant agricultural workers in California in May through August 1969. Families were of Mexican descent in two labor camps (Madison camp, 10 miles west of Woodland, and Davis camp, 10 miles east of Davis) and were “Anglo” families at the Harney Lane camp 17 miles north of Stockton. Participation was 34 of 50 families at the Madison camp, 31 of 50 families at the Davis camp, and 26 of 26 families at the Harney Lane camp. Respondents for the studied families (primarily wives) gave positive responses to open-ended questions such as “Do you know of anyone who eats dirt or laundry starch?” Bruhn and Pangborn (1971) apparently asked a modified version of this question pertaining to the respondents’ own or relatives’ families. They reported 18 percent (12 of 65) of Mexican families’ respondents as giving positive responses for consumption of “dirt” among children within the Mexican respondents’ own or relatives’ families. They reported 42 percent (11 of 26) of “Anglo” families’ respondents as giving positive responses for consumption of “dirt” among children within the Anglo respondents’ own or relatives’ families.

5.3.4.6 *Robischon, 1971 - Pica Practice and Other Hand-Mouth Behavior and Children’s Developmental Level*

A survey response sample of 19- to 24-month old children examined at an urban well-child clinic in the late 1960s or 1970 in an unspecified location indicated that 48 of the 130 children whose caregivers were interviewed, exhibited pica behavior (defined as "ate nonedibles more than once a week"). The specific substances eaten were reported for 30 of the 48 children. All except 2 of the 30 children habitually ate more than one nonedible substance. The soil and dust-like substances reported as eaten by these 30 children were: ashes (17), "earth" (5), dust (3), fuzz from rugs (2), clay (1), and pebbles/stones (1). Caregivers for some of the study subjects (between 0 and 52 of the 130 subjects, exact number not specified) reported that the children "ate nonedibles less than once a week."

5.3.4.7 *Bronstein and Dollar, 1974 - Pica in Pregnancy*

The frequency and effects of pica behavior was investigated by Bronstein and Dollar (1974) in 410 pregnant, low- income women from both urban (n = 201) and rural (n = 209) areas in Georgia. The women selected were part of the Nutrition Demonstration Project, a study investigating the effect of nutrition on the outcome of the pregnancy, conducted at the Eugene Talmadge Memorial Hospital and University Hospital in Augusta, Georgia. During their initial prenatal visit, each patient was interviewed by a nutrition counselor who questioned her food frequency, social and dietary history, and the presence of pica. Patients were categorized by age, parity and place of residence (rural or urban).

Of the 410 women interviewed, 65 (16%) stated that they practiced pica. A variety of substances were ingested, with laundry starch being the most common. There was no significant difference in the practice of pica between rural and urban women, although older rural women (20-35 years) showed a greater tendency to practice pica than younger rural or urban women (<20 years). The number of previous pregnancies did not influence the practice of pica. The authors noted that the frequency of pica among rural patients had declined from a previous study conducted 8 years earlier, and attributed the reduction to a program of intensified nutrition education and counseling provided in the area. No specific information on the amount of pica substances ingested was provided by this study, and the data are more than 30 years old.

5.3.4.8 *Hook, 1978 - Dietary Cravings and Aversions During Pregnancy*

Hook (1978) conducted interviews of 250 women who had delivered a live infant at two New York hospitals; the interviews took place in 1975. The mothers were first asked about any differences in consumption of seven beverages during their pregnancy, and the reasons for any changes. They were then asked, without mentioning specific items, about any cravings or aversions for other foods or nonfood items that may have developed at any time during their pregnancy.

Nonfood items reportedly ingested during pregnancy were ice, reported by 3 women, and chalk from a river clay bank, reported by one woman. In addition, one woman reported an aversion to nonfood items (specific nonfood item not reported). No quantity data were provided by this study.

5.3.4.9 *Binder et al., 1986 - Estimating Soil Ingestion: The Use of Tracer Elements in Estimating the Amount of Soil Ingested by Young Children*

Binder et al. (1986) used a tracer technique modified from a method previously used to measure soil ingestion among grazing animals to study the ingestion of soil among children 1 to 3 years of age who wore diapers. The children were studied during the summer of 1984 as part of a larger study of residents living near a lead smelter in East Helena, Montana. Soiled diapers were collected over a 3-day period from 65 children (42 males and 23 females), and composited samples of soil were obtained from the children's yards. Both excreta and soil samples were analyzed for aluminum, silicon, and titanium. These elements were found in soil but were thought to be poorly absorbed in the gut and to have been present in the diet only in limited quantities. Excreta measurements were obtained for 59 of the children. Soil ingestion by each child was estimated on the basis of each of the three tracer elements using a standard assumed fecal dry weight of 15 g/day, and the following equation (5-2):

$$T_{i,e} = \frac{f_{i,e} \times F_i}{S_{i,e}} \qquad \text{(Eq. 5-2)}$$

where:

$T_{i,e}$ = estimated soil ingestion for child *i* based on element *e* (g/day);
$f_{i,e}$ = concentration of element *e* in fecal sample of child *i* (mg/g);
F_i = fecal dry weight (g/day); and
$S_{i,e}$ = concentration of element *e* in child *i*'s yard soil (mg/g).

The analysis assumed that (1) the tracer elements were neither lost nor introduced during sample processing; (2) the soil ingested by children originates primarily from their own yards; and (3) that absorption of the tracer elements by children occurred in only small amounts. The study did not distinguish between ingestion of soil and house dust, nor did it account for the presence of the tracer elements in ingested foods or medicines.

The arithmetic mean quantity of soil ingested by the children in the Binder et al. (1986) study was estimated to be 181 mg/day (range 25 to 1,324) based on the aluminum tracer; 184 mg/day (range 31 to 799) based on the silicon tracer; and 1,834 mg/day (range 4 to 17,076) based on the titanium tracer (Table 5-13). The overall mean soil ingestion estimate, based on the minimum of the three individual tracer estimates for each child, was 108 mg/day (range 4 to 708). The median values were 121 mg/day, 136 mg/day, and 618 mg/day for aluminum, silicon, and titanium, respectively. The 95th percentile values for aluminum, silicon, and titanium were 584 mg/day, 578 mg/day, and 9,590 mg/day, respectively. The 95th percentile value based on the minimum of the three individual tracer estimates for each child was 386 mg/day.

The authors were not able to explain the difference between the results for titanium and for the other two elements, but they speculated that unrecognized sources of titanium in the diet or in the laboratory processing of stool samples may have accounted for the increased levels. The frequency distribution graph of soil ingestion estimates based on titanium shows that a group of 21 children had particularly high titanium values (i.e., >1,000 mg/day). The remainder of the children showed titanium ingestion estimates at lower levels, with a distribution more comparable to that of the other elements.

5.3.4.10 *Clausing, et al., 1987 - A method for estimating soil ingestion by children*

Clausing et al. (1987) conducted a soil ingestion study with Dutch children using a tracer element methodology. Clausing et al. (1987) measured aluminum, titanium, and acid-insoluble residue contents of fecal samples from children aged 2 to 4 years attending a nursery school, and for samples of playground dirt at that school. Over a 5-day period, 27 daily fecal samples were obtained for 18 children. Using the average soil concentrations present at the school, and assuming a standard fecal dry weight of 10 g/day, soil ingestion was estimated for each tracer. Six hospitalized, bedridden children served as a control group, representing children who had very limited access to soil; 8 daily fecal samples were collected from the hospitalized children.

Without correcting for the tracer element contribution from background sources, represented by the hospitalized children's soil ingestion estimates, the aluminum-based soil ingestion estimates for the school children in this study ranged from 23 to 979 mg/day, the AIR-based estimates ranged from 48 to 362 mg/day, and the titanium-based estimates ranged from 64 to 11,620 mg/day. As in the Binder et al. (1986) study, a fraction of the children (6/18) showed titanium values above 1,000 mg/day, with most of the remaining children showing substantially lower values. Calculating an arithmetic mean quantity of soil ingested based on each fecal sample yielded 230 mg/day for aluminum; 129 mg/day for AIR, and 1,430 mg/day for titanium (Table 5-14). Based on the Limiting Tracer Method (LTM) and averaging across each fecal sample, the arithmetic mean soil ingestion was estimated to be 105 mg/day with a population standard deviation of 67 mg/day (range 23 to 362 mg/day); geometric mean soil ingestion was estimated to be 90 mg/day. Use of the LTM assumed that "the maximum amount of soil ingested corresponded with the lowest estimate from the three tracers" (Clausing et al., 1987).

The hospitalized children's arithmetic mean aluminum-based soil ingestion estimate was 56 mg/day; titanium-based estimates included estimates for three of the six children that exceeded 1,000 mg/day, with the remaining three children in the range of 28 to 58 mg/day (Table 5-15). AIR measurements were not reported for the hospitalized children. Using the LTM method, the mean soil ingestion rate was estimated to be 49 mg/day with a population standard deviation of 22 mg/day (range 26 to 84 mg/day). The geometric mean soil ingestion rate was 45 mg/day. The hospitalized children's data suggested a major nonsoil source of titanium for some children and a background nonsoil source of aluminum. However, conditions specific to hospitalization (e.g., medications) were not considered.

Clausing et al. (1987) estimated that the average soil ingestion of the nursery school children was 56 mg/day, after subtracting the mean LTM soil ingestion for the hospitalized children (49 mg/day) from the nursery school children's mean LTM soil ingestion (105 mg/day), to account for background tracer intake from dietary and other nonsoil sources.

5.3.4.11 *Calabrese et al., 1990 - Preliminary Adult Soil Ingestion Estimates: Results of a Pilot Study*

Calabrese et al., (1990) studied six adults to evaluate the extent to which they ingest soil. This adult study was originally part of the children soil ingestion study (Calabrese et al., 1989) and was used to validate part of the analytical methodology used in the children's study. The participants were six healty adults, three males and three females, 25-41 years old. Each volunteer ingested one empty gelatin capsule at breakfast and one at dinner Monday, Tuesday, and Wednesday during the first week of the study. During the second week, they ingested 50 mg of sterilized soil within a gelatin capsule at breakfast and at dinner (a total of 100 mg of sterilized soil per day) for 3 days. For the third week, the participants ingested 250 mg of sterilized soil in a gelatin capsule at breakfast and at dinner (a total of 500 mg of soil per day) during the three days. Duplicate meal samples (food and beverage) were collected from the six adults. The sample included all foods ingested from breakfast Monday, through the evening meal Wednesday during each of the 3 weeks. In addition, all medications and vitamins ingested by the adults were collected. Total excretory output was collected from Monday noon through Friday midnight over 3 consecutive weeks.

Data obtained from the first week, when empty gelatin capsules were ingested, were used to estimate soil intake by adults. On the basis of recovery values, Al, Si, Y, and Zr were considered the most valid tracers. The mean values for these four tracers were: Al, 110 mg; Si, 30 mg; Y, 63 mg; and Zr, 134 mg.

5.3.4.12 *Cooksey,, 1995 - Pica and Olfactory Craving of Pregnancy: How Deep Are the Secrets?*

Postpartum interviews were conducted between 1992 and 1994 of 300 women at a mid-western hospital, to document their experiences of pica behavior. The majority of women were black and low-income, and ranged in age from 13 to 42 years. In addition to questions regarding nutrition, each woman was asked if during her pregnancy she experienced a craving to eat ice or other things that are not food.

Of the 300 women, 194 (65%) described ingesting one or more pica substances during their pregnancy, and the majority (78%) ate ice/freezer frost alone or in addition to other pica substances. Reported quantities of items ingested on a daily basis were 3-4 8-pound bags of ice, 2-3 boxes of cornstarch, 2 cans of baking powder, 1 cereal bowl of dirt, 5 quarts of freezer frost, and 1 large can of powdered cleanser.

5.3.4.13 *Smulian et al., 1995 - Pica in a Rural Obstetric Population*

In 1992, Smulian et al. (1995) conducted a survey response study of pica in a convenience sample of 125 pregnant women in Muscogee County, Georgia, who ranged in age from 12 to 37. Of these, 73 were black, 47 were white, 4 were Hispanic, and 1 was Asian. Interviews were conducted at the time of the first prenatal visit, using nondirective questionnaires to obtain information regarding substances ingested as well as patterns of pica behavior and influences on pica behavior. Only women ingesting nonfood items were considered to have pica. Ingestion of ice was included as a pica behavior only if the ice was reported to be ingested multiple times per day, if the ice was purchased solely for ingestion, or if the ice was obtained from an unusual source such as freezer frost.

The overall prevalence of pica behavior in this study was 14.4% (18 of 125 women), and was highest among black women (17.8%). There was no significant difference between groups with respect to age, race, weight, or gestational age at the time of enrollment in the study. The most common form of pica was ice eating (pagophagia), reported by 44.4% of the patients. Nine of the women reported information on the frequency and amount of the substances they were ingesting. Of these women, 66.7% reported daily consumption and 33.3% reported pica behavior 3 times per week. Soap, paint chips, or burnt matches were reportedly ingested 3 days per week. One patient ate ice 60 times per week. Women who ate dirt or clay reported ingesting 0.5-1 pound per week. The largest amount of ice consumed was 5 pounds per day.

5.3.4.14 *Grigsby et al., 1999 - Chalk Eating in Middle Georgia: A Culture-Bound Syndrome of Pica?*

Grigsby et al. (1999) investigated the ingestion of kaolin, also known as white dirt, chalk, or white clay, in the central Georgia Piedmont area as a culture-bound syndrome. A total of 21 individuals who consumed kaolin at the time or had a history of consuming kaolin were interviewed, using a seven-item, one-page interview protocol. All of those interviewed were black, ranging in age from 28 to 88 years (mean age of 46.5 years), and all were female except for one.

Reasons for eating kaolin included liking the taste, being pregnant, craving it, and to gain weight. Eight respondents indicated that they obtained the kaolin from others, five reported getting it directly from the earth, four purchased it from a store, and two obtained it from a kaolin pit mine. The majority of the respondents reported that they liked the taste and feel of the kaolin as they ate it. Only three individuals reported knowing either males or white persons who consumed kaolin. Most individuals were not forthcoming in discussing their ingestion of kaolin and recognized that their behavior was unusual.

The study suggests that kaolin-eating is primarily practiced by black women who were introduced to the behavior by family members or friends, during childhood or pregnancy. The authors concluded that kaolin ingestion is a culturally-transmitted form of pica, not associated with any other psychopathology. Although information on kaolin eating habits and attitudes were provided by this study, no quantitative information on consumption was included, and the sample population was small and non-random.

5.3.4.15 *Ward, and Kutner, , 1999 - Reported Pica Behavior in a Sample of Incident Dialysis Patients*

Structured interviews were conducted with a sample of 226 dialysis patients in the metropolitan Atlanta, Georgia area from September 1996 to September 1997. Interviewers were trained in nutrition data collection methods, and patients also received a 3-day diet diary that they were asked to complete and return by mail. If a subject reported a strong past or current food or nonfood craving, a separate form was used to collect information to determine if this was a pica behavior.

Pica behavior was reported by 37 of the dialysis patients studied (16%), and most of these patients (31 of 37) reported that they were currently practicing some form of pica behavior. The patients' race and gender were significantly associated with pica behavior, with black patients and women making up 86% and 84% of those reporting pica, respectively. Those reporting pica behavior were also younger than the remainder of the sample, and approximately two thirds described a persistent craving for ice. Other pica items reportedly consumed included starch, dirt, flour, or aspirin.

5.3.4.16 *Simpson et al., 2000 - Pica During Pregnancy in Low-Income Women Born in Mexico*

Simpson et al. (2000) interviewed 225 Mexican-born women, aged 18-42 years (mean age of 25 years), using a questionnaire administered in Spanish. Subjects were recruited by approaching women in medical facilities that served low-income populations in the cities of Ensenada, Mexico (n=75), and Santa Ana, Bakerfield, and East Los Angeles, California (n=150). Criteria for participation were that the women had to be Mexican-born, speak Spanish as their primary language, and be pregnant or have been pregnant within the past year. Only data for U.S. women are included in this handbook.

Pica behavior was reported in 31% of the women interviewed in the U.S. The items ingested and the number of women reporting the pica behavior are shown in Table 5-16. Of the items ingested only ice was said to be routinely eaten outside of pregnancy, and was only reported by U.S. women, probably because none of the low-income women interviewed in Mexico owned a refrigerator. Removing the 12 women who reported eating only ice from the survey lowers the percentage of U.S. women who reported pica behavior to 23%. Women said they engaged in pica behavior because of the taste, smell or texture of the items, for medicinal purposes, or because of advice from someone, and one woman reported eating clay for religious reasons. Magnesium carbonate, a pica item not found to be previously reported in the literature, was reportedly consumed by 17% of women. The amount of magnesium carbonate ingested ranged from a quarter of a block to five blocks per day; the blocks were approximately the size of a 35-mm film box. No specific quantity information on the amounts of pica substances ingested were provided in the study.

5.3.4.17 *Obialo et al., 2001 - Clay Pica Has No Hematologic or Metabolic Correlate to Chronic Hemodialysis Patients*

A total of 138 dialysis patients at the Morehouse School of Medicine, Atlanta, Georgia, were interviewed about their unusual cravings or food habits. The patients were black and ranged in age from 37 to 78 years.

Thirty of the patients (22%) reported some form of pica behavior, while 13 patients (9.4%) reported clay pica. The patients with clay pica reported daily consumption of 225-450 g of clay.

5.3.4.18 *Klitzman et al., 2002 - Lead Poisoning Among Pregnant Women in New York City: Risk Factors and Screening Practices*

Klitzman et al. (2002) interviewed 33 pregnant women whose blood lead levels were >20 ug/dL as reported to the New York City Department of Health between 1996 and 1999. The median age of the women was 24 years (range of 15 to 43 years), and the majority were foreign born. The women were interviewed regarding their work, reproductive and lead exposure history. A home visit was also conducted and included a visual inspection and a colorimetric swab test; consumable items suspected to contain lead were sent to a laboratory for analysis.

There were 13 women (39%) who reported pica behavior during their current pregnancies. Of these, 10 reported eating soil, dirt or clay, 2 reported pulverizing and eating pottery, and 1 reported eating soap. One of the women reported eating approximately one quart of dirt daily from her backyard for the past three months. No other quantity data were reported.

5.3.5 Relevant Studies of Secondary Analysis

The secondary analysis literature on soil and dust ingestion rates gives important insights into methodological strengths and limitations. The tracer element studies described in this section are grouped to some extent according to methodological issues associated with the tracer element methodology. These methodological issues include attempting to determine the origins of apparent positive and negative bias in the methodologies, including: food input/fecal output misalignment; missed fecal samples; assumptions about children's fecal weights; particle sizes of, and relative contributions of soils and dusts to total soil and dust ingestion; and attempts to identify a "best" tracer element or combination of tracer elements. Potential error from using short-term studies' estimates for long term soil and dust ingestion behavior estimates is also discussed.

5.3.5.1 *Stanek et al., 2001a - Biasing Factors for Simple Soil Ingestion Estimates in Mass Balance Studies of Soil Ingestion*

In order to identify and evaluate biasing factors for soil ingestion estimates, the authors developed a simulation model based on data from previous soil ingestion studies. The soil ingestion data used in this model were taken from Calabrese et al. (1989) (the Amherst study); Davis et al. (1990) (southeastern Washington State); Calabrese et al. (1997a) (the Anaconda study) and Calabrese et al. (1997b) (soil-pica in Massachusetts), and relied only on the aluminum and silicon trace element estimates provided in these studies.

Of the biasing factors explored, the impact of study duration was the most striking, with a positive bias of more than 100 percent for 95th percentile estimates in a 4-day tracer element study. A smaller bias was observed for the impact of absorption of trace elements from food. Although the trace elements selected for use in these studies are believed to have low absorption, whatever amount is not accounted for will result in an underestimation of the soil ingestion distribution. In these simulations, the absorption of trace elements from food of up to 30 percent was shown to negatively bias the estimated soil ingestion distribution by less than 20 mg/day. No biasing effect was found for misidentifying play areas for soil sampling (i.e., ingested soil from a yard other than the subject's yard).

5.3.5.2 *Calabrese and Stanek, 1995 - Resolving Intertracer Inconsistencies in Soil Ingestion Estimation*

Calabrese and Stanek (1995) explored sources and magnitude of positive and negative errors in soil ingestion estimates for children on a subject-week and trace element basis. Calabrese and Stanek (1995) identified possible sources of positive errors to be:

- Ingestion of high levels of tracers before the start of the study and low ingestion during the study period; and
- Ingestion of element tracers from a non-food or non-soil source during the study period.

Possible sources of negative bias were identified as:

- Ingestion of tracers in food that are not captured in the fecal sample either due to slow lag time or not having a fecal sample available on the final study day; and
- Sample measurement errors that result in diminished detection of fecal tracers, but not in soil tracer levels.

The authors developed an approach that attempted to reduce the magnitude of error in the individual trace element ingestion estimates. Results from a previous study conducted by Calabrese et al. (1989) were used to quantify these errors based on the following criteria: (1) a lag period of 28 hours was assumed for the passage of tracers ingested in food to the feces (this value was applied to all subject-day estimates); (2) a daily soil ingestion rate was estimated for each tracer for each 24-hour day a fecal sample was obtained; (3) the median tracer-based soil ingestion rate for each subject-day was determined; and (4) negative errors due to missing fecal samples at the end of the study period were also determined. Also, upper- and lower-bound estimates were determined based on criteria formed using an assumption of the magnitude of the relative standard deviation (RSD) presented in another study conducted by Stanek and Calabrese (1995a). Daily soil ingestion rates for tracers that fell beyond the upper and lower ranges were excluded from subsequent calculations, and the median soil ingestion rates of the remaining tracer elements were considered the best estimate for that particular day. The magnitude of positive or negative error for a specific tracer per day was derived by determining the difference between the value for the tracer and the median value.

Table 5-17 presents the estimated magnitude of positive and negative error for six tracer elements in the children's study (conducted by Calabrese et al., 1989). The original non-negative mean soil ingestion rates (Table 5-3) ranged from a low of 21 mg/day based on zirconium to a high of 459 mg/day based on vanadium. The adjusted mean soil ingestion rate after correcting for negative and positive errors ranged from 97 mg/day based on yttrium to 208 mg/day based on titanium. Calabrese and Stanek (1995) concluded that correcting for errors at the individual level for each tracer element provides more reliable estimates of soil ingestion.

5.3.5.3 ***Stanek and Calabrese, 1995a - Daily Estimates of Soil Ingestion in Children***

Stanek and Calabrese (1995a) presented a methodology which links the physical passage of food and fecal samples to construct daily soil ingestion estimates from daily food and fecal trace-element concentrations. Soil ingestion data for children obtained from the Amherst study (Calabrese et al., 1989) were reanalyzed by Stanek and Calabrese (1995a). A lag period of 28 hours between food intake and fecal output was assumed for all respondents. Day 1 for the food sample corresponded to the 24 hour period from midnight on Sunday to midnight on Monday of a study week; day 1 of the fecal sample corresponded to the 24 hour period from noon on Monday to noon on Tuesday. Based on these definitions, the food soil equivalent was subtracted from the fecal soil equivalent to obtain an estimate of soil ingestion for a trace element. A daily overall ingestion estimate was constructed for each child as the median of trace element values remaining after tracers falling outside of a defined range around the overall median were excluded.

Table 5-18 presents adjusted estimates, modified according to the input/output misalignment correction, of mean daily soil ingestion per child (mg/day) for the 64 study participants. The approach adopted in this paper led to changes in ingestion estimates from those presented in Calabrese et al. (1989).

Estimates of children's soil ingestion projected over a period of 365 days were derived by fitting log-normal distributions to the overall daily soil ingestion estimates using estimates modified according to the input/output misalignment correction (Table 5-19). The estimated median value of the 64 respondents' daily soil ingestion averaged over a year was 75 mg/day, while the 95th percentile was 1,751 mg/day. In developing the 365-day soil ingestion estimates, data that were obtained over a short period of time (as is the case with all available soil ingestion studies) were extrapolated over a year. The 2-week study period may not reflect variability in tracer element ingestion over a year. While Stanek and Calabrese (1995a) attempted to address this through modeling of the long term ingestion, new uncertainties were introduced through the parametric modeling of the limited subject day data.

5.3.5.4 ***Calabrese and Stanek, 1992b - What Proportion of Household Dust is Derived from Outdoor Soil?***

Calabrese and Stanek (1992b) estimated the amount of outdoor soil in indoor dust using statistical modeling. The model used soil and dust data from the 60 households that participated in the Calabrese et al. (1989) study, by preparing scatter plots of each tracer's concentration in soil versus dust. Correlation analysis of the scatter plots was performed. The scatter plots showed little evidence of a consistent relationship between outdoor soil and indoor dust concentrations. The model estimated the proportion of outdoor soil in indoor dust using the simplifying assumption that the following variables were constants in all houses: the amount of dust produced every day from both indoor and outdoor sources; the proportion of indoor dust due to outdoor soil; and the concentration of the tracer element in dust produced from indoor sources. Using these assumptions, the model predicted that 31.3 percent by weight of indoor dust came from outdoor soil. This model was then used to adjust the soil ingestion estimates from Calabrese et al. (1989). Using an assumption that 50 percent of excess fecal tracers were from indoor origin and 50 percent were from outdoor origin, and multiplying the 50 percent indoor-origin excess fecal tracer by the model prediction that 31.3 percent of indoor dust came from outdoor soil, results in an estimate that 15 percent of excess fecal tracers were from soil materials that were present in indoor dust. Adding this 15 percent to the 50 percent assumed outdoor (soil) origin excess fecal tracer quantity results in an estimate that approximately 65 percent of the total residual excess fecal tracer was of soil origin (Calabrese and Stanek, 1992b).

5.3.5.5 ***Calabrese et al., 1996 - Methodology to Estimate the Amount and Particle Size of Soil Ingested by Children: Implications for Exposure Assessment at Waste Sites***

Calabrese et al., 1996 examined the hypothesis that one cause of the variation between tracers seen in soil ingestion studies could be related to differences in soil tracer concentrations by particle size. This study, published prior to the Calabrese et al. (1997a) primary analysis study results, used laboratory analytical results for the Anaconda, Montana soil's tracer concentration after it had been sieved to a particle size of <250 μm in diameter (it was sieved to <2 mm soil particle size in Calabrese et al. (1997a)). The smaller particle size was examined based on the assumption that children principally ingest soil of small particle size adhering to fingertips and under fingernails. For five of the tracers used in the original study (aluminum, silicon, titanium, yttrium, and zirconium), soil concentration was not changed by particle size. However, the soil concentrations of three tracers (lanthanum, cerium, and neodymium) were increased two- to fourfold at the smaller soil particle size. Soil ingestion estimates for these three tracers were decreased by approximately 60 percent at the 95th percentile compared to the Calabrese et al. (1997a) results.

5.3.5.6 *Stanek et al., 1999 - Soil Ingestion Estimates for Children in Anaconda Using Trace Element Concentrations in Different Particle Size Fractions*

Stanek et al. (1999) extends the findings from Calabrese et al. (1996) by quantifying trace element concentrations in soil based on sieving to particle sizes of 100 to 250 µm and to particle sizes of 53 to < 100 µm. This study used the data from soil concentrations from the Anaconda, Montana site reported by Calabrese et al. (1997a). Results of the study indicated that soil concentrations of aluminum, silicon and titanium do not increase at the two finer particle size ranges measured. However, soil concentrations of cerium, lanthanum and neodymium increased by a factor of 2.5 to 4.0 in the 100-250 µm particle size range when compared with the 0 to 2 µm particle size range. There was not a significant increase in concentration in the 53 to 100 µm particle size range.

5.3.5.7 *Stanek and Calabrese, 1995b - Soil Ingestion Estimates for Use in Site Evaluations Based on the Best Tracer Method*

Stanek and Calabrese (1995b) recalculated soil ingestion rates for adults and children from two previous studies, using data for 8 tracers from Calabrese et al., 1989 and 3 tracers from Davis et al., 1990. Recalculations were performed using the Best Tracer Method (BTM). This method selected the "best"tracer(s), by dividing the total amount of tracer in a particular child's duplicate food sample by tracer concentration in that child's soil sample to yield a food/soil (F/S) ratio. The F/S ratio was small when the tracer concentration in food was low compared to the tracer concentration in soil. Small F/S ratios were desirable because they lessened the impact of transit time error (the error that occurs when fecal output does not reflect food ingestion, due to fluctuation in gastrointestinal transit time) in the soil ingestion calculation.

For adults, Stanek and Calabrese (1995b) used data for 8 tracers from the Calabrese et al. (1989) study to estimate soil ingestion by the BTM. The lowest F/S ratios were Zr and Al and the element with the highest F/S ratio was Mn. For soil ingestion estimates based on the median of the lowest four F/S ratios, the tracers contributing most often to the soil ingestion estimates were Al, Si, Ti, Y, V, and Zr. Using the median of the soil ingestion rates based on the best four tracer elements, the average adult soil ingestion rate was estimated to be 64 mg/day with a median of 87 mg/day. The 95th percentile soil ingestion estimate was 142 mg/day. These estimates are based on 18 subject weeks for the six adult volunteers described in Calabrese et al. (1989).

The BTM used a ranking scheme of F/S ratios to determine the best tracers for use in the ingestion rate calculation. To reduce the impact of biases that may occur as a result of sources of fecal tracers other than food or soil, the median of soil ingestion estimates based on the four lowest F/S ratios was used to represent soil ingestion.

Using the lowest four F/S ratios for each individual, calculated on a per-week ("subject-week") basis, the median of the soil ingestion estimates from the Calabrese et al. (1989) study most often included aluminum, silicon, titanium, yttrium, and zirconium. Based on the median of soil ingestion estimates from the best four tracers, the mean soil ingestion rate for children was 132 mg/day and the median was 33 mg/day. The 95th percentile value was 154 mg/day. For the 101 children in the Davis et al. (1990) study, the mean soil ingestion rate was 69 mg/day and the median soil ingestion rate was 44 mg/day. The 95th percentile estimate was 246 mg/day. These data are based on the three tracers (i.e., aluminum, silicon and titanium) from the Davis et al. (1990) study. When the results for the 128 subject-weeks in Calabrese et al. (1989) and 101 children in Davis et al. (1990) were combined, soil ingestion for children was estimated to be 104 mg/day (mean); 37 mg/day (median); and 217 mg/day (95th percentile), using the BTM.

5.3.5.8 *Stanek and Calabrese, 2000 - Daily Soil Ingestion Estimates for Children at a Superfund Site*

Stanek and Calabrese (2000) reanalyzed the soil ingestion data from the Anaconda study. The authors assumed a lognormal distribution for the soil ingestion estimates in the Anaconda study to predict average soil ingestion for children over a longer time period. Using "best linear unbiased predictors," the authors predicted 95th percentile soil ingestion values over time periods of 7 days, 30 days, 90 days, and 365 days. The 95th percentile soil ingestion values were predicted to be 133 mg/day over 7 days, 112 mg/day over 30 days, 108 mg/day over 90 days, and 106 mg/day over 365 days. Based on this analysis, estimates of the distribution of longer term average soil ingestion are expected to be narrower, with the 95th percentile estimates being as much as 25 percent lower (Stanek and Calabrese, 2000).

5.3.5.9 *Stanek et al., 2001b - Soil Ingestion Distributions for Monte Carlo Risk Assessment in Children*

Stanek et al. (2001b) developed "best linear unbiased predictors" to reduce the biasing effect of short-term soil ingestion estimates. This study estimated the long-term average soil ingestion distribution using daily soil ingestion estimates from children who participated in the Anaconda, Montana study. In this long-term (annual) distribution, the soil ingestion estimates were: mean 31, median 24, 75th percentile 42, 90th percentile 75, and 95th percentile 91 mg/day.

5.3.5.10 *von Lindern et al., 2003 - Assessing remedial effectiveness through the blood lead:soil/dust lead relationship at the Bunker Hill Superfund Site in the Silver Valley of Idaho*

Similar to Hogan et al. (1998), von Lindern et al. (2003) used the IEUBK model to predict blood lead levels in a non-random sample of several hundred children ages 0-9 years in an area of northern Idaho from 1989-1998 during community-wide soil remediation. Von Lindern et al. (2003) used the IEUBK default soil and dust ingestion rates together with observed house dust/soil lead levels (and imputed values based on community soil and dust lead levels, when observations were missing). The authors compared the predicted blood lead levels with observed blood lead levels and found that the default IEUBK soil and dust ingestion rates and lead bioavailability value overpredicted blood lead levels, with the overprediction decreasing as the community soil remediation progressed. The authors stated that the overprediction may have been caused either by a default soil and dust ingestion that was too high, a default bioavailability value for lead that was too high, or some combination of the two. They also noted underpredictions for some children, for whom follow up interviews revealed exposures to lead sources not accounted for by the model, and noted that the study sample included many children with a short residence time within the community.

Von Lindern et al. (2003) developed a statistical model that apportioned the contributions of community soils, yard soils of the residence, and house dust to lead intake; the models' results suggested that community soils contributed more (50 percent) than neighborhood soils (28 percent) or yard soils (22 percent) to soil found in house dust of the studied children.

5.4 LIMITATIONS OF KEY STUDY METHODOLOGIES

The three types of information needed to provide recommendations to exposure assessors on soil and dust ingestion rates among U.S. children include quantities of soil and dust ingested, frequency of high soil and dust ingestion episodes, and prevalence of high soil and dust ingesters. The methodologies provide different types of information: the tracer element and biokinetic model comparison methodologies provide information on quantities of soil and dust ingested; the tracer element methodology provides limited evidence of the frequency of high soil ingestion episodes; the survey response methodology can shed light on prevalence of high soil ingesters and frequency of high soil ingestion episodes. The methodologies used to estimate soil and dust ingestion rates and prevalence of soil and dust ingestion behaviors have certain limitations, when used for the purpose of developing recommended soil and dust ingestion rates. This section describes some of the known limitations, presents an evaluation of the current state of the science for U.S. children's soil and dust ingestion rates, and describes how the limitations affect the confidence ratings given to the recommendations.

5.4.1 Tracer Element Methodology

This section describes some previously identified limitations of the tracer element methodology as it has been implemented by U.S. researchers, as well as additional potential limitations that have not been explored. Some of these same limitations would also apply to the Dutch and Jamaican studies that used a control group of hospitalized children to account for dietary and pharmaceutical tracer intakes.

Binder et al. (1986) described some of the major and obvious limitations of the early U.S. tracer element methodology as follows:

> [T]he algorithm assumes that children ingest predominantly soil from their own yards and that concentrations of elements in composite soil samples from front and back yards are representative of overall concentrations in the yards....children probably eat a

> combination of soil and dust; the algorithm used does not distinguish between soil and dust ingestion....fecal sample weights...were much lower than expected...the assumption that aluminum, silicon and titanium are not absorbed is not entirely true....dietary intake of aluminum, silicon and titanium is not negligible when compared with the potential intake of these elements from soil....Before accepting these estimates as true values of soil ingestion in toddlers, we need a better understanding of the metabolisms of aluminum, silicon and titanium in children, and the validity of the assumptions we made in our calculations should be explored further.

The subsequent U.S. tracer element studies (Calabrese et al. (1989)/Barnes (1990), Davis et al. (1990), Calabrese et al. (1997a), and Davis and Mirick (2006)) made some progress in addressing some of the Binder et al. (1986) study's stated limitations.

Regarding the issue of non-yard (community-wide) soil as a source of ingested soil, one study (Calabrese et al. 1989/Barnes 1990) addressed this issue to some extent, by including samples of children's day care center soil in the analysis. Calabrese et al. (1997a) attempted to address the issue by excluding children in day care from the study sample frame. Homogeneity of community soils' tracer element content would play a role in whether this issue is an important biasing factor for the tracer element studies' estimates. Davis et al. (1990) evaluated community soils' aluminum, silicon and titanium content and found little variation among 101 yards throughout the three-city area. Stanek et al. (2001a) conclude that there is "minimal impact" on estimates of soil ingestion due to mis-specifying a child's play area.

Regarding the issue of soil and dust both contributing to measured tracer element quantities in excreta samples, the five key U.S. tracer element studies all attempt to address the issue by including samples of household dust in the analysis, and in some cases estimates are presented in the published articles that adjust soil ingestion estimates on the basis of the measured tracer elements found in the household dust. The relationship between soil ingestion rates and indoor settled dust ingestion rates has been evaluated in some of the secondary studies (e.g., Calabrese and Stanek,1992b). An issue similar to the community-wide soil exposures in the previous paragraph could also exist with community-wide indoor dust exposures (such as dust found in schools and community buildings occupied by study subjects during or prior to the study period). A portion of the community-wide indoor dust exposures (that due to occupying day care facilities) was addressed in the Calabrese et al. (1989)/Barnes (1990) study, but not in the other three key tracer element studies. In addition, if the key studies' vacuum cleaner collection method for household and day care indoor settled dust samples influenced tracer element composition of indoor settled dust samples, the dust sample collection method would be another area of uncertainty with the key studies' indoor dust related estimates. The survey response studies suggest that some young children may prefer ingesting dust to ingesting soil. The existing literature on soil versus dust sources of children's lead exposure may provide useful information that has not yet been compiled for use in soil and dust ingestion recommendations.

Regarding the issue of fecal sample weights and the related issue of missing fecal and urine samples, the five key tracer element studies have varying strengths and limitations. The Calabrese et al. (1989) article stated that wipes and toilet paper were not collected by the researchers, and thus underestimates of fecal quantities may have occurred. Calabrese et al. (1989) stated that cotton cloth diapers were supplied for use during the study; commodes apparently were used to collect both feces and urine for those children who were not using diapers. Barnes (1990) described cellulose and polyester disposable diapers with significant variability in silicon and titanium content and suggested that children's urine was not included in the analysis. Thus, it is unclear to what extent complete fecal and urine output was obtained, for each study subject. The Calabrese et al. (1997a) study did not describe missing fecal samples and did not state whether urinary tracer element quantities were used in the soil and dust ingestion estimates, but stated that wipes and toilet paper were not collected. Missing fecal samples may have resulted in negative bias in the estimates from both of these studies. Davis et al. (1990) and Davis and Mirick (2006) were limited to children who no longer wore diapers. Missed fecal sample adjustments might affect those studies' estimates in either a positive or negative direction, due to the assumptions the authors made regarding the quantities of feces and urine in missed samples. Adjustments for missing fecal and urine samples could introduce errors sufficient to cause negative estimates if missed samples were heavier than the collected samples used in the soil and dust ingestion estimate calculations.

Regarding the issue of dietary intake, the five key U.S. tracer element studies have all addressed dietary (and non-dietary, non-soil) intake by subtracting quantitated estimates of these sources of tracer elements from excreta tracer element quantities, or by providing study subjects with personal hygiene products that were low in tracer element content. Applying the food and non-dietary, non-soil corrections required subtracting the tracer element contributions from these non-soil sources from the measured fecal/urine tracer element quantities. To perform this correction required assumptions to be made regarding the gastrointestinal transit time, or the time lag between inputs (food, non-dietary non-soil, and soil) and outputs (fecal and urine). The gastrointestinal transit time assumption introduced a new potential source of bias that some authors (e.g., Stanek and Calabrese, 1995a) called input/output misalignment or transit time error. This lag time may also be a function of age. Davis et al. (1990) and Davis and Mirick (2006) assumed a 24-hour lag time in contrast to the 28-hour lag times used in Calabrese et al. (1989)/Barnes (1990) and Calabrese et al. (1997a). ICRP (2002) suggested a lag time of 37 hours for one year old children and 5 to 15 year old children. Stanek and Calabrese (1995a) describe a method designed to reduce bias from this error source.

Regarding gastrointestinal absorption, the authors of three of the studies appeared to agree that the presence of silicon in urine represented evidence that silicon was being absorbed from the gastrointestinal tract (Davis et al., 1990; Calabrese et al., 1989/Barnes (1990); Davis and Mirick, 2006). There was some evidence of aluminum absorption in Calabrese et al., 1989/Barnes (1990); Davis and Mirick (2006) stated that aluminum and titanium did not appear to have been absorbed, based on low urinary levels. Davis et al. (1990) stated that silicon appears to have been absorbed to a greater degree than aluminum and titanium, based on urine concentrations.

Aside from the gastrointestinal absorption, lag time and missed fecal sample issues, Davis and Mirick (2006) offer another possible explanation for the negative soil and dust ingestion rates estimated for some study participants. Because the weights of dried food and liquid (input) samples were sufficiently great, relative to the urine and fecal (output) samples, overestimates in laboratory analytical values for the input samples would not be compensated for by a similar overestimate in the output samples.

Another limitation on accuracy of tracer element-based estimates of soil and dust ingestion relates to inaccuracies inherent in environmental sampling and laboratory analytical techniques. The "percent recovery" of different tracer elements varies (according to validation of the study methodology performed with adults who swallowed gelatin capsules with known quantities of sterilized soil, as part of the Calabrese et al., 1989 and 1997a studies). Estimates based on a particular tracer element with a lower or higher recovery than the expected 100 percent in any of the study samples would be influenced in either a positive or negative direction, depending on the recoveries in the various samples and their degree of deviation from 100 percent (e.g., Calabrese et al., 1989).

Davis et al. (1990) offered an assessment of the impact of swallowed toothpaste on the tracer-based estimates by adjusting estimates for those children whose caregivers reported that they had swallowed toothpaste. Davis et al. (1990) had supplied study children with toothpaste that had been pre-analyzed for its tracer element content, but it is not known to what extent the children actually used the supplied toothpaste. Similarly, Calabrese et al., 1989 and 1997a supplied children in the Amherst, Massachusetts and Anaconda, Montana studies with toothpaste containing low levels of most tracers, but it is unclear to what extent those children used the supplied toothpaste.

Other research suggests additional possible limitations that have not yet been explored. First, lymph tissue structures in the gastrointestinal tract might serve as reservoirs for titanium dioxide food additives and soil particles, which could bias estimates either upward or downward depending on tracers' entrapment within, or release from, these reservoirs during the study period (ICRP, 2002; Shepherd et al., 1987; Powell et al., 1996). Second, gastrointestinal uptake of silicon may have occurred, which could bias those estimates downward. Evidence of silicon's role in bone formation (e.g., Carlisle, 1980) supported by newer research on dietary silicon uptake (Jugdaohsingh et al., 2002); Van Dyck et al., 2000) suggests a possible negative bias in the silicon-based soil ingestion estimates, depending on the quantities of silicon absorbed by growing children. Third, regarding the potential for swallowed toothpaste to bias soil ingestion estimates upward, commercially available toothpaste may contain quantities of titanium and perhaps silicon and aluminum in the range that could be expected to affect the soil and dust ingestion estimates. Fourth, for those children who drank bottled or tap water during the study period, and did not include those drinking water samples in their duplicate food samples, slight upward bias may exist in some of the estimates for those children, since drinking water may contain small, but relevant, quantities of silicon and potentially other tracer elements. Fifth, the tracer element studies conducted to date have not explored the impact of soil properties' influence on toxicant uptake or excretion within the gastrointestinal tract. Nutrition researchers investigating influence of clay geophagy behavior on human nutrition have begun using in vitro models of the human digestion (e.g., Dominy et al., 2003; Hooda et al., 2004). A recent review (Wilson, 2003) covers a wide range of geophagy research in humans and various hypotheses proposed to explain soil ingestion behaviors, with emphasis on the soil properties of geophagy materials.

5.4.2 Biokinetic Model Comparison Methodology

It is possible that the IEUBK biokinetic model comparison methodology contained sources of both positive and negative bias, like the tracer element studies, and that the net impact of the competing biases was in either the positive or negative direction. U.S. EPA's judgment about the major sources of bias in the biokinetic model comparison studies is that there may be three significant sources of bias. The first source of potential bias was the possibility that the biokinetic model failed to account for sources of lead exposure that are important for certain children. For these children, the model might either under-predict, or accurately predict, blood lead levels compared to actual measured lead levels. However, this result may actually mean that the default assumed lead intake rates via either soil and dust ingestion, or another lead source that is accounted for by the model, are too high. The second source of potential bias was use of the biokinetic model for predicting blood lead levels in children who have not spent a significant amount of time in the areas characterized as the main sources of environmental lead exposure. Modeling this population could result in either upward or downward biases in predicted blood lead levels. Comparing upward-biased predictions with actual measured blood lead levels and finding a relatively good match could lead to inferences that the model's default soil and dust ingestion rates are accurate, when in fact the children's soil and dust ingestion rates, or some other lead source, were actually higher than the default assumption. The third source of potential bias was the assumption within the model itself regarding the biokinetics of absorbed lead, which could result in either positively or negatively biased predictions and the same kinds of incorrect inferences as the second source of potential bias.

5.4.3 Survey Response Methodology

Each data collection methodology (in-person interview, mailed questionnaire, or questions administered in "test" format in a school setting) may have had specific limitations. In-person interviews could result in either positive or negative response bias due to distractions posed by young children, especially when interview respondents simultaneously care for young children and answer questions. Other limitations include positive or negative response bias due to respondents' perceptions of a "correct" answer, question wording difficulties, lack of understanding of definitions of terms used, language and dialect differences between investigators and respondents, respondents' desires to avoid negative emotions associated with giving a particular type of answer, and respondent memory problems ("recall" effects) concerning past events. Mailed questionnaires have many of the same limitations as in-person interviews, but may allow respondents to respond when they are not distracted by childcare duties. An in-school test format is more problematic than either interviews or mailed surveys, because respondent bias related to teacher expectations could influence responses.

Unweighted survey responses from the National Health and Nutrition Examination Survey (NHANES) I and II regarding children's clay and dirt ingestion are available (U.S. DHHS 1981a, U.S. DHHS 1981b, U.S. DHHS 1985a, U.S. DHHS 1985b) and appear generally to corroborate the results of the survey response studies summarized in this chapter, in that a small proportion of respondents acknowledge eating dirt or clay. U.S. EPA has undertaken an effort to weight the survey responses among adult caregiver respondents who acknowledged clay and dirt ingestion by children under age 12 years and among child respondents ages 12 up to 21 years who acknowledged clay and dirt ingestion, to develop an estimate of prevalence of the behavior among children.

One approach to evaluating the degree of bias in survey response studies may be to make use of a surrogate biomarker indicator providing suggestive evidence of ingestion of significant quantities of soil (although quantitative estimates would not be possible). The biomarker technique measures the presence of serum antibodies to *Toxocara* species, a parasitic roundworm from cat and dog feces. Two U.S. studies have found associations between reported soil ingestion and positive serum antibody tests for *Toxocara* infection (Marmor et al., 1987; Glickman et al., 1981); a third (Nelson et al., 1996) has not, but the authors state that reliability of survey responses regarding soil ingestion may have been an issue. Further refinement of survey response methodologies, together with recent NHANES data on U.S. prevalence of positive serum antibody status regarding infection with *Toxocara* species, may be useful.

5.4.4 Key Studies: Representativeness of U.S. Population

The two key studies of Dutch and Jamaican children may represent different conditions and different study populations than those in the U.S.; thus, it is unclear to what extent those children's soil ingestion behaviors may differ from U.S. children's soil ingestion behaviors. The subjects in the Davis and Mirick (2006) study may not have been representative of the general population since they were selected for their high compliance with the protocol from a previous study.

Limitations regarding the key studies performed in the U.S. for estimating soil and dust ingestion rates in the entire population of U.S. children ages 0 to <21 years fall into the broad categories of geographic range and demographics (age, gender, race/ethnicity, socioeconomic status).

Regarding geographic range, the two most obvious issues relate to soil types and climate. Soil properties might influence the soil ingestion estimates that are based on excreted tracer elements. The Davis et al. (1990), Calabrese et al. (1989)/Barnes (1990), Davis and Mirick (2006) and Calabrese et al. (1997a) tracer element studies were in locations with soils that had sand content ranging from 21-80 percent, silt content ranging from 16-71 percent, and clay content ranging from 3-20 percent by weight, based on data from USDA (2008). The location of children in the Calabrese et al. (1997b) study was not specified, but due to the original survey response study's occurrence in western Massachusetts, the soil types in the vicinity of the Calabrese et al. (1997b) study are likely to be similar to those in the Calabrese et al. (1989)/Barnes (1990) study.

The Hogan et al. (1998) study included locations in the central part of the U.S. (an area along the Kansas/Missouri border, and an area in western Illinois) and one in the eastern U.S. (Palmerton, Pennsylvania). The only key study conducted in the southern part of the U.S. was Vermeer and Frate (1979).

Children might be outside and have access to soil in a very wide range of weather conditions (Wong et al., 2000). In the parts of the U.S. that experience moderate temperatures year-round, soil ingestion rates may be fairly evenly distributed throughout the year. During conditions of deep snow cover, extreme cold, or extreme heat, children could be expected to have minimal contact with outside soil. All children, regardless of location, could ingest soils located indoors in plant containers, or outdoor soil tracked inside buildings by human or animal building occupants. Davis et al. (1990) did not find a clear or consistent association between the number of hours spent indoors per day and soil ingestion, but reported a consistent association between spending a greater number of hours outdoors and high (defined as the uppermost tertile) soil ingestion levels across all three tracers used.

The five key tracer element studies all took place in northern latitudes. The temperature and precipitation patterns that occurred during these four studies' data collection periods were difficult to discern due to no mention of specific data collection dates in the published articles. The Calabrese et al. (1989)/Barnes (1990) study apparently took place in mid- to late September 1987 in and near Amherst, Massachusetts; Calabrese et al. (1997a) apparently took place in late September and early October 1992, in Anaconda, Montana; Davis et al. (1990) took place in July, August and September 1987, in Richland, Kennewick and Pasco, Washington; and Davis and Mirick (2006) took place in the same Washington state location in late July, August and very early September 1988 (raw data). Inferring exact data collection dates, a wide range of temperatures may have occurred during the four studies' data collection periods (daily lows from 22-60 ^{o}F and 25-48 ^{o}F, and daily highs from 53-81 ^{o}F and 55-88 ^{o}F in Calabrese et al. (1989) and Calabrese et al. (1997a), respectively, and daily lows from 51-72 ^{o}F and 51 - 67 ^{o}F, and daily highs from 69-103 ^{o}F and 80-102 ^{o}F in Davis et al. (1990) and Davis and Mirick (2006), respectively) (National Climatic Data Center, 2008). Significant amounts of precipitation occurred during Calabrese et al. (1989) (more than 0.1 inches per 24 hour period) on several days; somewhat less precipitation was observed during Calabrese et al. (1997a); precipitation in Kennewick and Richland during the data collection periods of Davis et al. (1990) was almost nonexistent; there was no recorded precipitation in Kennewick or Richland during the data collection period for Davis and Mirick (2006) (National Climatic Data Center, 2008).

The key biokinetic model comparison study (Hogan et al., 1998) targeted three locations in more southerly latitudes (Pennsylvania, southern Illinois, and southern Kansas/Missouri) than the five tracer element studies. The biokinetic model comparison methodology had an advantage over the tracer element studies in that the study represented long-term environmental exposures over periods up to several years that would include a range of seasons and climate conditions.

A brief review of the representativeness of the key studies' samples with respect to gender and age suggested that males and females were represented roughly equally in those studies for which study subjects' gender was stated. Children up to age 8 years were studied in seven of the nine studies, with an emphasis on younger children. Wong (1988)/Calabrese et al. (1993) and Vermeer and Frate (1979) are the only studies with children 8 years or older.

A brief review of the representativeness of the key studies' samples with respect to socioeconomic status and racial/ethnic identity suggested that there were some discrepancies between the study subjects and the current U.S. population of children age 0 to <21 years. The single survey response study (Vermeer and Frate (1979)) was specifically targeted toward a predominantly rural black population in a particular county in Mississippi. The tracer element studies are of predominantly white populations, apparently with limited representation from other racial and ethnic groups. The Amherst, Massachusetts study (Calabrese et al. 1989/Barnes 1990) did not publish the study participants' socioeconomic status or racial and ethnic identities. The socioeconomic level of the Davis et al. (1990) studied children was reported to be primarily of middle to high income. Self-reported race and ethnicity of relatives of the children studied (in most cases, they were the parents of the children studied) in Davis et al. (1990) were White (86.5 percent), Asian (6.7 percent), Hispanic (4.8 percent), Native American (1.0 percent), and Other (1.0 percent), and the 91 married or living-as-married respondents identified their spouses as White (86.8 percent), Hispanic (7.7 percent), Asian (4.4 percent), and Other (1.1 percent). Davis and Mirick (2006) did not state the race and ethnicity of the follow-up study participants, who were a subset of the original study participants from Davis et al. (1990). For the Calabrese et al. (1997a) study in Anaconda, Montana, population demographics were not presented in the published article. The study sample appeared to have been drawn from a door-to-door census of Anaconda residents that identified 642 toilet trained children who were less than 72 months of age. Of the 414 children participating in a companion study (out of the 642 eligible children identified), 271 had complete study data for that companion study, and of these 271, 97.4 percent were identified as white and the remaining 2.6 percent were identified as native American, black, Asian and Hispanic (Hwang et al., 1997). The 64 children in the Calabrese et al. (1997a) study apparently were a stratified random sample drawn from the 642 children identified in the door-to-door census. Presumably these children identified as similar races and ethnicities to the Hwang et al. (1997) study children. The Calabrese et al. (1997b) study indicated that 11 of the 12 children studied were white.

5.5 SUMMARY OF SOIL AND DUST INGESTION ESTIMATES FROM KEY STUDIES

Table 5-20 summarizes the soil and dust ingestion estimates from the 9 key studies. For the U.S. tracer element studies, in order to compare estimates that were calculated in a similar manner, the summary is limited to estimates that use the same basic algorithm of ((fecal and urine tracer content) - (food and medication tracer content))/(soil or dust tracer concentration). Note that several of the published reanalyses suggest different variations on these algorithms, or suggest adjustments that should be made for various reasons. However, because individual observations were not available from the studies with reanalyzed data, those reanalyzed estimates were not included in the summary table. Other reanalyses suggested that omitting some of the data according to statistical criteria would be a worthwhile exercise. Due to the current state of the science regarding soil and dust ingestion estimates, U.S. EPA does not advise omitting an individual's soil or dust ingestion estimate, based on statistical criteria, at this point in time.

There is a wide range of estimated soil and dust ingestion across key studies. Note that some of the soil-pica ingestion estimates from the tracer element studies were consistent with the estimated mean soil ingestion from the survey response study of geophagy behavior. Also note that the biokinetic model comparison methodology's confirmation of central tendency soil and dust ingestion default assumptions corresponded roughly with some of the central tendency tracer element study estimates.

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Table 5-3. Soil, Dust and Soil + Dust Ingestion Estimates for Amherst, Massachusetts Study Children

Tracer Element	N	Ingestion (mg/day)				
		Mean	Median	SD	95th Percentile	Maximum
Aluminum						
soil	64	153	29	852	223	6,837
dust	64	317	31	1,272	506	8,462
soil/dust combined	64	154	30	629	478	4,929
Barium						
soil	64	32	-37	1,002	283	6,773
dust	64	31	-18	860	337	5,480
soil/dust combined	64	29	-19	868	331	5,626
Manganese						
soil	64	-294	-261	1,266	788	7,281
dust	64	-1,289	-340	9,087	2,916	20,575
soil/dust combined	64	-496	-340	1,974	3,174	4,189
Silicon						
soil	64	154	40	693	276	5,549
dust	64	964	49	6,848	692	54,870
soil/dust combined	64	483	49	3,105	653	24,900
Vanadium						
soil	62	459	96	1,037	1,903	5,676
dust	64	453	127	1,005	1,918	6,782
soil//dust combined	62	456	123	1,013	1,783	6,736
Yttrium						
soil	62	85	9	890	106	6,736
dust	64	62	15	687	169	5,096
soil/dust combined	62	65	11	717	159	5,269
Zirconium						
soil	62	21	16	209	110	1,391
dust	64	27	12	133	160	789
soil/dust combined	62	23	11	138	159	838
Titanium						
soil	64	218	55	1,150	1,432	6,707
dust	64	163	28	659	1,266	3,354
soil/dust combined	64	170	30	691	1,059	3,597

SD = Standard deviation.

Source: Calabrese et al., 1989.

Table 5-4. Amherst, Massachusetts Soil-Pica Child's Daily Ingestion Estimates by Tracer and by Week (mg/day)		
Tracer element	Estimated Soil Ingestion (mg/day)	
	Week 1	Week 2
Al	74	13,600
Ba	458	12,088
Mn	2,221	12,341
Si	142	10,955
Ti	1,543	11,870
V	1,269	10,071
Y	147	13,325
Zr	86	2,695

Source: Calabrese et al., 1991.

Table 5-5. Amherst, Massachusetts Soil-Pica Child's Tracer Ratios					
Tracer Pairs		Ratio			Estimated Residual Fecal Tracers of Soil Origin as Predicted by Specific Tracer Ratios (%)
		Soil	Fecal	Dust	
1.	Mn/Ti	208.368	215.241	260.126	87
2.	Ba/Ti	187.448	206.191	115.837	100
3.	Si/Ti	148.117	136.662	7.490	92
4.	V/Ti	14.603	10.261	17.887	100
5.	Ai/Ti	18.410	21.087	13.326	100
6.	Y/Ti	8.577	9.621	5.669	100
7.	Mn/Y	24.293	22.373	45.882	100
8.	Ba/Y	21.854	21.432	20.432	71
9.	Si/Y	17.268	14.205	1.321	81
10.	V/Y	1.702	1.067	3.155	100
11.	Al/Y	2.146	2.192	2.351	88
12.	Mn/Al	11.318	10.207	19.520	100
13.	Ba/Al	10.182	9.778	8.692	73
14.	Si/Al	8.045	6.481	0.562	81
15.	V/Al	0.793	0.487	1.342	100
16.	Si/V	10.143	13.318	0.419	100
17.	Mn/Si	1.407	1.575	34.732	99
18.	Ba/Si	1.266	1.509	15.466	83
19.	Mn/Ba	1.112	1.044	2.246	100

Source: Calabrese and Stanek, 1992a.

Table 5-6. Van Wïjnen et al., 1990 Limiting Tracer Method (LTM) Soil Ingestion Estimates for Sample of Dutch Children

Age (years)	Sex	Daycare Centers			Campgrounds		
		N	GM LTM (mg/day)	GSD LTM (mg/day)	N	GM LTM (mg/day)	GSD LTM (mg/day)
Birth to <1	Girls	3	81	1.09	NA	NA	NA
	Boys	1	75	-	NA	NA	NA
1 to <2	Girls	20	124	1.87	3	207	1.99
	Boys	17	114	1.47	5	312	2.58
2 to <3	Girls	34	118	1.74	4	367	2.44
	Boys	17	96	1.53	8	232	2.15
3 to <4	Girls	26	111	1.57	6	164	1.27
	Boys	29	110	1.32	8	148	1.42
4 to <5	Girls	1	180	-	19	164	1.48
	Boys	4	99	1.62	18	136	1.30
All girls		86	117	1.70	36	179	1.67
All boys		72	104	1.46	42	169	1.79
Total		162[a]	111	1.60	78[b]	174	1.73

[a] Age and/or sex not registered for 8 children; one untransformed value = 0.
[b] Age not registered for 7 children; geometric mean LTM value = 140.
N = Number of subjects.
GM = Geometric mean.
LTM = Limiting tracer method.
GSD = Geometric standard deviation.
NA = Not available.

Source: Adapted from Van Wïjnen et al., 1990.

Table 5-7. Estimated Geometric Mean Limiting Tracer Method (LTM) Values of Children Attending Daycare Centers According to Age, Weather Category, and Sampling Period

Weather Category	Age (years)	First Sampling Period		Second Sampling Period	
		N	Estimated Geometric Mean LTM Value (mg/day)	N	Estimated Geometric Mean LTM Value (mg/day)
Bad (>4 days/week precipitation)	<1	3	94	3	67
	1 to <2	18	103	33	80
	2 to <3	33	109	48	91
	4 to <5	5	124	6	109
Reasonable (2-3 days/week precipitation)	<1			1	61
	1 to <2			10	96
	2 to <3			13	99
	3 to <4			19	94
	4 to <5			1	61
Good (<2 days/week precipitation)	<1	4	102		
	1 to <2	42	229		
	2 to <3	65	166		
	3 to <4	67	138		
	4 to <5	10	132		

N = Number of subjects.
LTM = Limiting tracer method.

Source: Van Wijnen et al., 1990.

Table 5-8. Estimated Soil Ingestion for Sample of Washington State Children [a]

Element	Mean (mg/day)	Median (mg/day)	Standard Error of the Mean (mg/day)	Range (mg/day)[b]
Aluminum	38.9	25.3	14.4	-279.0 to 904.5
Silicon	82.4	59.4	12.2	-404.0 to 534.6
Titanium	245.5	81.3	119.7	-5,820.8 to 6,182.2
Minimum	38.9	25.3	12.2	-5,820.8
Maximum	245.5	81.3	119.7	6,182.2

[a] Excludes three children who did not provide any samples (N=101).
[b] Negative values occurred as a result of correction for non-soil sources of the tracer elements. For aluminum, lower end of range published as 279.0 mg/day in article appears to be a typographical error that omitted the negative sign.

Source: Adapted from Davis et al., 1990.

Table 5-9. Soil Ingestion Estimates for 64 Anaconda Children								
Tracer	Estimated Soil Ingestion (mg/day)							
	P1	P50	P75	P90	P95	Max	Mean	SD
Al	-202.8	-3.3	17.7	66.6	94.3	461.1	2.7	95.8
Ce	-219.8	44.9	164.6	424.7	455.8	862.2	116.9	186.1
La	-10,673	84.5	247.9	460.8	639.0	1,089.7	8.6	1,377.2
Nd	-387.2	220.1	410.5	812.6	875.2	993.5	269.6	304.8
Si	-128.8	-18.2	1.4	36.9	68.9	262.3	-16.5	57.3
Ti	-15,736	11.9	398.2	1,237.9	1,377.8	4,066.6	-544.4	2,509.0
Y	-441.3	32.1	85.0	200.6	242.6	299.3	42.3	113.7
Zr	-298.3	-30.8	17.7	94.6	122.8	376.1	-19.6	92.5

P = Percentile.
SD = Standard deviation.
Note: Negative values are a result of limitations in the methodology.

Source: Calabrese et al., 1997a.

Table 5-10. Soil Ingestion Estimates for Massachusetts Child Displaying Soil Pica Behavior (mg/day)			
Study day	Al-based estimate	Si-based estimate	Ti-based estimate
1	53	9	153
2	7,253	2,704	5,437
3	2,755	1,841	2,007
4	725	573	801
5	5	12	21
6	1,452	1,393	794
7	238	92	84

Source: Calabrese et al., 1997b.

Table 5-11. Mean and Median Soil Ingestion (mg/day) by Family Member

Participant	Tracer Element	Estimated Soil Ingestion[a] (mg/day)			Maximum
		Mean	Median	Std	
Child[b]	Aluminum	36.7	33.3	35.4	107.9
	Silicon	38.1	26.4	31.4	95.0
	Titanium	206.9	46.7	277.5	808.3
Mother[c]	Aluminum	92.1	0	218.3	813.6
	Silicon	23.2	5.2	37.0	138.1
	Titanium	359.0	259.5	421.5	1394.3
Father[d]	Aluminum	68.4	23.2	129.9	537.4
	Silicon	26.1	0.2	49.0	196.8
	Titanium	624.9	198.7	835.0	2899.1

[a] For some study participants, estimated soil ingestion resulted in a negative value. These estimates have been set to 0 mg/day for tabulation and analysis.
[b] Results based on 12 children with complete food, excreta, and soil data.
[c] Results based on 16 mothers with complete food, excreta, and soil data.
[d] Results based on 17 fathers with complete food, excreta, and soil data.

Source: Davis and Mirick 2006.

Table 5-12. Estimated Soil Ingestion for Six High Soil Ingesting Jamaican Children

Child	Month	Estimated soil ingestion (mg/day)
11	1	55
	2	1,447
	3	22
	4	40
12	1	0
	2	0
	3	7,924
	4	192
14	1	1,016
	2	464
	3	2,690
	4	898
18	1	30
	2	10,343
	3	4,222
	4	1,404
22	1	0
	2	-
	3	5,341
	4	0
27	1	48,314
	2	60,692
	3	51,422
	4	3,782

- = No data.

Source: Calabrese and Stanek, 1993.

Table 5-13. Estimated Daily Soil Ingestion for East Helena, Montana Children						
Estimation Method	Mean (mg/day)	Median (mg/day)	Standard Deviation (mg/day)	Range (mg/day)	95th Percentile (mg/day)	Geometric Mean (mg/day)
Aluminum	181	121	203	25-1,324	584	128
Silicon	184	136	175	31-799	578	130
Titanium	1,834	618	3,091	4-17,076	9,590	401
Minimum	108	88	121	4-708	386	65

Source: Binder et al., 1986.

Table 5-14. Estimated Soil Ingestion for Sample of Dutch Nursery School Children					
Child	Sample Number	Soil Ingestion as Calculated from Ti (mg/day)	Soil Ingestion as Calculated from Al (mg/day)	Soil Ingestion as Calculated from AIR (mg/day)	Limiting Tracer (mg/day)
1	L3	103	300	107	103
	L14	154	211	172	154
	L25	130	23	-	23
2	L5	131	-	71	71
	L13	184	103	82	82
	L27	142	81	84	81
3	L2	124	42	84	42
	L17	670	566	174	174
4	L4	246	62	145	62
	L11	2,990	65	139	65
5	L8	293	-	108	108
	L21	313	-	152	152
6	L12	1,110	693	362	362
	L16	176	-	145	145
7	L18	11,620	-	120	120
	L22	11,320	77	-	77
8	L1	3,060	82	96	82
9	L6	624	979	111	111
10	L7	600	200	124	124
11	L9	133	-	95	95
12	L10	354	195	106	106
13	L15	2,400	-	48	48
14	L19	124	71	93	71
15	L20	269	212	274	212
16	L23	1,130	51	84	51
17	L24	64	566	-	64
18	L26	184	56	-	56
Arithmetic Mean		1,431	232	129	105

\- = No data.

Source: Adapted from Clausing et al., 1987.

Table 5-15. Estimated Soil Ingestion for Sample of Dutch Hospitalized, Bedridden Children

Child	Sample	Soil Ingestion as Calculated from Ti (mg/day)	Soil Ingestion as Calculated from Al (mg/day)	Limiting Tracer (mg/day)
1	G5	3,290	57	57
	G6	4,790	71	71
2	G1	28	26	26
3	G2	6,570	94	84
	G8	2,480	57	57
4	G3	28	77	28
5	G4	1,100	30	30
6	G7	58	38	38
Arithmetic Mean		2,293	56	49

Source: Adapted from Clausing et al., 1987.

Table 5-16. Items Ingested by Low-Income Mexican-Born Women Who Practiced Pica During Pregnancy in the United States (N = 46).

Item Ingested	Number (%) Ingesting Items
Dirt	11 (24)
Bean stones[a]	17 (37)
Magnesium carbonate	8 (17)
Ashes	5 (11)
Clay	4 (9)
Ice	18 (39)
Other[b]	17 (37)

N = Number of individuals reporting pica behavior.
[a] Little clods of dirt found among unwashed beans.
[b] Including eggshells, starch, paper, lipstick, pieces of clay pot, and adobe.

Source: Simpson et al. 2000.

Table 5-17. Positive/negative Error (Bias) in Soil Ingestion Estimates in Calabrese et al. (1989) Study: Effect on Mean Soil Ingestion Estimate (mg/day)[a]

Tracer	Negative Error						
	Lack of Fecal Sample on Final Study Day	Other Causes[b]	Total Negative Error	Total Positive Error	Net Error	Original Mean	Adjusted Mean
Aluminum	14	11	25	43	+18	153	136
Silicon	15	6	21	41	+20	154	133
Titanium	82	187	269	282	+13	218	208
Vanadium	66	55	121	432	+311	459	148
Yttrium	8	26	34	22	-12	85	97
Zirconium	6	91	97	5	-92	21	113

[a] How to read table: for example, aluminum as a soil tracer displayed both negative and positive error. The cumulative total negative error is estimated to bias the mean estimate by 25 mg/day downward. However, aluminum has positive error biasing the original mean upward by 43 mg/day. The net bias in the original mean was 18 mg/day positive bias. Thus, the original 156 mg/day mean for aluminum should be corrected downward to 136 mg/day.

[b] Values indicate impact on mean of 128-subject-weeks in milligrams of soil ingested per day.

Source: Calabrese and Stanek, 1995.

Table 5-18. Distribution of Average (Mean) Daily Soil Ingestion Estimates per Child for 64 Children[a] (mg/day)

Type of Estimate	Overall	A1	Ba	Mn	Si	Ti	V	Y	Zr
Number of Samples	64	64	33	19	63	56	52	61	62
Mean	179	122	655	1,053	139	271	112	165	23
25th Percentile	10	10	28	35	5	8	8	0	0
50th Percentile	45	19	65	121	32	31	47	15	15
75th Percentile	88	73	260	319	94	93	177	47	41
90th Percentile	186	131	470	478	206	154	340	105	87
95th Percentile	208	254	518	17,374	224	279	398	144	117
Maximum	7,703	4,692	17,991	17,374	4,975	12,055	845	8,976	208

[a] For each child, estimates of soil ingestion were formed on days 4-8 and the mean of these estimates was then evaluated for each child. The values in the column "overall" correspond to percentiles of the distribution of these means over the 64 children. When specific trace elements were not excluded via the relative standard deviation criteria, estimates of soil ingestion based on the specific trace element were formed for 108 days for each subject. The mean soil ingestion estimate was again evaluated. The distribution of these means for specific trace elements is shown.

Source: Stanek and Calabrese, 1995a.

Table 5-19. Estimated Distribution of Individual Mean Daily Soil Ingestion Based on Data for 64 Subjects Projected over 365 Days[a]	
Range	1 - 2,268 mg/d[b]
50th Percentile (median)	75 mg/d
90th Percentile	1,190 mg/d
95th Percentile	1,751 mg/d

[a] Based on fitting a log-normal distribution to model daily soil ingestion values.
[b] Subject with pica excluded.

Source: Stanek and Calabrese, 1995a.

Table 5- 20. Summary of Estimates of Soil and Dust Ingestion by Adults and Children (0.5-14 years old) from Key Studies (mg/day)

Sample Size	Age (years)	Ingestion medium	Mean	P25	P50	P75	P90	P95	Reference
292	0.1 - <1	Soil	0 to 30 [a]	NR	NR	NR	NR	NR	Van Wijnen et al., 1990
	1 - <5	Soil	0 to 200 [a]	NR	NR	NR	≤300	NR	
101	2-<8	Soil	39 to 246	NR	25 to 81	NR	NR	NR	Davis et al., 1990
		Soil and Dust	65 to 268	NR	52 to 117	NR	NR	NR	
64	1-<4	Soil	-294 to +459	NR	-261 to +96	NR	67 to 1,366	106 to 1,903	Calabrese et al., 1989
		Dust	-1,289 to +964	NR	-340 to +127	NR	91 to 1,700	160 to 2,916	
		Soil and Dust	-496 to +483	NR	-340 to +456	NR	89 to 1,701	159 to 3,174	
33	Adult	Soil	23 to 625	NR	0 to 260	NR	NR	138 to 2899	Davis and Mirick, 2006
12	3-<8	Soil	37 to 207	NR	26 to 47	NR	NR	95 to 808	Davis and Mirick, 2006
64	1-<4	Soil	-544 to +270	-582 - +65	-31 to +220	1 to 411	37 to 1,238	69 to 1,378	Calabrese et al., 1997a
478	<1 - <7	Soil and Dust	113	NR	NR	NR	NR	NR	Hogan et al., 1998
89	Adult	Soil	50,000 [b]	NR	NR	NR	NR	NR	Vermeer and Frate, 1979
140	1 - 13+	Soil	50,000 [b]	NR	NR	NR	NR	NR	Vermeer and Frate, 1979
52	0.3 - 14	Soil	NR	NR	NR	NR	~1,267	~4,000	Wong (1988)/Calabrese and Stanek (1993)

[a] Geometric mean.
[b] Average includes adults and children.
NR = Not reported.

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6 INHALATION RATES

6.1 INTRODUCTION

Ambient and indoor air are potential sources of exposure to toxic substances. Adults and children can be exposed to contaminated air during a variety of activities in different environments. They may be exposed to contaminants in ambient air, and may also inhale chemicals from the indoor use of various consumer products. Due to their size, physiology, and activity level, the inhalation rates of children differ from those of adults.

Infants and children have a higher resting metabolic rate and oxygen consumption rate per unit of body weight than adults, because of their rapid growth and relatively larger lung surface area per unit of body weight that requires cooling. For example, the oxygen consumption rate for a resting infant between one week and one year of age is 7 milliliters per kilogram of body weight (mL/kg) per minute, while the rate for an adult under the same conditions is 3-5 mL/kg per minute (WHO, 1986). Thus, while greater amounts of air and pollutants are inhaled by adults than children over similar time periods on an absolute basis, the volume of air passing through the lungs of a resting infant is up to twice that of a resting adult on a body weight basis.

The Agency defines exposure as the chemical concentration at the boundary of the body (U.S. EPA, 1992). In the case of inhalation, the situation is complicated by the fact that oxygen exchange with carbon dioxide takes place in the distal portion of the lung. The anatomy and physiology of the respiratory system as well as the characteristics of the inhaled agent diminishes the pollutant concentration in inspired air (potential dose) such that the amount of a pollutant that actually enters the body through the lung (internal dose) is less than that measured at the boundary of the body. A detailed discussion of this concept can be found in *Guidelines for Exposure Assessment* (U.S. EPA, 1992). When constructing risk assessments that concern the inhalation route of exposure, one must be aware of any adjustments that have been employed in the estimation of the pollutant concentration to account for this reduction in potential dose.

Children's inhalation dosimetry and health effects were topics of discussion at a U.S. EPA workshop held in June 2006 (Foos and Sonawane, 2008). Age related differences in lung structure and function, breathing patterns, and how these affect the inhaled dose and the deposition of particles in the lung are important factors in assessing risks from inhalation exposures (Foos et al., 2008). Children may have a lesser nasal contribution to breathing during rest and while performing various activities. The uptake of particles in the nasal airways is also less efficient in children. Thus, the deposition of particles in the lower respiratory tract may be greater (Foos et al., 2008).

Inclusion of this chapter in the Exposure Factors Handbook does not imply that assessors will always need to select and use inhalation rates when evaluating exposure to air contaminants. For example, it is unnecessary to calculate inhaled dose when using dose-response factors from the Integrated Risk Information System (IRIS) (U.S. EPA, 1994), because the IRIS methodology accounts for inhalation rates in the development of "dose-response" relationships. Information in this chapter may be used by toxicologists in their derivation of human equivalent concentrations. When using IRIS for inhalation risk assessments, "dose-response" relationships require only an average air concentration to evaluate health concerns:

- For non-carcinogens, IRIS uses Reference Concentrations (RfCs) which are expressed in concentration units. Hazard is evaluated by comparing the inspired air concentration to the RfC.
- For carcinogens, IRIS uses unit risk values which are expressed in inverse concentration units. Risk is evaluated by multiplying the unit risk by the inspired air concentration.

Detailed descriptions of the IRIS methodology for derivation of inhalation reference concentrations can be found in two methods manuals produced by the Agency (U.S. EPA, 1992; 1994).

The Superfund Program has also updated its approach for determining inhalation risk, eliminating the use of inhalation rates when evaluating exposure to air contaminants (U.S. EPA, 2008). The current methodology recommends that risk assessors use the concentration of the chemical in air as the exposure metric (e.g., mg/m^3), instead of the intake of a contaminant in air based on inhalation rate and body weight (e.g., mg/kg-day).

Recommended inhalation rates (both long- and short-term) are provided in the next section, along with the confidence ratings for these recommendations. These recommendations are based on four key studies identified by U.S. EPA for this factor. Long-term exposure is repeated exposure for more than 30 days, up to approximately 10% of the life span in humans (more than 30 days). Long-term inhalation rates for adults and children (including infants) are presented as daily rates (m^3/day). Short-term exposure is repeated exposure for more than 24 hours, up to 30 days. Short-term inhalation rates are reported for adults and children (including infants) performing various activities in m^3/minute. Following the recommendations, the available studies (both key and relevant studies) on inhalation rates are summarized.

6.2 RECOMMENDATIONS

The recommended inhalation rates for adults and children are based on three recent studies (Brochu et al., 2006a; U.S. EPA, 2009; and Stifelman, 2007), as well as an additional study of children (Arcus-Arth and Blaisdell, 2007). These studies represent an improvement upon those previously used for recommended inhalation rates in previous versions of this handbook, because they use a large data set that is representative of the United States as a whole and consider the correlation between body weight and inhalation rate.

The selection of inhalation rates to be used for exposure assessments depends on the age of the exposed population and the specific activity levels of this population during various exposure scenarios. The recommended long-term values for adults and children (including infants) for use in various exposure scenarios are presented in Table 6-1. For children, the age groups included are from EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005a). Concordance between the age groupings used for adults and children in this handbook and the original age groups in the key studies is shown in Table 6-55. As shown in Table 6-1, the daily average inhalation rates for long-term exposures for children (males and females combined, unadjusted for body weight) range from 3.5 m^3/day for children from 1 to <3 months to 16.3 m^3/day for children aged 16 to <21 years. Mean values for adults range from 12.2 m^3/day (81 years and older) to 16.0 m^3/day (31 to <51 years). The 95th percentile values for children range from 5.8 m^3/day (1 to <3 months) to 24.6 m^3/day (16 to <21 years) and for adults range from 15.7 m^3/day (81 years and older) to 21.4 m^3/day (31 to <41 years). The mean and 95th percentile values shown in Table 6-1 represent averages of the inhalation rate data from the key studies for which data were available for selected age groups. It should be noted that there may be a high degree of uncertainty associated with the upper percentiles. These values represent unusually high estimates of caloric intake per day, and are not representative of the average adult or child. For example, using Layton's equation (Layton, 1993) for estimating metabolically consistent inhalation rates to calculate caloric equivalence (see Section 6.4.9), the 95th percentile value for 16 to <21 year old children is greater than 4,000 kcal/day (Stifelman, 2003). All of the 95th percentile values listed in Table 6-1 represent unusually high inhalation rates for long-term exposures, even for the upper end of the distribution, but were included in this handbook to provide exposure assessors a sense of the possible range of inhalation rates for adults and children. These values should be used with caution when estimating long-term exposures.

Short-term mean and 95th percentile data in m^3/minute are provided in Table 6-2 for males and females combined for adults and children for which activity patterns are known. These values represent averages of the activity level data from the one key study from which short-term inhalation rate data were available (U.S. EPA, 2009).

The confidence ratings for the inhalation rate recommendations are shown in Table 6-3. Multiple percentiles for long- and short-term inhalation rates for both males and females are provided in Tables 6-4 through 6-11 and 6-13 and 6-14.

Table 6-1. Recommended Long-Term Exposure (More Than 30 Days) Values for Inhalation (Males and Females Combined)

Age Group[f]	Mean m^3/day	Sources Used for Means	95th Percentile[e] m^3/day	Sources Used for 95th Percentiles	Multiple Percentiles
Birth to <1 month	3.6	a	7.1	a	
1 to <3 months	3.5	a, b	5.8	a, b	
3 to <6 months	4.1	a, b	6.1	a, b	
6 to <12 months	5.4	a, b	8.0	a, b	
Birth to <1 year	5.4	a, b, c, d	9.2	a, b, c	
1 to <2 years	8.0	a, b, c, d	12.8	a, b, c	
2 to <3 years	8.9	a, b, c, d	13.7	a, b, c	See Tables 6-4 through 6-11 (none available for Stifelman, 2007)
3 to <6 years	10.1	a, b, c, d	13.8	a, b, c	
6 to <11 years	12.0	a, b, c, d	16.6	a, b, c	
11 to <16 years	15.2	a, b, c, d	21.9	a, b, c	
16 to <21 years	16.3	a, b, c, d	24.6	a, b, c	
21 to <31 years	15.7	b, c, d	21.3	b, c	
31 to <41 years	16.0	b, c, d	21.4	b, c	
41 to <51 years	16.0	b, c, d	21.2	b, c	
51 to <61 years	15.7	b, c, d	21.3	b, c	
61 to <71 years	14.2	b, c, d	18.1	b, c	
71 to <81 years	12.9	b, c	16.6	b, c	
81 years and older	12.2	b, c	15.7	b, c	

[a] Arcus-Arth and Blaisdell, 2007.
[b] Brochu et al., 2006a.
[c] U.S. EPA, 2009.
[d] Stifelman, 2007.
[e] Some 95th percentile values may be unrealistically high and not representative of the average person.
[f] When age groupings in the original reference did not match the U.S. EPA groupings used for this handbook, means from all age groupings in the original reference that overlapped U.S. EPA's age groupings by more than 1 year were averaged, weighted by the number of observations contributed from each age group. Similar calculations were performed for the 95th percentiles. See Table 6-55 for concordance with EPA age groupings.

Table 6-2. Recommended Short-Term Exposure (Less Than 30 Days) Values for Inhalation (Males and Females Combined)

Activity Level	Age Group years	Mean m^3/minute	95th Percentile m^3/minute	Multiple Percentiles
Sleep or Nap	Birth to <1 year	3.0E-03	4.6E-03	
	1 to <2 years	4.5E-03	6.4E-03	
	2 to <3 years	4.6E-03	6.4E-03	
	3 to <6 years	4.3E-03	5.8E-03	
	6 to <11 years	4.5E-03	6.3E-03	
	11 to <16 years	5.0E-03	7.4E-03	
	16 to <21 years	4.9E-03	7.1E-03	
	21 to <31	4.3E-03	6.5E-03	
	31 to <41	4.6E-03	6.6E-03	
	41 to <51	5.0E-03	7.1E-03	
	51 to <61	5.2E-03	7.5E-03	
	61 to <71	5.2E-03	7.2E-03	
	71 to <81	5.3E-03	7.2E-03	
	81 years and older	5.2E-03	7.0E-03	
Sedentary/ Passive	Birth to <1 year	3.1E-03	4.7E-03	
	1 to <2 years	4.7E-03	6.5E-03	
	2 to <3 years	4.8E-03	6.5E-03	
	3 to <6 years	4.5E-03	5.8E-03	See Tables 6-13 and 6-14
	6 to <11 years	4.8E-03	6.4E-03	
	11 to <16 years	5.4E-03	7.5E-03	
	16 to <21 years	5.3E-03	7.2E-03	
	21 to <31 years	4.2E-03	6.5E-03	
	31 to <41 years	4.3E-03	6.6E-03	
	41 to <51 years	4.8E-03	7.0E-03	
	51 to <61 years	5.0E-03	7.3E-03	
	61 to <71 years	4.9E-03	7.3E-03	
	71 to <81 years	5.0E-03	7.2E-03	
	81 years and older	4.9E-03	7.0E-03	
Light Intensity	Birth to <1 year	7.6E-03	1.1E-02	
	1 to <2 years	1.2E-02	1.6E-02	
	2 to <3 years	1.2E-02	1.6E-02	
	3 to <6 years	1.1E-02	1.4E-02	
	6 to <11 years	1.1E-02	1.5E-02	
	11 to <16 years	1.3E-02	1.7E-02	
	16 to <21 years	1.2E-02	1.6E-02	

Table 6-2. Recommended Short-Term Exposure (Less Than 30 Days) Values for Inhalation (Males and Females Combined) (continued)				
Activity Level	Age Group years	Mean m^3/minute	95th Percentile m^3/minute	Multiple Percentiles
	21 to <31 years	1.1E-02	1.6E-02	
	31 to <41 years	1.1E-02	1.6E-02	
	41 to <51 years	1.2E-02	1.6E-02	
	51 to <61 years	1.2E-02	1.7E-02	
	61 to <71 years	1.1E-02	1.6E-02	
	71 to <81 years	1.1E-02	1.5E-02	
Moderate Intensity	Birth to <1 year	1.4E-02	2.2E-02	
	1 to <2 years	2.1E-02	2.9E-02	
	2 to <3 years	2.1E-02	2.9E-02	
	3 to <6 years	2.1E-02	2.7E-02	
	6 to <11 years	2.2E-02	2.9E-02	
	11 to <16 years	2.5E-02	3.4E-02	
	16 to <21 years	2.6E-02	3.7E-02	
	21 to <31 years	2.6E-02	3.8E-02	
	31 to <41 years	2.7E-02	3.7E-02	
	41 to <51 years	2.8E-02	3.9E-02	
	51 to <61 years	2.9E-02	4.0E-02	
	61 to <71 years	2.6E-02	3.4E-02	
	71 to <81 years	2.5E-02	3.2E-02	
	81 years and older	2.5E-02	3.1E-02	
High Intensity	Birth to <1 year	2.6E-02	4.1E-02	
	1 to <2 years	3.8E-02	5.2E-02	
	2 to <3 years	3.9E-02	5.3E-02	
	3 to <6 years	3.7E-02	4.8E-02	
	6 to <11 years	4.2E-02	5.9E-02	
	11 to <16 years	4.9E-02	7.0E-02	
	16 to <21 years	4.9E-02	7.3E-02	
	21 to <31 years	5.0E-02	7.6E-02	
	31 to <41 years	4.9E-02	7.2E-02	
	41 to <51 years	5.2E-02	7.6E-02	
	51 to <61 years	5.3E-02	7.8E-02	
	61 to <71 years	4.7E-02	6.6E-02	
	71 to <81 years	4.7E-02	6.5E-02	
	81 years and older	4.8E-02	6.8E-02	
Source: U.S. EPA, 2009.				

Table 6-3. Confidence in Recommendations for Inhalation Rates		
General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	The survey methodology and data analysis was adequate. Measurements were made by indirect methods. The studies analyzed existing primary data.	
Minimal (or defined) Bias	Potential bias within the studies was fairly well documented.	
Applicability and Utility		High
Exposure Factor of Interest	The studies focused on inhalation rates and factors influencing them.	
Representativeness	The studies focused on the U.S. population. A wide range of age groups were included.	
Currency	The studies were published during 2006 and 2009 and represent current exposure conditions.	
Data Collection Period	The data collection period for the studies may not be representative of long-term exposures.	
Clarity and Completeness		Medium
Accessibility	All key studies are available from the peer reviewed literature.	
Reproducibility	The methodologies were clearly presented; enough information was included to reproduce most results.	
Quality Assurance	Information on ensuring data quality in the key studies was limited.	
Variability and Uncertainty		Medium
Variability in Population	In general, the key studies addressed variability in inhalation rates based on age and activity level. And although some factors affecting inhalation rate, such as body mass, are discussed, other factors (e.g., ethnicity) are omitted.	
Uncertainty	Multiple sources of uncertainty exist for these studies. Assumptions associated with Energy Expenditure (EE) based estimation procedures are a source of uncertainty in inhalation rate estimates.	
Evaluation and Review		High
Peer Review	Three of the key studies appeared in peer reviewed journals, and one key study is a U.S. EPA peer reviewed report.	
Number and Agreement of Studies	There are four key studies. The results of studies from different researchers are in general agreement.	
Overall Rating		**Medium**

6.3 KEY INHALATION RATE STUDIES

6.3.1 *Brochu et al., 2006a - Physiological Daily Inhalation Rates for Free-living Individuals Aged 1 Month to 96 Years, Using Data from Doubly Labeled Water Measurements: A proposal for Air Quality Criteria, Standard Calculations and Health Risk Assessment*

Brochu et al. (2006a) calculated physiological daily inhalation rates (PDIR) for 2,210 individuals aged 3 weeks to 96 years using the reported disappearance rates of oral doses of doubly labeled water (DLW) (^2H_2O and $H_2{}^{18}O$) in urine, monitored by gas-isotope-ratio mass spectrometry for an aggregate period of more than 30,000 days. DLW data were complemented with indirect calorimetry and nutritional balance measurements.

In the DLW method, the disappearance of the stable isotopes deuterium (^2H) and heavy oxygen-18 (^{18}O) are monitored in urine, saliva, or blood samples over a long period of time (from 7 to 21 days) after subjects receive oral doses of ^2H_2O and $H_2{}^{18}O$. The disappearance rate of ^2H reflects water output and that of ^{18}O represents water output plus carbon dioxide (CO_2) production rates. The CO_2 production rate is then calculated by difference between the two disappearance rates. Total daily energy expenditures (TDEEs) are determined from CO_2 production rates using classic respirometry formulas, in which values for the respiratory quotient ($RQ = CO_{2\ produced} / O_{2\ consumed}$) are derived from the composition of the diet during the period of time of each study. The DLW method also allows for measurement of the energy cost of growth (ECG). TDEE and ECG measurements can be converted into PDIR values using the following equation developed by Layton (1993):

$$PDIR = (TDEE + ECG) \times H \times VQ\ 10^{-3} \qquad \text{(Eqn. 6-1)}$$

where:

PDIR	=	physiological daily inhalation rates (m^3/day);
TDEE	=	total daily energy expenditure (kcal/day);
ECG	=	stored daily energy cost for growth (kcal/day);
H	=	oxygen uptake factor, volume of 0.21 L of oxygen (at standard temperature and pressure, dry air) consumed to produce 1 kcal of energy expended;
VQ	=	ventilatory equivalent ratio of the minute volume (V_E) at body temperature pressure saturation) to the oxygen uptake rate (VO_2 at standard temperature and pressure, dry air) $V_E/VO_2 = 27$; and
10^{-3}	=	conversion factor (L/m^3).

Brochu et al. (2006a) calculated daily inhalation rates (expressed in m^3/day and m^3/kg-day) for the following age groups and physiological conditions: (1) healthy newborns aged 3 to 5 weeks old (*n* = 33), (2) healthy normal-weight males and females aged 2.6 months to 96 years (*n* = 1252), (3) low-body mass index (BMI) subjects (underweight women, *n* = 17; adults from less affluent societies *n* = 59) and (4) overweight/obese individuals (*n* = 679), as well as (5) athletes, explorers, and soldiers when reaching very high energy expenditures (*n* = 170). Published data on BMI, body weight, basal metabolic rate (BMR), ECG, and TDEE measurements (based on DLW method and indirect calorimetry) for subjects aged 2.6 months to 96 years were used. Data for underweight, healthy normal-weight, and overweight/obese individuals were gathered and defined according to BMI cutoffs. Data for newborns were included regardless of BMI values, because they were clinically evaluated as being healthy infants.

The distribution of daily inhalation rates for normal-weight and overweight/obese individuals by gender and age groups are presented in Tables 6-4 to 6-8. Mean inhalation rates for newborns are presented in Table 6-9. Due to the insufficient number of subjects, no distributions were derived for this group.

An advantage of this study is that data are provided for age groups of less than one year. A limitation of this study is that data for individuals with pre-existing medical conditions was lacking.

6.3.2 *U.S. EPA, 2009 - Metabolically-derived Human Ventilation Rates: A Revised Approach Based Upon Oxygen Consumption Rates*

U.S. EPA (2009) conducted a study to ascertain inhalation rates for children and adults. Specifically, U.S. EPA sought to improve upon the methodology used by Layton (1993) and other studies that relied upon the ventilatory equivalent (VQ) and a linear relationship between oxygen consumption and fitness rate. A revised approach, developed by U.S. EPA's National Exposure Research Laboratory (NERL), was used, in which an individual's inhalation rate was derived from his or her assumed oxygen consumption rate. U.S. EPA applied this revised approach using body weight data from the 1999-2002 National Health and Nutrition Examination Survey (NHANES) and metabolic equivalents (METS) data from U.S. EPA's Consolidated Human Activity Database (CHAD). In this database, metabolic cost is given in units of "METS" or "metabolic equivalents of work," an energy expenditure metric used by exercise physiologists and clinical nutritionists to represent activity levels. An activity's METS value represents a dimensionless ratio of its metabolic rate (energy expenditure) to a person's resting, or basal metabolic rate (BMR).

NHANES provided age, gender, and body weight data for 19,022 individuals from throughout the United States. From these data, basal metabolic rate (BMR) was estimated using an age-specific linear equation used in the Exposure Factors Handbook (U.S. EPA, 1997), and in several other studies and reference works.

The CHAD database is a compilation of several databases of human activity patterns. U.S. EPA used one of these studies, the National Human Activity Pattern Survey (NHAPS), as its source for METS values because it was more representative of the entire United States population than the other studies in the database. The NHAPS data set included activity data for 9,196 individuals, each of which provided 24 hours of activity pattern data using a diary-based questionnaire. While NHAPS was identified as the best available data source for activity patterns, there were some shortcomings in the quality of the data. Study respondents did not provide body weights; instead, body weights are simulated using statistical sampling. Also, the NHAPS data extracted from CHAD could not be corrected to account for non-random sampling of study participants and survey days.

NHANES and NHAPS data were grouped into age categories using the age categories presented elsewhere in this handbook, with the exception that children under the age of one year were placed into a single category to preserve an adequate sample size within the category. For each NHANES participant, a "simulated" 24-hour activity pattern was generated by randomly sampling activity patterns from the set of NHAPS participants with the same gender and age category as the NHANES participant. Twenty such patterns were selected at random for each NHANES participant, resulting in 480 hours of simulated activity data for each NHANES participant. The data were then scaled down to a 24-hour time frame to yield an average 24-hour activity pattern for each of the 19,022 NHANES individuals.

Each activity was assigned a METS value based on statistical sampling of the distribution assigned by CHAD to each activity code. For most codes, these distributions were not age-dependent, but age was a factor for some activities for which intensity level varies strongly with age. Using statistical software, equations for METS based on normal, lognormal, exponential, triangular, and uniform distributions were generated as needed for the various activity codes. The METS values were then translated into energy expenditure (EE) by multiplying the METS by the basal metabolic rate (BMR), which was calculated as a linear function of body weight. The oxygen consumption rate (VO_2) was calculated by multiplying EE by H, the volume of oxygen consumed per unit of energy. VO_2 was calculated both as volume per time and as volume per time per unit body weight.

The inhalation rate for each activity within the 24-hour simulated activity pattern for each individual was estimated as a function of VO_2, body weight, age, and gender. Following this, the average inhalation rate was calculated for each individual for the entire 24-hour period, as well as for four separate classes of activities based on METS value (sedentary/passive (METS less than or equal to 1.5), light intensity (METS greater than 1.5 and less than or equal to 3.0), moderate intensity (METS greater than 3.0 and less than or equal to 6.0), and high intensity (METS greater than 6.0). Data for individuals were then used to generate summary tables based on gender and age categories.

Data from this study are presented in Tables 6-10, 11 and Tables 6-12 through 6-15. Tables 6-10 and 6-11 present, for male and female subjects, respectively, summary statistics for daily average inhalation rate by age category on a volumetric (m^3/day) and body-weight adjusted (m^3/day-kg) basis. Table 6-12 presents the mean and 95th percentile values for males, females, and males and females combined. Tables 6-13 and 6-14 present, for male and female subjects, respectively, mean ventilation rates by age category on a volumetric (m^3/min) and body-weight adjusted (m^3/min-kg) basis for the five different activity level ranges described above. Table 6-15 presents the number of hours spent per day at each activity level by males and females.

An advantage of this study is the large sample size. In addition, the datasets used, NHAPS and NHANES, are representative of the U.S. general population. Limitations are that the NHAPS data are 10 years old, there is variability in the 24-hour activity, and there is uncertainty in the METs randomization, all of which were noted by the authors.

6.3.3 *Arcus-Arth and Blaisdell, 2007 - Statistical Distributions of Daily Breathing Rates for Narrow Age Groups of Infants and Children*

Arcus-Arth and Blaisdell (2007) derived daily breathing rates for narrow age ranges of children using the metabolic conversion method of Layton (1993) and energy intake data adjusted to represent the U.S. population from the Continuing Survey of Food Intake for Individuals (CSFII) 1994-1996, 1998. Normalized (m^3/kg-day) and nonnormalized (m^3/day) breathing rates for children 0-18 years of age were derived using the general equation developed by Layton (1993) to calculate energy-dependent inhalation rates (see Equation 6-2).

$$VE = H \times VQ \times EE \qquad \text{(Eqn. 6-2)}$$

where:

VE = volume of air breathed per day (m^3/day);
H = volume of oxygen consumed to produce 1 kcal of energy (m^3/kcal);
VQ = ratio of the volume of air to the volume of oxygen breathed per unit time (unitless); and
EE = energy (kcal) expended per day.

Arcus-Arth and Blaisdell (2007) calculated H values of 0.22 and 0.21 for infants and noninfant children, respectively, using the 1977-1978 NFCS and CSFII data sets. Ventilatory equivalent (VQ) data, including those for infants, were obtained from 13 studies that reported VQ data for children aged 4-8 ears. Separate preadolescent (4-8 years) and adolescent (9-18 years) VQ values were calculated in addition to separate VQ values for adolescent boys and girls. Two-day-averaged daily energy intake (EI) values reported in the CSFII data set were used a surrogate for EE. CSFII records that did not report body weight and those for children who consumed breast milk or were breast fed were excluded from their analyses. The EIs of children 9 years of age and older were multiplied by 1.2, the value calculated by Layton (1993) to adjust for potential bias related to underreporting of dietary intakes by older children. For infants, EI values were adjusted by subtracting the amount of energy put into storage by infants as estimated by Scrimshaw et al. (1996). Self-reported body weights for each individual from the CSFII data set were used to calculate nonnormalized (m^3/day) and normalized (m^3/kg-day) breathing rates, which decreased the variability in the resulting breathing rate data. Daily breathing rates were grouped into three-month age groups for infants, one-year age groups for children 1 to 18 years of age, and the age groups recommended by U.S. EPA cancer guidelines supplement (U.S. EPA, 2005b) to receive greater weighting for mutagenic carcinogens (0 to <2 years of age, and 2 to < 16 years of age). Data were also presented for adolescent boys and girls, aged 9 to 18 years (Table 6-16). For each age and age-gender group, Arcus-Arth and Blaisdell (2007) calculated the arithmetic mean, standard error of the mean, percentiles (50th, 90th, and 95th), geometric mean, standard deviation, and best-fit parametric models of the breathing rate distributions. Overall, the CSFII-derived nonnormalized breathing rates progressively increased with age from infancy through 18 years of age, while normalized breathing rates progressively decreased. The data are presented in Table 6-17 in units of m^3/day. There were statistical differences between boys and girls 9 to 18 years of age, both for these years combined ($p< 0.00$) and for each year of age separately ($p< 0.05$). The authors reasoned that since the fat-free mass (basically muscle mass) of boys typically increases during adolescence, and because fat-free mass is highly correlated to basal metabolism which accounts for the majority of EE, nonnormalized breathing rates for adolescent boys may be expected to increase with increasing age. Table 6-17 presents the mean and 95th percentile values for males and females combined, averaged to fit within the standard U.S. EPA age groups.

The CSFII-derived mean breathing rates derived by Arcus-Arth and Blaisdell (2007) were compared to the mean breathing rates estimated in studies that utilized doubly labeled water (DLW) technique EE data that had been coupled with the Layton (1993) method. The infants' CSFII-derived breathing rates were 15 to 27 percent greater than the comparison DLW EE breathing rates while the children's CSFII rates ranged from 23 percent less to 14 percent greater than comparison rates. Thus, the CSFII and comparison rates were quite similar across age groups.

An advantage of this study is that it provides breathing rates specific to narrow age ranges, which can be useful for assessing inhalation dose during periods of greatest susceptibility. However, the study is limited by the potential for misreporting, underestimating, or overestimating of food intake data in the CSFII. In addition to underreporting of food intake by adolescents, EI values for younger children may be under- or overestimated. Overweight children (or their parents) may also underreport food intakes. In addition, adolescents who misreport food intake may have also misreported body weights.

6.3.4 *Stifelman, 2007 - Using Doubly-labeled Water Measurements of Human Energy Expenditure to Estimate Inhalation Rates*

Stifelman (2007) estimated inhalation rates using DLW energy data. The DLW method administers two forms of stable isotopically labeled water: deuterium-labeled (^2H_2O) and ^{18}oxygen-labeled ($H_2{}^{18}O$). The difference in disappearance rates between the two isotopes represents the energy expended over a period of 1–3 half-lives of the labeled water (Stifelman, 2007). The resulting duration of observation is typically 1–3 weeks, depending on the size and activity level.

The DLW database contains subjects from areas around the world and represents diversity in ethnicity, age, activity, body type, and fitness level. DLW data have been compiled by the Institute of Medicine (IOM) Panel on Macronutrients and the Food and Agriculture Organization of the United Nations (FAO). Stifelman (2007) used the equation of Layton (1993) to convert the recommended energy levels of IOM for the active-very active people to their equivalent inhalation rates. The IOM reports recommend energy expenditure levels organized by gender, age and body size (Stifelman, 2007).

The equivalent inhalation rates are shown in Table 6-18. Shown in Table 6-19 are the mean values for the IOM “active” energy level category, averaged to fit within the standard EPA age groups. Stifelman (2007) noted that the estimates based on the DLW are consistent with previous findings of Layton (1993) and the Exposure Factors Handbook (U.S. EPA, 1997) and that inhalation rates based on the IOM active classification are consistent with the mean inhalation rate in the handbook.

The advantages of this study are that the inhalation rates were estimated using the DLW data from a large data set. Stifelman (2007) noted that DLW methods are advantageous; the data are robust, measurements are direct and avoid errors associated with indirect measurements (heart rate), subjects are free-living, and the period of observation is longer than what is possible from staged activity measures. Observations over a longer period of time reduce the uncertainties associated with using short duration studies to infer long-term inhalation rates. A limitation with the study is that the inhalation rates that are presented are for active/very active persons only.

6.3.5 Key Studies Combined

In order to provide the recommended long-term inhalation rates shown in Table 6-1**,** data from the four key studies were combined. Mean and 95th percentile inhalation rate values for the four key studies are shown in Tables 6-20 and 6-21, respectively. The data from each study were averaged by gender and grouped according to the age groups selected for use in this handbook, when possible. Concordance between the age groupings used in this handbook and the original age groups in the key studies is shown in Table 6-55.

6.4 RELEVANT INHALATION RATE STUDIES

6.4.1 *International Commission on Radiological Protection (ICRP), 1981 - Report of the Task Group on Reference Man*

The International Commission on Radiological Protection (ICRP, 1981) estimated daily inhalation rates for reference adult males and females, children (10 years old), infants (1 year old), and newborn babies by using a time-activity-ventilation approach. This approach for estimating an inhalation rate over a specified period of time was based on calculating a time weighted average of inhalation rates associated with physical activities of varying durations (Table 6-22). ICRP (1981) compiled reference values (Table 6-23) of minute volume/inhalation rates from various literature sources. ICRP (1981) assumed that the daily activities of a reference male, female, and child (10 years of age) consisted of 8 hours of rest and 16 hours of light activities. It was also assumed that 16 hours were divided evenly between occupational and non-occupational activities. It was assumed that a day consisted of 14 hours resting and 10 hours light activity for an infant (1 year). A newborn's daily activities consisted of 23 hours resting and 1 hour light activity. The estimated inhalation rates were 22.8 m^3/day for adult males, 21.1 m^3/day for adult females, 14.8 m^3/day for children (age 10 years), 3.76 m^3/day for infants (age 1 year), and 0.78 m^3/day for newborns (Table 6-22).

A limitation associated with this study is that the validity and accuracy of the inhalation rate data used in the compilation of reference values were not specified. This introduces some degree of uncertainty in the results obtained. Also, the approach used required that assumptions be made regarding the hours spent by various age/gender cohorts in specific activities. These assumptions may over/under-estimate the inhalation rates obtained.

6.4.2 *U.S. EPA, 1985 - Development of Statistical Distributions or Ranges of Standard Factors Used in Exposure Assessments*

The U.S. EPA (1985) compiled measured values of minute ventilation for various age/gender cohorts from early studies. The data compiled by the U.S. EPA (1985) for each age/gender cohorts were obtained at various activity levels (Table 6-24). These levels were categorized as light, moderate, or heavy according to the criteria developed by the U.S. EPA Office of Environmental Criteria and Assessment for the Ozone Criteria Document. These criteria were developed for a reference male adult with a body weight of 70 kg (U.S. EPA, 1985). The minute ventilation rates for adult males based on these activity level categories are detailed in Table 6-25.

Table 6-24 presents a summary of inhalation rates by age and activity level. A description of activities included in each activity level is also presented in Table 6-24. Table 6-24 indicates that at rest, the average adult inhalation rate is 0.5 m^3/hr. Table 6-24 indicates that at rest, the mean inhalation rate for children, ages 6 and 10 years, is 0.4 m^3/hr. Table 6-26 presents activity pattern data aggregated for three microenvironments by activity level for all age groups. The total average hours spent indoors was 20.4, outdoors was 1.77, and in a transportation vehicle was 1.77. Based on the data presented in Tables 6-24 and 6-26, a daily inhalation rate was calculated for adults and children by using a time-activity-ventilation approach. These data are presented for adults and children in Table 6-27. The calculated average daily inhalation rate is 16 m^3/day for adults. The average daily inhalation rate for 6 and 10 years old children is 16.74 and 21.02 m^3/day, respectively.

Limitations associated with this study are its age and that many of the values used in the data compilation were from early studies. The accuracy and/or validity of the values used and data collection method were not presented in U.S. EPA (1985). This introduces uncertainty in the results obtained. An advantage of this study is that the data are actual measurement data for a large number of adults and children.

6.4.3 *Shamoo et al., 1990 - Improved Quantitation of Air Pollution Dose Rates by Improved Estimation of Ventilation Rate*

Shamoo et al. (1990) conducted a study to develop and validate new methods to accurately estimate ventilation rates for typical individuals during their normal activities. Two practical approaches were tested for estimating ventilation rates indirectly: (1) volunteers were trained to estimate their own VR at various controlled levels of exercise; and (2) individual VR and HR relationships were determined in another set of volunteers during supervised exercise sessions (Shamoo et al., 1990). In the first approach, the training session involved 9 volunteers (3 females and 6 males) from 21 to 37 years old. Initially the subjects were trained on a treadmill with regularly increasing speeds. VR measurements were recorded during the last minute of the 3-minute interval at each speed. VR was reported to the subjects as low (1.4 m^3/hr), medium (1.5-2.3 m^3/hr), heavy (2.4-3.8 m^3/hr), and very heavy (3.8 m^3/hr or higher) (Shamoo et al., 1990).

Following the initial test, treadmill training sessions were conducted on a different day in which 7 different speeds were presented, each for 3 minutes in arbitrary order. VR was measured and the subjects were given feedback with the four ventilation ranges provided previously. After resting, a treadmill testing session was conducted in which seven speeds were presented in different arbitrary order from the training session. VR was measured and each subject estimated their own ventilation level at each speed. The correct level was then revealed to each subject after his/her own estimate. Subsequently, two 3-hour outdoor supervised exercise sessions were conducted in the summer on two consecutive days. Each hour consisted of 15 minutes each of rest, slow walking, jogging, and fast walking. The subjects' ventilation level and VR were recorded; however, no feedback was given to the subjects. Electrocardiograms were recorded via direct connection or telemetry and HR was measured concurrently with ventilation measurement for all treadmill sessions.

The second approach consisted of two protocol phases (indoor/outdoor exercise sessions and field testing). Twenty outdoor adult workers between 19 and 50 years old were recruited. Indoor and outdoor supervised exercises similar to the protocols in the first approach were conducted; however, there were no feedbacks. Also, in this approach, electrocardiograms were recorded and HR was measured concurrently with VR. During the field testing phase, subjects were trained to record their activities during three different 24-hour periods during one week. These periods included their most active working and non-working days. HR was measured quasi-continuously during the 24-hour periods that activities were recorded. The subjects recorded in a diary all changes in physical activity, location, and exercise levels during waking hours. Self-estimated activities in supervised exercises and field studies were categorized as slow (resting, slow walking or equivalent), medium (fast walking or equivalent), and fast (jogging or equivalent).

Inhalation rates were not presented in this study. In the first approach, about 68 percent of all self-estimates were correct for the 9 subjects sampled (Shamoo et al., 1990). Inaccurate self-estimates occurred in the younger male population who were highly physically fit and were competitive aerobic trainers. This subset of the sample population tended to underestimate their own physical activity levels at higher VR ranges. Shamoo et al. (1990) attributed this to a "macho effect." In the second approach, a regression analysis was conducted that related the logarithm of VR to HR. The logarithm of VR correlated better with HR than VR itself (Shamoo et al., 1990).

Limitations associated with this study are its age and that the population sampled is not representative of the general U.S. population. Also, ventilation rates were not presented. Training individuals to estimate their VR may contribute to uncertainty in the results because the estimates are subjective. Another limitation is that calibration data were not obtained at extreme conditions; therefore, the VR/HR relationship obtained may be biased. An additional limitation is that training subjects may be too labor-intensive for widespread use in exposure assessment studies. An advantage of this study is that HR recordings are useful in predicting ventilation rates which in turn are useful in estimating exposure.

6.4.4 *Shamoo et al., 1991 - Activity Patterns in a Panel of Outdoor Workers Exposed to Oxidant Pollution*

Shamoo et al. (1991) investigated summer activity patterns in 20 adult volunteers with potentially high exposure to ambient oxidant pollution. The selected volunteer subjects were 15 men and 5 women ages 19-50 years from the Los Angeles area. All volunteers worked outdoors at least 10 hours per week. The experimental approach involved two stages: (1) indirect objective estimation of VR from HR measurements; and (2) self estimation of inhalation/ventilation rates recorded by subjects in diaries during their normal activities.

The approach consisted of calibrating the relationship between VR and HR for each test subject in controlled exercise; monitoring by subjects of their own normal activities with diaries and electronic HR recorders; and then relating VR with the activities described in the diaries (Shamoo et al., 1991). Calibration tests were conducted for indoor and outdoor supervised exercises to determine individual relationships between VR and HR. Indoors, each subject was tested on a treadmill at rest and at increasing speeds. HR and VR were measured at the third minute at each 3-minute interval speed. In addition, subjects were tested while walking a 90-meter course in a corridor at 3 self-selected speeds (normal, slower than normal, and faster than normal) for 3 minutes.

Two outdoor testing sessions (one hour each) were conducted for each subject, 7 days apart. Subjects exercised on a 260-meter asphalt course. A session involved 15 minutes each of rest, slow walking, jogging, and fast walking during the first hour. The sequence was also repeated during the second hour. HR and VR measurements were recorded starting at the 8th minute of each 15-minute segment. Following the calibration tests, a field study was conducted in which subject's self-monitored their activities by filling out activity diary booklets, self-estimated their breathing rates, and their HR. Breathing rates were defined as sleep, slow (slow or normal walking); medium (fast walking); and fast (running) (Shamoo et al., 1991). Changes in location, activity, or breathing rates during three 24-hr periods within a week were recorded. These periods included their most active working and non-working days. Each subject wore Heart Watches which recorded their HR once per minute during the field study. Ventilation rates were estimated for the following categories: sleep, slow, medium, and fast.

Calibration data were fit to the equation log (VR) = intercept + (slope x HR), each individual's intercept and slope were determined separately to provide a specific equation that predicts each subject's VR from measured HR (Shamoo et al., 1991). The average measured VRs were 0.48, 0.9, 1.68, and 4.02 m^3/hr for rest, slow walking or normal walking, fast walking and jogging, respectively (Shamoo et al., 1991). Collectively, the diary recordings showed that sleep occupied about 33 percent of the subject's time; slow activity 59 percent; medium activity 7 percent; and fast activity 1 percent. The diary data covered an average of 69 hours per subject (Shamoo et al., 1991). Table 6-28 presents the distribution pattern of predicted ventilation rates and equivalent ventilation rates (EVR) obtained at the four activity levels. EVR was defined as the VR per square meter of body surface area, and also as a percentage of the subjects average VR over the entire field monitoring period (Shamoo et al., 1991). The overall mean predicted VR was 0.42 m^3/hr for sleep; 0.71 m^3/hr for slow activity; 0.84 m^3/hr for medium activity; and 2.63 m^3/hr for fast activity.

The mean predicted VR and standard deviation, and the percentage of time spent in each combination of VR, activity type (essential and non-essential), and location (indoor and outdoor) are presented in Table 6-29. Essential activities include income-related work, household chores, child care, study and other school activities, personal care and destination-oriented travel. Non-essential activities include sports and active leisure, passive leisure, some travel, and social or civic activities (Shamoo et al., 1991). Table 6-29 shows that inhalation rates were higher outdoors than indoors at slow, medium, and fast activity levels. Also, inhalation rates were higher for outdoor non-essential activities than for indoor non-essential activity levels at slow, medium, and fast self-reported breathing rates (Table 6-29).

An advantage of this study is that subjective activity diary data can provide exposure modelers with useful rough estimates of VR for groups of generally healthy people. Limitation of this study is its age and that the results obtained show high within-person and between-person variability in VR at each diary-recorded level, indicating that VR estimates from diary reports could potentially be substantially misleading in individual cases. Another limitation of this study is that elevated HR data of slow activity at the second hour of the exercise session reflect persistent effects of exercise and/or heat stress. Therefore, predictions of VR from the VR/HR relationship may be biased.

6.4.5 Linn et al., 1992 - Documentation of Activity Patterns in "High-risk" Groups Exposed to Ozone in the Los Angeles Area

Linn et al. (1992) conducted a study that estimated the inhalation rates for "high-risk" subpopulation groups exposed to ozone in their daily activities in the Los Angeles area. The population surveyed consisted of seven subject panels: Panel 1: 20 healthy outdoor workers (15 males, 5 females, ages 19-50 years); Panel 2: 17 healthy elementary school students (5 males, 12 females, ages 10-12 years); Panel 3: 19 healthy high school students (7 males, 12 females, ages 13-17 years); Panel 4: 49 asthmatic adults (clinically mild, moderate, and severe, 15 males, 34 females, ages 18-50 years); Panel 5: 24 asthmatic adults from 2 neighborhoods of contrasting O3 air quality (10 males, 14 females, ages 19-46 years); Panel 6: 13 young asthmatics (7 males, 6 females, ages 11-16 years); Panel 7: construction workers (7 males, ages 26-34 years).An initial calibration test was conducted, followed by a training session. Finally, a field study that involved the subjects collecting their own heart rates and diary data was conducted. During the calibration tests, ventilation rate (VR), breathing rate, and heart rate (HR) were measured simultaneously at each exercise level. From the calibration data an equation was developed using linear regression analysis to predict VR from measured HR.

In the field study, each subject (except construction workers) recorded in diaries their daily activities, change in locations (indoors, outdoors, or in a vehicle), self-estimated breathing rates during each activity/location, and time spent at each activity/location. Healthy subjects recorded their HR once every 60 seconds using a Heart Watch, an automated system consisting of a transmitter and receiver worn on the body. Asthmatic subjects recorded their diary information once every hour. Subjective breathing rates were defined as slow (walking at their normal pace), medium (faster than normal walking), and fast (running or similarly strenuous exercise). Table 6-30 presents the calibration and field protocols for self-monitoring of activities for each subject panel.

Table 6-31 presents the mean, 99th percentile, and mean VR at each subjective activity level (slow, medium, fast). The mean and 99th percentile VR were derived from all HR recordings that appeared to be valid, without considering the diary data. Each of the three activity levels was determined from both the concurrent diary data and HR recordings by direct calculation or regression. The mean VR for healthy adults was 0.78 m^3/hr while the mean VR for asthmatic adults was 1.02 m^3/hr (Table 6-31). The preliminary data for construction workers indicated that during a 10-hr work shift, their mean VR (1.50 m^3/hr) exceeded the VRs of all other subject panels (Table 6-31). The authors reported that the diary data showed that on a typical day, most individuals spent most of their time indoors at slow activity level. During slow activity, asthmatic subjects had higher VRs than healthy subjects (Table 6-31). The authors also reported that in every panel the predicted VR correlated significantly with the subjective estimates of activity levels.

A limitation of this study is that calibration data may overestimate the predictive power of HR during actual field monitoring. The wide variety of exercises in everyday activities may result in greater variation of the VR-HR relationship than was calibrated. Another limitation is the small sample size of each subpopulation surveyed. An advantage of this study is that diary data can provide rough estimates of ventilation patterns which are useful in exposure assessments. Another advantage is that inhalation rates were presented for various subpopulations (i.e., healthy outdoor adult workers, healthy children, asthmatics, and construction workers).

6.4.6 *Shamoo et al., 1992 - Effectiveness of Training Subjects to Estimate Their Level of Ventilation*

Shamoo et al. (1992) conducted a study where nine non-sedentary subjects in good health were trained on a treadmill to estimate their own ventilation rates at four activity levels: low, medium, heavy, and very heavy. The purpose of the study was to train the subjects self-estimation of ventilation in the field and assess the effectiveness of the training (Shamoo et al., 1992). The subjects included 3 females and 6 males between 21 to 37 years of age. The tests were conducted in four stages. First, an initial treadmill pretest was conducted indoors at various speeds until the four ventilation levels were experienced by each subject; VR was measured and feedback was given to the subjects. Second, two treadmill training sessions which involved seven 3-minute segments of varying speeds based on initial tests were conducted; VR was measured and feedback was given to the subjects. Another similar session was conducted; however, the subjects estimated their own ventilation level during the last 20 seconds of each segment and VR was measured during the last minute of each segment. Immediate feedback was given to the subject's estimate; and the third and fourth stages involved 2 outdoor sessions of 3 hours each. Each hour comprised 15 minutes each of rest, slow walking, jogging, and fast walking. The subjects estimated their own ventilation level at the middle of each segment. The subject's estimate was verified by a respirometer which measured VR in the middle of each 15-minute activity. No feedback was given to the subject. The overall percent correct score obtained for all ventilation levels was 68 percent (Shamoo et al., 1992). Therefore, Shamoo et al. (1992) concluded that this training protocol was effective in training subjects to correctly estimate their minute ventilation levels.

For this handbook, inhalation rates were analyzed from the raw data provided by Shamoo et al. (1992). Table 6-32 presents the mean inhalation rates obtained from this analysis at four ventilation levels in two microenvironments (i.e., indoors and outdoors) for all subjects. The mean inhalation rates for all subjects were 0.93, 1.92, 3.01, 4.80 m^3/hr for low, medium, heavy, and very heavy activities, respectively.

Limitations of this study are its age and the population sample size used in this study was small and was not selected to represent the general U.S. population. The training approach employed may not be cost effective because it was labor intensive; therefore, this approach may not be viable in field studies especially for field studies within large sample sizes.

6.4.7 *Spier et al., 1992 - Activity Patterns in Elementary and High School Students Exposed to Oxidant Pollution*

Spier et al. (1992) investigated the activity patterns of 17 elementary school students (10-12 years old) and 19 high school students (13-17 years old) in suburban Los Angeles from late September to October (oxidant pollution season). Calibration tests were conducted in supervised outdoor exercise sessions. The exercise sessions consisted of 5 minutes each of rest, slow walking, jogging, and fast walking. HR and VR were measured during the last 2 minutes of each exercise. Individual VR and HR relationships for each individual were determined by fitting a regression line to HR values and log VR values. Each subject recorded their daily activities, changes in location, and breathing rates in diaries for 3 consecutive days. Self-estimated breathing rates were recorded as slow (slow walking), medium (walking faster than normal), and fast (running). HR was recorded once per minute during the 3 days using a Heart Watch. VR values for each self-estimated breathing rate and activity type were estimated from the HR recordings by employing the VR and HR equation obtained from the calibration tests.

The data presented in Table 6-33 represent HR distribution patterns and corresponding predicted VR for each age group during hours spent awake. At the same self-reported activity levels for both age groups, inhalation rates were higher for outdoor activities than for indoor activities. The total number of hours spent indoors was higher for high school students (21.2 hours) than for elementary school students (19.6 hours). The converse was true for outdoor activities: 2.7 hours for high school students and 4.4 hours for elementary school students (Table 6-34). Table 6-35 describes the distribution patterns of daily inhalation rates for elementary and high school students grouped by activity level.

A limitation of this study is the small sample size. The results may not be representative of all children in these age groups. Another limitation is that the accuracy of the self-estimated breathing rates reported by younger age groups is uncertain. This may affect the validity of the data set generated. An advantage of this study is that inhalation rates were determined for children and adolescents. These data are useful in estimating exposure for the younger population.

6.4.8 Adams, 1993 - Measurement of Breathing Rate and Volume in Routinely Performed Daily Activities, Final Report

Adams (1993) conducted research to accomplish two main objectives: (1) identification of mean and ranges of inhalation rates for various age/gender cohorts and specific activities, and (2) derivation of simple linear and multiple regression equations that could be used to predict inhalation rates through other measured variables: breathing frequency and oxygen consumption. A total of 160 subjects participated in the primary study. There were four age dependent groups: (1) children 6 to 12.9 years old, (2) adolescents between 13 and 18.9 years old, (3) adults between 19 and 59.9 years old, and (4) seniors >60 years old (Adams, 1993). An additional 40 children from 6 to 12 years old and 12 young children from 3 to 5 years old were identified as subjects for pilot testing purposes in this age group (Adams, 1993). An additional 40 children from 6 to 12.9 years old and 12 young children from 3 to 5.9 years old were identified as subjects for pilot testing purposes.

Resting protocols conducted in the laboratory for all age groups consisted of three phases (25 minutes each) of lying, sitting, and standing. The phases were categorized as resting and sedentary activities. Two active protocols—moderate (walking) and heavy (jogging/ running) phases— were performed on a treadmill over a progressive continuum of intensity levels made up of 6-minute intervals at three speeds ranging from slow to moderately fast. All protocols involved measuring VR, HR, f_B (breathing frequency), and VO_2 (oxygen consumption). Measurements were taken in the last 5 minutes of each phase of the resting protocol and the last 3 minutes of the 6-minute intervals at each speed designated in the active protocols.

In the field, all children completed spontaneous play protocols. the older adolescent population (16 to 18 years) completed car driving and riding, car maintenance (males), and housework (females) protocols. All adult females (19 to 60 years) and most of the senior (60 to 77 years) females completed housework, yardwork, and car driving and riding protocols. Adult and senior males completed car driving and riding, yardwork, and mowing protocols. HR, VR, and fB were measured during each protocol. Most protocols were conducted for 30 minutes. All the active field protocols were conducted twice.

During all activities in either the laboratory or field protocols, VR for the children's group revealed no significant gender differences, but those for the adult groups demonstrated gender differences. Therefore, IR data presented in Tables 6-36 and 6-37 were categorized as young children, children (no gender), and for adult female, and adult male by activity type (lying, sitting, standing, walking, and running). These categorized data from Tables 6-36 and 6-37 are summarized as inhalation rates in Tables 6-38 and 6-39. The laboratory protocols are shown in Table 6-38. Table 6-39 presents the mean inhalation rates by group and for moderate activity levels in field protocols. A comparison of the data shown in Tables 6-38 and 6-39 suggest that during light and sedentary activities in laboratory and field protocols, similar inhalation rates were obtained for adult females and adult males. Accurate predictions of inhalation rates across all population groups and activity types were obtained by including body surface area (SA), HR, and breathing frequency in multiple regression analysis (Adams, 1993). Adams (1993) calculated SA from measured height and body weight using the equation:

$$SA = Height^{(0.725)} \times Weight^{(0.425)} \times 71.84 \qquad \text{(Eqn. 6-3)}$$

A limitation associated with this study is that the population does not represent the general U.S. population. Also, the classification of activity types (i.e., laboratory and field protocols) into activity levels may bias the inhalation rates obtained for various age/gender cohorts. The estimated rates were based on short-term data and may not reflect long-term patterns.

6.4.9 Layton, 1993 - Metabolically Consistent Breathing Rates for Use in Dose Assessments

Layton (1993) presented a method for estimating metabolically consistent inhalation rates for use in quantitative dose assessments of airborne radionuclides. Generally, the approach for estimating the breathing rate for a specified time frame was to calculate a time-weighted-average of ventilation rates associated with physical activities of varying durations. However, in this study, breathing rates were calculated on the basis of oxygen consumption associated with energy expenditures for short (hours) and long (weeks and months) periods of time, using the following general equation to calculate energy-dependent inhalation rates:

$$V_E = E \times H \times VQ \qquad \text{(Eqn. 6-4)}$$

where:

V_E = ventilation rate (m^3/min or m^3/day);
E = energy expenditure rate;

[kilojoules/minute (KJ/min) or megajoules/hour (MJ/hr)];

H = volume of oxygen (at standard temperature and pressure, dry air consumed in the production of 1 kilojoule (KJ) of energy expended (L/KJ or m^3/MJ)); and

VQ = ventilatory equivalent (ratio of minute volume (m^3/min) to oxygen uptake (m^3/min)) unitless.

Layton (1993) used three approaches to estimate daily chronic (long term) inhalation rates for different age/gender cohorts of the U.S. population using this methodology.

First Approach

Inhalation rates were estimated by multiplying average daily food energy intakes for different age/gender cohorts, H, and VQ, as shown in the equation above. The average food energy intake data (Table 6-40) are based on approximately 30,000 individuals and were obtained from the 1977-78 USDA-NFCS. The food energy intakes were adjusted upwards by a constant factor of 1.2 for all individuals 9 years and older. This factor compensated for a consistent bias in USDA-NFCS that was attributed to under-reporting of the foods consumed or the methods used to ascertain dietary intakes. Layton (1993) used a weighted average oxygen uptake of 0.05 L O_2/KJ which was determined from data reported in the 1977-78 USDA-NFCS and the second NHANES (NHANES II). The survey sample for NHANES II was approximately 20,000 participants. A VQ of 27 used in the calculations was calculated as the geometric mean of VQ data that were obtained from several studies.

The inhalation rate estimation techniques are shown in footnote (a) of Table 6-41. Table 6-42 presents the daily inhalation rate for each age/gender cohort. The highest daily inhalation rates were 10 m^3/day for children between the ages of 6 and 8 years, 17 m^3/day for males between 15 and 18 years, and 13 m^3/day for females between 9 and 11 years. Estimated average lifetime inhalation rates for males and females are 14 m^3/day and 10 m^3/day, respectively (Table 6-41). Inhalation rates were also calculated for active and inactive periods for the various age/gender cohorts.

The inhalation rate for inactive periods was estimated by multiplying the BMR times H times VQ. BMR was defined as "the minimum amount of energy required to support basic cellular respiration while at rest and not actively digesting food" (Layton, 1993). The inhalation rate for active periods was calculated by multiplying the inactive inhalation rate by the ratio of the rate of energy expenditure during active hours to the estimated BMR. This ratio is presented as F in Table 6-41. These data for active and inactive inhalation rates are also presented in Table 6-41. For children, inactive and active inhalation rates ranged from 2.35 to 5.95 m^3/day and from 6.35 to 13.09 m^3/day, respectively. For adult males (19 to 64 years old), the average inactive and active inhalation rates were approximately 10 and 19 m^3/day, respectively. Also, the average inactive and active inhalation rates for adult females (19 to 64 years old) were approximately 8 and 12 m^3/day, respectively.

Second Approach

Inhalation rates were calculated as the product of the BMR of the population cohorts, the ratio of total daily energy expenditure to daily BMR, H, and VQ. The BMR data obtained from the literature were statistically analyzed, and regression equations were developed to predict BMR from body weights of various age/gender cohorts. The statistical data used to develop the regression equations are presented in Table 6-42. The data obtained from the second approach are presented in Table 6-43. Inhalation rates for children (6 months - 10 years) ranged from 7.3 to 9.3 m^3/day for male and 5.6 to 8.6 m^3/day for female children; for older children (10 to 18 years), inhalation rates were 15 m^3/day for males and 12 m^3/day for females. Adult females (18 years and older) ranged from 9.9-11 m^3/day and adult males (18 years and older) ranged from 13-17 m^3/day. These rates are similar to the daily inhalation rates obtained using the first approach. Also, the inactive inhalation rates obtained from the first approach are lower than the inhalation rates obtained using the second approach. This may be attributed to the BMR multiplier employed in the equation of the second approach to calculate inhalation rates.

Third Approach

Inhalation rates were calculated by multiplying estimated energy expenditures associated with different levels of physical activity engaged in over the course of an average day by VQ and H for each age/gender cohort. The energy expenditure associated with each level of activity was estimated by multiplying BMRs of each activity level by the metabolic equivalent (MET) and by the time spent per day performing each activity for each age/gender population. The time-activity data used in this approach were obtained from a survey conducted by Sallis et al. (1985) (Layton, 1993). In that survey, the physical-activity categories and associated MET values used were sleep, MET=1; light-activity, MET=1.5; moderate activity, MET=4; hard activity, MET=6; and very hard activity, MET=10. The physical activities were based on recall by the test subject (Layton, 1993). The survey sample was 2,126 individuals (1,120 women and 1,006 men) ages 20-74 years that were randomly selected from four communities in California. The body weights were obtained from a study conducted by Najjar and Rowland (1987) which randomly sampled individuals from the U.S. population (Layton, 1993). Table 6-44 presents the inhalation rates (VE) in m^3/day and m^3/hr for adult males and females aged 20-74 years at five physical activity levels. The total daily inhalation rates ranged from 13-17 m^3/day for adult males and 11-15 m^3/day for adult females.

The rates for adult females were higher when compared with the other two approaches. Layton (1993) reported that the estimated inhalation rates obtained from the third approach were particularly sensitive to the MET value that represented the energy expenditures for light activities. Layton (1993) stated further that in the original time-activity survey (i.e., conducted by Sallis et al., 1985), time spent performing light activities was not presented. Therefore, the time spent at light activities was estimated by subtracting the total time spent at sleep, moderate, heavy, and very heavy activities from 24 hours (Layton, 1993). The range of inhalation rates for adult females were 9.6 to 11 m^3/day, 9.9 to 11 m^3/day, and 11 to 15 m^3/day, for the first, second, and third approach, respectively. The inhalation rates for adult males ranged from 13 to 16 m^3/day for the first approach, and 13 to 17 m^3/day for the second and third approaches.

Inhalation rates were also obtained for short-term exposures for various age/gender cohorts and five energy-expenditure categories (rest, sedentary, light, moderate, and heavy). BMRs were multiplied by the product of MET, H, and VQ. The data obtained for short-term exposures are presented in Table 6-45.

This study obtained similar results using two different approaches. The major strengths of the Layton (1993) study are that it obtains similar results using three different approaches to estimate inhalation rates in different age groups and that the populations are large, consisting of men, women, and children. Explanations for differences in results due to metabolic measurements, reported diet, or activity patterns are supported by observations reported by other investigators in other studies. Major limitations of this study are (1) the estimated activity pattern levels are somewhat subjective; (2) the explanation that activity pattern differences are responsible for the lower level obtained with the metabolic approach (25 %) compared to the activity pattern approach is not well supported by the data; and (3) different populations were used in each approach, which may have introduced error.

6.4.10 Linn et al., 1993 - Activity patterns in Ozone Exposed Construction Workers

Linn et al. (1993) - Activity patterns in Ozone Exposed Construction Workers - Linn et al. (1993) estimated the inhalation rates of 19 construction workers who perform heavy outdoor labor before and during a typical work shift. The workers (laborers, iron workers, and carpenters) were employed at a site on a hospital campus in suburban Los Angeles. The construction site included a new hospital building and a separate medical office complex. The study was conducted between mid-July and early November, 1991. During this period, ozone (O_3) levels were typically high. Initially, each subject was calibrated with a 25-minute exercise test that included slow walking, fast walking, jogging, lifting, and carrying. All calibration tests were conducted in the mornings. VR and HR were measured simultaneously during the test. The data were analyzed using least squares regression to derive an equation for predicting VR at a given HR. Following the calibration tests, each subject recorded the type of activities to be performed during their work shift (i.e., sitting/standing, walking, lifting/carrying, and "working at trade" - defined as tasks specific to the individual's job classification). Location, and self-estimated breathing rates ("slow" similar to slow walking, "medium" similar to fast walking, and "fast" similar to running) were also recorded in the diary. During work, an investigator recorded the diary information dictated by the subjects. HR was recorded minute by minute for each subject before work and during the entire work shift. Thus, VR ranges for each breathing rate and activity category were estimated from the HR recordings by employing the relationship between VR and HR obtained from the calibration tests.

A total of 182 hours of HR recordings were obtained during the survey from the 19 volunteers; 144 hours reflected actual working time according to the diary records. The lowest actual working hours recorded was 6.6 hours and the highest recorded for a complete work shift was 11.6 hours (Linn et al., 1993). Summary statistics for predicted VR distributions for all subjects, and for job or site defined subgroups are presented in Table 6-46. The data reflect all recordings before and during work, and at break times. For all subjects, the mean IR was 1.68 m^3/hr with a standard deviation of ±0.72 (Table

6-46). Also, for most subjects, the 1st and 99th percentiles of HR were outside of the calibration range. Therefore, corresponding IR percentiles were extrapolated using the calibration data (Linn et al., 1993).

The data presented in Table 6-47 represent distribution patterns of IR for each subject, total subjects, and job or site defined subgroups by self-estimated breathing rates (slow, medium, fast) or by type of job activity. All data include working and non-working hours. The mean inhalation rates for most individuals showed statistically significant increases with higher self-estimated breathing rates or with increasingly strenuous job activity (Linn et al., 1993). Inhalation rates were higher in hospital site workers when compared with office site workers (Table 6-47). In spite of their higher predicted VR workers at the hospital site reported a higher percentage of slow breathing time (31 percent) than workers at the office site (20 percent), and a lower percentage of fast breathing time, 3 percent and 5 percent, respectively (Linn et al., 1993). Therefore, individuals whose work was objectively heavier than average (from VR predictions) tended to describe their work as lighter than average (Linn et al., 1993). Linn et al. (1993) also concluded that during an O_3 pollution episode, construction workers should experience similar microenvironmental O_3 exposure concentrations as other healthy outdoor workers, but with approximately twice as high a VR. Therefore, the inhaled dose of O_3 should be almost two times higher for typical heavy-construction workers than for typical healthy adults performing less strenuous outdoor jobs.

Limitations associated with this study are its age and the small sample size. Another limitation of this study is that calibration data were not obtained at extreme conditions. Therefore, it was necessary to predict IR values that were outside the calibration range. This may introduce an unknown amount of uncertainty to the data set. Subjective self-estimated breathing rates may be another source of uncertainty in the inhalation rates estimated. An advantage is that this study provides empirical data useful in exposure assessments for a subpopulation thought to be the most highly exposed common occupational group (outdoor workers).

6.4.11 Rusconi et al., 1994 - Reference Values for Respiratory Rate in the First 3 Years of Life

Rusconi et al. (1994) examined a large number of infants and children in Milano, Italy in order to determine the reference values for respiratory rate in children aged 15 days to 3 years. A total of 618 infants and children (336 males and 282 females) who did not have respiratory infections or any severe disease were included in the study. Of the 618, a total of 309 were in good health and were observed in day care centers, while the remaining 309 were seen in hospitals or as outpatients.

Respiratory rates were recorded twice, 30 to 60 minutes apart, listening to breath sounds for 60 seconds with a stethoscope, when the child was awake and calm and when the child was sleeping quietly (sleep not associated with any spontaneous movement, including eye movements or vocalizations) (Table 6-48). The children were assessed for one year in order to determine the repeatability of the recordings, to compare respiratory rate counts obtained by stethoscope and by observation, and to construct reference percentile curves by age in a large number of subjects.

The authors plotted the differences between respiratory rate counts determined by stethoscope at 30- to 60-minute intervals against their mean count in waking and sleeping subjects. The standard deviation of the differences between the two counts was 2.5 and 1.7 breaths/minute, respectively, for waking and sleeping children. This standard deviation yielded 95% repeatability coefficients of 4.9 breaths/minute when the infants and children were awake and 3.3 breaths/minute when they were asleep.

In both waking and sleeping states, the respiratory rate counts determined by stethoscope were found to be higher than those obtained by observation. The mean difference was 2.6 and 1.8 breaths per minute, respectively, in waking and sleeping states. The mean respiratory rate counts were significantly higher in infants and children at all ages when awake and calm than when asleep. A decrease in respiratory rate with increasing age was seen in waking and sleeping infants and children. A scatter diagram of respiratory rate counts by age in waking and sleeping subjects showed that the pattern of respiratory rate decline with age was similar in both states, but it was much faster in the first few months of life. The authors constructed centile curves by first log-transforming the data and then applying a second degree polynormal curve, which allowed excellent fitting to observed data. Figures 6-1 and 6-2 show smoothed percentiles by age in waking and sleeping subjects, respectively. The variability of respiratory rate among subjects was higher in the first few months of life, which may be attributable to biological events that occur during these months, such as maturation of the neurologic control of breathing and changes in lung and chest wall compliance and lung volumes.

An advantage of this study is that it provides distribution data for respiratory rate for children from infancy (less than 2 months) to 36 months old. These data are not U.S. data; U.S. distributions were not available. Although, there is no reason to believe that the respiratory rates for Italian children would be different from that of U.S. children, this study only provided data for a narrow range of activities.

6.4.12 Price et al., 2003 - Modeling Interindividual Variation in Physiological Factors Used in PBPK Models of Humans

Price et al. (2003) developed a database of values for physiological parameters often used in physiologically-based pharmacokinetic models (PBPK). The database consisted of approximately 31,000 records containing information on volumes and masses of selected organs and tissues, blood flows for the organ and tissues, and total resting cardiac output and average inhalation rates. Records were created based on data from the NHANES III survey.

The study authors note that the database provides a source of data for human physiological parameters were the parameter values for an individual are correlated with one another and capture interindividual variation in populations of a specific gender, race, and age range. A computer program, Physiological Parameters for PBPK Modeling (PPPM or P^3M), which is publicly available (The Lifeline Group, 2007), was also developed to randomly retrieve records from the database for groups of individuals of specified age ranges, gender, and ethnicities. Price et al. (2003) recommends that output sets be used as inputs to Monte Carlo-based PBPK models of interindividual variation in dose.

6.3.13 Brochu et al., 2006b - Physiological Daily Inhalation Rates for Free-Living Pregnant and Lactating Adolescents and Women Aged 11 to 55 Years, Using Data from Doubly Labeled Water Measurements for Use in Health Risk Assessment

Physiological daily inhalation rates (PDIRs) were determined by Brochu et al. (2006b) for underweight, normal-weight, and overweight/obese pregnant and lactating females aged 11 to 55 years using published data on total daily energy expenditures, and energy costs for growth, pregnancy and lactation (breast-energy output and maternal milk-energy synthesis) in free-living females. These data were obtained using the doubly labeled water methodology (DWL) in which disappearance rates of predetermined doses of DLW (^2H_2O and $H_2{}^{18}O$) in urine from non-pregnant and non-lactating females (*n* = 357) and normal-weight males (*n* = 131) as well as saliva from gravid and breastfeeding females (*n* = 91) were monitored by gas-isotope-ratio mass spectrometry.

PDIRs were calculated for underweight, normal-weigth, and overweight/obese females aged 11 to 55 years in prepregnancy, at weeks 9, 22, and 36 during pregnancy, and weeks 6 and 27 postpartum. Weight groups were determined by BMI cutoffs settled by the IOM (1990) for prepregnant females. Underweight, normal-weight, and overweight/obese individuals were defined as those having BMIs lower than 19.8 kg/m^2, between 19.8 and 26 kg/m^2, and greater than 26 kg/m^2, respectively. Parameters used for breast-energy output and the extra energy cost for milk synthesis were 539.29 ± 106.26 kcal/day (IOM, 2002) and 107.86 ± 21.25 kcal/day, respectively. Monte Carlo simulations were necessary to integrate total daily energy requirements of non-pregnant and non-lactating females into energy costs and weight changes at the 9th, 22nd, and 36th week of pregnancy and at the 6th and 27th postpartum week. A total of 108 sets of 5,000 energetic data were run resulting in a simulation of 540,000 data, pertaining to 45,000 simulated subjects. Means, standard deviations, and percentiles of energetic values in kcal/day and kcal/kg-day for males and females were converted into PDIRs in m^3/day and m^3/kg-day by using the equation developed by Layton (1993).

Tables 6-49, 6-50, and 6-51 present the distribution of physiological daily inhalation rate percentiles in m^3/day for underweight, normal-weight, and overweight/obese females, respectively, during pregnancy and postpartum weeks. Tables 6-52, 6-53, and 6-54 present physiological daily inhalation rate percentiles in m^3/kg-day for the same categories. PDIRs for under-, normal-, and overweight/obese pregnant and lactating females were higher than those for males reported in Brochu et al. (2006a). In normal-weight subjects, inhalation rates are higher by 18 to 41% throughout pregnancy and 23 to 39% during postpartum weeks: actual values were higher in females by 1.13 to 2.01 m^3/day at the 9th week of pregnancy, 3.74 to 4.53 m^3/day at the 22nd week and 4.41 to 5.20 m^3/day at the 36th week, and by 4.43 to 5.30 m^3/day at the 6th postpartum week and 4.22 to 5.11 m^3/day at the 27th postpartum week. The highest 99th percentiles were found to be 0.622 m^3/kg-day in pregnant females and 0.647 m^3/kg-day in lactating females. By comparison, the highest 99th percentile value for individuals aged 2.6 months to 96 years was determined to be 0.725 m^3/kg-day (Brochu, *et al.* 2006a). The authors concluded that air quality criteria and standard calculations based on the latter value for non-carcinogenic toxic compounds should therefore be protective for virtually all pregnant and lactating females. Brochu et al. (2006b) also noted that the default assumption used by IRIS to derive human equivalent concentrations (HECs) (total respiratory tract surface of an adult human male of 54.3m^2 is exposed to a total daily air intake of 20 m^3) would underestimate exposures to pregnant or lactating females since approximately one pregnant or lactating female out of two is exposed to a total daily air intake of 20 m^3 up to the highest 99th percentile of 47.3 m^3.

6.5 REFERENCES FOR CHAPTER 6

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Table 6-4. Distribution Percentiles of Physiological Daily Inhalation Rates (m^3/day) for Free-living Normal-weight Males and Females Aged 2.6 months to 96 years

Age Group (years)	N	Body Weight[a] (kg) Mean ± SD	Physiological Daily Inhalation Rates[b] (m^3/day)								
			Mean ± SD	Percentile[c]							
				5th	10th	25th	50th	75th	90th	95th	99th
Males											
0.22 to <0.5	32	6.7 ± 1.0	3.38 ± 0.72	2.19	2.46	2.89	3.38	3.87	4.30	4.57	5.06
0.5 to <1	40	8.8 ± 1.1	4.22 ± 0.79	2.92	3.21	3.69	4.22	4.75	5.23	5.51	6.05
1 to <2	35	10.6 ± 1.1	5.12 ± 0.88	3.68	3.99	4.53	5.12	5.71	6.25	6.56	7.16
2 to <5	25	15.3 ± 3.4	7.60 ± 1.28	5.49	5.95	6.73	7.60	8.47	9.25	9.71	10.59
5 to <7	96	19.8 ± 2.1	8.64 ± 1.23	6.61	7.06	7.81	8.64	9.47	10.21	10.66	11.50
7 to <11	38	28.9 ± 5.6	10.59 ± 1.99	7.32	8.04	9.25	10.59	11.94	13.14	13.87	15.22
11 to <23	30	58.6 ± 13.9	17.23 ± 3.67	11.19	12.53	14.75	17.23	19.70	21.93	23.26	25.76
23 to <30	34	70.9 ± 6.5	17.48 ± 2.81	12.86	13.88	15.59	17.48	19.38	21.08	22.11	24.02
30 to <40	41	71.5 ± 6.8	16.88 ± 2.50	12.77	13.68	15.20	16.88	18.57	20.09	21.00	22.70
40 to <65	33	71.1 ± 7.2	16.24 ± 2.67	11.84	12.81	14.44	16.24	18.04	19.67	20.64	22.46
65 to ≤96	50	68.9 ± 6.7	12.96 ± 2.48	8.89	9.79	11.29	12.96	14.63	16.13	17.03	18.72
Females											
0.22 to <0.5	53	6.5 ± 0.9	3.26 ± 0.66	2.17	2.41	2.81	3.26	3.71	4.11	4.36	4.81
0.5 to <1	63	8.5 ± 1.0	3.96 ± 0.72	2.78	3.05	3.48	3.96	4.45	4.88	5.14	5.63
1 to <2	66	10.6 ± 1.3	4.78 ± 0.96	3.20	3.55	4.13	4.78	5.43	6.01	6.36	7.02
2 to <5	36	14.4 ± 3.0	7.06 ± 1.16	5.15	5.57	6.28	7.06	7.84	8.54	8.97	9.76
5 to <7	102	19.7 ± 2.3	8.22 ± 1.31	6.06	6.54	7.34	8.22	9.11	9.90	10.38	11.27
7 to <11	161	28.3 ± 4.4	9.84 ± 1.69	7.07	7.68	8.70	9.84	10.98	12.00	12.61	13.76
11 to <23	87	50.0 ± 8.9	13.28 ± 2.60	9.00	9.94	11.52	13.28	15.03	16.61	17.56	19.33
23 to <30	68	59.2 ± 6.6	13.67 ± 2.28	9.91	10.74	12.13	13.67	15.21	16.59	17.42	18.98
30 to <40	59	58.7 ± 5.9	13.68 ± 1.76	10.78	11.42	12.49	13.68	14.87	15.94	16.58	17.78
40 to <65	58	58.8 ± 5.1	12.31 ± 2.07	8.91	9.66	10.92	12.31	13.70	14.96	15.71	17.12
65 to ≤96	45	57.2 ± 7.3	9.80 ± 2.17	6.24	7.02	8.34	9.80	11.27	12.58	13.37	14.85

[a] Measured body weight. Normal-weight individuals defined according to the body mass index (BMI) cut-offs.
[b] Physiological daily inhalation rates were calculated using the following equation: (TDEE + ECG)*H*(V_E/VO_2)*10^{-3}, where H = 0.21 L of O_2/Kcal, V_E/VO_2 = 27 (Layton, 1993), TDEE = total daily energy expenditure (kcal/day) and ECG = stored daily energy cost for growth (kcal/day).
[c] Percentiles based on a normal distribution assumption for age groups.
N = Number of individuals.
SD = Standard deviation.

Source: Brochu et al., 2006a.

Table 6-5. Mean and 95th Percentile Inhalation Rate Values (m^3/day) for Free-living Normal-weight Males, Females, and Males and Females Combined

Age Group[a, c]	N	Mean[b]	95th, b
Males			
1 to <3 months	32	3.38	4.57
3 to <6 months	32	3.38	4.57
6 to <12 months	40	4.22	5.51
Birth to <1 year	72	3.85	5.09
1 to <2 years	35	5.12	6.56
2 to <3	25	7.60	9.71
3 to <6	25	7.60	9.71
6 to <11	38	10.59	13.87
11 to <16	30	17.23	23.26
16 to <21	30	17.23	23.26
21 to <31	64	17.36	22.65
31 to <41	41	16.88	21.00
41 to <51	33	16.24	20.64
51 to <61	33	16.24	20.64
61 to <71	83	14.26	18.47
71 to <81	50	12.96	17.03
≥81	50	12.96	17.03
Females			
1 to <3 months	53	3.26	4.36
3 to <6 months	53	3.26	4.36
6 to <12 months	63	3.96	5.14
Birth to <1 year	116	3.64	4.78
1 to <2 years	66	4.78	6.36
2 to <3	36	7.06	8.97
3 to <6	36	7.06	8.97
6 to <11	161	9.84	12.61
11 to <16	87	13.28	17.56
16 to <21	87	13.28	17.56
21 to <31	155	13.45	17.50
31 to <41	59	13.68	16.58
41 to <51	58	12.31	15.71
51 to <61	58	12.31	15.71
61 to <71	103	11.21	14.69
71 to <81	45	9.80	13.37
≥81	45	9.80	13.37

Table 6-5. Mean and 95th Percentile Inhalation Rate Values (m^3/day) for Free-living Normal-weight Males, Females, and Males and Females Combined (continued)

Age Group[a, c]	N	Mean[b]	95[th, b]
Males and Females Combined			
1 to <3 months	85	3.31	4.44
3 to <6 months	85	3.31	4.44
6 to <12 months	103	4.06	5.28
Birth to <1 year	188	3.72	4.90
1 to <2 years	101	4.90	6.43
2 to <3	61	7.28	9.27
3 to <6	61	7.28	9.27
6 to <11	199	9.98	12.85
11 to <16	117	14.29	19.02
16 to <21	117	14.29	19.02
21 to <31	219	14.59	19.00
31 to <41	100	14.99	18.39
41 to <51	91	13.74	17.50
51 to <61	91	13.74	17.50
61 to <71	186	12.57	16.37
71 to <81	95	11.46	15.30
≥81	95	11.46	15.30

[a] No other age groups from Table 6-4 (Brochu et al., 2006a) fit into the U.S. EPA age groupings.
[b] Weighted (where possible) average of reported study means and 95[th] percentiles.
[c] See Table 6-55 for concordance with EPA age groupings.

N = Number of individuals.

Source: Brochu et al., 2006a.

Table 6-6. Distribution Percentiles of Physiological Daily Inhalation Rates (m^3/day) for Free-living Normal-weight and Overweight/obese Males and Females Aged 4 to 96 years

Age Group (years)	N	Body Weight[a] (kg) Mean ± SD	Physiological Daily Inhalation Rates[b] (m^3/day)								
			Mean ± SD	Percentile[c]							
				5th	10th	25th	50th	75th	90th	95th	99th
Males - Normal-weight											
4 to <5.1	77	19.0 ± 1.9	7.90 ± 0.97	6.31	6.66	7.25	7.90	8.56	9.15	9.50	10.16
5.1 to <9.1	52	22.6 ± 3.5	9.14 ± 1.44	6.77	7.29	8.17	9.14	10.11	10.99	11.51	12.49
9.1 to <18.1	36	41.4 ± 12.1	13.69 ± 3.95	7.19	8.63	11.02	13.69	16.35	18.75	20.19	22.88
18.1 to <40.1	98	71.3 ± 6.1	17.41± 2.70	12.96	13.94	15.58	17.41	19.23	20.87	21.85	23.69
40.1 to <70.1	34	70.0 ± 7.8	15.60 ± 2.89	10.85	11.89	13.65	15.60	17.54	19.30	20.34	22.31
70.1 to ≤96	38	68.9 ± 6.8	12.69 ± 2.33	8.85	9.70	11.11	12.69	14.26	15.68	16.53	18.12
Males - Overweight/obese											
4 to <5.1	54	26.5 ± 4.9	9.59 ± 1.26	7.52	7.98	8.74	9.59	10.44	11.21	11.66	12.52
5.1 to <9.1	40	32.5 ± 9.2	10.88 ± 2.49	6.78	7.69	9.20	10.88	12.56	14.07	14.98	16.68
9.1 to <18.1	33	55.8 ± 10.8	14.52 ± 1.98	11.25	11.98	13.18	14.52	15.85	17.06	17.78	19.13
18.1 to <40.1	52	98.1 ± 25.2	20.39 ± 3.62	14.44	15.75	17.95	20.39	22.83	25.03	26.35	28.81
40.1 to <70.1	81	93.2 ± 14.9	17.96 ± 3.71	11.85	13.20	15.45	17.96	20.46	22.71	24.06	26.59
70.1 to ≤96	32	82.3 ± 10.3	14.23 ± 2.94	9.40	10.46	12.25	14.23	16.21	18.00	19.06	21.07
Females - Normal-weight											
4 to <5.1	82	18.7 ± 2.0	7.41 ± 0.91	5.92	6.25	6.80	7.41	8.02	8.57	8.90	9.52
5.1 to <9.1	151	25.5 ± 4.1	9.39 ± 1.62	6.72	7.31	8.30	9.39	10.48	11.47	12.05	13.16
9.1 to <18.1	124	42.7 ± 11.1	12.04 ± 2.86	7.34	8.38	10.11	12.04	13.97	15.70	16.74	18.68
18.1 to <40.1	135	59.1 ± 6.3	13.73 ± 2.01	10.41	11.15	12.37	13.73	15.09	16.31	17.04	18.41
40.1 to <70.1	79	59.1 ± 5.3	11.93 ± 2.16	8.38	9.16	10.47	11.93	13.38	14.69	15.48	16.95
70.1 to ≤96	24	54.8 ± 7.5	8.87 ± 1.79	5.92	6.57	7.66	8.87	10.07	11.16	11.81	13.03
Females - Overweight/obese											
4 to <5.1	56	26.1 ± 5.5	8.70 ± 1.13	6.84	7.26	7.94	8.70	9.47	10.15	10.56	11.33
5.1 to <9.1	68	34.6 ± 9.9	10.55 ± 2.23	6.88	7.69	9.05	10.55	12.06	13.41	14.22	15.75
9.1 to <18.1	68	59.2 ± 12.8	14.27 ± 2.70	9.83	10.81	12.45	14.27	16.09	17.73	18.71	20.55
18.1 to <40.1	76	84.4 ± 16.3	15.66 ± 2.11	12.18	12.95	14.23	15.66	17.08	18.36	19.13	20.57
40.1 to <70.1	91	81.7 ± 17.2	13.01 ± 2.82	8.37	9.40	11.11	13.01	14.91	16.62	17.64	19.56
70.1 to ≤96	28	69.0 ± 7.8	10.00 ± 1.78	7.07	7.71	8.80	10.00	11.20	12.28	12.93	14.14

a Measured body weight. Normal-weight and overweight/obese males defined according to the body mass index (BMI) cut-offs.
b Physiological daily inhalation rates were calculated using the following equation: (TDEE + ECG)*H*(V_E/VO_2)*10^{-3}, where H = 0.21 L of O_2/Kcal, V_E/VO_2 = 27 (Layton, 1993), TDEE = total daily energy expenditure (kcal/day) and ECG = stored daily energy cost for growth (kcal/day).
c Percentiles based on a normal distribution assumption for age groups.
N = Number of individuals.
SD = Standard deviation.

Source: Brochu et al., 2006a.

Table 6-7. Distribution Percentiles of Physiological Daily Inhalation Rates per Unit of Body Weight (m^3/kg-day) for Free-living Normal-weight Males and Females Aged 2.6 months to 96 years

Age Group (years)	Physiological Daily Inhalation Rates[a] (m^3/kg-day)								
	Mean ± SD	Percentile[b]							
		5th	10th	25th	50th	75th	90th	95th	99th
Males									
0.22 to <0.5	0.51 ± 0.09	0.36	0.39	0.45	0.51	0.57	0.63	0.66	0.73
0.5 to <1	0.48 ± 0.07	0.36	0.39	0.43	0.48	0.53	0.57	0.60	0.64
1 to <2	0.48 ± 0.06	0.38	0.41	0.44	0.48	0.52	0.56	0.58	0.62
2 to <5	0.44 ± 0.04	0.38	0.39	0.42	0.44	0.47	0.50	0.51	0.54
5 to <7	0.42 ± 0.05	0.34	0.35	0.38	0.42	0.45	0.48	0.49	0.52
7 to <11	0.37 ± 0.06	0.27	0.29	0.33	0.37	0.41	0.45	0.47	0.52
11 to <23	0.30 ± 0.05	0.22	0.24	0.27	0.30	0.33	0.36	0.38	0.41
23 to <30	0.25 ± 0.04	0.18	0.20	0.22	0.25	0.27	0.30	0.31	0.34
30 to <40	0.24 ± 0.03	0.18	0.19	0.21	0.24	0.26	0.28	0.29	0.32
40 to <65	0.23 ± 0.04	0.16	0.18	0.20	0.23	0.26	0.28	0.30	0.33
65 to ≤96	0.19 ± 0.03	0.14	0.15	0.17	0.19	0.21	0.23	0.24	0.26
Females									
0.22 to <0.5	0.50 ± 0.09	0.35	0.39	0.44	0.50	0.57	0.62	0.66	0.72
0.5 to <1	0.46 ± 0.06	0.36	0.38	0.42	0.46	0.51	0.55	0.57	0.61
1 to <2	0.45 ± 0.08	0.33	0.35	0.40	0.45	0.50	0.55	0.58	0.63
2 to <5	0.44 ± 0.07	0.32	0.35	0.39	0.44	0.49	0.53	0.56	0.61
5 to <7	0.40 ± 0.05	0.32	0.33	0.36	0.40	0.43	0.46	0.47	0.51
7 to <11	0.35 ± 0.06	0.25	0.27	0.31	0.35	0.39	0.43	0.45	0.50
11 to <23	0.27 ± 0.05	0.19	0.21	0.24	0.27	0.30	0.33	0.35	0.38
23 to <30	0.23 ± 0.04	0.16	0.18	0.20	0.23	0.26	0.29	0.30	0.33
30 to <40	0.24 ± 0.04	0.18	0.19	0.21	0.24	0.26	0.28	0.29	0.32
40 to <65	0.21 ± 0.04	0.15	0.16	0.19	0.21	0.24	0.26	0.27	0.30
65 to ≤96	0.17 ± 0.04	0.11	0.13	0.15	0.17	0.20	0.22	0.23	0.26

[a] Physiological daily inhalation rates were calculated using the following equation: (TDEE + ECG)*H*(V_E/VO_2)*10^{-3}, where H = 0.21 L of O_2/Kcal, V_E/VO_2 = 27 (Layton, 1993), TDEE = total daily energy expenditure (kcal/day) and ECG = stored daily energy cost for growth (kcal/day).

[b] Percentiles based on a normal distribution assumption for age groups.

SD = Standard deviation.

Source: Brochu et al., 2006a.

Table 6-8. Distribution Percentiles of Physiological Daily Inhalation Rates (m^3/kg-day) for Free-living Normal-weight and Overweight/obese Males and Females Aged 4 to 96 years

Age Group (years)	Physiological Daily Inhalation Rates[a] (m^3/kg-day)								
	Mean ± SD	Percentile[b]							
		5th	10th	25th	50th	75th	90th	95th	99th
Males - Normal-weight									
4 to <5.1	0.42 ± 0.04	0.35	0.36	0.39	0.42	0.45	0.47	0.49	0.52
5.1 to <9.1	0.41 ± 0.06	0.31	0.34	0.37	0.41	0.45	0.48	0.50	0.54
9.1 to <18.1	0.33 ± 0.05	0.26	0.27	0.30	0.33	0.37	0.40	0.41	0.45
18.1 to <40.1	0.25± 0.04	0.18	0.20	0.22	0.25	0.27	0.29	0.31	0.33
40.1 to <70.1	0.22 ± 0.04	0.16	0.17	0.20	0.22	0.25	0.28	0.29	0.32
70.1 to ≤96	0.19 ± 0.03	0.13	0.14	0.16	0.19	0.21	0.23	0.24	0.26
Males - Overweight/obese									
4 to <5.1	0.37 ± 0.04	0.30	0.31	0.34	0.37	0.40	0.42	0.44	0.47
5.1 to <9.1	0.35 ± 0.08	0.22	0.25	0.29	0.35	0.40	0.45	0.47	0.53
9.1 to <18.1	0.27 ± 0.04	0.20	0.22	0.24	0.27	0.29	0.32	0.33	0.36
18.1 to <40.1	0.21 ± 0.04	0.15	0.17	0.19	0.21	0.22	0.26	0.27	0.30
40.1 to <70.1	0.19 ± 0.03	0.14	0.15	0.17	0.19	0.22	0.24	0.25	0.28
70.1 to ≤96	0.17 ± 0.03	0.12	0.13	0.15	0.17	0.19	0.21	0.22	0.24
Females - Normal-weight									
4 to <5.1	0.40 ± 0.05	0.32	0.34	0.37	0.40	0.43	0.46	0.48	0.51
5.1 to <9.1	0.37 ± 0.06	0.27	0.29	0.33	0.37	0.41	0.45	0.47	0.52
9.1 to <18.1	0.29 ± 0.06	0.20	0.22	0.25	0.29	0.33	0.36	0.38	0.42
18.1 to <40.1	0.23 ± 0.04	0.17	0.19	0.21	0.23	0.26	0.28	0. 30	0.32
40.1 to <70.1	0.20 ± 0.04	0.14	0.15	0.18	0.20	0.23	0.25	0.27	0.29
70.1 to ≤96	0.16 ± 0.04	0.11	0.12	0.14	0.16	0.19	0.20	0.22	0.24
Females - Overweight/obese									
4 to <5.1	0.34 ± 0.04	0.27	0.28	0.31	0.34	0.37	0.40	0.41	0.44
5.1 to <9.1	0.32 ± 0.07	0.21	0.23	0.27	0.32	0.36	0.40	0.43	0.47
9.1 to <18.1	0.25 ± 0.05	0.17	0.18	0.21	0.25	0.28	0.31	0.33	0.36
18.1 to <40.1	0.19 ± 0.03	0.14	0.15	0.17	0.19	0.21	0.22	0.23	0.25
40.1 to <70.1	0.16 ± 0.03	0.11	0.12	0.14	0.16	0.18	0.20	0.21	0.23
70.1 to ≤96	0.15 ± 0.03	0.10	0.11	0.13	0.15	0.16	0.18	0.19	0.21

a Physiological daily inhalation rates were calculated using the following equation: (TDEE + ECG)*H*(V_E/VO_2)*10^{-3}, where H = 0.21 L of O_2/Kcal, V_E/VO_2 = 27 (Layton, 1993), TDEE = total daily energy expenditure (kcal/day) and ECG = stored daily energy cost for growth (kcal/day).

b Percentiles based on a normal distribution assumption for age groups.

SD = Standard deviation.

Source: Brochu et al., 2006a.

Table 6-9. Physiological Daily Inhalation Rates for Newborns Aged 1 Month or Less				
Age Group	N	Body Weight (kg) Mean ± SD	Physiological Daily Inhalation Rates[e] Mean ± SD	
			(m^3/day)	(m^3/kg-day)
21 days (3 weeks)	13[a,c]	1.2 ± 0.2	0.85 ± 0.17[f]	0.74 ± 0.09[f]
32 days (~ 1 month)	10[b,d]	4.7 ± 0.7	2.45 ± 0.59[g]	0.53 ± 0.10[g]
33 days (~ 1 month)	10[a,d]	4.8 ± 0.3	2.99 ± 0.47[g]	0.62 ±0.09[g]

[a] Formula-fed infants.
[b] Breast-fed infants.
[c] Healthy infants with very low birth weight.
[d] Infants evaluated as being clinically healthy and neither underweight or overweight.
[e] Physiological daily inhalation rates were calculated using the following equation: (TDEE + ECG)*H*(V_E/VO_2)*10^{-3}, where H = 0.21 L of O_2/Kcal, V_E/VO_2 = 27 (Layton, 1993), TDEE = total daily energy expenditure (kcal/day) and ECG = stored daily energy cost for growth (kcal/day).
[f] TDEEs based on nutritional balance measurements during 3-day periods.
[g] TDEEs based on ^2H_2O and $H_2{}^{18}O$ disappearance rates from urine.

N = Number of individuals.
SD = Standard deviation.

Source: Brochu et al., 2006a.

Table 6-10. Descriptive Statistics for Daily Average Inhalation Rate in Males, by Age Category[a]

Age Group	N	Daily Average Inhalation Rate, Unadjusted for Body Weight (m^3/day)								
		Mean	Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th	
Birth to <1 year	419	8.76	4.78	5.70	7.16	8.70	10.43	11.92	12.69	17.05
1 to < 2 years	308	13.49	9.73	10.41	11.65	13.12	15.02	17.02	17.90	24.24
2 to < 3 years	261	13.23	9.45	10.21	11.43	13.19	14.50	16.27	17.71	28.17
3 to <6 years	540	12.64	10.43	10.87	11.39	12.59	13.64	14.63	15.41	19.53
6 to <11 years	940	13.42	10.08	10.68	11.74	13.09	14.73	16.56	17.73	24.97
11 to <16 years	1,337	15.32	11.40	12.11	13.28	14.79	16.82	19.54	21.21	28.54
16 to <21 years	1,241	17.21	12.60	13.41	14.49	16.63	19.17	21.93	23.37	39.21
21 to <31 years	701	18.82	12.69	13.56	15.49	18.17	21.24	24.57	27.13	43.42
31 to <41 years	728	20.29	14.00	14.96	16.96	19.83	23.01	26.77	28.90	40.72
41 to <51 years	753	20.94	14.66	15.54	17.50	20.59	23.89	26.71	28.37	45.98
51 to <61 years	627	20.91	14.99	16.07	17.60	20.40	23.16	27.01	29.09	38.17
61 to <71 years	678	17.94	13.91	14.50	15.88	17.60	19.54	21.77	23.50	28.09
71 to <81 years	496	16.34	13.10	13.61	14.66	16.23	17.57	19.43	20.42	24.52
81 years and older	255	15.15	11.95	12.57	13.82	14.90	16.32	18.01	18.69	22.64
Age Group	N	Daily Average Inhalation Rate, Adjusted for Body Weight (m^3/day-kg)								
		Mean	Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th	
Birth to <1 year	419	1.09	0.91	0.94	1.00	1.09	1.16	1.26	1.29	1.48
1 to < 2 years	308	1.19	0.96	1.02	1.09	1.17	1.26	1.37	1.48	1.73
2 to < 3 years	261	0.95	0.78	0.82	0.87	0.94	1.01	1.09	1.13	1.36
3 to <6 years	540	0.70	0.52	0.56	0.61	0.69	0.78	0.87	0.92	1.08
6 to <11 years	940	0.44	0.32	0.34	0.38	0.43	0.50	0.55	0.58	0.80
11 to <16 years	1,337	0.29	0.21	0.22	0.25	0.28	0.32	0.36	0.38	0.51
16 to <21 years	1,241	0.23	0.17	0.18	0.20	0.23	0.25	0.28	0.30	0.39
21 to <31 years	701	0.23	0.16	0.17	0.19	0.22	0.26	0.30	0.32	0.51
31 to <41 years	728	0.24	0.16	0.18	0.20	0.23	0.27	0.31	0.34	0.46
41 to <51 years	753	0.24	0.17	0.18	0.20	0.23	0.28	0.32	0.34	0.47
51 to <61 years	627	0.24	0.16	0.18	0.20	0.24	0.27	0.30	0.34	0.43
61 to <71 years	678	0.21	0.17	0.18	0.19	0.20	0.22	0.24	0.25	0.32
71 to <81 years	496	0.20	0.17	0.18	0.19	0.20	0.21	0.23	0.24	0.31
81 years and older	255	0.20	0.17	0.18	0.19	0.20	0.22	0.23	0.25	0.28

[a] Individual daily averages are weighted by their 4-year sampling weights as assigned within NHANES 1999-2002 when calculating the statistics in this table. Inhalation rate was estimated using a multiple linear regression model.

N = Number of individuals.

BW = Body weight.

Source: U.S. EPA, 2009.

Table 6-11. Descriptive Statistics for Daily Average Inhalation Rate in Females, by Age Category[a]

Age Group	N	Daily Average Inhalation Rate, Unadjusted for Body Weight (m^3/day)								
		Mean	Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th	
Birth to <1 year	415	8.52	4.84	5.49	6.84	8.41	9.78	11.65	12.66	26.25
1 year	245	13.31	9.09	10.12	11.25	13.03	14.64	17.45	18.62	24.77
2 years	255	12.74	8.91	10.07	11.38	12.60	13.95	15.58	16.36	23.01
3 to <6 years	543	12.17	9.88	10.38	11.20	12.02	13.02	14.03	14.93	19.74
6 to <11 years	894	12.41	9.99	10.35	11.02	11.95	13.42	15.13	16.34	20.82
11 to <16 years	1,451	13.44	10.47	11.12	12.04	13.08	14.54	16.26	17.41	26.58
16 to <21 years	1,182	13.59	9.86	10.61	11.78	13.20	15.02	17.12	18.29	30.11
21 to <31 years	1,023	14.57	10.15	10.67	11.94	14.10	16.62	19.32	21.14	30.23
31 to <41 years	869	14.98	11.07	11.81	13.02	14.69	16.32	18.50	20.45	28.28
41 to <51 years	763	16.20	12.11	12.57	14.16	15.88	17.96	19.92	21.34	35.88
51 to <61 years	622	16.19	12.33	12.96	14.07	15.90	17.80	19.93	21.21	25.70
61 to <71 years	700	12.99	10.40	10.77	11.78	12.92	13.91	15.39	16.14	20.33
71 to <81 years	470	12.04	9.89	10.20	10.89	11.82	12.96	14.11	15.19	17.70
81 years and older	306	11.15	9.19	9.46	10.14	11.02	11.87	12.84	13.94	16.93
		Daily Average Inhalation Rate, Adjusted for Body Weight (m^3/day-kg)								
Age Group	N	Mean	Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th	
Birth to <1 year	415	1.14	0.91	0.97	1.04	1.13	1.24	1.33	1.38	1.60
1 year	245	1.20	0.97	1.01	1.10	1.18	1.30	1.41	1.46	1.73
2 years	255	0.95	0.82	0.84	0.89	0.96	1.01	1.07	1.10	1.23
3 to <6 years	543	0.69	0.48	0.54	0.60	0.68	0.77	0.88	0.92	1.12
6 to <11 years	894	0.43	0.28	0.31	0.36	0.43	0.49	0.55	0.58	0.75
11 to <16 years	1,451	0.25	0.19	0.20	0.22	0.24	0.28	0.31	0.34	0.47
16 to <21 years	1,182	0.21	0.16	0.17	0.19	0.21	0.23	0.27	0.28	0.36
21 to <31 years	1,023	0.21	0.14	0.16	0.18	0.20	0.23	0.26	0.28	0.40
31 to <41 years	869	0.21	0.14	0.15	0.18	0.20	0.23	0.27	0.30	0.43
41 to <51 years	763	0.22	0.15	0.16	0.19	0.21	0.25	0.28	0.31	0.41
51 to <61 years	622	0.22	0.15	0.16	0.18	0.21	0.24	0.28	0.30	0.40
61 to <71 years	700	0.18	0.14	0.15	0.16	0.17	0.19	0.21	0.22	0.27
71 to <81 years	470	0.18	0.14	0.15	0.16	0.17	0.19	0.21	0.23	0.34
81 years and older	306	0.18	0.14	0.15	0.16	0.18	0.20	0.21	0.22	0.28

[a] Individual daily averages are weighted by their 4-year sampling weights as assigned within NHANES 1999-2002 when calculating the statistics in this table. Inhalation rate was estimated using a multiple linear regression model.

N = Number of individuals.

Source: U.S. EPA, 2009.

Table 6-12. Mean and 95th Percentile Inhalation Rate Values (m^3/day) for Males, Females and Males and Females Combined

Age Group	N	Mean	95th
Males			
Birth to <1 year	419	8.76	12.69
1 to <2 years	308	13.49	17.90
2 to <3 years	261	13.23	17.71
3 to <6 years	540	12.64	15.41
6 to <11 years	940	13.42	17.73
11 to <16 years	1,337	15.32	21.21
16 to <21 years	1,241	17.21	23.37
21 to <31 years	701	18.82	27.13
31 to <41 years	728	20.29	28.90
41 to <51 years	753	20.94	28.37
51 to <61 years	627	20.91	29.09
61 to <71 years	678	17.94	23.50
71 to <81 years	496	16.34	20.42
81 years and older	255	15.15	18.69
Females			
Birth to <1 year	415	8.52	12.66
1 to <2 years	245	13.31	18.62
2 to <3 years	255	12.74	16.36
3 to <6 years	543	12.17	14.93
6 to <11 years	894	12.41	16.34
11 to <16 years	1,451	13.44	17.41
16 to <21 years	1,182	13.59	18.29
21 to <31 years	1,023	14.57	21.14
31 to <41 years	869	14.98	20.45
41 to <51 years	763	16.20	21.34
51 to <61 years	622	16.19	21.21
61 to <71 years	700	12.99	16.14
71 to <81 years	470	12.04	15.19
81 years and older	306	11.15	13.94

Table 6-12. Mean and 95th Percentile Inhalation Rate Values (m^3/day) for Males, Females and Males and Females Combined (continued)

Age Group	N	Mean	95^{th}
Males and Females Combined[a]			
Birth to <1 year	834	8.64	12.67
1 to <2 years	553	13.41	18.22
2 to <3 years	516	12.99	17.04
3 to <6 years	1,083	12.40	15.17
6 to <11 years	1,834	12.93	17.05
11 to <16 years	2,788	14.34	19.23
16 to <21 years	2,423	15.44	20.89
21 to <31 years	1,724	16.30	23.57
31 to <41 years	1,597	17.40	24.30
41 to <51 years	1,516	18.55	24.83
51 to <61 years	1,249	18.56	25.17
61 to <71 years	1,378	15.43	19.76
71 to <81 years	966	14.25	17.88
81 years and older	561	12.97	16.10

[a] Weighted average of reported male and female means and 95^{th} percentiles.
N = Number of individuals.

Source: U.S. EPA, 2009.

Table 6-13. Descriptive Statistics for Average Ventilation Rate[a] While Performing Activities Within the Specified Activity Category, for Males by Age Category

Age Group	N	Average Ventilation Rate (m^3/min), Unadjusted for Body Weight									Average Ventilation Rate (m^3/min-kg), Adjusted for Body Weight								
		Mean	Percentiles							Maximum	Mean	Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th			5th	10th	25th	50th	75th	90th	95th	
Sleep or nap (Activity ID = 14500)																			
Birth to <1 year	419	3.08E-03	1.66E-03	1.91E-03	2.45E-03	3.00E-03	3.68E-03	4.35E-03	4.77E-03	7.19E-03	3.85E-04	2.81E-04	3.01E-04	3.37E-04	3.80E-04	4.27E-04	4.65E-04	5.03E-04	6.66E-04
1 year	308	4.50E-03	3.11-03	3.27E-03	3.78E-03	4.35E-03	4.95E-03	5.90E-03	6.44E-03	1.00E-02	3.95E-04	2.95E-04	3.13E-04	3.45E-04	3.84E-04	4.41E-04	4.91E-04	5.24E-04	6.26E-04
2 years	261	4.61E-03	3.01E-03	3.36E-03	3.94E-03	4.49E-03	5.21E-03	6.05E-03	6.73E-03	8.96E-03	3.30E-04	2.48E-04	2.60E-04	2.89E-04	3.26E-04	3.62E-04	4.05E-04	4.42E-04	5.38E-04
3 to < 6 years	540	4.36E-03	3.06E-03	3.30E-03	3.76E-03	4.29E-03	4.86E-03	5.54E-03	5.92E-03	7.67E-03	2.43E-04	1.60E-04	1.74E-04	1.98E-04	2.37E-04	2.79E-04	3.14E-04	3.50E-04	4.84E-04
6 to < 11 years	940	4.61E-03	3.14E-03	3.39E-03	3.83E-03	4.46E-03	5.21E-03	6.01E-03	6.54E-03	9.94E-03	1.51E-04	1.02E-04	1.09E-04	1.25E-04	1.48E-04	1.74E-04	2.00E-04	2.15E-04	3.02E-04
11 to < 16 years	1,337	5.26E-03	3.53E-03	3.78E-03	4.34E-03	5.06E-03	5.91E-03	6.94E-03	7.81E-03	1.15E-02	9.80E-05	6.70E-05	7.20E-05	8.10E-05	9.40E-05	1.10E-04	1.29E-04	1.41E-04	2.08E-04
16 to < 21 years	1,241	5.31E-03	3.55E-03	3.85E-03	4.35E-03	5.15E-03	6.09E-03	6.92E-03	7.60E-03	1.28E-02	7.10E-05	4.70E-05	5.20E-05	6.10E-05	6.90E-05	8.00E-05	9.00E-05	9.80E-05	1.47E-04
21 to <31 years	701	4.73E-03	3.16E-03	3.35E-03	3.84E-03	4.56E-03	5.42E-03	6.26E-03	6.91E-03	1.12E-02	5.80E-05	3.80E-05	4.20E-05	4.80E-05	5.60E-05	6.60E-05	7.60E-05	8.30E-05	1.32E-04
31 to <41 years	728	5.16E-03	3.37E-03	3.62E-03	4.23E-03	5.01E-03	5.84E-03	6.81E-03	7.46E-03	1.09E-02	6.10E-05	3.80E-05	4.30E-05	5.00E-05	6.00E-05	7.00E-05	8.00E-05	8.60E-05	1.27E-04
41 to <51 years	753	5.65E-03	3.74E-03	4.09E-03	4.73E-03	5.53E-03	6.47E-03	7.41E-03	7.84E-03	1.08E-02	6.50E-05	4.40E-05	4.70E-05	5.40E-05	6.40E-05	7.40E-05	8.60E-05	9.20E-05	1.37E-04
51 to <61 years	627	5.78E-03	3.96E-03	4.20E-03	4.78E-03	5.57E-03	6.54E-03	7.74E-03	8.26E-03	1.18E-02	6.60E-05	4.50E-05	4.90E-05	5.50E-05	6.40E-05	7.60E-05	8.60E-05	9.30E-05	1.41E-04
61 to <71 years	678	5.98E-03	4.36E-03	4.57E-03	5.13E-03	5.81E-03	6.68E-03	7.45E-03	7.93E-03	1.23E-02	6.90E-05	5.10E-05	5.40E-05	6.00E-05	6.80E-05	7.60E-05	8.60E-05	9.30E-05	1.17E-04
71 to <81 years	496	6.07E-03	4.26E-03	4.55E-03	5.17E-03	6.00E-03	6.77E-03	7.65E-03	8.33E-03	1.05E-02	7.50E-05	5.50E-05	5.80E-05	6.40E-05	7.30E-05	8.30E-05	9.30E-05	9.90E-05	1.25E-04
81 years and older	255	5.97E-03	4.20E-03	4.49E-03	5.23E-03	5.90E-03	6.68E-03	7.36E-03	7.76E-03	1.00E-02	8.00E-05	6.10E-05	6.40E-05	7.10E-05	7.80E-05	8.80E-05	9.70E-05	1.11E-04	1.22E-04
Sedentary & Passive Activities (METS ≤ 1.5 – Includes Sleep or Nap)																			
Birth to <1 year	419	3.18E-03	1.74E-03	1.99E-03	2.50E-03	3.10E-03	3.80E-03	4.40E-03	4.88E-03	7.09E-03	3.97E-04	3.03E-04	3.17E-04	3.51E-04	3.91E-04	4.37E-04	4.70E-04	4.98E-04	6.57E-04
1 year	308	4.62E-03	3.17E-03	3.50E-03	3.91E-03	4.49E-03	5.03E-03	5.95E-03	6.44E-03	9.91E-03	4.06E-04	3.21E-04	3.31E-04	3.63E-04	3.97E-04	4.48E-04	4.88E-04	5.25E-04	6.19E-04
2 years	261	4.79E-03	3.25E-03	3.66E-03	4.10E-03	4.69E-03	5.35E-03	6.05E-03	6.71E-03	9.09E-03	3.43E-04	2.74E-04	2.86E-04	3.09E-04	3.40E-04	3.69E-04	4.05E-04	4.46E-04	5.10E-04
3 to < 6 years	540	4.58E-03	3.47E-03	3.63E-03	4.07E-03	4.56E-03	5.03E-03	5.58E-03	5.82E-03	7.60E-03	2.55E-04	1.78E-04	1.93E-04	2.15E-04	2.50E-04	2.88E-04	3.27E-04	3.46E-04	4.54E-04
6 to < 11 years	940	4.87E-03	3.55E-03	3.78E-03	4.18E-03	4.72E-03	5.40E-03	6.03E-03	6.58E-03	9.47E-03	1.60E-04	1.13E-04	1.18E-04	1.35E-04	1.57E-04	1.80E-04	2.09E-04	2.18E-04	2.89E-04
11 to < 16 years	1,337	5.64E-03	4.03E-03	4.30E-03	4.79E-03	5.43E-03	6.26E-03	7.20E-03	7.87E-03	1.11E-02	1.05E-04	7.70E-05	8.00E-05	8.80E-05	1.01E-04	1.18E-04	1.35E-04	1.42E-04	1.95E-04
16 to < 21 years	1,241	5.76E-03	4.17E-03	4.42E-03	4.93E-03	5.60E-03	6.43E-03	7.15E-03	7.76E-03	1.35E-02	7.70E-05	5.50E-05	6.00E-05	6.80E-05	7.60E-05	8.50E-05	9.50E-05	1.02E-04	1.32E-04
21 to <31 years	701	5.11 E-03	3.76 E-03	3.99 E-03	4.33 E-03	5.00 E-03	5.64E-03	6.42E-03	6.98E-03	1.03E-02	6.20E-05	4.70E-05	4.90E-05	5.50E-05	6.10E-05	6.90E-05	7.70E-05	8.20E-05	1.18E-04
31 to <41 years	728	5.57 E-03	3.99 E-03	4.42 E-03	4.86 E-03	5.45 E-03	6.17E-03	6.99E-03	7.43E-03	1.00E-02	6.60E-05	4.60E-05	5.00E-05	5.70E-05	6.50E-05	7.40E-05	8.20E-05	8.60E-05	1.19E-04
41 to <51 years	753	6.11 E-03	4.65 E-03	4.92 E-03	5.37 E-03	6.02 E-03	6.65E-03	7.46E-03	7.77E-03	1.05E-02	7.10E-05	5.40E-05	5.70E-05	6.20E-05	7.00E-05	7.80E-05	8.60E-05	9.10E-05	1.29E-04
51 to <61 years	627	6.27 E-03	4.68 E-03	5.06 E-03	5.50 E-03	6.16 E-03	6.89E-03	7.60E-03	8.14E-03	1.04E-02	7.20E-05	5.50E-05	5.80E-05	6.30E-05	7.10E-05	7.90E-05	8.80E-05	9.20E-05	1.35E-04
61 to <71 years	678	6.54 E-03	5.02 E-03	5.31 E-03	5.85 E-03	6.47 E-03	7.12E-03	7.87E-03	8.22E-03	1.09E-02	7.60E-05	6.10E-05	6.40E-05	6.90E-05	7.50E-05	8.10E-05	8.90E-05	9.40E-05	1.11E-04
71 to <81 years	496	6.65 E-03	5.26 E-03	5.55 E-03	5.96 E-03	6.59 E-03	7.18E-03	7.81E-03	8.26E-03	9.9 E-03	8.20E-05	6.70E-05	7.00E-05	7.50E-05	8.10E-05	8.80E-05	9.40E-05	9.80E-05	1.15E-04
81 years and older	255	6.44 E-03	5.09 E-03	5.37 E-03	5.82 E-03	6.43 E-03	7.01E-03	7.57E-03	7.90E-03	9.13 E-03	8.60E-05	7.10E-05	7.50E-05	8.00E-05	8.60E-05	9.20E-05	9.90E-05	1.06E-04	1.15E-04
Light Intensity Activities (1.5 < METS ≤ 3.0)																			
Birth to <1 year	419	7.94E-03	4.15E-03	5.06E-03	6.16E-03	7.95E-03	9.57E-03	1.08E-02	1.19E-02	1.55E-02	9.88E-04	7.86E-04	8.30E-04	8.97E-04	9.72E-04	1.07E-03	1.17E-03	1.20E-03	1.44E-03
1 year	308	1.16E-02	8.66E-03	8.99E-03	9.89E-03	1.14E-02	1.29E-02	1.44E-02	1.58E-02	2.11E-02	1.02E-03	8.36E-04	8.59E-04	9.18E-04	1.01E-03	1.10E-03	1.22E-03	1.30E-03	1.49E-03
2 years	261	1.17E-02	8.52E-03	9.14E-03	9.96E-03	1.14E-02	1.30E-02	1.47E-02	1.53E-02	1.90E-02	8.37E-04	6.83E-04	7.16E-04	7.61E-04	8.26E-04	8.87E-04	9.95E-04	1.03E-03	1.18E-03
3 to < 6 years	540	1.14E-02	9.20E-03	9.55E-03	1.02E-02	1.11E-02	1.23E-02	1.34E-02	1.40E-02	1.97E-02	6.33E-04	4.41E-04	4.80E-04	5.44E-04	6.26E-04	7.11E-04	7.94E-04	8.71E-04	1.08E-03
6 to < 11 years	940	1.16E-02	8.95E-03	9.33E-03	1.02E-02	1.13E-02	1.28E-02	1.46E-02	1.56E-02	2.18E-02	3.84E-04	2.67E-04	2.86E-04	3.24E-04	3.77E-04	4.37E-04	4.93E-04	5.29E-04	7.09E-04
11 to < 16 years	1,337	1.32E-02	9.78E-03	1.03E-02	1.13E-02	1.28E-02	1.47E-02	1.64E-02	1.87E-02	2.69E-02	2.46E-04	1.76E-04	1.87E-04	2.09E-04	2.38E-04	2.82E-04	3.11E-04	3.32E-04	4.42E-04
16 to < 21 years	1,241	1.34E-02	1.00E-02	1.05E-02	1.15E-02	1.30E-02	1.50E-02	1.70E-02	1.80E-02	2.91E-02	1.79E-04	1.37E-04	1.44E-04	1.56E-04	1.78E-04	1.99E-04	2.18E-04	2.30E-04	3.32E-04
21 to <31 years	701	1.30 E-02	9.68	1.02 E-02	1.13 E-02	1.24 E-02	1.40E-02	1.65E-02	1.77E-02	2.72 E-02	1.58E-04	1.24E-04	1.30E-04	1.42E-04	1.54E-04	1.71E-04	1.90E-04	2.07E-04	2.90E-04
31 to <41 years	728	1.36 E-02	1.06 E-02	1.11 E-02	1.20 E-02	1.33 E-02	1.48E-02	1.65E-02	1.81E-02	2.55 E-02	1.61E-04	1.18E-04	1.28E-04	1.40E-04	1.57E-04	1.77E-04	1.98E-04	2.09E-04	2.81E-04
41 to <51 years	753	1.44 E-02	1.12 E-02	1.18 E-02	1.30 E-02	1.41 E-02	1.56E-02	1.74E-02	1.83E-02	2.30 E-02	1.66E-04	1.26E-04	1.33E-04	1.47E-04	1.64E-04	1.81E-04	2.00E-04	2.14E-04	3.32E-04
51 to <61 years	627	1.46 E-02	1.11 E-02	1.16 E-02	1.30 E-02	1.44 E-02	1.59E-02	1.80E-02	1.94E-02	2.55 E-02	1.67E-04	1.27E-04	1.35E-04	1.48E-04	1.65E-04	1.83E-04	2.01E-04	2.16E-04	2.87E-04
61 to <71 years	678	1.41 E-02	1.11 E-02	1.17 E-02	1.27 E-02	1.39 E-02	1.54E-02	1.69E-02	1.80E-02	2.05 E-02	1.64E-04	1.37E-04	1.41E-04	1.50E-04	1.63E-04	1.75E-04	1.87E-04	1.95E-04	2.69E-04
71 to <81 years	496	1.39 E-02	1.12 E-02	1.17 E-02	1.27 E-02	1.37 E-02	1.50E-02	1.62E-02	1.69E-02	2.00 E-02	1.71E-04	1.43E-04	1.48E-04	1.58E-04	1.70E-04	1.82E-04	1.95E-04	2.03E-04	2.63E-04
81 years and older	255	1.38 E-02	1.10 E-02	1.17 E-02	1.26 E-02	1.38 E-02	1.47E-02	1.60E-02	1.67E-02	2.07 E-02	1.85E-04	1.52E-04	1.60E-04	1.68E-04	1.83E-04	1.98E-04	2.12E-04	2.24E-04	2.47E-04

Table 6-13. Descriptive Statistics for Average Ventilation Rate[a] While Performing Activities Within the Specified Activity Category, for Males by Age Category (continued)

Age Group	N	Average Ventilation Rate (m^3/min), Unadjusted for Body Weight									Average Ventilation Rate (m^3/min-kg), Adjusted for Body Weight								
		Mean	Percentiles							Maximum	Mean	Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th			5th	10th	25th	50th	75th	90th	95th	
Moderate Intensity Activities (3.0 < METS ≤ 6.0)																			
Birth to <1 year	419	1.45E-02	7.41E-03	8.81E-03	1.15E-02	1.44E-02	1.70E-02	2.01E-02	2.25E-02	3.05E-02	1.80E-03	1.40E-03	1.49E-03	1.62E-03	1.78E-03	1.94E-03	2.18E-03	2.28E-03	3.01E-03
1 year	308	2.14E-02	1.45E-02	1.59E-02	1.80E-02	2.06E-02	2.41E-02	2.69E-02	2.89E-02	3.99E-02	1.88E-03	1.41E-03	1.50E-03	1.65E-03	1.82E-03	2.02E-03	2.34E-03	2.53E-03	3.23E-03
2 years	261	2.15E-02	1.54E-02	1.67E-02	1.84E-02	2.08E-02	2.41E-02	2.69E-02	2.97E-02	5.09E-02	1.55E-03	1.21E-03	1.28E-03	1.40E-03	1.54E-03	1.66E-03	1.84E-03	2.02E-03	2.29E-03
3 to < 6 years	540	2.10E-02	1.63E-02	1.72E-02	1.87E-02	2.06E-02	2.29E-02	2.56E-02	2.71E-02	3.49E-02	1.17E-03	8.05E-04	8.83E-04	9.99E-04	1.12E-03	1.31E-03	1.56E-03	1.68E-03	2.10E-03
6 to < 11 years	940	2.23E-02	1.64E-02	1.72E-02	1.93E-02	2.16E-02	2.50E-02	2.76E-02	2.95E-02	4.34E-02	7.36E-04	5.03E-04	5.45E-04	6.18E-04	7.14E-04	8.34E-04	9.58E-04	1.04E-03	1.43E-03
11 to < 16 years	1,337	2.64E-02	1.93E-02	2.05E-02	2.26E-02	2.54E-02	2.92E-02	3.38E-02	3.69E-02	5.50E-02	4.91E-04	3.59E-04	3.75E-04	4.18E-04	4.73E-04	5.52E-04	6.35E-04	6.81E-04	1.06E-03
16 to < 21 years	1,241	2.90E-02	2.03E-02	2.17E-02	2.45E-02	2.80E-02	3.17E-02	3.82E-02	4.21E-02	6.74E-02	3.87E-04	2.81E-04	2.96E-04	3.34E-04	3.80E-04	4.31E-04	4.86E-04	5.18E-04	7.11E-04
21 to <31 years	701	2.92E-02	1.97E-02	2.10E-02	2.42E-02	2.79E-02	3.30E-02	3.88E-02	4.31E-02	7.17E-02	3.57E-04	2.43E-04	2.64E-04	2.96E-04	3.45E-04	4.04E-04	4.68E-04	5.09E-04	8.24E-04
31 to <41 years	728	3.03E-02	2.14E-02	2.27E-02	2.51E-02	2.91E-02	3.41E-02	3.96E-02	4.35E-02	5.77E-02	3.57E-04	2.42E-04	2.65E-04	3.00E-04	3.44E-04	4.00E-04	4.71E-04	5.21E-04	7.62E-04
41 to <51 years	753	3.16E-02	2.26E-02	2.44E-02	2.72E-02	3.04E-02	3.51E-02	4.03E-02	4.50E-02	6.34E-02	3.66E-04	2.55E-04	2.72E-04	3.10E-04	3.53E-04	4.08E-04	4.69E-04	5.18E-04	7.16E-04
51 to <61 years	627	3.27E-02	2.24E-02	2.40E-02	2.80E-02	3.14E-02	3.70E-02	4.17E-02	4.58E-02	7.05E-02	3.76E-04	2.59E-04	2.78E-04	3.13E-04	3.66E-04	4.31E-04	4.82E-04	5.49E-04	7.64E-04
61 to <71 years	678	2.98E-02	2.25E-02	2.40E-02	2.61E-02	2.92E-02	3.23E-02	3.69E-02	4.00E-02	5.23E-02	3.44E-04	2.72E-04	2.84E-04	3.13E-04	3.42E-04	3.71E-04	3.99E-04	4.24E-04	5.73E-04
71 to <81 years	496	2.93E-02	2.28E-02	2.39E-02	2.61E-02	2.88E-02	3.20E-02	3.57E-02	3.73E-02	4.49E-02	3.60E-04	2.91E-04	3.06E-04	3.28E-04	3.59E-04	3.88E-04	4.18E-04	4.36E-04	5.49E-04
81 years and older	255	2.85E-02	2.25E-02	2.34E-02	2.55E-02	2.82E-02	3.10E-02	3.34E-02	3.55E-02	4.11E-02	3.83E-04	3.12E-04	3.23E-04	3.47E-04	3.77E-04	4.16E-04	4.47E-04	4.70E-04	5.29E-04
High Intensity (METS > 6.0)																			
Birth to <1 year	183	2.75E-02	1.51E-02	1.73E-02	2.06E-02	2.78E-02	3.25E-02	3.84E-02	4.22E-02	5.79E-02	3.48E-03	2.70E-03	2.93E-03	3.10E-03	3.46E-03	3.81E-03	4.14E-03	4.32E-03	5.08E-03
1 year	164	4.03E-02	2.83E-02	3.17E-02	3.47E-02	3.98E-02	4.43E-02	5.16E-02	5.59E-02	6.07E-02	3.52E-03	2.52E-03	2.89E-03	3.22E-03	3.57E-03	3.91E-03	4.11E-03	4.34E-03	4.86E-03
2 years	162	4.05E-02	2.82E-02	2.97E-02	3.45E-02	4.06E-02	4.62E-02	5.19E-02	5.51E-02	9.20E-02	2.89E-03	2.17E-03	2.34E-03	2.58E-03	2.87E-03	3.20E-03	3.43E-03	3.54E-03	4.30E-03
3 to < 6 years	263	3.90E-02	2.95E-02	3.14E-02	3.40E-02	3.78E-02	4.32E-02	4.89E-02	5.22E-02	6.62E-02	2.17E-03	1.55E-03	1.66E-03	1.81E-03	2.11E-03	2.50E-03	2.73E-03	2.98E-03	3.62E-03
6 to < 11 years	637	4.36E-02	3.07E-02	3.28E-02	3.58E-02	4.19E-02	4.95E-02	5.66E-02	6.24E-02	8.99E-02	1.41E-03	9.36E-04	1.03E-03	1.19E-03	1.38E-03	1.59E-03	1.83E-03	1.93E-03	2.68E-03
11 to < 16 years	1,111	5.08E-02	3.43E-02	3.68E-02	4.15E-02	4.91E-02	5.74E-02	6.63E-02	7.29E-02	1.23E-01	9.50E-04	6.35E-04	6.96E-04	7.90E-04	9.09E-04	1.09E-03	1.27E-03	1.36E-03	1.98E-03
16 to < 21 years	968	5.32E-02	3.60E-02	3.83E-02	4.35E-02	5.05E-02	5.93E-02	7.15E-02	8.30E-02	1.30E-01	7.11E-04	4.75E-04	5.27E-04	5.99E-04	6.91E-04	8.02E-04	9.17E-04	9.97E-04	1.94E-03
21 to <31 years	546	5.39E-02	3.36E-02	3.80E-02	4.48E-02	5.15E-02	6.16E-02	7.24E-02	8.21E-02	1.12E-01	6.60E-04	4.49E-04	4.74E-04	5.43E-04	6.44E-04	7.49E-04	8.55E-04	9.73E-04	1.27E-03
31 to <41 years	567	5.43E-02	3.78E-02	4.04E-02	4.54E-02	5.21E-02	6.12E-02	7.14E-02	7.74E-02	1.04E-01	6.44E-04	4.42E-04	4.70E-04	5.33E-04	6.25E-04	7.31E-04	8.53E-04	9.30E-04	1.23E-03
41 to <51 years	487	5.73E-02	3.83E-02	4.25E-02	4.83E-02	5.52E-02	6.45E-02	7.56E-02	8.44E-02	1.10E-01	6.55E-04	4.38E-04	4.85E-04	5.48E-04	6.25E-04	7.41E-04	8.56E-04	9.44E-04	1.77E-03
51 to <61 years	452	5.84E-02	3.90E-02	4.16E-02	4.87E-02	5.59E-02	6.60E-02	7.86E-02	8.65E-02	1.41E-01	6.75E-04	4.46E-04	4.81E-04	5.47E-04	6.43E-04	7.67E-04	9.13E-04	1.02E-03	1.32E-03
61 to <71 years	490	5.41E-02	3.63E-02	3.95E-02	4.52E-02	5.24E-02	6.08E-02	7.20E-02	7.52E-02	1.02E-01	6.24E-04	4.41E-04	4.70E-04	5.31E-04	6.12E-04	7.03E-04	7.88E-04	8.55E-04	1.08E-03
71 to <81 years	343	5.25E-02	3.70E-02	3.95E-02	4.41E-02	5.00E-02	5.90E-02	6.76E-02	7.65E-02	9.73E-02	6.46E-04	4.66E-04	5.02E-04	5.53E-04	6.26E-04	7.16E-04	8.49E-04	9.10E-04	1.04E-03
81 years and older	168	5.33E-02	3.54E-02	3.92E-02	4.55E-02	5.09E-02	6.12E-02	6.96E-02	7.71E-02	9.68E-02	7.16E-04	5.05E-04	5.44E-04	6.02E-04	7.00E-04	8.05E-04	9.42E-04	9.91E-04	1.35E-03

[a] An individual's ventilation rate for the given activity category equals the weighted average of the individual's activity-specific ventilation rates for activities falling within the category, estimated using a multiple linear regression model, with weights corresponding to the number of minutes spent performing the activity. Numbers in these two columns represent averages, calculated across individuals in the specified age category, of these weighted averages. These are weighted averages, with the weights corresponding to the 4-year sampling weights assigned within NHANES 1999-2002.

N = Number of individuals.

MET = Metabolic equivalent.

Source: U.S. EPA, 2009.

Table 6-14. Descriptive Statistics for Average Ventilation Rate[a] While Performing Activities Within the Specified Activity Category, for Females by Age Category

Age Group	N	Average Ventilation Rate (m^3/min), Unadjusted for Body Weight									Average Ventilation Rate (m^3/min-kg), Adjusted for Body Weight								
		Mean	Percentiles							Maximum	Mean	Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th			5th	10th	25th	50th	75th	90th	95th	
Sleep or nap (Activity ID = 14500)																			
Birth to <1 year	415	2.92E-03	1.54E-03	1.72E-03	2.27E-03	2.88E-03	3.50E-03	4.04E-03	4.40E-03	8.69E-03	3.91E-04	2.80E-04	3.01E-04	3.35E-04	3.86E-04	4.34E-04	4.79E-04	5.17E-04	7.39E-04
1 year	245	4.59E-03	3.02E-03	3.28E-03	3.76E-03	4.56E-03	5.32E-03	5.96E-03	6.37E-03	9.59E-03	4.14E-04	3.15E-04	3.29E-04	3.61E-04	4.05E-04	4.64E-04	5.21E-04	5.36E-04	6.61E-04
2 years	255	4.56E-03	3.00E-03	3.30E-03	3.97E-03	4.52E-03	5.21E-03	5.76E-03	6.15E-03	9.48E-03	3.42E-04	2.58E-04	2.71E-04	2.93E-04	3.33E-04	3.91E-04	4.25E-04	4.53E-04	4.94E-04
3 to < 6 years	543	4.18E-03	2.90E-03	3.20E-03	3.62E-03	4.10E-03	4.71E-03	5.22E-03	5.73E-03	7.38E-03	2.38E-04	1.45E-04	1.63E-04	1.95E-04	2.33E-04	2.75E-04	3.20E-04	3.53E-04	5.19E-04
6 to < 11 years	894	4.36E-03	2.97E-03	3.17E-03	3.69E-03	4.24E-03	4.93E-03	5.67E-03	6.08E-03	8.42E-03	1.51E-04	8.90E-05	9.70E-05	1.20E-04	1.46E-04	1.76E-04	2.11E-04	2.29E-04	2.97E-04
11 to < 16 years	1,451	4.81E-03	3.34E-03	3.57E-03	3.99E-03	4.66E-03	5.39E-03	6.39E-03	6.99E-03	9.39E-03	9.00E-05	5.90E-05	6.50E-05	7.50E-05	8.70E-05	1.02E-04	1.18E-04	1.30E-04	1.76E-04
16 to < 21 years	1,182	4.40E-03	2.78E-03	2.96E-03	3.58E-03	4.26E-03	5.05E-03	5.89E-03	6.63E-03	1.23E-02	6.90E-05	4.40E-05	4.70E-05	5.70E-05	6.70E-05	8.00E-05	9.30E-05	1.02E-04	1.52E-04
21 to <31 years	1,023	3.89E-03	2.54E-03	2.74E-03	3.13E-03	3.68E-03	4.44E-03	5.36E-03	6.01E-03	9.58E-03	5.50E-05	3.50E-05	3.80E-05	4.50E-05	5.40E-05	6.50E-05	7.40E-05	8.20E-05	9.80E-05
31 to <41 years	869	4.00E-03	2.66E-03	2.86E-03	3.31E-03	3.89E-03	4.54E-03	5.28E-03	5.77E-03	8.10E-03	5.60E-05	3.40E-05	3.70E-05	4.50E-05	5.40E-05	6.50E-05	7.60E-05	8.20E-05	1.15E-04
41 to <51 years	763	4.40E-03	3.00E-03	3.23E-03	3.69E-03	4.25E-03	4.95E-03	5.66E-03	6.25E-03	8.97E-03	6.00E-05	3.90E-05	4.10E-05	4.80E-05	5.70E-05	7.00E-05	8.40E-05	9.00E-05	1.14E-04
51 to <61 years	622	4.56E-03	3.12E-03	3.30E-03	3.72E-03	4.41E-03	5.19E-03	6.07E-03	6.63E-03	8.96E-03	6.10E-05	3.90E-05	4.20E-05	5.00E-05	5.90E-05	7.10E-05	8.30E-05	8.80E-05	1.35E-04
61 to <71 years	700	4.47E-03	3.22E-03	3.35E-03	3.78E-03	4.38E-03	4.99E-03	5.72E-03	6.37E-03	9.57E-03	6.10E-05	4.30E-05	4.60E-05	5.20E-05	5.90E-05	6.70E-05	7.60E-05	8.10E-05	1.01E-04
71 to <81 years	470	4.52E-03	3.31E-03	3.47E-03	3.89E-03	4.40E-03	5.11E-03	5.67E-03	6.06E-03	7.35E-03	6.60E-05	4.70E-05	5.10E-05	5.60E-05	6.40E-05	7.40E-05	8.40E-05	9.00E-05	1.25E-04
81 years and older	306	4.49E-03	3.17E-03	3.49E-03	3.82E-03	4.39E-03	4.91E-03	5.61E-03	6.16E-03	8.27E-03	7.20E-05	5.10E-05	5.60E-05	6.30E-05	7.00E-05	7.90E-05	9.10E-05	9.60E-05	1.15E-04
Sedentary & Passive Activities (METS ≤ 1.5 – Includes Sleep or Nap)																			
Birth to <1 year	415	3.00E-03	1.60E-03	1.80E-03	2.32E-03	2.97E-03	3.58E-03	4.11E-03	4.44E-03	9.59E-03	4.02E-04	2.97E-04	3.16E-04	3.52E-04	3.96E-04	4.46E-04	4.82E-04	5.19E-04	7.19E-04
1 year	245	4.71E-03	3.26E-03	3.44E-03	3.98E-03	4.73E-03	5.30E-03	5.95E-03	6.63E-03	9.50E-03	4.25E-04	3.35E-04	3.48E-04	3.76E-04	4.18E-04	4.69E-04	5.12E-04	5.43E-04	6.42E-04
2 years	255	4.73E-03	3.34E-03	3.53E-03	4.19E-03	4.67E-03	5.25E-03	5.75E-03	6.22E-03	9.42E-03	3.55E-04	2.85E-04	2.96E-04	3.20E-04	3.48E-04	3.91E-04	4.20E-04	4.42E-04	4.85E-04
3 to < 6 years	543	4.40E-03	3.31E-03	3.49E-03	3.95E-03	4.34E-03	4.84E-03	5.29E-03	5.73E-03	7.08E-03	2.51E-04	1.64E-04	1.79E-04	2.11E-04	2.48E-04	2.84E-04	3.28E-04	3.58E-04	4.89E-04
6 to < 11 years	894	4.64E-03	3.41E-03	3.67E-03	4.04E-03	4.51E-03	5.06E-03	5.88E-03	6.28E-03	8.31E-03	1.60E-04	9.90E-05	1.10E-04	1.31E-04	1.57E-04	1.85E-04	2.12E-04	2.34E-04	2.93E-04
11 to < 16 years	1,451	5.21E-03	3.90E-03	4.16E-03	4.53E-03	5.09E-03	5.68E-03	6.53E-03	7.06E-03	9.07E-03	9.70E-05	7.10E-05	7.50E-05	8.30E-05	9.50E-05	1.09E-04	1.23E-04	1.33E-04	1.74E-04
16 to < 21 years	1,182	4.76E-03	3.26E-03	3.56E-03	4.03E-03	4.69E-03	5.32E-03	6.05E-03	6.60E-03	1.18E-02	7.50E-05	5.30E-05	5.70E-05	6.30E-05	7.40E-05	8.50E-05	9.60E-05	1.04E-04	1.41E-04
21 to <31 years	1,023	4.19E-03	3.04E-03	3.19E-03	3.55E-03	4.00E-03	4.63E-03	5.38E-03	6.02E-03	9.22E-03	6.00E-05	4.30E-05	4.50E-05	5.10E-05	5.90E-05	6.70E-05	7.50E-05	8.00E-05	9.90E-05
31 to <41 years	869	4.33E-03	3.22E-03	3.45E-03	3.77E-03	4.24E-03	4.80E-03	5.33E-03	5.79E-03	7.70E-03	6.00E-05	4.00E-05	4.20E-05	5.10E-05	5.90E-05	6.90E-05	7.80E-05	8.30E-05	1.05E-04
41 to <51 years	763	4.75E-03	3.60E-03	3.82E-03	4.18E-03	4.65E-03	5.19E-03	5.74E-03	6.26E-03	8.70E-03	6.50E-05	4.40E-05	4.80E-05	5.50E-05	6.30E-05	7.30E-05	8.30E-05	9.10E-05	1.14E-04
51 to <61 years	622	4.96E-03	3.78E-03	4.00E-03	4.36E-03	4.87E-03	5.44E-03	6.06E-03	6.44E-03	8.30E-03	6.70E-05	4.60E-05	5.10E-05	5.70E-05	6.50E-05	7.60E-05	8.30E-05	9.00E-05	1.18E-04
61 to <71 years	700	4.89E-03	3.81E-03	4.02E-03	4.34E-03	4.81E-03	5.30E-03	5.86E-03	6.29E-03	8.18E-03	6.60E-05	5.20E-05	5.40E-05	5.90E-05	6.60E-05	7.20E-05	7.80E-05	8.40E-05	1.04E-04
71 to <81 years	470	4.95E-03	4.07E-03	4.13E-03	4.41E-03	4.89E-03	5.42E-03	5.89E-03	6.15E-03	7.59E-03	7.20E-05	5.50E-05	6.00E-05	6.50E-05	7.10E-05	7.80E-05	8.80E-05	9.20E-05	1.48E-04
81 years and older	306	4.89E-03	3.93E-03	4.10E-03	4.39E-03	4.79E-03	5.25E-03	5.71E-03	6.12E-03	7.46E-03	7.80E-05	6.30E-05	6.50E-05	7.00E-05	7.70E-05	8.60E-05	9.30E-05	9.60E-05	1.12E-04
Light Intensity Activities (1.5 < METS ≤ 3.0)																			
Birth to <1 year	415	7.32E-03	3.79E-03	4.63E-03	5.73E-03	7.19E-03	8.73E-03	9.82E-03	1.08E-02	1.70E-02	9.78E-04	7.91E-04	8.17E-04	8.80E-04	9.62E-04	1.05E-03	1.18E-03	1.23E-03	1.65E-03
1 year	245	1.16E-02	8.59E-03	8.80E-03	1.00E-02	1.12E-02	1.29E-02	1.52E-02	1.58E-02	2.02E-02	1.05E-03	8.45E-04	8.68E-04	9.49E-04	1.04E-03	1.14E-03	1.25E-03	1.27E-03	1.64E-03
2 years	255	1.20E-02	8.74E-03	9.40E-03	1.03E-02	1.17E-02	1.32E-02	1.56E-02	1.63E-02	2.36E-02	8.97E-04	7.30E-04	7.63E-04	8.19E-04	8.93E-04	9.64E-04	1.04E-03	1.10E-03	1.26E-03
3 to < 6 years	543	1.09E-02	8.83E-03	9.04E-03	9.87E-03	1.07E-02	1.17E-02	1.29E-02	1.38E-02	1.64E-02	6.19E-04	4.48E-04	4.84E-04	5.37E-04	5.99E-04	6.98E-04	7.83E-04	8.28E-04	1.02E-03
6 to < 11 years	894	1.11E-02	8.51E-03	9.02E-03	9.79E-03	1.08E-02	1.20E-02	1.35E-02	1.47E-02	2.22E-02	3.82E-04	2.52E-04	2.70E-04	3.15E-04	3.76E-04	4.42E-04	5.03E-04	5.39E-04	7.10E-04
11 to < 16 years	1,451	1.20E-02	9.40E-03	9.73E-03	1.06E-02	1.18E-02	1.31E-02	1.47E-02	1.58E-02	2.21E-02	2.25E-04	1.63E-04	1.74E-04	1.96E-04	2.17E-04	2.49E-04	2.84E-04	3.05E-04	3.96E-04
16 to < 21 years	1,182	1.11E-02	8.31E-03	8.73E-03	9.64E-03	1.08E-02	1.23E-02	1.38E-02	1.49E-02	2.14E-02	1.74E-04	1.29E-04	1.38E-04	1.54E-04	1.73E-04	1.93E-04	2.13E-04	2.24E-04	2.86E-04
21 to <31 years	1,023	1.06E-02	7.75E-03	8.24E-03	9.05E-03	1.02E-02	1.17E-02	1.34E-02	1.43E-02	2.15E-02	1.49E-04	1.16E-04	1.23E-04	1.34E-04	1.49E-04	1.63E-04	1.78E-04	1.90E-04	2.27E-04
31 to <41 years	869	1.11E-02	8.84E-03	9.30E-03	9.96E-03	1.09E-02	1.19E-02	1.31E-02	1.39E-02	1.74E-02	1.54E-04	1.07E-04	1.15E-04	1.33E-04	1.54E-04	1.76E-04	1.92E-04	2.02E-04	2.67E-04
41 to <51 years	763	1.18E-02	9.64E-03	1.00E-02	1.07E-02	1.16E-02	1.27E-02	1.39E-02	1.45E-02	1.77E-02	1.61E-04	1.14E-04	1.23E-04	1.38E-04	1.58E-04	1.82E-04	2.03E-04	2.16E-04	2.83E-04
51 to <61 years	622	1.20E-02	9.76E-03	1.02E-02	1.09E-02	1.18E-02	1.30E-02	1.42E-02	1.49E-02	1.79E-02	1.61E-04	1.20E-04	1.27E-04	1.41E-04	1.58E-04	1.80E-04	1.99E-04	2.10E-04	2.65E-04
61 to <71 years	700	1.08E-02	8.87E-03	9.28E-03	9.85E-03	1.06E-02	1.17E-02	1.26E-02	1.32E-02	1.74E-02	1.47E-04	1.17E-04	1.22E-04	1.32E-04	1.45E-04	1.61E-04	1.73E-04	1.82E-04	2.44E-04
71 to <81 years	470	1.08E-02	8.84E-03	9.23E-03	9.94E-03	1.07E-02	1.17E-02	1.25E-02	1.30E-02	1.76E-02	1.58E-04	1.24E-04	1.30E-04	1.43E-04	1.56E-04	1.69E-04	1.88E-04	2.02E-04	2.77E-04
81 years and older	306	1.04E-02	8.69E-03	8.84E-03	9.36E-03	1.03E-02	1.14E-02	1.21E-02	1.26E-02	1.61E-02	1.67E-04	1.31E-04	1.38E-04	1.50E-04	1.64E-04	1.82E-04	1.97E-04	2.08E-04	2.34E-04

Table 6-14. Descriptive Statistics for Average Ventilation Rate[a] While Performing Activities Within the Specified Activity Category, for Females by Age Category (continued)

Age Group	N	Average Ventilation Rate (m^3/min), Unadjusted for Body Weight									Average Ventilation Rate (m^3/min-kg), Adjusted for Body Weight								
		Mean	Percentiles							Maximum	Mean	Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th			5th	10th	25th	50th	75th	90th	95th	
Moderate Intensity Activities (3.0 < METS ≤ 6.0)																			
Birth to <1 year	415	1.40E-02	7.91E-03	9.00E-03	1.12E-02	1.35E-02	1.63E-02	1.94E-02	2.23E-02	4.09E-02	1.87E-03	1.47E-03	1.52E-03	1.67E-03	1.85E-03	2.01E-03	2.25E-03	2.40E-03	2.83E-03
1 year	245	2.10E-02	1.56E-02	1.63E-02	1.79E-02	2.01E-02	2.35E-02	2.71E-02	2.93E-02	3.45E-02	1.90E-03	1.52E-03	1.62E-03	1.73E-03	1.87E-03	2.02E-03	2.24E-03	2.37E-03	3.24E-03
2 years	255	2.13E-02	1.42E-02	1.56E-02	1.82E-02	2.15E-02	2.39E-02	2.76E-02	2.88E-02	3.76E-02	1.60E-03	1.27E-03	1.31E-03	1.44E-03	1.58E-03	1.75E-03	1.92E-03	2.02E-03	2.59E-03
3 to < 6 years	543	2.00E-02	1.53E-02	1.63E-02	1.78E-02	1.98E-02	2.16E-02	2.38E-02	2.59E-02	3.29E-02	1.14E-03	7.92E-04	8.53E-04	9.64E-04	1.11E-03	1.31E-03	1.45E-03	1.56E-03	1.93E-03
6 to < 11 years	894	2.10E-02	1.60E-02	1.68E-02	1.85E-02	2.04E-02	2.30E-02	2.61E-02	2.81E-02	4.31E-02	7.23E-04	4.62E-04	5.12E-04	5.98E-04	7.15E-04	8.38E-04	9.42E-04	1.01E-03	1.37E-03
11 to < 16 years	1,451	2.36E-02	1.82E-02	1.95E-02	2.08E-02	2.30E-02	2.54E-02	2.84E-02	3.14E-02	4.24E-02	4.41E-04	3.17E-04	3.38E-04	3.80E-04	4.31E-04	4.92E-04	5.51E-04	6.11E-04	9.86E-04
16 to < 21 years	1,182	2.32E-02	1.66E-02	1.76E-02	1.96E-02	2.24E-02	2.61E-02	3.03E-02	3.20E-02	5.25E-02	3.65E-04	2.67E-04	2.82E-04	3.10E-04	3.51E-04	4.07E-04	4.63E-04	4.94E-04	6.50E-04
21 to <31 years	1,023	2.29E-02	1.56E-02	1.67E-02	1.90E-02	2.19E-02	2.60E-02	3.00E-02	3.28E-02	5.42E-02	3.25E-04	2.35E-04	2.45E-04	2.81E-04	3.16E-04	3.60E-04	4.16E-04	4.52E-04	6.57E-04
31 to <41 years	869	2.27E-02	1.69E-02	1.76E-02	1.95E-02	2.20E-02	2.48E-02	2.89E-02	3.11E-02	4.73E-02	3.16E-04	2.13E-04	2.31E-04	2.68E-04	3.04E-04	3.50E-04	4.10E-04	4.60E-04	7.08E-04
41 to <51 years	763	2.45E-02	1.76E-02	1.89E-02	2.08E-02	2.39E-02	2.74E-02	3.08E-02	3.36E-02	5.07E-02	3.33E-04	2.21E-04	2.36E-04	2.76E-04	3.25E-04	3.76E-04	4.41E-04	4.88E-04	6.20E-04
51 to <61 years	622	2.52E-02	1.88E-02	1.98E-02	2.18E-02	2.43E-02	2.81E-02	3.19E-02	3.50E-02	4.62E-02	3.39E-04	2.35E-04	2.54E-04	2.83E-04	3.26E-04	3.83E-04	4.38E-04	4.86E-04	3.69E-04
61 to <71 years	700	2.14E-02	1.69E-02	1.77E-02	1.92E-02	2.09E-02	2.32E-02	2.57E-02	2.73E-02	3.55E-02	2.92E-04	2.24E-04	2.38E-04	2.59E-04	2.85E-04	3.20E-04	3.51E-04	3.71E-04	5.11E-04
71 to <81 years	470	2.11E-02	1.69E-02	1.76E-02	1.89E-02	2.07E-02	2.29E-02	2.49E-02	2.64E-02	3.44E-02	3.08E-04	2.40E-04	2.50E-04	2.70E-04	2.99E-04	3.40E-04	3.75E-04	4.07E-04	6.77E-04
81 years and older	306	2.09E-02	1.65E-02	1.75E-02	1.91E-02	2.06E-02	2.25E-02	2.46E-02	2.60E-02	2.93E-02	3.35E-04	2.47E-04	2.66E-04	2.98E-04	3.33E-04	3.72E-04	4.02E-04	4.20E-04	5.20E-04
High Intensity (METS > 6.0)																			
Birth to <1 year	79	2.42E-02	1.24E-02	1.33E-02	1.72E-02	2.25E-02	2.93E-02	3.56E-02	4.07E-02	7.46E-02	3.26E-03	2.53E-03	2.62E-03	2.89E-03	3.23E-03	3.63E-03	3.96E-03	4.08E-03	5.02E-03
1 year	55	3.65E-02	2.59E-02	2.62E-02	3.04E-02	3.61E-02	4.20E-02	4.73E-02	4.86E-02	7.70E-02	3.38E-03	2.57E-03	2.75E-03	2.97E-03	3.24E-03	3.71E-03	4.16E-03	4.87E-03	4.88E-03
2 years	130	3.76E-02	2.90E-02	3.05E-02	3.23E-02	3.64E-02	4.08E-02	4.81E-02	5.14E-02	7.30E-02	2.80E-03	2.20E-03	2.31E-03	2.48E-03	2.81E-03	3.13E-03	3.36E-03	3.48E-03	3.88E-03
3 to < 6 years	347	3.45E-02	2.70E-02	2.82E-02	3.00E-02	3.33E-02	3.76E-02	4.32E-02	4.47E-02	5.66E-02	1.98E-03	1.36E-03	1.51E-03	1.69E-03	1.90E-03	2.19E-03	2.50E-03	2.99E-03	3.24E-03
6 to < 11 years	707	3.94E-02	2.86E-02	3.01E-02	3.37E-02	3.80E-02	4.41E-02	5.05E-02	5.46E-02	8.29E-02	1.33E-03	8.85E-04	9.67E-04	1.12E-03	1.33E-03	1.52E-03	1.72E-03	1.81E-03	2.22E-03
11 to < 16 years	1,170	4.66E-02	3.11E-02	3.38E-02	3.88E-02	4.53E-02	5.29E-02	6.08E-02	6.63E-02	1.02E-01	8.79E-04	5.89E-04	6.25E-04	7.12E-04	8.53E-04	1.01E-03	1.18E-03	1.31E-03	2.05E-03
16 to < 21 years	887	4.41E-02	2.87E-02	3.06E-02	3.65E-02	4.27E-02	5.02E-02	5.82E-02	6.34E-02	1.09E-01	6.96E-04	4.52E-04	4.96E-04	5.67E-04	6.86E-04	7.93E-04	9.16E-04	1.00E-03	1.50E-03
21 to <31 years	796	4.57E-02	2.88E-02	3.12E-02	3.67E-02	4.31E-02	5.22E-02	6.19E-02	6.89E-02	1.08E-01	6.50E-04	4.17E-04	4.62E-04	5.46E-04	6.27E-04	7.30E-04	8.84E-04	9.39E-04	1.30E-03
31 to <41 years	687	4.44E-02	3.03E-02	3.29E-02	3.70E-02	4.22E-02	5.05E-02	5.95E-02	6.53E-02	8.95E-02	6.13E-04	3.84E-04	4.20E-04	4.96E-04	5.90E-04	7.08E-04	8.35E-04	9.05E-04	1.55E-03
41 to <51 years	515	4.70E-02	3.10E-02	3.40E-02	3.84E-02	4.56E-02	5.41E-02	6.15E-02	6.74E-02	8.87E-02	6.35E-04	3.79E-04	4.44E-04	5.17E-04	6.41E-04	7.65E-04	8.79E-04	9.50E-04	1.61E-03
51 to <61 years	424	4.74E-02	3.15E-02	3.48E-02	3.94E-02	4.57E-02	5.41E-02	6.23E-02	6.88E-02	8.44E-02	6.34E-04	3.93E-04	4.31E-04	5.07E-04	6.12E-04	7.55E-04	8.51E-04	9.28E-04	1.37E-03
61 to <71 years	465	4.00E-02	2.76E-02	3.06E-02	3.46E-02	3.87E-02	4.53E-02	5.08E-02	5.64E-02	7.13E-02	5.44E-04	3.64E-04	4.04E-04	4.49E-04	5.29E-04	6.10E-04	7.18E-04	8.03E-04	1.11E-03
71 to <81 years	304	4.06E-02	2.85E-02	3.01E-02	3.43E-02	3.96E-02	4.70E-02	5.20E-02	5.41E-02	7.53E-02	5.94E-04	3.95E-04	4.45E-04	4.98E-04	5.80E-04	6.75E-04	7.76E-04	8.29E-04	1.26E-03
81 years and older	188	4.19E-02	2.85E-02	3.09E-03	3.44E-02	4.14E-02	4.76E-02	5.56E-02	5.83E-02	7.21E-02	6.66E-04	4.54E-04	4.80E-04	5.43E-04	6.26E-04	7.68E-04	9.32E-04	9.72E-04	1.22E-03

[a] An individual's ventilation rate for the given activity category equals the weighted average of the individual's activity-specific ventilation rates for activities falling within the category, estimated using a multiple linear regression model, with weights corresponding to the number of minutes spent performing the activity. Numbers in these two columns represent averages, calculated across individuals in the specified age category, of these weighted averages. These are weighted averages, with the weights corresponding to the 4-year sampling weights assigned within NHANES 1999-2002.

N = Number of individuals.

MET = Metabolic equivalent.

Source: U.S. EPA, 2009.

Table 6-15. Descriptive Statistics for Duration of Time (hours/day) Spent Performing Activities Within the Specified Activity Category, by Age and Gender Categories[a]

Age Group	N	Duration (hours/day) Spent at Activity - Males									N	Duration (hours/day) Spent at Activity - Females								
		Mean	Percentiles							Maximum		Mean	Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th				5th	10th	25th	50th	75th	90th	95th	
Sleep or nap (Activity ID = 14500)																				
Birth to <1 year	419	13.51	12.63	12.78	13.19	13.53	13.88	14.24	14.46	15.03	415	12.99	12.00	12.16	12.53	12.96	13.44	13.82	14.07	14.82
1 year	308	12.61	11.89	12.15	12.34	12.61	12.89	13.13	13.29	13.79	245	12.58	11.59	11.88	12.29	12.63	12.96	13.16	13.31	14.55
2 years	261	12.06	11.19	11.45	11.80	12.07	12.39	12.65	12.75	13.40	255	12.09	11.45	11.68	11.86	12.08	12.34	12.57	12.66	13.48
3 to < 6 years	540	11.18	10.57	10.70	10.94	11.18	11.45	11.63	11.82	12.39	543	11.13	10.45	10.70	10.92	11.12	11.38	11.58	11.75	12.23
6 to < 11 years	940	10.18	9.65	9.75	9.93	10.19	10.39	10.59	10.72	11.24	894	10.26	9.55	9.73	10.01	10.27	10.54	10.74	10.91	11.43
11 to < 16 years	1,337	9.38	8.84	8.94	9.15	9.38	9.61	9.83	9.95	10.33	1,451	9.57	8.82	8.97	9.27	9.55	9.87	10.17	10.31	11.52
16 to < 21 years	1,241	8.69	7.91	8.08	8.36	8.67	9.03	9.34	9.50	10.44	1,182	9.08	8.26	8.44	8.74	9.08	9.39	9.79	10.02	11.11
21 to <31 years	701	8.36	7.54	7.70	8.02	8.36	8.67	9.03	9.23	9.77	1,023	8.60	7.89	7.99	8.26	8.59	8.90	9.20	9.38	10.35
31 to <41 years	728	8.06	7.36	7.50	7.77	8.06	8.36	8.59	8.76	9.82	869	8.31	7.54	7.70	7.98	8.28	8.59	8.92	9.17	10.22
41 to <51 years	753	7.89	7.15	7.30	7.58	7.88	8.17	8.48	8.68	9.38	763	8.32	7.58	7.75	7.99	8.31	8.63	8.93	9.13	10.02
51 to <61 years	627	7.96	7.29	7.51	7.69	7.96	8.23	8.48	8.66	9.04	622	8.12	7.36	7.53	7.81	8.11	8.43	8.73	8.85	9.29
61 to <71 years	678	8.31	7.65	7.78	8.01	8.30	8.6	8.83	9.01	9.66	700	8.40	7.67	7.88	8.15	8.40	8.68	8.93	9.09	9.80
71 to <81 years	496	8.51	7.80	8.02	8.27	8.53	8.74	8.99	9.10	9.89	470	8.58	7.85	8.01	8.26	8.55	8.89	9.19	9.46	10.34
81 years and older	255	9.24	8.48	8.64	8.97	9.25	9.54	9.74	9.96	10.69	306	9.11	8.35	8.53	8.84	9.10	9.34	9.73	10.04	10.55
Sedentary & Passive Activities (METS ≤ 1.5 – Includes Sleep or Nap)																				
Birth to <1 year	419	14.95	13.82	14.03	14.49	14.88	15.44	15.90	16.12	17.48	415	14.07	12.86	13.05	13.53	14.08	14.54	15.08	15.49	16.14
1 year	308	14.27	13.22	13.33	13.76	14.25	14.74	15.08	15.38	16.45	245	14.32	13.02	13.25	13.73	14.31	14.88	15.36	15.80	16.40
2 years	261	14.62	13.52	13.67	14.11	14.54	15.11	15.60	15.77	17.28	255	14.86	13.81	13.95	14.44	14.81	15.32	15.78	16.03	16.91
3 to < 6 years	540	14.12	13.01	13.18	13.54	14.03	14.53	15.26	15.62	17.29	543	14.27	12.88	13.15	13.56	14.23	14.82	15.43	15.85	17.96
6 to < 11 years	940	13.51	12.19	12.45	12.86	13.30	13.85	14.82	15.94	19.21	894	13.97	12.49	12.74	13.22	13.82	14.50	15.34	16.36	18.68
11 to < 16 years	1,337	13.85	12.39	12.65	13.06	13.61	14.30	15.41	16.76	18.79	1,451	14.19	12.38	12.76	13.34	14.05	14.82	15.87	16.81	19.27
16 to < 21 years	1,241	13.21	11.39	11.72	12.32	13.08	13.97	14.83	15.44	18.70	1,182	13.58	11.80	12.17	12.79	13.52	14.29	15.08	15.67	16.96
21 to <31 years	701	12.41	10.69	11.06	11.74	12.39	13.09	13.75	14.16	15.35	1,023	12.59	10.97	11.29	11.88	12.60	13.21	13.75	14.19	16.24
31 to <41 years	728	12.31	10.73	10.98	11.61	12.24	12.98	13.63	14.05	15.58	869	12.29	10.91	11.14	11.61	12.24	12.91	13.50	13.90	15.18
41 to <51 years	753	12.32	10.56	11.00	11.67	12.30	12.95	13.67	13.98	15.48	763	12.22	10.78	11.08	11.56	12.18	12.82	13.40	13.79	15.17
51 to <61 years	627	13.06	11.47	11.86	12.36	13.03	13.72	14.38	14.76	15.95	622	12.66	11.08	11.40	12.08	12.64	13.30	13.89	14.12	15.80
61 to <71 years	678	14.49	12.96	13.24	13.76	14.48	15.16	15.72	16.24	17.50	700	14.25	12.89	13.16	13.68	14.22	14.86	15.38	15.69	17.14
71 to <81 years	496	15.90	14.22	14.67	15.25	15.94	16.65	17.11	17.46	18.47	470	15.38	13.66	14.20	14.76	15.41	16.05	16.62	16.94	17.90
81 years and older	255	16.58	15.13	15.45	15.92	16.64	17.21	17.7	18.06	18.76	306	16.48	14.87	15.09	15.80	16.59	17.15	17.71	18.07	19.13
Light Intensity Activities (1.5 < METS ≤ 3.0)																				
Birth to <1 year	419	5.30	2.97	3.25	3.71	4.52	7.29	8.08	8.50	9.91	415	6.00	3.49	3.70	4.26	5.01	8.43	9.31	9.77	10.53
1 year	308	5.52	2.68	2.89	3.37	4.31	8.23	9.04	9.73	10.90	245	5.61	2.83	2.94	3.46	4.39	8.28	9.03	9.39	10.57
2 years	261	5.48	3.06	3.26	3.85	4.58	7.58	8.83	9.04	9.92	255	5.78	3.20	3.54	4.29	5.33	7.48	8.46	8.74	9.93
3 to < 6 years	540	6.60	3.86	4.25	5.16	6.20	8.26	9.31	9.70	10.74	543	6.25	3.78	4.10	4.79	5.84	7.86	8.84	9.38	10.32
6 to < 11 years	940	7.62	5.07	5.57	6.63	7.63	8.72	9.78	10.12	11.59	894	7.27	4.63	5.46	6.33	7.17	8.34	9.42	9.79	11.06
11 to < 16 years	1,337	7.50	4.48	5.59	6.75	7.67	8.51	9.19	9.63	10.91	1,451	7.55	4.89	5.62	6.75	7.67	8.55	9.27	9.57	10.85
16 to < 21 years	1,241	7.13	4.37	4.97	6.00	7.02	8.29	9.43	10.03	11.50	1,182	6.98	4.60	5.08	5.91	6.85	7.96	9.16	9.57	12.29
21 to <31 years	701	6.09	3.15	3.50	4.20	5.08	8.49	9.96	10.47	12.25	1,023	6.42	3.66	4.09	4.84	5.82	8.18	9.56	10.14	12.11
31 to <41 years	728	5.72	2.80	3.12	3.70	4.64	8.34	9.87	10.49	12.10	869	6.51	4.06	4.33	5.06	5.98	8.14	9.46	9.93	13.12
41 to <51 years	753	6.07	2.97	3.41	3.92	4.82	8.56	10.19	10.79	12.68	763	6.56	3.99	4.30	4.97	5.90	8.40	9.75	10.18	11.83
51 to <61 years	627	5.64	3.21	3.44	4.03	4.79	7.59	8.94	9.75	12.09	622	6.52	4.09	4.42	5.19	6.05	7.95	9.12	9.43	11.58
61 to <71 years	678	5.49	3.50	3.82	4.58	5.29	6.41	7.40	7.95	10.23	700	6.23	4.40	4.74	5.47	6.23	6.96	7.67	8.17	11.13
71 to <81 years	496	4.96	3.45	3.75	4.29	4.81	5.59	6.26	6.59	9.90	470	5.96	4.22	4.51	5.24	5.92	6.63	7.46	7.91	9.43
81 years and older	255	4.86	3.54	3.71	4.17	4.74	5.39	6.33	6.59	7.56	306	5.3	3.67	3.96	4.63	5.16	6.00	6.70	7.01	8.78

Table 6-15. Descriptive Statistics for Duration of Time (hours/day) Spent Performing Activities Within the Specified Activity Category, by Age and Gender Categories[a] (continued)

Age Group	N	Duration (hours/day) Spent at Activity - Males									N	Duration (hours/day) Spent at Activity - Females								
		Mean	Percentiles							Maximum		Mean	Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th				5th	10th	25th	50th	75th	90th	95th	
Moderate Intensity Activities (3.0 < METS ≤ 6.0)																				
Birth to <1 year	419	3.67	0.63	0.97	1.74	4.20	5.20	5.80	6.21	7.52	415	3.91	0.53	0.74	1.10	4.87	5.77	6.27	6.54	7.68
1 year	308	4.04	0.45	0.59	1.14	5.29	6.06	6.61	6.94	7.68	245	4.02	0.52	0.73	1.08	5.14	6.10	7.00	7.37	8.07
2 years	261	3.83	0.59	0.76	1.23	4.74	5.37	5.82	6.15	7.40	255	3.27	0.50	0.78	1.22	4.01	4.88	5.35	5.57	6.93
3 to < 6 years	540	3.15	0.55	0.75	1.30	3.80	4.52	5.11	5.32	6.30	543	3.35	0.70	0.89	1.61	3.88	4.71	5.29	5.65	7.58
6 to < 11 years	940	2.66	0.65	0.92	1.65	2.68	3.57	4.36	4.79	5.95	894	2.57	0.65	0.95	1.82	2.66	3.41	3.95	4.32	6.10
11 to < 16 years	1,337	2.35	0.88	1.09	1.66	2.30	3.02	3.62	3.89	5.90	1,451	2.01	0.89	1.08	1.45	1.96	2.51	3.03	3.28	4.96
16 to < 21 years	1,241	3.35	1.13	1.42	2.19	3.45	4.37	5.24	5.59	6.83	1,182	3.26	1.27	1.48	2.21	3.39	4.24	4.74	5.07	6.68
21 to <31 years	701	5.24	1.15	1.58	2.52	6.01	7.15	7.95	8.39	9.94	1,023	4.80	1.62	1.94	2.78	5.37	6.42	7.19	7.52	9.21
31 to <41 years	728	5.69	1.26	1.65	2.84	6.67	7.75	8.45	8.90	9.87	869	5.00	1.71	2.06	3.09	5.41	6.60	7.31	7.58	9.59
41 to <51 years	753	5.40	1.21	1.55	2.39	6.46	7.57	8.40	8.85	10.52	763	5.05	1.75	2.00	2.97	5.48	6.66	7.50	7.97	10.16
51 to <61 years	627	5.00	1.29	1.63	2.72	5.68	6.75	7.60	8.01	9.94	622	4.58	1.71	2.13	3.10	4.79	5.98	6.89	7.14	8.97
61 to <71 years	678	3.73	1.62	1.97	2.81	3.70	4.67	5.45	6.01	7.45	700	3.31	1.65	1.97	2.56	3.34	4.01	4.61	5.01	6.90
71 to <81 years	496	2.87	1.56	1.83	2.28	2.86	3.45	3.95	4.31	5.44	470	2.48	1.19	1.36	1.82	2.48	2.99	3.64	4.01	5.63
81 years and older	255	2.35	1.32	1.45	1.79	2.29	2.85	3.28	3.61	4.37	306	2.06	1.01	1.25	1.55	1.99	2.51	3.07	3.44	4.68
High Intensity (METS > 6.0)																				
Birth to <1 year	183	0.20	0.00	0.00	0.01	0.14	0.28	0.50	0.59	0.96	79	0.17	0.03	0.05	0.09	0.14	0.21	0.33	0.40	0.58
1 year	164	0.31	0.01	0.01	0.03	0.22	0.56	0.78	0.93	1.52	55	0.22	0.03	0.05	0.09	0.18	0.35	0.40	0.43	0.48
2 years	162	0.10	0.00	0.01	0.03	0.05	0.14	0.25	0.33	0.48	130	0.15	0.00	0.01	0.03	0.08	0.16	0.48	0.65	1.01
3 to < 6 years	263	0.27	0.02	0.03	0.04	0.13	0.33	0.75	1.16	1.48	347	0.19	0.01	0.02	0.05	0.10	0.22	0.46	0.73	1.43
6 to < 11 years	637	0.32	0.01	0.01	0.03	0.13	0.38	1.10	1.50	3.20	707	0.24	0.02	0.03	0.06	0.12	0.26	0.67	0.98	1.71
11 to < 16 years	1,111	0.38	0.03	0.04	0.10	0.21	0.47	1.03	1.34	2.35	1,170	0.30	0.03	0.04	0.08	0.19	0.40	0.66	0.96	3.16
16 to < 21 years	968	0.40	0.03	0.04	0.14	0.27	0.53	0.99	1.29	2.59	887	0.24	0.01	0.03	0.08	0.18	0.34	0.51	0.60	1.61
21 to <31 years	546	0.33	0.02	0.05	0.11	0.27	0.45	0.69	0.85	1.95	796	0.26	0.03	0.05	0.10	0.19	0.36	0.56	0.67	1.40
31 to <41 years	567	0.38	0.03	0.07	0.14	0.28	0.51	0.83	1.03	1.77	687	0.25	0.03	0.05	0.09	0.19	0.33	0.52	0.72	1.40
41 to <51 years	487	0.34	0.03	0.05	0.09	0.23	0.50	0.78	1.00	2.40	515	0.26	0.03	0.04	0.09	0.20	0.36	0.55	0.68	1.49
51 to <61 years	452	0.41	0.03	0.05	0.13	0.34	0.59	0.87	1.13	1.95	424	0.34	0.03	0.04	0.12	0.28	0.50	0.74	0.85	1.58
61 to <71 years	490	0.37	0.03	0.05	0.13	0.28	0.49	0.80	1.08	2.21	465	0.32	0.03	0.04	0.10	0.23	0.46	0.68	0.89	1.77
71 to <81 years	343	0.39	0.01	0.03	0.10	0.29	0.57	0.90	1.11	2.06	304	0.29	0.03	0.05	0.10	0.25	0.43	0.60	0.71	1.24
81 years and older	168	0.32	0.02	0.03	0.08	0.25	0.47	0.71	0.88	1.76	188	0.26	0.02	0.03	0.09	0.21	0.38	0.59	0.71	1.23

[a] Individual measures are weighted by their 4-year sampling weights as assigned within NHANES 1999-2000 when calculating the statistics in this table. Ventilation rate was estimated using a multiple linear regression model.

N = Number of individuals.

MET = Metabolic equivalent.

Source: U.S. EPA, 2009.

Table 6-16. Nonnormalized Daily Inhalation Rates (m^3/day) Derived Using Layton's (1993) Method and CSFII Energy Intake Data

Age	Sample Size (Nonweighted)	Mean	SEM	Percentiles			SE of 95th percentile
				50th	90th	95th	
Infancy							
0-2 months	182	3.63	0.14	3.30	5.44	7.10	0.64
3-5 months	294	4.92	0.14	4.56	6.86	7.72	0.48
6-8 months	261	6.09	0.15	5.67	8.38	9.76	0.86
9-11 months	283	7.41	0.20	6.96	10.21	11.77	-
0-11 months	1,020	5.70	0.10	5.32	8.74	9.95	0.55
Children							
1 year	934	8.77	0.08	8.30	12.19	13.79	0.25
2 years	989	9.76	0.10	9.38	13.56	14.81	0.35
3 years	1,644	10.64	0.10	10.28	14.59	16.03	0.27
4 years	1,673	11.40	0.09	11.05	15.53	17.57	0.23
5 years	790	12.07	0.13	11.56	15.72	18.26	0.47
6 years	525	12.25	0.18	11.95	16.34	17.97	0.87
7 years	270	12.86	0.21	12.51	16.96	19.06	1.27
8 years	253	13.05	0.25	12.42	17.46	19.02	1.08
9 years	271	14.93	0.29	14.45	19.68	22.45[a]	1.35
10 years	234	15.37	0.35	15.19	20.87	22.90[a]	1.02
11 years	233	15.49	0.32	15.07	21.04	23.91[a]	1.62
12 years	170	17.59	0.54	17.11	25.07[a]	29.17[a]	1.61
13 years	194	15.87	0.44	14.92	22.81[a]	26.23[a]	1.11
14 years	193	17.87	0.62	15.90	25.75[a]	29.45[a]	4.38
15 years	185	18.55	0.55	17.91	28.11[a]	29.93[a]	1.79
16 years	201	18.34	0.54	17.37	27.56	31.01	2.07
17 years	159	17.98	0.96	15.90	31.42[a]	36.69[a]	-
18 years	135	18.59	0.78	17.34	28.80[a]	35.24[a]	4.24
Adolescent Boys							
9-18 years	983	19.27	0.28	17.96	28.78	32.82	1.39
Adolescent Girls							
9-18 years	992	14.27	0.22	13.99	21.17	23.30	0.61
U.S. EPA Cancer Guidelines' Age Groups with Greater Weighting							
0 through 1 year	1,954	7.50	0.08	7.19	11.50	12.86	0.17
2 through 15 years	7,624	14.09	0.12	13.13	20.99	23.88	0.50

[a] FASEB/LSRO (1995) convention, adopted by CSFII, denotes a value that might be less statistically reliable than other estimates due to small cell size.
\- Denotes unable to calculate.
SEM = Standard error of the mean.
SE = Standard error.

Source: Arcus-Arth and Blaisdell, 2007.

Table 6-17. Mean and 95th Percentile Inhalation Rate Values (m^3/day) for Males and Females Combined

Age Group[a, c]	Sample Size	Mean[b]	95th, b
Birth to <1 month	182	3.63	7.10
1 to <3 months	182	3.63	7.10
3 to <6 months	294	4.92	7.72
6 to <12 months	544	6.78	10.81
Birth to <1 year	1,020	5.70	9.95
1 to <2 years	934	8.77	13.79
2 to <3 years	989	9.76	14.81
3 to <6 years	4,107	11.22	17.09
6 to <11 years	1,553	13.42	19.86
11 to <16 years	975	16.98	27.53
16 to <21 years	495	18.29	33.99

a No other age groups from Table 6-16 (Arcus-Arth and Blaisdell, 2007) fit into the U.S. EPA age groupings.
b Weighted (where possible) average of reported study means and 95th percentiles.
c See Table 6-55 for concordance with EPA age groupings.

Source: Arcus-Arth and Blaisdell, 2007.

Table 6-18. Summary of Institute of Medicine Energy Expenditure Recommendations for Active and Very Active People with Equivalent Inhalation Rates

	Males		Females	
Age Years	Energy Expenditure (kcal/day)	Inhalation Rate (m^3/day)	Energy Expenditure (kcal/day)	Inhalation Rate (m^3/day)
<1	607	3.4	607	3.4
1	869	4.9	869	4.9
2	1,050	5.9	977	5.5
3	1,485—1,683	8.4—9.5	1,395—1,649	7.9—9.3
4	1,566—1,783	8.8—10.1	1,475—1,750	8.3—9.9
5	1,658—1,894	9.4—10.7	1,557—1,854	8.8—10.5
6	1,742—1,997	9.8—11.3	1,642—1,961	9.3—11.1
7	1,840—2,115	10.4—11.9	1,719—2,058	9.7—11.6
8	1,931—2,225	10.9—12.6	1,810—2,173	10.2—12.3
9	2,043—2,359	11.5—13.3	1,890—2,273	10.7—12.8
10	2,149—2,486	12.1—14.0	1,972—2,376	11.1—13.4
11	2,279—2,640	12.9—14.9	2,071—2,500	11.7—14.1
12	2,428—2,817	13.7—15.9	2,183—2,640	12.3—14.9
13	2,618—3,038	14.8—17.2	2,281—2,762	12.9—15.6
14	2,829—3,283	16.0—18.5	2,334—2,831	13.2—16.0
15	3,013—3,499	17.0—19.8	2,362—2,870	13.3—16.2
16	3,152—3,663	17.8—20.7	2,368—2,883	13.4—16.3
17	3,226—3,754	18.2—21.2	2,353—2,871	13.3—16.2
18	2,823—3,804	18.4—21.5	2,336—2,858	13.2—16.1
19—30	3,015—3,490	17.0—19.7	2,373—2,683	13.4—15.2
31—50	2,862—3,338	16.2—18.9	2,263—2,573	12.8—14.5
51—70	2,671—3,147	15.1—17.8	2,124—2,435	12.0—13.8

Source: Stifelman, 2007.

Table 6-19. Mean Inhalation Rate Values (m^3/day) for Males, Females, and Males and Females Combined.[a]

Age Group[b, d]	Males[c]	Females[c]	Combined[c]
Birth to <1 year	3.4	3.4	3.4
1 to <2 years	4.9	4.9	4.9
2 to <3 years	5.9	5.5	5.7
3 to <6 years	9.5	9.1	9.3
6 to <11 years	11.8	11.2	11.5
11 to <16 years	16.1	14.0	15.0
16 to <21 years	19.3	14.6	17.0
21 to <31 years	18.4	14.3	16.3
31 to <41 years	17.6	13.7	15.6
41 to <51 years	17.6	13.7	15.6
51 to <61 years	16.5	12.9	14.7
61 to <71 years	16.5	12.9	14.7

[a] Inhalation rates are for IOM Physical Activity Level (PAL) category "active"; the total number of subjects for all PAL categories was 3007. Sample sizes were not reported.
[b] Age groups from Table 6-18 were regrouped to fit into the EPA age groupings.
[c] Weighted (where possible) average of reported study means.
[d] See Table 6-55 for concordance with EPA age groupings.

Source: Stifelman, 2007.

Table 6-20. Mean Inhalation Rate Values (m^3/day) from Key Studies for Males and Females Combined

Age Group[d]	U.S. EPA (2009)[a]		Brochu et al. (2006a)[a]		Arcus-Arth and Blaisdell (2007)[a]		Stifelman (2007)[c]		Combined Key Studies[b]	
	N[c]	Mean	N	Mean	N	Mean	N	Mean	N	Mean
Birth to <1 month	-	-	-	-	182	3.63	-	-	182	3.63
1 to <3 months	-	-	85	3.31	182	3.63	-	-	267	3.47
3 to <6 months	-	-	85	3.31	294	4.92	-	-	379	4.11
6 to <12 months	-	-	103	4.06	544	6.78	-	-	647	5.42
Birth to <1 year	834	8.64	188	3.72	1,020	5.70	-	3.4	2,042	5.36
1 to <2 years	553	13.41	101	4.90	934	8.77	-	4.9	1,588	7.99
2 to <3 years	516	12.99	61	7.28	989	9.76	-	5.7	1,566	8.93
3 to <6 years	1,083	12.40	61	7.28	4,107	11.22	-	9.3	5,251	10.05
6 to <11 years	1,834	12.93	199	9.98	1,553	13.42	-	11.5	3,586	11.96
11 to <16 years	2,788	14.34	117	14.29	975	16.98	-	15.0	3,880	15.17
16 to <21 years	2,423	15.44	117	14.29	495	18.29	-	17.0	3,035	16.25
21 to <31 years	1,724	16.30	219	14.59	-	-	-	16.3	1,943	15.74
31 to <41 years	1,597	17.40	100	14.99	-	-	-	15.6	1,697	16.00
41 to <51 years	1,516	18.55	91	13.74	-	-	-	15.6	1,607	15.96
51 to <61 years	1,249	18.56	91	13.74	-	-	-	14.7	1,340	15.66
61 to <71 years	1,378	15.43	186	12.57	-	-	-	14.7	1,564	14.23
71 to <81 years	966	14.25	95	11.46	-	-	-	-	1,061	12.86
81 years and older	561	12.97	95	11.46	-	-	-	-	656	12.21

[a] Weighted (where possible) average of reported study means.
[b] Unweighted average of means from Key Studies.
[c] The total number of subjects for Stifelman (2007) was 3,007.
[d] When age groupings in the original reference did not match the US EPA groupings used for this handbook, means from all age groupings in the original reference that overlapped EPA's age groupings by more than 1 year were averaged, weighted by the number of observations contributed from each age group. See Table 6-55 for concordance with EPA age groupings.

Table 6-21. 95th Percentile Inhalation Rate Values (m^3/day) from Key Studies for Males and Females Combined										
Age Group[d]	U.S. EPA (2009)[a]		Brochu et al. (2006a) [a]		Arcus-Arth and Blaisdell (2007) [a]		Stifelman (2007) [c]		Combined Key Studies[b]	
	N[a]	95th	N	95th	N	95th	N	95th	N	95th
Birth to <1 month	-[b]	-	-	-	182	7.10	-	-	182	7.10
1 to <3 months	-	-	85	4.44	182	7.10	-	-	267	5.77
3 to <6 months	-	-	85	4.44	294	7.72	-	-	379	6.08
6 to <12 months	-	-	103	5.28	544	10.81	-	-	647	8.04
Birth to <1 year	834	12.67	188	4.90	1,020	9.95	-	-	2,042	9.17
1 to <2 years	553	18.22	101	6.43	934	13.79	-	-	1,588	12.81
2 to <3 years	516	17.04	61	9.27	989	14.81	-	-	1,566	13.71
3 to <6 years	1,083	15.17	61	9.27	4,107	17.09	-	-	5,251	13.84
6 to <11 years	1,834	17.05	199	12.85	1,553	19.86	-	-	3,586	16.59
11 to <16 years	2,788	19.23	117	19.02	975	27.53	-	-	3,880	21.93
16 to <21 years	2,423	20.89	117	19.02	495	33.99	-	-	3,035	24.63
21 to <31 years	1,724	23.57	219	19.00	-	-	-	-	1,943	21.29
31 to <41 years	1,597	24.30	100	18.39	-	-	-	-	1,697	21.35
41 to <51 years	1,516	24.83	91	17.50	-	-	-	-	1,607	21.16
51 to <61 years	1,249	25.17	91	17.50	-	-	-	-	1,340	21.33
61 to <71 years	1,378	19.76	186	16.37	-	-	-	-	1,564	18.07
71 to <81 years	966	17.88	95	15.30	-	-	-	-	1,061	16.59
81 years and older	561	16.10	95	15.30	-	-	-	-	656	15.70

a Weighted (where possible) average of reported study 95th percentiles.
b Unweighted average of 95th percentiles from Key Studies.
c The total number of subjects for Stifelman (2007) was 3,007.
d When age groupings in the original reference did not match the US EPA groupings used for this handbook, 95th percentiles from all age groupings in the original reference that overlapped EPA's age groupings by more than 1 year were averaged, weighted by the number of observations contributed from each age group. See Table 6-55 for concordance with EPA age groupings.

Table 6-22. Daily Inhalation Rates Estimated From Daily Activities[a]

Subject	Inhalation Rate (m^3/hour)		Daily Inhalation Rate (DIR)[b] (m^3/day)
	Resting	Light Activity	
Child (10 years)	0.29	0.78	14.8
Infant (1 year)	0.09	0.25	3.76
Newborn	0.03	0.09	0.78
Adult Man	0.45	1.2	22.8
Adult Woman	0.36	1.14	21.1

[a] Assumptions made were based on 8 hours resting and 16 hours light activity for adults and children (10 yrs); 14 hours resting and 10 hours light activity for infants (1 yr); 23 hours resting and 1 hour light activity for newborns.

[b]

$$DIR = \frac{1}{T}\sum_{i=1}^{K} IR_i t_i$$

DIR = Daily Inhalation Rate
IR_i = Corresponding inhalation rate at i^{th} activity
t_i = Hours spent during the i^{th} activity
k = Number of activity periods
T = Total time of the exposure period (i.e., a day)

Source: ICRP, 1981.

Table 6-23. Selected Inhalation Rate Values During Different Activity Levels Obtained From Various Literature Sources

Subject	W (kg)	Resting			Light Activity			Heavy Work			Maximal Work During Exercise		
		f	VT	V*	f	VT	V*	f	VT	V*	f	VT	V*
Adolescent													
Male, 14-16 y		16	330	5.2							53	2,520	113
Male, 14-15 y	59.4												
Female, 14-16 y		15	300	4.5									
Female, 14-15 y; 164.9 cm L	56										52	1,870	88
Children													
10 y; 140 cm L		16	300	4.8	24	600	14						
Males, 10-11 y	36.5										58	1,330	71
Males, 10-11 y; 140.6 cm L	32.5										61	1,050	61
Females, 4-6 y	20.8										70	600	40
Females, 4-6 y; 111.6 cm L	18.4										66	520	34
Infant, 1 y		30	48	1.4[a]									
Newborn	2.5	34	15	0.5									
20 hrs-13 wk	2.5-5.3										68[b]	51[a,b]	3.5[b]
9.6 hrs	3.6	25	21	0.5									
6.6 days	3.7	29	21	0.6									
Adult													
Man	68.5	12	750	7.4	17	1,670	29	21	2,030	43			
1.7 m^2 SA		12	500	6									
30y; 170cm L		15	500	7.5	16	1,250	20						
20-33 y	70.4										40	3,050	111
Woman	54	12	340	4.5	19	860	16	30	880	25			
30y; 160 cm L		15	400	6	20	940	19						
20-25 y 165.8 cm L	60.3										46	2,100	90
Pregnant (8th mo)		16	650	10									

W = Body weights; f = frequency (breaths/min); VT = tidal volume (ml); V* = minute volume (l/min); cm L = length/height; y = years of age; wk = week.

[a] Calculated from V* = f x VT.

[b] Crying.

Source: ICRP, 1981.

Table 6-24. Summary of Human Inhalation Rates by Activity Level (m^3/hour)[a]

	N[b]	Resting[c]	N[b]	Light[d]	N[b]	Moderate[e]	N[b]	Heavy[f]
Child, 6 years	8	0.4	16	0.8	4	2.0	5	2.3
Child, 10 years	10	0.4	40	1.0	29	3.2	43	3.9
Adult male	454	0.7	102	0.8	102	2.5	267	4.8
Adult female	595	0.3	786	0.5	106	1.6	211	2.9
Average adult	1,049	0.5	888	0.6	208	2.1	478	3.9

[a] Values of inhalation rates for children (male and female) presented in this table represent the mean of values reported for each activity level in 1985.
[b] Number of observations at each activity level.
[c] Includes watching television, reading, and sleeping.
[d] includes most domestic work, attending to personal needs and care, hobbies, and conducting minor indoor repairs and home improvements.
[e] Includes heavy indoor cleanup, performance of major indoor repairs and alterations, and climbing stairs.
[f] Includes vigorous physical exercise and climbing stairs carrying a load.

Source: Adapted from U.S. EPA, 1985.

Table 6-25. Estimated Minute Ventilation Associated with Activity Level for Average Male Adult[a]

Level of work	L/min	Representative activities
Light	13	Level walking at 2 mph; washing clothes
Light	19	Level walking at 3 mph; bowling; scrubbing floors
Light	25	Dancing; pushing wheelbarrow with 15-kg load; simple construction; stacking firewood
Moderate	30	Easy cycling; pushing wheelbarrow with 75-kg load; using sledgehammer
Moderate	35	Climbing stairs; playing tennis; digging with spade
Moderate	40	Cycling at 13 mph; walking on snow; digging trenches
Heavy Heavy Very heavy	55	Cross-country skiing; rock climbing; stair climbing with load; playing squash or handball; chopping with axe
Very heavy	85	Level running at 10 mph; competitive cycling
Severe	100+	Competitive long distance running; cross-country skiing

[a] Average adult assumed to weigh 70 kg.

Source: Adapted from U.S. EPA, 1985.

Table 6-26. Activity Pattern Data Aggregated for Three Microenvironments by Activity Level for All Age Groups		
Microenvironment	Activity Level	Average Hours Per Day in Each Microenvironment at Each Activity Level
Indoors	Resting	9.82
	Light	9.82
	Moderate	0.71
	Heavy	0.10
	TOTAL	20.4
Outdoors	Resting	0.51
	Light	0.51
	Moderate	0.65
	Heavy	0.12
	TOTAL	1.77
In Transportation Vehicle	Resting	0.86
	Light	0.86
	Moderate	0.05
	Heavy	0.0012
	TOTAL	1.77

Source: Adapted from U.S. EPA, 1985.

Table 6-27. Summary of Daily Inhalation Rates Grouped by Age and Activity Level

Subject	Daily Inhalation Rate (m^3/day)[a]				Total Daily IR[b] (m^3/day)
	Resting	Light	Moderate	Heavy	
Child, 6 years	4.47	8.95	2.82	0.50	16.74
Child, 10 years	4.47	11.19	4.51	0.85	21.02
Adult Male	7.83	8.95	3.53	1.05	21.4
Adult Female	3.35	5.59	2.26	0.64	11.8
Adult Average	5.60	6.71	2.96	0.85	16

[a] Daily inhalation rate was calculated using the following equation:

$$\mathrm{IR} = \frac{1}{T}_i \sum_{i=1}^{K} IR_i \, t_i$$

IR_i = Inhalation rate at i^{th} activity
t_i = Hours spent per day during i^{th} activity
k = Number of activity periods
T = Total time of the exposure period (e.g., a day)

[b] Total daily inhalation rate was calculated by summing the specific activity (resting, light, moderate, heavy) and dividing them by the total amount of time spent on all activities.

Source: Generated using the data from U.S. EPA (1985) as shown in Tables 6-24 and 6-26.

Table 6-28. Distribution Pattern of Predicted VR and EVR (equivalent ventilation rate) for 20 Outdoor Workers

Self-Reported Activity Level	N[c]	VR (m^3/hr)[a] Arithmetic Mean ± SD	VR (m^3/hr)[a] Geometric Mean ± SD	EVR[b] (m^3/hr/m^2 body surface) Arithmetic Mean ± SD	EVR[b] (m^3/hr/m^2 body surface) Geometric Mean ± SD
Sleep	18,597	0.42 ± 0.16	0.39 ± 0.08	0.23 ± 0.08	0.22 ± 0.08
Slow	41,745	0.71 ± 0.4	0.65 ± 0.09	0.38 ± 0.20	0.35 ± 0.09
Medium	3,898	0.84 ± 0.47	0.76 ± 0.09	0.48 ± 0.24	0.44 ± 0.09
Fast	572	2.63 ± 2.16	1.87 ± 0.14	1.42 ± 1.20	1.00 ± 0.14

Percentile Rankings, VR

	1	5	10	50	90	95	99	99.9
Sleep	0.18	0.18	0.24	0.36	0.66	0.72	0.90	1.20
Slow	0.30	0.36	0.36	0.66	1.08	1.32	1.98	4.38
Medium	0.36	0.42	0.48	0.72	1.32	1.68	2.64	3.84
Fast	0.42	0.54	0.60	1.74	5.70	6.84	9.18	10.26

Percentile Rankings, EVR

	1	5	10	50	90	95	99	99.9
Sleep	0.12	0.12	0.12	0.24	0.36	0.36	0.48	0.60
Slow	0.18	0.18	0.24	0.36	0.54	0.66	1.08	2.40
Medium	0.18	0.24	0.30	0.42	0.72	0.90	1.38	2.28
Fast	0.24	0.30	0.36	0.90	3.24	3.72	4.86	5.52

[a] Data presented by Shamoo et al. (1991) in liters/minute were converted to m^3/hr.
[b] EVR = VR per square meter of body surface area.
[c] Number of minutes with valid appearing heart rate records and corresponding daily records of breathing rate.

Source: Shamoo et al., 1991.

Table 6-29. Distribution Pattern of Inhalation Rate by Location and Activity Type for 20 Outdoor Workers

Location	Activity Type[a]	Self-reported Activity Level	% of Time	Inhalation rate (m^3/hr)[b] ± SD	% of Avg.[c]
Indoor	Essential	Sleep	28.7	0.42 ± 0.12	69 ± 15
		Slow	29.5	0.72 ± 0.36	106 ± 43
		Medium	2.4	0.72 ± 0.30	129 ± 38
		Fast	0	0	0
Indoor	Non-essential	Slow	20.4	0.66 ± 0.36	98 ± 36
		Medium	0.9	0.78 ± 0.30	120 ± 50
		Fast	0.2	1.86 ± 0.96	278 ± 124
Outdoor	Essential	Slow	11.3	0.78 ± 0.36	117 ± 42
		Medium	1.8	0.84 ± 0.54	130 ± 56
		Fast	0	0	0
Outdoor	Non-essential	Slow	3.2	0.90 ± 0.66	136 ± 90
		Medium	0.8	1.26 ± 0.60	213 ± 91
		Fast	0.7	2.82 ± 2.28	362 ± 275

[a] Essential activities include income-related work, household chores, child care, study and other school activities, personal care, and destination-oriented travel; Non-essential activities include sports and active leisure, passive leisure, some travel, and social or civic activities.

[b] Data presented by Shamoo et al. (1991) in liters/minute were converted to m^3/hr.

[c] Statistic was calculated by converting each VR for a given subject to a percentage of her/his overall average.

Source: Adapted from Shamoo et al., 1991.

Table 6-30. Calibration and Field Protocols for Self-monitoring of Activities Grouped by Subject Panels		
Panel	Calibration Protocol	Field Protocol
Panel 1 - Healthy Outdoor Workers - 15 female, 5 male, age 19-50	Laboratory treadmill exercise tests, indoor hallway walking tests at different self-chosen speeds, 2 outdoor tests consisted of 1-hour cycles each of rest, walking, and jogging.	3 days in 1 typical summer week (included most active workday and most active day off); HR recordings and activity diary during waking hours.
Panel 2 - Healthy Elementary School Students - 5 male, 12 female, ages 10-12	Outdoor exercises each consisted of 20 minute rest, slow walking, jogging and fast walking	Saturday, Sunday and Monday (school day) in early autumn; heart rate recordings and activity diary during waking hours and during sleep.
Panel 3 - Healthy High School Students 7 male, 12 female, ages 13-17	Outdoor exercises each consisted of 20 minute rest, slow walking, jogging and fast walking	Same as Panel 2, however, no heart rate recordings during sleep for most subjects.
Panel 4 - Adult Asthmatics, clinically mild, moderate, and severe - 15 male, 34 female, age 18-50	Treadmill and hallway exercise tests	1 typical summer week, 1 typical winter week; hourly activity/health diary during waking hours; lung function tests 3 times daily; HR recordings during waking hours on at least 3 days (including most active work day and day off).
Panel 5 - Adult Asthmatics from 2 neighborhoods of contrasting O_3 air quality - 10 male, 14 female, age 19-46	Treadmill and hallway exercise tests	Similar to Panel 4, personal NO_2 and acid exposure monitoring included. (Panels 4 and 5 were studied in different years, and had 10 subjects in common).
Panel 6 - Young Asthmatics - 7 male, 6 female, ages 11-16	Laboratory exercise tests on bicycles and treadmills	Summer monitoring for 2 successive weeks, including 2 controlled exposure studies with few or no observable respiratory effects.
Panel 7 - Construction Workers - 7 male, age 26-34	Performed similar exercises as Panel 2 and 3, and also performed job-related tests including lifting and carrying a 9-kg pipe.	HR recordings and diary information during 1 typical summer work day.
Source: Linn et al., 1992.		

Table 6-31. Subject Panel Inhalation Rates by Mean VR, Upper Percentiles, and Self-estimated Breathing Rates

Panel Number and Description	N[a]	Inhalation Rates (m^3/hour)				
		Mean VR	99th Percentile VR	Mean VR at Activity Levels[b] Slow	Medium	Fast
Healthy						
1 – Adults	20	0.78	2.46	0.72	1.02	3.06
2 - Elementary School Students	17	0.90	1.98	0.84	0.96	1.14
3 - High School Students	19	0.84	2.22	0.78	1.14	1.62
7 –Construction Workers[c]	7	1.50	4.26	1.26	1.50	1.68
Asthmatics						
4 – Adults	49	1.02	1.92	1.02	1.68	2.46
5 – Adults[d]	24	1.20	2.40	1.20	2.04	4.02
6 - Elementary and High School Students	13	1.20	2.40	1.20	1.20	1.50

[a] Number of individuals in each survey panel.

[b] Some subjects did not report medium and/or fast activity. Group means were calculated from individual means (i.e., give equal weight to each individual who recorded any time at the indicated activity level).

[c] Construction workers recorded only on 1 day, mostly during work, while others recorded on ≥ 1 work or school day and ≥ 1 day off.

[d] Excluding subjects also in Panel 4.

VR = Ventilation rate.

Source: Linn et al., 1992.

Table 6-32. Actual Inhalation Rates Measured at Four Ventilation Levels

Subject	Location	Mean Inhalation Rate[a] (m^3/hr)[a]			
		Low	Medium	Heavy	Very Heavy
All subjects	Indoor (Treadmill post)	1.23	1.83	3.13	4.13
	Outdoor	0.88	1.96	2.93	4.90
	Total	0.93	1.92	3.01	4.80

[a] Original data were presented in L/min. Conversion to m^3/hr was obtained as follows:

L/min * 0.001 m^3/L * 60 min/hr = m^3/hr

Source: Adapted from Shamoo et al., 1992.

Table 6-33. Distribution of Predicted Inhalation Rates by Location and Activity Levels for Elementary and High School Students

Age (years)	Student	Location	Activity Level	% Recorded Time[a]	Inhalation Rates (m^3/hour) Mean ± SD	Percentile Rankings[b] 1st	50th	99.9th
10-12	EL[c] (N[d]=17)	Indoors	slow	49.6	0.84 ± 0.36	0.18	0.78	2.34
			medium	23.6	0.96 ± 0.36	0.24	0.84	2.58
			fast	2.4	1.02 ± 0.60	0.24	0.84	3.42
		Outdoors	slow	8.9	0.96 ± 0.54	0.36	0.78	4.32
			medium	11.2	1.08 ± 0.48	0.24	0.96	3.36
			fast	4.3	1.14 ± 0.60	0.48	0.96	3.60
13-17	HS[c] (N[d]=19)	Indoors	slow	70.7	0.78 ± 0.36	0.30	0.72	3.24
			medium	10.9	0.96 ± 0.42	0.42	0.84	4.02
			fast	1.4	1.26 ± 0.66	0.54	1.08	6.84[e]
		Outdoors	slow	8.2	0.96 ± 0.48	0.42	0.90	5.28
			medium	7.4	1.26 ± 0.78	0.48	1.08	5.70
			fast	1.4	1.44 ± 1.08	0.48	1.02	5.94

[a] Recorded time averaged about 23 hr per elementary school student and 33 hours per high school student over 72-hour periods.
[b] Geometric means closely approximated 50th percentiles; geometric standard deviations were 1.2-1.3 for HR,1.5-1.8 for VR.
[c] Elementary school student or high school student.
[d] Number of students that participated in survey.
[e] Highest single value.
SD = Standard deviation.

Source: Spier et al., 1992.

Table 6-34. Average Hours Spent Per Day in a Given Location and Activity Level for Elementary and High School Students					
Students	Location	Activity Level			Total Time Spent (hours/day)
		Slow	Medium	Fast	
Elementary school, ages 10-12 years (N=17)	Indoors	16.3	2.9	0.4	19.6
	Outdoors	2.2	1.7	0.5	4.4
High school, ages 13-17 years (N=19)	Indoors	19.5	1.5	0.2	21.2
	Outdoors	1.2	1.3	0.2	2.7

N = Number of students that participated in survey.

Source: Spier et al., 1992.

Table 6-35. Distribution Patterns of Daily Inhalation Rates for Elementary (EL) and High School (HS) Students Grouped by Activity Level							
Students	Age (yrs)	Location	Activity type[a]	Mean IR[b] (m^3/day)	Percentile Rankings		
					1st	50th	99.9th
EL (n[c]=17)	10-12	Indoor	Light	13.7	2.93	12.71	38.14
			Moderate	2.8	0.70	2.44	7.48
			Heavy	0.4	0.10	0.34	1.37
EL		Outdoor	Light	2.1	0.79	1.72	9.5
			Moderate	1.84	0.41	1.63	5.71
			Heavy	0.57	0.24	0.48	1.80
HS (n=19)	13-17	Indoor	Light	15.2	5.85	14.04	63.18
			Moderate	1.4	0.63	1.26	6.03
			Heavy	0.25	0.11	0.22	1.37
HS		Outdoor	Light	1.15	0.5	1.08	6.34
			Moderate	1.64	0.62	1.40	7.41
			Heavy	0.29	0.10	0.20	1.19

a For this report, activity type presented in tables 6-33 and 6-34 was redefined as light activity for slow, moderate activity for medium, and heavy activity for fast.

b Daily inhalation rate was calculated by multiplying the hours spent at each activity level (Table 6-34) by the corresponding inhalation rate (Table 6-33).

c Number of elementary (EL) and high school students (HS).

Source: Adapted from Spier et al., 1992 (Generated using data from Tables 6-33 and 6-34).

Table 6-36. Mean Minute Inhalation Rate (m^3/minute) by Group and Activity for Laboratory Protocols

Activity	Young Children[a]	Children[a]	Adult Females[a]	Adult Males[a]	Adults (combined)[a]
Lying	6.19E-03	7.51E-03	7.12E-03	8.93E-03	8.03E-03
Sitting	6.48E-03	7.28E-03	7.72E-03	9.30E-03	8.51E-03
Standing	6.76E-03	8.49E-03	8.36E-03	10.65E-03	9.51E-03
Walking					
1.5 mph	1.03E-02	DNP[b]	DNP	DNP	DNP
1.875 mph	1.05E-02	DNP	DNP	DNP	DNP
2.0 mph	DNP	1.41E-02	DNP	DNP	DNP
2.25 mph	1.17E-02	DNP	DNP	DNP	DNP
2.5 mph	DNP	1.56E-02	2.03E-02	2.41E-02	2.22E-02
3.0 mph	DNP	1.78E-02	2.42E-02	DNP	DNP
3.3 mph	DNP	DNP	DNP	2.79E-02	DNP
4.0 mph	DNP	DNP	DNP	3.65E-02	DNP
Running					
3.5 mph	DNP	2.68E-02	DNP	DNP	DNP
4.0 mph	DNP	3.12E-02	4.60E-02[b]	DNP	DNP
4.5 mph	DNP	3.72E-02	4.79E-02[b]	5.73E-02	5.26E-02
5.0 mph	DNP	DNP	5.08E-02[b]	5.85E-02	5.47E-02
6.0 mph	DNP	DNP	DNP	6.57E-02[b]	DNP

[a] Young Children, male and female 3-5.9 yr olds; Children, male and female 6-12.9 yr olds; Adult Females, adolescent, young to middle-aged, and older adult females; Adult Males, adolescent, young to middle-aged, and older adult males; DNP, group did not perform this protocol or N was too small for appropriate mean comparisons.

[b] Older adults not included in the mean value since they did not perform running protocol at particular speeds.

Source: Adams, 1993.

Table 6-37. Mean Minute Inhalation Rate (m^3/minute) by Group and Activity for Field Protocols

Activity	Young Children[a]	Children[a]	Adult Females[a]	Adult Males[a]	Adults (combined)[a]
Play	1.13E-02	1.79E-02	DNP	DNP	DNP
Car Driving	DNP	DNP	8.95E-03	1.08E-02	9.87E-03
Car Riding	DNP	DNP	8.19E-03	9.83E-03	9.01E-03
Yardwork	DNP	DNP	1.92E-02[e]	2.61E-02[b]/3.19E-02[c]	2.27E-02[b]/2.56E-02[c]
Housework	DNP	DNP	1.74E-02	DNP	DNP
Car Maintenance	DNP	DNP	DNP	2.32E-02[d]	DNP
Mowing	DNP	DNP	DNP	3.66E-02[e]	DNP
Woodworking	DNP	DNP	DNP	2.44E-02[e]	DNP

[a] Young Children, male and female 3-5.9 yr olds; Children, male and female 6-12.9 yr olds; Adult Females, adolescent, young to middle-aged, and older adult females; Adult Males, adolescent, young to middle-aged, and older adult males; DNP, group did not perform this protocol or N was too small for appropriate mean comparisons.

[b] Mean value for young to middle-aged adults only.

[c] Mean value for older adults only.

[d] Older adults not included in the mean value since they did not perform this activity.

[e] Adolescents not included in mean value since they did not perform this activity.

Source: Adams, 1993.

Table 6-38. Summary of Average Inhalation Rates (m^3/hour) by Age Group and Activity Levels for Laboratory Protocols

Age Group	Activity Level				
	Resting[a]	Sedentary[b]	Light[c]	Moderate[d]	Heavy[e]
Young Children (3-5.9 years) Average inhalation rate (m^3/hour) (N=12, gender not specified)	0.37	0.40	0.65	DNP[f]	DNP
Children (6-12.9 years) Average inhalation rate (m^3/hour) (N=40, 20 male and 20 female)	0.45	0.47	0.95	1.74	2.23
Adults (females) (Adolescent, young to middle aged, and older adult females) (N=37)	0.43	0.48	1.33	2.76	2.96[g]
Adults (males) (Adolescent, young to middle aged, and older adult males) (N=39)	0.54	0.60	1.45	1.93	3.63
Adults (combined) (N=76)	0.49	0.54	1.38	2.35	3.30

[a] Resting defined as lying (see Table 6-36 for original data).
[b] Sedentary defined as sitting and standing (see Table 6-36 for original data).
[c] Light defined as walking at speed level 1.5 - 3.0 mph (see Table 6-36 for original data).
[d] Moderate defined as fast walking (3.3 - 4.0 mph) and slow running (3.5 - 4.0 mph) (see Table 6-36 for original data).
[e] Heavy defined as fast running (4.5 - 6.0 mph) (see Table 6-36 for original data).
[f] Group did not perform (DNP) this protocol or N was too small for appropriate mean comparisons. All young children did not run.
[g] Older Adults not included in mean value since they did not perform running protocols at particular speeds.

Source: Adapted from Adams, 1993.

Table 6-39. Summary of Average Inhalation Rates (m^3/hour) by Age Group And Activity Levels in Field Protocols			
Age Group	Light Activity[a]	Sedentary Activity[b]	Moderate Activity[c]
Young Children (3-5.9 years) Average inhalation rate (m^3/hour) (N=12, gender not specified)	DNP[d]	DNP	0.68
Children (6-12.9 years) Average inhalation rate (m^3/hour) (N=40, 20 male and 20 female)	DNP	DNP	1.07
Adults (females) (Adolescent, young to middle aged, and older adult females) (N=37)	1.10[e]	0.51	DNP
Adults (males) (Adolescent, young to middle aged, and older adult males) (N=39)	1.40	0.62	1.78[f]
Adults (combined) (N=76)	1.25	0.57	DNP

a Light activity was defined as car maintenance (males), housework (females), and yard work (females) (see Table 6-37 for original data).
b Sedentary activity was defined as car driving and riding (both genders) (see Table 6-37 for original data).
c Moderate activity was defined as mowing (males); wood working (males); yard work (males); and play (children) (see Table 6-37 for original data).
d DNP. Group did not perform this protocol or N was too small for appropriate mean comparisons.
e Older adults not included in mean value since they did not perform this activity.
f Adolescents not included in mean value since they did not perform this activity.
N = Number of individuals.

Source: Adams, 1993.

Table 6-40. Comparisons of Estimated Basal Metabolic Rates (BMR) with Average Food-energy Intakes (EFD) for Individuals Sampled in the 1977-78 NFCS

Cohort/Age (years)	Body Weight (kg)	BMR[a]		Energy Intake (EFD)		Ratio EFD[d]/BMR
		MJ/day[b]	Kcal/day[c]	MJ/day	Kcal/day	
Males and Females						
< 1	7.6	1.74	416	3.32	793	1.90
1 to 2	13	3.08	734	5.07	1,209	1.65
3 to 5	18	3.69	881	6.14	1,466	1.66
6 to 8	26	4.41	1,053	7.43	1,774	1.68
Males						
9 to 11	36	5.42	1,293	8.55	2,040	1.58
12 to 14	50	6.45	1,540	9.54	2,276	1.48
15 to 18	66	7.64	1,823	10.8	2,568	1.41
19 to 22	74	7.56	1,804	10.0	2,395	1.33
23 to 34	79	7.87	1,879	10.1	2,418	1.29
35 to 50	82	7.59	1,811	9.51	2,270	1.25
51 to 64	80	7.49	1,788	9.04	2,158	1.21
65 to 74	76	6.18	1,476	8.02	1,913	1.30
75 +	71	5.94	1,417	7.82	1,866	1.32
Females						
9 to 11	36	4.91	1,173	7.75	1,849	1.58
12 to 14	49	5.64	1,347	7.72	1,842	1.37
15 to 18	56	6.03	1,440	7.32	1,748	1.21
19 to 22	59	5.69	1,359	6.71	1,601	1.18
23 to 34	62	5.88	1,403	6.72	1,603	1.14
35 to 50	66	5.78	1,380	6.34	1,514	1.10
51 to 64	67	5.82	1,388	6.40	1,528	1.10
65 to 74	66	5.26	1,256	5.99	1,430	1.14
75 +	62	5.11	1,220	5.94	1,417	1.16

[a] Calculated from the appropriate age and gender-based BMR equations given in Table 6-42.
[b] MJ/day - mega joules/day.
[c] Kcal/d - kilo calories/day.
[d] Food energy intake (Kcal/day) or (MJ/day).

Source: Layton, 1993.

Table 6-41. Daily Inhalation Rates Calculated from Food-energy Intakes

Cohort/Age (years)	L[d]	Daily Inhalation Rate[a] (m^3/day)	Sleep (hours)	MET[b] Value		Inhalation Rates	
				A[e]	F[f]	Inactive[c] (m^3/day)	Active[c] (m^3/day)
Males and Females							
<1	1	4.5	11	1.9	2.7	2.35	6.35
1 to 2	2	6.8	11	1.6	2.2	4.16	9.15
3 to 5	3	8.3	10	1.7	2.2	4.98	10.96
6 to 8	3	10	10	1.7	2.2	5.95	13.09
Males							
9 to 11	3	14	9	1.9	2.5	7.32	18.3
12 to 14	3	15	9	1.8	2.2	8.71	19.16
15 to 18	4	17	8	1.7	2.1	10.31	21.65
19 to 22	4	16	8	1.6	1.9	10.21	19.4
23 to 34	11	16	8	1.5	1.8	10.62	19.12
35 to 50	16	15	8	1.5	1.8	10.25	18.45
51 to 64	14	15	8	1.4	1.7	10.11	17.19
65 to 74	10	13	8	1.6	1.8	8.34	15.01
75+	1	13	8	1.6	1.9	8.02	15.24
Lifetime average [g]		14					
Females							
9 to 11	3	13	9	1.9	2.5	6.63	16.58
12 to 14	3	12	9	1.6	2.0	7.61	15.22
15 to 18	4	12	8	1.5	1.7	8.14	13.84
19 to 22	4	11	8	1.4	1.6	7.68	12.29
23 to 34	11	11	8	1.4	1.6	7.94	12.7
35 to 50	16	10	8	1.3	1.5	7.80	11.7
51 to 64	14	10	8	1.3	1.5	7.86	11.8
65 to 74	10	9.7	8	1.4	1.5	7.10	10.65
75+	1	9.6	8	1.4	1.6	6.90	11.04
Lifetime average [g]		10					

[a] Daily inhalation rate was calculated by multiplying the EFD values (see Table 6-40) by H x VQ x (m^3 1,000 L^{-1}) for subjects under 9 years of age and by 1.2 x H x VQ x (m^3 1,000 L^{-1}) (for subjects 9 years of age and older (see text for explanation).
Where:
EFD = Food energy intake (Kcal/day) or (MJ/day)
H = Oxygen uptake = 0.05 LO_2/KJ or 0.21 LO_2/Kcal
VQ = Ventilation equivalent = 27 = geometric mean of VQs (unitless)

[b] MET = Metabolic equivalent.

[c] Inhalation rate for inactive periods was calculated as BMR x H x VQ x (d 1,440 min^{-1}) and for active periods by multiplying inactive inhalation rate by F (See footnote f); BMR values are from Table 6-40.
Where BMR = Basal metabolic rate (MJ/day) or (kg/hr).

[d] L is the number of years for each age cohort.

[e] For individuals 9 years of age and older, A was calculated by multiplying the ratio for EFD/BMR (unitless) (Table 6-40) by the factor 1.2 (see text for explanation).

[f] F = (24A - S)/(24 - S) (unitless), ratio of the rate of energy expenditure during active hours to the estimated BMR (unitless)
Where S = Number of hours spent sleeping each day (hrs)

[g] Lifetime average was calculated by multiplying individual inhalation rate by corresponding L values summing the products across cohorts and dividing the result by 75, the total of the cohort age spans.

Source: Layton, 1993.

Table 6-42. Statistics of the Age/gender Cohorts Used to Develop Regression Equations for Predicting Basal Metabolic Rates (BMR)

Gender, Age (years)	BMR		CV	Body Weight (kg)	N	BMR Equation[a]	r
	$MJ\ d^{-1}$	SD					
Males							
Under 3	1.51	0.92	0.61	6.6	162	0.249 bw - 0.127	0.95
3 to < 10	4.14	0.50	0.12	21	338	0.095 bw + 2.110	0.83
10 to < 18	5.86	1.17	0.20	42	734	0.074 bw + 2.754	0.93
18 to <30	6.87	0.84	0.12	63	2,879	0.063 bw + 2.896	0.65
30 to <60	6.75	0.87	0.13	64	646	0.048 bw + 3.653	0.60
≥ 60	5.59	0.93	0.17	62	50	0.049 bw + 2.459	0.71
Females							
Under 3	1.54	0.92	0.59	6.9	137	0.244 bw - 0.130	0.96
3 to < 10	3.85	0.49	0.13	21	413	0.085 bw + 2.033	0.81
10 to < 18	5.04	0.78	0.15	38	575	0.056 bw + 2.898	0.80
18 to <30	5.33	0.72	0.14	53	829	0.062 bw + 2.036	0.73
30 to <60	5.62	0.63	0.11	61	372	0.034 bw + 3.538	0.68
≥ 60	4.85	0.61	0.12	56	38	0.038 bw + 2.755	0.68

[a] Body weight (bw) in kg.
SD = Standard deviation.
CV = Coefficient of variation (SD/mean).
N = Number of observations.
r = Coefficient of correlation.

Source: Layton, 1993.

Table 6-43. Daily Inhalation Rates Obtained from the Ratios of Total Energy Expenditure to Basal Metabolic Rate (BMR)

Gender/Age (years)	Body Weight[a] (kg)	BMR[b] (MJ/day)	VQ	A[c]	H (m^3O_2/MJ)	Inhalation Rate, V_E (m^3/day)[d]
Males						
0.5 to <3	14	3.4	27	1.6	0.05	7.3
3 to <10	23	4.3	27	1.6	0.05	9.3
10 to <18	53	6.7	27	1.7	0.05	15
18 to <30	76	7.7	27	1.59	0.05	17
30 to <60	80	7.5	27	1.59	0.05	16
≥ 60	75	6.1	27	1.59	0.05	13
Females						
0.5 to <3	11	2.6	27	1.6	0.05	5.6
3 to <10	23	4.0	27	1.6	0.05	8.6
10 to <18	50	5.7	27	1.5	0.05	12
18 to <30	62	5.9	27	1.38	0.05	11
30 to <60	68	5.8	27	1.38	0.05	11
≥ 60	67	5.3	27	1.38	0.05	9.9

[a] Body weight was based on the average weights for age/gender cohorts in the U.S. population.
[b] The BMRs (basal metabolic rate) are calculated using the respective body weights and BMR equations (see Table 6-42).
[c] The values of the BMR multiplier (EFD/BMR) for those 18 years and older were derived from the Basiotis et al. (1989) study: Male = 1.59, Female = 1.38. For males and females under 10 years old, the mean BMR multiplier used was 1.6. For males and females aged 10 to < 18 years, the mean values for A given in Table 6-41 for 12-14 years and 15-18 years, age brackets for males and females were used: male = 1.7 and female = 1.5.
[d] Inhalation rate = BMR x A x H x VQ; VQ = ventilation equivalent and H = oxygen uptake.

Source: Layton, 1993.

Table 6-44. Daily Inhalation Rates Based on Time-Activity Survey

Age (yrs) and Activity	MET	Males						Females					
		Body Weight[a] (kg)	BMR[b] (KJ/hr)	Duration[c] (hr/day)	E[d] (MJ/day)	V_E[e] (m^3/day)	V_E[f] (m^3/hr)	Body Weight[a] (kg)	BMR[b] (KJ/hr)	Duration[c] (hr/day)	E[d] (MJ/day)	V_E[e] (m^3/day)	V_E[f] (m^3/hr)
20-34													
Sleep	1	76	320	7.2	2.3	3.1	0.4	62	283	7.2	2.0	2.8	0.4
Light	1.5	76	320	14.5	7.0	9.4	0.7	62	283	14.5	6.2	8.3	0.6
Moderate	4	76	320	1.2	1.5	2.1	1.7	62	283	1.2	1.4	1.8	1.5
Hard	6	76	320	0.64	1.2	1.7	2.6	62	283	0.64	1.1	1.5	2.3
Very Hard	10	76	320	0.23	0.74	1.0	4.3	62	283	0.23	0.65	0.88	3.8
Totals				24	17	17				24	11	15	
35-49													
Sleep	1	81	314	7.1	2.2	3.0	0.4	67	242	7.1	1.7	2.3	0.3
Light	1.5	81	314	14.6	6.9	9.3	0.6	67	242	14.6	5.3	7.2	0.5
Moderate	4	81	314	1.4	1.8	2.4	1.7	67	242	1.4	1.4	1.8	1.3
Hard	6	81	314	0.59	1.1	1.5	2.5	67	242	0.59	0.9	1.2	2.0
Very Hard	10	81	314	0.29	0.91	1.2	4.2	67	242	0.29	0.70	0.95	3.2
Totals				24	13	17				24	9.9	13	
50-64													
Sleep	1	80	312	7.3	2.3	3.1	0.4	68	244	7.3	1.8	2.4	0.3
Light	1.5	80	312	14.9	7.0	9.4	0.6	68	244	14.9	5.4	7.4	0.5
Moderate	4	80	312	1.1	1.4	1.9	1.7	68	244	1.1	1.1	1.4	1.3
Hard	6	80	312	0.50	0.94	1.3	2.5	68	244	0.5	0.7	1.0	2.0
Very Hard	10	80	312	0.14	0.44	0.6	4.2	68	244	0.14	0.34	0.46	3.3
Totals				24	12	16				24	9.4	13	
65-74													
Sleep	1	75	256	7.3	1.9	2.5	0.3	67	221	7.3	1.6	2.2	0.3
Light	1.5	75	256	14.9	5.7	7.7	0.5	67	221	14.9	4.9	6.7	0.4
Moderate	4	75	256	1.1	1.1	1.5	1.4	67	221	1.1	1.0	1.3	1.2
Hard	6	75	256	0.5	0.8	1.0	2.1	67	221	0.5	0.7	0.9	1.8
Very Hard	10	75	256	0.14	0.36	0.48	3.5	67	221	0.14	0.31	0.42	3.0
Totals				24	9.8	13				24	8.5	11	

[a] Body weights were obtained from Najjar and Rowland (1987).
[b] The basal metabolic rates (BMRs) for the age/gender cohorts were calculated using the respective body weights and the BMR equations (Table 6-42).
[c] Duration of activities were obtained from Sallis et al. (1985).
[d] Energy expenditure rate (E) was calculated by multiplying BMR (KJ/hr) x (MJ/1000 KJ) x duration (hr/day) x MET.
[e] V_E (inhalation rate) was calculated by multiplying E (MJ/day) by H(0.05 m^3 oxygen/MJ) by VQ (27).
[f] V_E (m^3/hr) was calculated by multiplying BMR (KJ/hr) x (MJ/1000 KJ) x MET x H (0.05 m^3 oxygen/MJ) x VQ (27).

Source: Layton, 1993.

Table 6-45. Inhalation Rates for Short-term Exposures

Gender/Age (years)	Body Weight (kg)[a]	BMR[b] (MJ/day)	Activity Type				
			Rest	Sedentary	Light	Moderate	Heavy
			MET (BMR Multiplier)				
			1	1.2	2[c]	4[d]	10[e]
			Inhalation Rate (m^3/minute)[f,g]				
Males							
0.5 to <3	14	3.40	3.2E-03	3.8E-03	6.3E-03	1.3E-02	–[h]
3 to <10	23	4.30	4.0E-03	4.8E-03	8.2E-03	1.6E-02	–[h]
10 to <18	53	6.70	6.3E-03	7.5E-03	1.3E-02	2.5E-02	6.3E-02
18 to <30	76	7.70	7.2E-03	8.7 E-03	1.4 E-02	2.9E-02	7.2 E-02
30 to <60	80	7.50	7.0E-03	8.3 E-03	1.4 E-02	2.8E-02	7.0 E-02
60+	75	6.10	5.7E-03	6.8 E-03	1.1 E-02	2.3E-02	5.7 E-02
Females							
0.5 to <3	11	2.60	2.4E-03	2.8E-03	4.8E-03	1.0E-02	–[h]
3 to <10	23	4.00	3.8E-03	4.5E-03	7.5E-03	1.5E-02	–[h]
10 to <18	50	5.70	5.3E-03	6.3E-03	1.1E-02	2.1E-02	5.3E-02
18 to <30	62	5.90	5.5E-03	6.7 E-03	1.1 E-02	2.2E-02	5.5 E-02
30 to <60	68	5.80	5.3E-03	6.5 E-03	1.1 E-02	2.2E-02	5.4 E-02
60+	67	5.30	5.0E-03	6.0 E-03	9.8 E-03	2.0E-02	5.0 E-02

[a] Body weights were based on average weights for age/gender cohorts of the U.S. population

[b] The BMRs for the age/gender cohorts were calculated using the respective body weights and the BMR equations (Table 6-42).

[c] Range = 1.5 - 2.5.

[d] Range = 3 - 5.

[e] Range = >5 - 20.

[f] The inhalation rate was calculated as IR = BMR (MJ/day) × H (0.05 L/KJ) × MET × VQ (27) × (day/1440 min)

[g] Original data were presented in L/min. Conversion to m^3/min was obtained as follows: $\frac{m^3}{1000L} x \frac{L}{\min}$

[h] The maximum possible MET sustainable for more than 5 minutes does not reach 10 for females and males until age 13 and 12, respectively. Therefore, a METs of 10 is not possible for this age category.

Source: Layton, 1993.

Table 6-46. Distributions of Individual and Group Inhalation/Ventilation Rate for Outdoor Workers

Population Group and Subgroup[a]	Mean ± SD	Ventilation Rate (VR) (m^3/hr) Percentile 1st	50th	99th
All Subjects (n[b] = 19)	1.68 ± 0.72	0.66	1.62	3.90
Job				
GCW[c]/Laborers (n=5)	1.44 ± 0.66	0.48	1.32	3.66
Iron Workers (n=3)	1.62 ± 0.66	0.60	1.56	3.24
Carpenters (n=11)	1.86 ± 0.78	0.78	1.74	4.14
Site				
Medical Office Site (n=7)	1.38 ± 0.66	0.60	1.20	3.72
Hospital Site (n=12)	1.86 ± 0.78	0.72	1.80	3.96

[a] Each group or subgroup mean was calculated from individual means, not from pooled data.
[b] n = number of individuals performing specific jobs or number of individuals at survey sites.
[c] GCW - general construction worker.

Source: Linn et al., 1993.

Table 6-47. Individual Mean Inhalation Rate (m^3/hr) by Self-Estimated Breathing Rate or Job Activity Category for Outdoor Workers

Population Group and Subgroup	Self-Estimated Breathing Rate (m^3/hr) Slow	Med	Fast	Job Activity Category (m^3/hr) Sit/Std	Walk	Carry	Trade[b]
All Subjects (n=19)	1.44	1.86	2.04	1.56	1.80	2.10	1.92
Job							
GCW[a]/Laborers (n=5)	1.20	1.56	1.68	1.26	1.44	1.74	1.56
Iron Workers (n=3)	1.38	1.86	2.10	1.62	1.74	1.98	1.92
Carpenters (n=11)	1.62	2.04	2.28	1.62	1.92	2.28	2.04
Site							
Office Site (n=12)	1.14	1.44	1.62	1.14	1.38	1.68	1.44
Hospital Site (n=12)	1.62	2.16	2.40	1.80	2.04	2.34	2.16

[a] GCW - general construction worker.
[b] Trade - "Working at Trade" (i.e., tasks specific to the individual's job classification).

Source: Linn et al., 1993.

Table 6-48. Mean, Median, and SD of Inhalation Rate According to Waking or Sleeping in 618 Infants and Children Grouped in Classes of Age

Age (months)	N	Inhalation Rate (breaths/min)			
		Waking		Sleeping	
		Mean ± SD	Median	Mean ± SD	Median
<2	104	48.0 ± 9.1	47	39.8 ± 8.7	39
2 to <6	106	44.1 ± 9.9	42	33.4 ± 7.0	32
6 to <12	126	39.1 ± 8.5	38	29.6 ± 7.0	28
12 to <18	77	34.5 ± 5.8	34	27.2 ± 5.6	26
18 to <24	65	32.0 ± 4.8	32	25.3 ± 4.6	24
24 to <30	79	30.0 ± 6.2	30	23.1 ± 4.6	23
30 to 36	61	27.1 ± 4.1	28	21.5 ± 3.7	21

SD = Standard deviation.
N = Number of individuals.

Source: Rusconi et al., 1994.

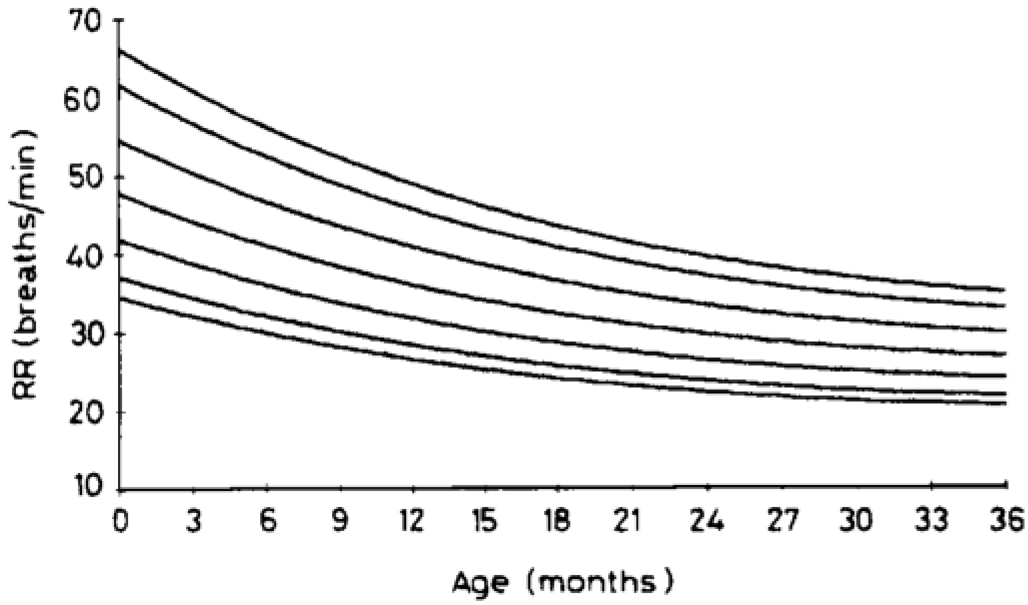

Figure 6-1. 5th, 10th, 25th, 50th, 75th, 90th, and 95th Smoothed Centiles by Age in Awake Subjects (RR = respiratory rate). Source: Rusconi et al., 1994.

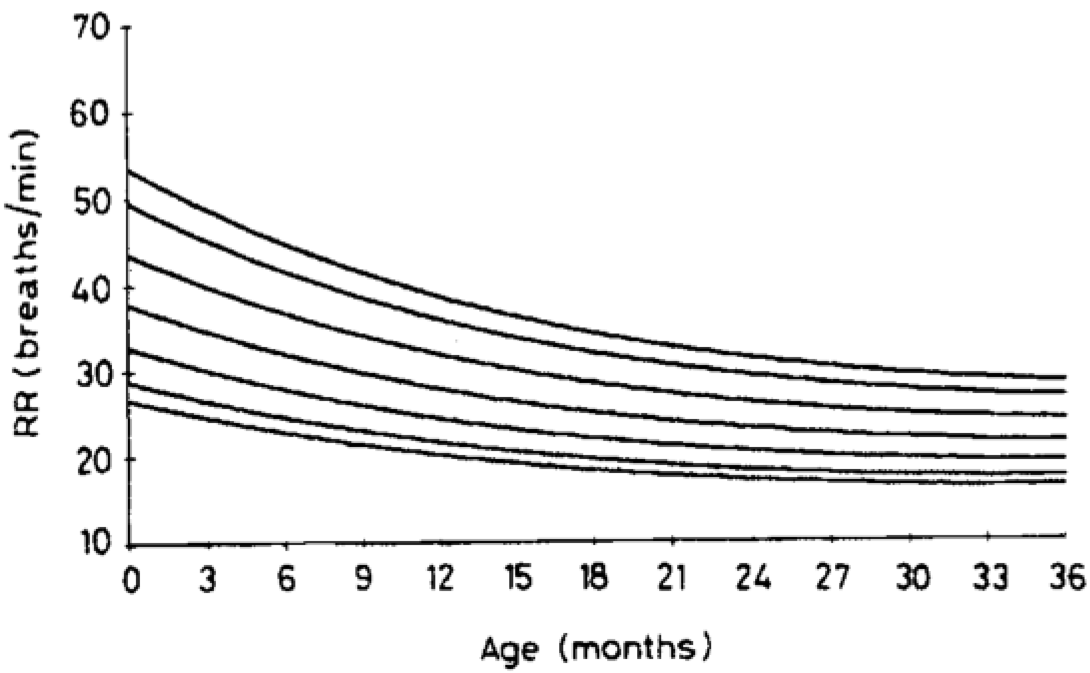

Figure 6-2. 5th, 10th, 25th, 50th, 75th, 90th, and 95th Smoothed Centiles by Age in Asleep Subjects (RR = respiratory rate). Source: Rusconi et al., 1994.

Table 6-49. Distribution of physiological daily inhalation rate (m^3/day) percentiles for free-living underweight[a] adolescents and women aged 11 to 55 years during pregnancy and postpartum weeks.

Age group (years)	Progression of the reproductive cycle		Number of subjects[b] nExp or NSim	Physiological daily inhalation rates[c] (m^3/day)								
					Percentile							
				Mean ± S.D.	5th	10th	25th	50th	75th	90th	95th	99th
11 to <23	Non-pregnant females		50	12.18 ± 2.08	8.76	9.52	10.78	12.18	13.58	14.84	15.60	17.02
	Prepregnancy	0 week	5,000	12.27 ± 1.95	9.35	9.74	10.79	12.18	13.72	14.63	15.48	16.90
	Pregnancy	9th week	5,000	17.83 ± 4.52	13.20	13.91	15.40	17.34	19.55	21.38	23.13	27.40
	Pregnancy	22nd week	5,000	17.98 ± 4.77	13.19	13.95	15.47	17.46	19.73	22.09	23.90	30.69
	Pregnancy	36th week	5,000	18.68 ± 4.73	13.44	14.25	15.96	17.88	20.24	23.01	25.59	34.45
	Postpartum	6th week	5,000	20.39 ± 2.69	16.31	17.02	18.47	20.31	22.22	23.79	24.82	26.62
	Postpartum	27th week	5,000	20.21 ± 2.66	16.17	16.88	18.31	20.14	22.02	23.58	24.61	26.39
23 to <30	Non-pregnant females		17	13.93 ± 2.27	10.20	11.02	12.40	13.93	13.93	16.83	17.65	19.20
	Prepregnancy	0 week	5,000	13.91 ± 2.17	11.41	11.50	12.08	13.92	15.32	16.01	17.81	19.97
	Pregnancy	9th week	5,000	20.03 ± 5.01	15.83	16.17	17.08	19.75	21.60	23.76	26.94	34.21
	Pregnancy	22nd week	5,000	20.15 ± 4.24	15.81	16.16	17.07	19.80	21.67	24.49	27.46	32.69
	Pregnancy	36th week	5,000	20.91 ± 5.37	15.97	16.37	17.56	20.29	22.31	26.42	28.95	38.26
	Postpartum	6th week	5,000	22.45 ± 2.91	18.70	19.15	20.14	22.23	24.15	25.65	27.68	30.57
	Postpartum	27th week	5,000	22.25 ± 2.89	18.53	18.98	19.96	22.04	23.94	25.42	27.44	30.30
30 to 55	Non-pregnant females		14	12.89 ± 1.40	10.58	11.09	11.94	12.89	12.89	14.69	15.20	16.16
	Prepregnancy	0 week	5,000	12.91 ± 1.36	10.85	11.28	11.99	12.49	13.98	14.99	15.13	15.18
	Pregnancy	9th week	5,000	18.68 ± 3.95	15.33	15.93	16.79	18.05	20.22	21.39	22.69	27.38
	Pregnancy	22nd week	5,000	18.84 ± 4.08	15.30	15.93	16.80	18.07	20.23	21.52	23.20	30.80
	Pregnancy	36th week	5,000	19.60 ± 4.66	15.54	16.14	17.03	18.73	20.74	23.04	25.58	34.26
	Postpartum	6th week	5,000	21.19 ± 1.96	18.30	18.86	19.79	20.92	22.58	23.98	24.53	25.28
	Postpartum	27th week	5,000	21.01 ± 1.94	18.14	18.69	19.62	20.74	22.39	23.77	24.31	25.07

[a] Underweight females are defined as those having a body mass index lower than 19.8 kg/m^2 in prepregnancy.

[b] nExp = number of experimental non-pregnant and non-lactating females; nSim- = number of simulated females. S.D. = standard deviation.

[c] Resulting TDERs from the integration of energetic measurements in underweight non-pregnant and non-lactating females with those during pregnancy and lactation by Monte Carlo simulations were converted into physiological daily inhalation rates by the following equation: TDER*H*(V_E/VO_2)*10~^{3}. TDER = total energy requirement (EGG + TDEE). EGG = stored daily energy cost for growth; TDEE = total daily energy.

Source: Brochu et al., 2006b.

Table 6-50. Distribution of physiological daily inhalation rate (m^3/day) percentiles for free-living normal-weight[a] adolescents and women aged 11 to 55 years during pregnancy and postpartum weeks.

Age group (years)	Progression of the reproductive cycle		Number of subjects[b] nExp or NSim	Physiological daily inhalation rates[c] (m^3/day)								
				Mean ± S.D.	Percentile 5th	10th	25th	50th	75th	90th	95th	99th
11 to <23	Non-pregnant females		57	14.55 ± 2.70	10.11	11.09	12.73	14.55	16.37	18.01	18.99	20.83
	Prepregnancy	0 week	5,000	14.55 ± 2.69	9.71	10.83	13.29	14.78	15.89	17.34	18.71	20.91
	Pregnancy	9th week	5,000	19.99 ± 3.89	13.32	14.84	18.32	20.26	21.86	23.86	25.89	28.75
	Pregnancy	22nd week	5,000	22.59 ± 4.83	15.35	17.09	20.06	22.27	24.69	28.25	30.75	35.88
	Pregnancy	36th week	5,000	23.27 ± 4.63	16.01	17.76	20.69	23.10	25.55	28.77	31.07	35.65
	Postpartum	6th week	5,000	23.28 ± 3.60	16.91	18.36	21.40	23.56	25.24	27.17	28.98	31.80
	Postpartum	27th week	5,000	23.08 ± 3.56	16.76	18.20	21.21	23.36	25.02	26.93	28.73	31.52
23 to <30	Non-pregnant females		54	13.59 ± 2.23	9.92	10.73	12.09	13.59	15.09	16.45	17.26	18.78
	Prepregnancy	0 week	5,000	13.66 ± 2.29	10.19	10.64	12.12	13.73	14.90	16.49	17.87	19.09
	Pregnancy	9th week	5,000	19.00 ± 9.98	13.92	14.55	16.55	18.76	20.49	22.80	24.49	27.04
	Pregnancy	22nd week	5,000	21.36 ± 4.36	15.54	16.70	18.63	20.89	23.58	26.59	28.43	33.98
	Pregnancy	36th week	5,000	22.14 ± 4.13	16.21	17.34	19.35	21.69	24.55	27.59	29.27	32.77
	Postpartum	6th week	5,000	22.15 ± 30.5	17.37	18.26	20.11	22.11	23.96	26.21	27.53	29.21
	Postpartum	27th week	5,000	21.96 ± 3.02	17.22	18.10	19.93	21.91	23.75	25.98	27.29	28.96
30 to 55	Non-pregnant females		61	13.82 ± 1.91	10.67	11.37	12.53	13.82	15.12	16.28	16.97	18.28
	Prepregnancy	0 week	5,000	13.79 ± 1.83	11.07	11.48	12.54	13.61	14.91	16.40	17.02	18.32
	Pregnancy	9th week	5,000	19.02 ± 3.81	15.18	15.74	17.14	18.63	20.46	22.45	23.38	27.39
	Pregnancy	22nd week	5,000	21.53 ± 4.06	16.71	17.56	19.01	20.85	23.45	26.03	28.30	33.44
	Pregnancy	36th week	5,000	22.20 ± 3.68	17.45	18.19	19.69	21.73	24.16	26.78	28.53	32.75
	Postpartum	6th week	5,000	22.31 ± 2.50	18.72	19.35	20.58	22.09	23.84	25.70	26.70	28.39
	Postpartum	27th week	5,000	22.12 ± 2.48	18.55	19.18	20.40	21.90	23.64	25.47	26.47	28.14

[a] Normal-weight females are defined as those having a body mass index varying between 19.8 and 26 kg/m^2 in prepregnancy.
[b] nExp = number of experimental non-pregnant and non-lactating females; nSim- = number of simulated females. S.D. = standard deviation.
[c] Resulting TDERs from the integration of energetic measurements in underweight non-pregnant and non-lactating females with those during pregnancy and lactation by Monte Carlo simulations were converted into physiological daily inhalation rates by the following equation: $TDER*H*(V_E/VO_2)*10^{\sim 3}$. TDER = total energy requirement (EGG + TDEE). EGG = stored daily energy cost for growth; TDEE = total daily energy.

Source: Brochu et al., 2006b.

Table 6-51. Distribution of physiological daily inhalation rate (m^3/day) percentiles for free-living overweight/obese[a] adolescents and women aged 11 to 55 years during pregnancy and postpartum weeks.

Age group (years)	Progression of the reproductive cycle		Number of subjects[b] nExp or NSim	Physiological daily inhalation rates[c] (m^3/day)									
					Percentile								
				Mean $\pm$ S.D.	5th	10th	25th	50th	75th	90th	95th	99th	
11 to <23	Non-pregnant females		15	16.62 $\pm$ 2.91	11.82	12.88	14.65	16.62	18.58	20.35	21.41	23.39	
	Prepregnancy	0 week	5,000	16.64 $\pm$ 2.81	10.21	12.13	15.52	17.22	18.52	19.68	20.06	20.16	
	Pregnancy	9th week	5,000	25.51 $\pm$ 6.48	16.11	19.09	23.04	25.38	27.85	30.62	33.32	41.61	
	Pregnancy	22nd week	5,000	26.10 $\pm$ 6.96	16.38	19.29	23.12	25.65	28.17	31.56	34.93	45.94	
	Pregnancy	36th week	5,000	25.71 $\pm$ 8.09	15.67	18.78	22.73	25.23	27.84	31.14	34.95	46.76	
	Postpartum	6th week	5,000	25.93 $\pm$ 3.70	17.94	20.12	24.52	26.61	28.38	29.87	30.53	31.27	
	Postpartum	27th week	5,000	25.71 $\pm$ 3.67	17.79	19.94	24.30	26.38	28.13	29.61	30.26	31.00	
23 to <30	Non-pregnant females		25	15.45 $\pm$ 2.32	11.63	12.47	13.88	15.45	17.02	18.43	19.27	20.86	
	Prepregnancy	0 week	5,000	15.47 $\pm$ 2.27	11.94	13.12	14.36	15.50	16.86	17.96	19.46	20.41	
	Pregnancy	9th week	5,000	23.93 $\pm$ 5.94	17.75	19.13	21.08	23.22	25.62	29.09	31.77	40.74	
	Pregnancy	22nd week	5,000	24.44 $\pm$ 6.24	18.06	19.45	21.32	23.51	26.44	29.92	33.49	44.56	
	Pregnancy	36th week	5,000	24.15 $\pm$ 6.82	17.60	19.00	20.91	23.05	26.02	30.04	34.18	47.31	
	Postpartum	6th week	5,000	24.47 $\pm$ 3.04	19.31	21.07	22.80	24.45	26.16	27.93	29.43	31.08	
	Postpartum	27th week	5,000	24.25 $\pm$ 3.02	19.14	20.88	22.60	24.23	25.93	27.68	29.17	30.81	
30 to 55	Non-pregnant females		64	15.87 $\pm$ 2.52	11.72	12.63	14.17	15.87	17.57	19.10	20.01	21.73	
	Prepregnancy	0 week	5,000	15.83 $\pm$ 2.46	11.92	12.79	14.30	15.79	17.19	18.78	19.47	22.03	
	Pregnancy	9th week	5,000	24.47 $\pm$ 5.68	17.87	19.17	21.38	23.77	26.37	29.77	33.08	41.49	
	Pregnancy	22nd week	5,000	25.02 $\pm$ 6.65	18.13	19.41	21.44	23.92	26.93	30.98	35.01	46.88	
	Pregnancy	36th week	5,000	24.46 $\pm$ 6.24	17.67	18.83	20.92	23.40	26.37	30.32	34.27	45.08	
	Postpartum	6th week	5,000	24.91 $\pm$ 3.28	19.82	20.92	22.82	24.91	26.81	28.70	29.75	32.94	
	Postpartum	27th week	5,000	24.70 $\pm$ 3.25	19.65	20.74	22.63	24.69	26.58	28.45	29.50	32.65	

[a] Overweight/obese females are defined as those having a body mass index higher than 26 kg/m^2 in prepregnancy.

[b] nExp = number of experimental non-pregnant and non-lactating females; nSim- = number of simulated females. S.D. = standard deviation.

[c] Resulting TDERs from the integration of energetic measurements in underweight non-pregnant and non-lactating females with those during pregnancy and lactation by Monte Carlo simulations were converted into physiological daily inhalation rates by the following equation: TDER*H*(V_E/VO_2)*10~^{3}. TDER = total energy requirement (EGG + TDEE). EGG = stored daily energy cost for growth; TDEE = total daily energy.

Source: Brochu et al., 2006b.

Table 6-52. Distribution of physiological daily inhalation rate (m^s/kg-day) percentiles for free-living underweight[a] adolescents and women aged 11 to 55 years during pregnancy and postpartum weeks. years during pregnancy and postpartum weeks.

Age group (years)	Progression of the reproductive cycle		Number of subjects[b] nExp or NSim	Physiological daily inhalation rates[c] (m^3/kg-day)								
					Percentile							
				Mean ± S.D.	5th	10th	25th	50th	75th	90th	95th	99th
11 to <23	Non-pregnant females		50	0.277 ± 0.046	0.201	0.218	0.246	0.277	0.277	0.335	0.352	0.383
	Prepregnancy	0 week	5,000	0.276 ± 0.045	0.209	0.218	0.238	0.277	0.313	0.337	0.345	0.368
	Pregnancy	9th week	5,000	0.385 ± 0.110	0.278	0.291	0.327	0.377	0.428	0.474	0.504	0.622
	Pregnancy	22nd week	5,000	0.343 ± 0.093	0.246	0.259	0.291	0.335	0.378	0.419	0.455	0.602
	Pregnancy	36th week	5,000	0.323 ± 0.083	0.230	0.243	0.274	0.314	0.357	0.404	0.452	0.575
	Postpartum	6th week	5,000	0.368 ± 0.058	0.321	0.337	0.370	0.414	0.467	0.517	0.548	0.596
	Postpartum	27th week	5,000	0.383 ± 0.064	0.329	0.348	0.383	0.433	0.491	0.549	0.584	0.647
23 to <30	Non-pregnant females		17	0.264 ± 0.047	0.186	0.203	0.232	0.264	0.264	0.325	0.342	0.374
	Prepregnancy	0 week	5,000	0.264 ± 0.046	0.206	0.212	0.228	0.257	0.284	0.342	0.361	0.362
	Pregnancy	9th week	5,000	0.366 ± 0.098	0.277	0.287	0.311	0.351	0.400	0.468	0.501	0.591
	Pregnancy	22nd week	5,000	0.332 ± 0.076	0.250	0.260	0.282	0.318	0.362	0.421	0.452	0.532
	Pregnancy	36th week	5,000	0.317± 0.086	0.233	0.242	0.266	0.301	0.346	0.402	0.439	0.582
	Postpartum	6th week	5,000	0.352 ± 0.056	0.307	0.320	0.348	0.385	0.431	0.486	0.518	0.573
	Postpartum	27th week	5,000	0.364 ± 0.061	0.316	0.330	0.357	0.397	0.449	0.508	0.545	0.606
30 to 55	Non-pregnant females		14	0.249 ± 0.027	0.204	0.214	0.231	0.249	0.249	0.283	0.293	0.312
	Prepregnancy	0 week	5,000	0.249 ± 0.026	0.208	0.220	0.232	0.242	0.268	0.286	0.294	0.299
	Pregnancy	9th week	5,000	0.347 ± 0.075	0.279	0.291	0.311	0.337	0.370	0.405	0.431	0.529
	Pregnancy	22nd week	5,000	0.315 ± 0.071	0.252	0.262	0.280	0.305	0.335	0.368	0.401	0.529
	Pregnancy	36th week	5,000	0.301 ± 0.074	0.233	0.243	0.260	0.287	0.321	0.360	0.404	0.529
	Postpartum	6th week	5,000	0.337 ± 0.038	0.312	0.326	0.347	0.376	0.408	0.439	0.457	0.489
	Postpartum	27th week	5,000	0.349 ± 0.042	0.320	0.333	0.357	0.389	0.425	0.462	0.483	0.518

[a] Underweight females are defined as those having a body mass index lower than 19.8 kg/m^2 in prepregnancy.
[b] nExp = number of experimental non-pregnant and non-lactating females; nSim- = number of simulated females. S.D. = standard deviation.
[c] Resulting TDERs from the integration of energetic and weight measurements in normal-weight non-pregnant and non-lactating females with those during pregnancy and lactation by Monte Carlo simulations were converted into physiological daily inhalation rates by the following equation: TDER*H*(V_E/VC>2)*10~^{3}. TDER = total energy requirement (EGG + TDEE). ECG = stored daily energy cost for growth; TDEE = total daily energy expenditure.

Source: Brochu et al., 2006b.

Table 6-53. Distribution of physiological daily inhalation rate (m^3/kg-day) percentiles for free-living normal-weight[a] and women aged 11 to 55 years during pregnancy and postpartum weeks.

Age group (years)	Progression of the reproductive cycle	Number of subjects[b] nExp or NSim	Physiological daily inhalation rates[c] (m^3/kg-day)								
				Percentile							
			Mean ± S.D.	5th	10th	25th	50th	75th	90th	95th	99th
11 to <23	Non-pregnant females	15	0.252 ± 0.051	0.168	0.186	0.217	0.252	0.286	0.317	0.336	0.370
	Prepregnancy 0 week	5,000	0.252 ± 0.051	0.169	0.189	0.218	0.246	0.282	0.324	0.339	0.361
	Pregnancy 9th week	5,000	0.344 ± 0.074	0.232	0.259	0.297	0.336	0.388	0.440	0.468	0.518
	Pregnancy 22nd week	5,000	0.360 ± 0.085	0.243	0.268	0.304	0.349	0.406	0.462	0.500	0.594
	Pregnancy 36th week	5,000	0.329 ± 0.072	0.225	0.247	0.281	0.323	0.372	0.422	0.453	0.517
	Postpartum 6th week	5,000	0.342 ± 0.062	0.272	0.292	0.327	0.369	0.418	0.469	0.499	0.544
	Postpartum 27th week	5,000	0.352 ± 0.067	0.279	0.298	0.334	0.380	0.433	0.490	0.527	0.580
23 to <30	Non-pregnant females	54	0.221 ± 0.035	0.164	0.176	0.197	0.221	0.244	0.265	0.278	0.301
	Prepregnancy 0 week	5,000	0.222 ± 0.035	0.174	0.181	0.199	0.218	0.242	0.269	0.285	0.317
	Pregnancy 9th week	5,000	0.308 ± 0.189	0.233	0.243	0.269	0.298	0.333	0.371	0.395	0.458
	Pregnancy 22nd week	5,000	0.321 ± 0.067	0.239	0.252	0.277	0.310	0.351	0.399	0.433	0.521
	Pregnancy 36th week	5,000	0.297 ± 0.056	0.220	0.233	0.258	0.289	0.328	0.369	0.399	0.448
	Postpartum 6th week	5,000	0.309 ± 0.045	0.265	0.278	0.302	0.333	0.368	0.402	0.425	0.464
	Postpartum 27th week	5,000	0.317 ± 0.049	0.269	0.283	0.309	0.342	0.380	0.416	0.441	0.490
30 to 55	Non-pregnant females	61	0.229 ± 0.035	0.171	0.184	0.206	0.229	0.253	0.274	0.287	0.311
	Prepregnancy 0 week	5,000	0.229 ± 0.035	0.174	0.187	0.202	0.229	0.253	0.275	0.287	0.302
	Pregnancy 9th week	5,000	0.314 ± 0.069	0.237	0.252	0.276	0.309	0.346	0.382	0.400	0.443
	Pregnancy 22nd week	5,000	0.330 ± 0.069	0.242	0.257	0.285	0.321	0.365	0.409	0.439	0.522
	Pregnancy 36th week	5,000	0.303 ± 0.057	0.225	0.238	0.264	0.297	0.336	0.373	0.401	0.461
	Postpartum 6th week	5,000	0.316 ± 0.046	0.267	0.280	0.307	0.343	0.382	0.416	0.434	0.467
	Postpartum 27th week	5,000	0.325 ± 0.050	0.272	0.285	0.314	0.352	0.394	0.432	0.453	0.491

a Normal-weight females are defined as those having a body mass index varying between 19.8 and 26 kg/m^2 in prepregnancy.

b nExp = number of experimental non-pregnant and non-lactating females; nSim- = number of simulated females. S.D. = standard deviation.

c Resulting TDERs from the integration of energetic and weight measurements in normal-weight non-pregnant and non-lactating females with those during pregnancy and lactation by Monte Carlo simulations were converted into physiological daily inhalation rates by the following equation: $TDER*H*(V_E/VC>2)*10\sim^3$. TDER = total energy requirement (EGG + TDEE). ECG = stored daily energy cost for growth; TDEE = total daily energy expenditure.

Source: Brochu et al., 2006b.

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Table 6-54. Distribution of physiological daily inhalation rate (m^3/kg-day) percentiles for free-living overweight/obese[a] adolescents and women aged 11 to 55 years during pregnancy and postpartum weeks.

Age group (years)	Progression of the reproductive cycle		Number of subjects[b] nExp or NSim	Physiological daily inhalation rates[c] (m^3/kg-day)								
					Percentile							
				Mean ± S.D.	5th	10th	25th	50th	75th	90th	95th	99th
11 to <23	Non-pregnant females		15	0.206 ± 0.033	0.151	0.163	0.184	0.206	0.229	0.249	0.261	0.284
	Prepregnancy	0 week	5,000	0.207 ± 0.032	0.146	0.153	0.188	0.214	0.227	0.240	0.253	0.259
	Pregnancy	9th week	5,000	0.302 ± 0.075	0.205	0.223	0.263	0.298	0.329	0.368	0.401	0.515
	Pregnancy	22nd week	5,000	0.287 ± 0.079	0.191	0.206	0.246	0.279	0.314	0.357	0.391	0.512
	Pregnancy	36th week	5,000	0.270 ± 0.090	0.179	0.193	0.225	0.259	0.296	0.337	0.377	0.521
	Postpartum	6th week	5,000	0.280 ± 0.050	0.213	0.230	0.266	0.301	0.337	0.372	0.395	0.444
	Postpartum	27th week	5,000	0.285 ± 0.053	0.214	0.233	0.269	0.307	0.344	0.381	0.409	0.464
23 to <30	Non-pregnant females		54	0.186 ± 0.025	0.144	0.153	0.169	0.186	0.203	0.218	0.227	0.244
	Prepregnancy	0 week	5,000	0.186 ± 0.025	0.143	0.155	0.172	0.183	0.201	0.222	0.233	0.236
	Pregnancy	9th week	5,000	0.274 ± 0.068	0.203	0.217	0.238	0.263	0.298	0.337	0.374	0.476
	Pregnancy	22nd week	5,000	0.261 ± 0.069	0.193	0.205	0.224	0.248	0.283	0.323	0.360	0.466
	Pregnancy	36th week	5,000	0.245 ± 0.074	0.175	0.185	0.205	0.231	0.268	0.314	0.360	0.498
	Postpartum	6th week	5,000	0.256 ± 0.042	0.205	0.217	0.241	0.271	0.304	0.338	0.360	0.406
	Postpartum	27th week	5,000	0.260 ± 0.046	0.209	0.222	0.246	0.277	0.311	0.349	0.372	0.426
30 to 55	Non-pregnant females		61	0.184 ± 0.031	0.132	0.144	0.163	0.184	0.205	0.224	0.235	0.257
	Prepregnancy	0 week	5,000	0.184 ± 0.031	0.127	0.141	0.166	0.185	0.205	0.221	0.226	0.246
	Pregnancy	9th week	5,000	0.272 ± 0.068	0.184	0.203	0.234	0.263	0.299	0.343	0.378	0.465
	Pregnancy	22nd week	5,000	0.259 ± 0.071	0.176	0.194	0.222	0.249	0.282	0.322	0.363	0.490
	Pregnancy	36th week	5,000	0.242 ± 0.068	0.162	0.177	0.201	0.230	0.265	0.313	0.351	0.455
	Postpartum	6th week	5,000	0.253 ± 0.048	0.188	0.205	0.237	0.270	0.305	0.340	0.364	0.404
	Postpartum	27th week	5,000	0.257 ± 0.051	0.191	0.208	0.239	0.273	0.310	0.348	0.374	0.430

a Overweight/obese females are defined as those having a body mass index higher than 26 kg/m^2 in prepregnancy.
b nExp = number of experimental non-pregnant and non-lactating females; nSim- = number of simulated females. S.D. = standard deviation.
c Resulting TDERs from the integration of energetic and weight measurements in normal-weight non-pregnant and non-lactating females with those during pregnancy and lactation by Monte Carlo simulations were converted into physiological daily inhalation rates by the following equation: TDER*H*(V_E/VC>2)*10~^{3}. TDER = total energy requirement (EGG + TDEE). ECG = stored daily energy cost for growth; TDEE = total daily energy expenditure.

Source: Brochu et al., 2006b.

Table 6-55. Concordance of Age Groupings Among Key Studies

Age Group[a]	U.S. EPA (2009)	Brochu (2006a)	Arcus-Arth and Blaisdell (2007)	Stifelman (2007)
Birth to <1 month	—	—	0 to 2 months	—
1 to <3 months	—	0.22 to <0.5 year	0 to 2 months	—
3 to <6 months	—	0.22 to <0.5 year	3 to 5 months	—
6 to <12 months	—	0.5 to <1 year	6 to 8 months	—
	—	—	9 to 11 months	—
Birth to <1 year	Birth to <1 year	0.22 to <0.5 year	0 to 11 months	<1 year
	—	0.5 to <1 year	—	—
1 to <2 years	1 to < 2 years	1 to <2 years	1 year	1 year
2 to <3 years	2 to < 3 years	2 to <5 years	2 years	2 years
3 to <6 years	3 to <6 years	2 to <5 years	3 years	3 years
	—	—	4 years	4 years
	—	—	5 years	5 years
6 to <11 years	6 to <11 years	7 to <11 years	6 years	6 years
	—	—	7 years	7 years
	—	—	8 years	8 years
	—	—	9 years	9 years
	—	—	10 years	10 years
11 to <16 years	11 to <16 years	11 to <23 years	11 years	11 years
	—	—	12 years	12 years
	—	—	13 years	13 years
	—	—	14 years	14 years
	—	—	15 years	15 years
16 to <21 years	16 to <21 years	11 to <23 years	16 years	16 years
	—	—	17 years	17 years
	—	—	18 years	18 years
	—	—	—	19 to 30 years
21 to <31 years	21 to <31 years	11 to <23 years	—	19 to 30 years
	—	23 to <30 years	—	—
31 to <41 years	31 to <41 years	30 to <40 years	—	31 to 50 years
41 to <51 years	41 to <51 years	40 to <65 years	—	31 to 50 years
51 to <61 years	51 to <61 years	40 to <65 years	—	51 to 70 years
61 to <71 years	61 to <71 years	40 to <65 years	—	51 to 70 years
	—	65 to ≤96 years	—	—
71 to <81 years	71 to <81 years	65 to ≤96 years	—	—
81 years and older	81 years and older	65 to ≤96 years	—	—

[a.] When age groups in the original reference did not match the EPA groupings used for this handbook, statistics were averaged from all age groupings in the original reference that overlapped EPA's age groupings by more than 1 year, weighted by the number of observations contributed from each age group. For example, Brochu 2006a contributes its 2 to <5-year age group data to both EPA's 2 to < 3-year and 3 to <6-year age groups.

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7 DERMAL EXPOSURE FACTORS

7.1 INTRODUCTION

Dermal exposure can occur during a variety of activities in different environmental media and microenvironments (U.S. EPA, 1992a; 1992b; 2004). These include:

- Water (e.g., bathing, washing, swimming);
- Soil (e.g., outdoor recreation, gardening, construction);
- Sediment (e.g., wading, fishing);
- Liquids (e.g., use of commercial products);
- Vapors/fumes (e.g., use of commercial products); and
- Indoor dust (e.g., carpets, floors, counter tops).

This chapter focuses on measurements of body surface area and dermal adherence of solids to the skin. These are only two of several parameters that influence dermal absorption. Other factors include the concentration of chemical in contact with the skin, characteristics of the chemical (i.e., lipophilicity, polarity, volatility, solubility), the site of application (i.e., the thickness of the stratum corneum varies over parts of the body), absorption of chemical through the skin and factors that affect absorption (i.e, thickness, age, condition), and the amount of chemical delivered to the target organ. For guidance on how to use skin surface area and dermal adherence factors, as well as these other factors to assess dermal exposure, readers are referred to *Dermal Exposure Assessment: Principles and Applications* (U.S. EPA, 1992b) and *Risk Assessment Guidelines for Superfund (RAGs) Part E* (U.S. EPA, 2004). Frequency and duration of contact also affect dermal exposure. Information on activity factors is presented in Chapter 16 of this handbook.

Surface area of the skin can be determined using measurement or estimation techniques. Coating, triangulation, and surface integration are direct measurement techniques that have been used to measure total body surface area and the surface area of specific body parts. The coating method consists of coating either the whole body or specific body regions with a substance of known density and thickness. Triangulation consists of marking the area of the body into geometric figures, then calculating the figure areas from their linear dimensions. Surface integration is performed by using a planimeter and adding the areas. The results of studies conducted using these various techniques have been summarized in *Development of Statistical Distributions or Ranges of Standard Factors Used in Exposure Assessments* (U.S. EPA, 1985). Because of the difficulties associated with direct measurements of body surface area, the existing direct measurement data are limited and dated. However, several researchers have developed methods for estimating body surface area from measurements of other body dimensions (DuBois and DuBois, 1916; Boyd, 1935; Gehan and George, 1970). Generally, these formulas are based on the observation that body weight and height are correlated with surface area and are derived using multiple regression techniques. U.S. EPA (1985) evaluated the various formulas for estimating total body surface area. A discussion and comparison of formulas are presented in Appendix 7A. The key studies on body surface area that are presented in Section 7.3 of this chapter are based on these formulas, and weight and height data from the National Health and Nutrition Examination Survey (NHANES).

Several field studies have been conducted to estimate the adherence of solids to skin. These field studies consider factors such as activity, gender, age, field conditions, and clothing worn. These studies are presented in Section 7.4 of this chapter.

The recommendations for skin surface area and dermal adherence of solids to skin are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values are based on key studies identified by U.S. EPA for these factors. Following the recommendations, the two key studies on skin surface area and the three key studies on dermal adherence of solids to skin are summarized. Relevant data on these factors are also presented to provide added perspective on the state-of-knowledge pertaining to dermal exposure factors.

7.2 RECOMMENDATIONS

7.2.1 Body Surface Area

The recommended mean and 95th percentile total body surface area values are summarized in Table 7-1. If gender-specific data for children, gender-combined data for adults, or data for statistics other than the mean or 95th percentile are needed, the reader is referred to Tables 7-8 through 7-10 of this chapter. The recommendations for total body surface area are based on the U.S. EPA analysis of NHANES 1999-2006 data for children under age 21 years and are presented for the standard age groupings recommended by U.S. EPA (2005) for male and female children combined. For adults 21 years and over, the recommendations for total body surface area are based on the U.S. EPA analysis of NHANES 2005-2006 data. The U.S. EPA analysis of NHANES data uses correlations with body weight and height for deriving skin surface area (see Section 7.3.1.2 and Appendix 7A). NHANES 1999-2006 used a statistically-based survey design which should ensure that the data are reasonably representative of the general population for each two year interval, *e.g.* 1999-2000, 2001-2002, etc. Multiple NHANES study years, supplying a larger sample size, were necessary for estimating surface area for children given the multiple stratifications by age. The recommendations for the percentage of total body surface area represented by individual body parts are based on data from U.S. EPA (1985), and are presented in Table 7-2 (See Section 7.3.1). Table 7-2 also provides age-specific body part surface areas (m^2) that were obtained by multiplying the mean body part percentages by the total body surface areas presented in Table 7-1. If gender-specific data for children, gender-combined data for adults, or data for statistics other than the mean and 95th percentile are needed, the body part percentages in Table 7-2 may be applied to the total skin surface area data in Tables 7-8 through 7-10. Tables 7-11 and 7-12 present the surface area of body parts for males and females respectively, 21 years of age and older. Table 7-3 presents the confidence ratings for the recommendations for body surface area.

For swimming and bathing scenarios, past exposure assessments have assumed that 75 to 100 percent of the skin surface is exposed (U.S. EPA, 1992b). More recent guidance recommends assuming 100 percent exposure for these scenarios (U.S. EPA, 2004). For other exposure scenarios, it is reasonable to assume that clothing reduces the contact area. However, while it is generally assumed that adherence of solids to skin occurs to only the areas of the body not covered by clothing, it is important to understand that soil and dust particles can get under clothing and be deposited on skin to varying degrees depending on the protective properties of the clothing. Likewise, liquids may soak through clothing and contact covered areas of the skin. Assessors should consider these possibilities for the scenario of concern and select skin areas that are judged appropriate.

7.2.2 Adherence of Solids to Skin

The adherence factor (AF) describes the amount of material that adheres to the skin per unit of surface area. Although most research in this area has focused on soils, a variety of other solid residues can accumulate on skin, including household dust, sediments and commercial powders. Studies on soil adherence have shown that: 1) soil properties influence adherence; 2) soil adherence varies considerably across different parts of the body; and 3) soil adherence varies with activity (U.S. EPA, 2004). It is recommended that exposure assessors use adherence data derived from testing that matches the exposure scenario of concern in terms of solid type, exposed body parts, and activities, as closely as possible. Assessors should refer to the activities described in Table 7-16 to select those that best represent the exposure scenarios of concern and use the corresponding adherence values from Table 7-17. Table 7-16 lists the age ranges covered by each study. This may be used as a general guide to the ages covered by these data. Recommended mean AF values are summarized in Table 7-4 according to common activities.. Insufficient data were available to develop distributions or probability functions for these values. Also, the small number of subjects in these studies prevented the development of recommendations for the childhood specific age groups recommended by U.S. EPA (2005).

RAGS Part E (U.S. EPA, 2004) recommends that scenario-specific adherence values be weighted according to the body parts exposed. Weighted adherence factors may be estimated according to the following equation:

$$AF_{wtd} = \frac{(AF_1)(SA_1) + (AF_2)(SA_2) + \ldots (AF_i)(SA_i)}{SA_1 + SA_2 + \ldots SA_i}$$

(Eqn. 7-1)

where:

AF_{wtd}	=	weighted adherence factor;
AF	=	adherence factor; and
SA	=	surface area.

For the purposes of this calculation, the surface area of the face may be assumed to be 1/3 that of the head, forearms may be assumed to represent 45 percent of the arms and lower legs may be assumed to represent 40 percent of the legs (U.S. EPA, 2004).

The recommended dermal AFs represent the amount of material on the skin at the time of measurement. U.S. EPA (1992b) recommends interpreting AFs as representative of contact events. Assuming that the amount of solids measured on the skin represents accumulation between washings, and that people wash at least once per day, these adherence values can be interpreted as daily contact rates (U.S. EPA, 1992b). The rate of solids accumulation on skin over time has not been well studied, but probably occurs fairly quickly. Therefore, pro-rating the adherence values for exposure time periods of less than one day is not recommended.

The confidence ratings for these AF

recommendations are shown in Table 7-5. It should be noted that while the recommendations are based on the best available estimates of activity-specific adherence, they are based on limited data from studies that have focused primarily on soil. Therefore, they have a high degree of uncertainty and considerable judgment must be used when selecting them for an assessment. It should also be noted that the skin adherence studies have not considered the influence of skin moisture on adherence. Skin moisture varies depending on a number of factors, including activity level and ambient temperature/humidity. It is uncertain how well this variability has been captured in the dermal adherence studies.

Table 7-1. Recommended Values for Total Body Surface Area, For Children (Genders Combined) and Adults by Gender				
Age Group	Mean (m^2)	95th Percentile (m^2)	Multiple Percentiles	Source
Birth to <1 month	0.29	0.34	See Tables 7-8, 7-9, and 7-10	U.S. EPA Analysis of NHANES 1999-2006 data
1 to <3 months	0.33	0.38		
3 to <6 months	0.38	0.44		
6 to <12 months	0.45	0.51		
1 to <2 years	0.53	0.61		
2 to <3 years	0.61	0.70		
3 to <6 years	0.76	0.95		
6 to <11 years	1.08	1.48		
11 to <16 years	1.59	2.06		
16 to <21 years	1.84	2.33		
Adult Males			See Tables 7-8 (for gender-combined data), 7-9 and 7-10	U.S. EPA Analysis of NHANES 2005-2006 data
21 to 30 years	2.05	2.52		
30 to <40 years	2.10	2.50		
40 to < 50 years	2.15	2.56		
50 to < 60 years	2.11	2.55		
60 to < 70 years	2.08	2.46		
70 to < 80 years	2.05	2.45		
80 years and over	1.92	2.22		
Adult Females			See Tables 7-8 (for gender-combined data), 7-9, and 7-10	U.S. EPA Analysis of NHANES 2005-2006 data
21 to 30 years	1.81	2.25		
30 to <40 years	1.85	2.31		
40 to < 50 years	1.88	2.36		
50 to < 60 years	1.89	2.38		
60 to < 70 years	1.88	2.34		
70 to < 80 years	1.77	2.13		
80 years and over	1.69	1.98		

Table 7-2. Recommended Values for Surface Area of Body Parts							
Age Group	Head	Trunk	Arms	Hands	Legs	Feet	Source
	Mean Percent of Total Surface Area						
Birth to <1 month	18.2	35.7	13.7	5.3	20.6	6.5	U.S. EPA, 1985
1 to <3 months	18.2	35.7	13.7	5.3	20.6	6.5	
3 to <6 months	18.2	35.7	13.7	5.3	20.6	6.5	
6 to <12 months	18.2	35.7	13.7	5.3	20.6	6.5	
1 to <2 years	16.5	35.5	13.0	5.7	23.1	6.3	
2 to <3 years	14.2	38.5	11.8	5.3	23.2	7.1	
3 to <6 years	13.7	31.7	14.2	5.9	27.3	7.3	
6 to <11 years	12.6	34.7	12.7	5.0	27.9	7.2	
11 to <16 years	9.4	33.7	12.9	5.3	31.3	7.5	
16 to <21 years	7.8	32.2	15.3	5.4	32.2	7.1	
Adult Males							U.S. EPA Analysis of NHANES 2005-2006 data and U.S. EPA, 1985
21+ years	6.6	40.1	15.2	5.2	33.1	6.7	
Adult Females							
21+ years	6.2	35.4	12.8	4.8	32.3	6.6	
	Mean Surface Area by Body Part[a] m^2						
Birth to <1 month	0.053	0.104	0.040	0.015	0.060	0.019	U.S. EPA Analysis of NHANES 1999-2006 data and U.S. EPA, 1985
1 to <3 months	0.060	0.118	0.045	0.017	0.068	0.021	
3 to <6 months	0.069	0.136	0.052	0.020	0.078	0.025	
6 to <12 months	0.082	0.161	0.062	0.024	0.093	0.029	
1 to <2 years	0.087	0.188	0.069	0.030	0.122	0.033	
2 to <3 years	0.087	0.235	0.072	0.032	0.142	0.043	
3 to <6 years	0.104	0.241	0.108	0.045	0.207	0.055	
6 to <11 years	0.136	0.375	0.137	0.054	0.301	0.078	
11 to <16 years	0.149	0.536	0.205	0.084	0.498	0.119	
16 to <21 years	0.144	0.592	0.282	0.099	0.592	0.131	
Adult Males							U.S. EPA Analysis of NHANES 2005-2006 data and U.S. EPA, 1985
21+ years	0.136	0.827	0.314	0.107	0.682	0.137	
Adult Females							
21+ years	0.114	0.654	0.237	0.089	0.598	0.122	

Table 7-2. Recommended Values for Surface Area of Body Parts (continued)							
Age Group	Head	Trunk	Arms	Hands	Legs	Feet	Source
	95th Percentile Surface Area by Body Part[b] m^2						
Birth to <1 month	0.062	0.121	0.047	0.018	0.070	0.022	U.S. EPA Analysis of NHANES 1999-2006 data and U.S. EPA, 1985
1 to <3 months	0.069	0.136	0.052	0.020	0.078	0.025	
3 to <6 months	0.080	0.157	0.060	0.023	0.091	0.029	
6 to <12 months	0.093	0.182	0.070	0.027	0.105	0.033	
1 to <2 years	0.101	0.217	0.079	0.035	0.141	0.038	
2 to <3 years	0.099	0.270	0.083	0.037	0.162	0.050	
3 to <6 years	0.130	0.301	0.135	0.056	0.259	0.069	
6 to <11 years	0.186	0.514	0.188	0.074	0.413	0.107	
11 to <16 years	0.194	0.694	0.266	0.109	0.645	0.155	
16 to <21 years	0.182	0.750	0.356	0.126	0.750	0.165	
Adult Males							U.S. EPA Analysis of NHANES 2005-2006 data and U.S. EPA, 1985
21+ years	0.154	1.10	0.399	0.131	0.847	0.161	
Adult Females							
21+ years	0.121	0.850	0.266	0.106	0.764	0.146	

[a] Calculated as mean percentage of body part times mean total body surface area.
[b] Calculated as mean percentage of body part times 95th percentile total body surface area.
Note: Surface area values reported in m^2 can be converted to cm^2 by multiplying by 10,000 cm^2/m^2.

Table 7-3. Confidence in Recommendations for Body Surface Area

General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	Total surface area estimates were based on algorithms developed using direct measurements and data from NHANES surveys. The methods used for developing these algorithms were adequate. The NHANES data and the secondary data analyses to estimate total surface areas were appropriate. NHANES included a large sample sizes; sample size varied with age. Body part percentages were based on direct measurements from a limited number of subjects.	
Minimal (or Defined) Bias	The data used to develop the algorithms for estimating surface area from height and weight data were limited. NHANES collected physical measurements of weight and height. Body part data were based on direct measurements from a limited number of subjects.	
Applicability and Utility		Medium
Exposure Factor of Interest	The key studies were directly relevant to surface area estimates.	
Representativeness	The direct measurement data used to develop the algorithms for estimating total body surface area from weight and height may not be representative of the U.S. population. However, NHANES height and weight data were collected using a complex, stratified, multi-stage probability cluster sampling design intended to be representative of the U.S. population. The sample used to derive body part percentages of total surface was not representative of U.S. population.	
Currency	The U.S. EPA analysis used the most current data at the time both studies were conducted. The data on body part percentages were dated; however, the age of the data is not expected to affect its utility.	
Data Collection Period	The U.S. EPA analysis was based on four NHANES data sets covering 1999-2006 for children and one NHANES data set, 2005-2006, for adults.	
Clarity and Completeness		Medium
Accessibility	The U.S. EPA analysis of the NHANES data is unpublished, but available upon request. U.S. EPA (1985) is a U.S. EPA-published report.	
Reproducibility	The methodology was clearly presented; enough information was included to reproduce the results.	
Quality Assurance	Quality assurance of NHANES data was good; quality control of secondary data analysis was not well described.	

Table 7-3. Confidence in Recommendations for Body Surface Area (continued)		
General Assessment Factors	Rationale	Rating
Variability and Uncertainty		Medium
Variability in Population	The full distributions were given for total surface area.	
Uncertainty	A source of uncertainty in total surface areas resulted from the limitations in data used to develop the algorithms for estimating total surface from height and weight. Because of the small sample size, there is uncertainty in the body part percentage estimates.	
Evaluation and Review		Medium
Peer Review	The NHANES surveys received a high level of peer review. The U.S. EPA analysis was not published in a peer-reviewed journal.	
Number and Agreement of Studies	There is one key study for total surface area and one key study for the surface area of body parts.	
Overall Rating		**Medium** for Total Surface Area and **Low** for Surface Area of Individual Body Parts

Table 7-4. Recommended Values for Mean Solids Adherence to Skin

	Face	Arms	Hands	Legs	Feet	Source
	mg/cm²					
Children						
Residential (indoors)[a]	-	0.0041	0.011	0.0035	0.010	Holmes et al., 1999
Daycare (indoors & outdoors)[b]	-	0.024	0.099	0.020	0.071	Holmes et al., 1999
Outdoor sports[c]	0.012	0.011	0.11	0.031	-	Kissel et al., 1996a
Indoor sports[d]	-	0.0019	0.0063	0.0020	0.0022	Kissel et al., 1996a
Activities with soil[e]	0.054	0.046	0.17	0.051	0.20	Holmes et al., 1999
Playing in mud[f]	-	11	47	23	15	Kissel et al., 1996a
Playing in sediment[g]	0.040	0.17	0.49	0.70	21	Shoaf et al., 2005
Adults						
Outdoor sports[h]	0.0314	0.0872	0.1336	0.1223	-	Holmes et al., 1999; Kissel et al., 1996a
Activities with soil [i]	0.0240	0.0379	0.1595	0.0189	0.1393	Holmes et al., 1999; Kissel et al., 1996a
Construction Activities[j]	0.0982	0.1859	0.2763	0.0660	-	Holmes et al., 1999

[a] Based on weighted average of geometric mean soil loadings for 2 groups of children (ages 3 to13 years; N = 10) playing indoors.

[b] Based on weighted average of geometric mean soil loadings for 4 groups of daycare children (ages 1 to 6.5 years; N = 21) playing both indoors and outdoors.

[c] Based on geometric mean soil loadings of 8 children (ages 13 to 15 years) playing soccer.

[d] Based on geometric mean soil loadings of 6 children (ages $\geq$8 years) and 1 adult engaging in Tae Kwon Do.

[e] Based on weighted average of geometric mean soil loadings for gardeners and archeologists (ages 16 to 35 years).

[e] Based on weighted average of geometric mean soil loadings of 2 groups of children (age 9 to 14 years; N= 12) playing in mud.

[f] Based on weighted average of geometric mean soil loading of 6 children (ages 9 to 14 years) playing in mud.

[g] Based on geometric mean soil loadings of 9 children (ages 7 to 12 years) playing in tidal flats.

[h] Based on weighted average of geometric mean soil loadings of 3 groups of adults(ages 23 to 33 years) playing rugby and 2 groups of adults (ages 24 to 34) playing soccer.

[i] Based on weighted average of geometric mean soil loadings for 69 gardeners, farmers, groundskeepers, landscapers and archeologists (ages 16 to 64 years) for faces, arms and hands; 65 gardeners, farmers, groundskeepers, and archeologists (ages 16 to 64 years) for legs; and 36 gardeners, groundskeepers and archeologists (ages 16 to 62) for feet.

[j] Based on weighted average of geometric mean soil loadings for 27 construction workers, utility workers and equipment operators (ages 21 to 54) for faces, arms and hands; and based on geometric mean soil loadings for 8 construction workers (ages 21 to 30 years) for legs.

\- = No data.

Table 7-5. Confidence in Recommendations for Solids Adherence to Skin		
General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	The approach was adequate; the skin rinsing technique is widely employed for purposes similar to this. Small sample sizes were used in the studies; the key studies directly measured soil adherence to skin.	
Minimal (or Defined) Bias	The studies attempted to measure soil adherence for selected activities and conditions. The number of activities and study participants was limited.	
Applicability and Utility		Low
Exposure Factor of Interest	The studies were relevant to the factor of interest; the goal was to determine soil adherence to skin.	
Representativeness	The soil/dust studies were limited to the State of Washington and the sediment study was limited to Rhode Island. The data may not be representative of other locales.	
Currency	The studies were published between 1996 and 2005.	
Data Collection Period	Short-term data were collected. Seasonal factors may be important, but have not been studied adequately.	
Clarity and Completeness		Medium
Accessibility	Articles were published in widely circulated journals/reports.	
Reproducibility	The reports clearly describe the experimental methods, and enough information was provided to allow for the study to be reproduced.	
Quality Assurance	Quality control was not well described.	
Variability and Uncertainty		Low
Variability in Population	Variability in soil adherence is affected by many factors including soil properties, activity and individual behavior patterns. Not all age groups were represented in the sample.	
Uncertainty	The estimates are highly uncertain; the soil adherence values were derived from a small number of observations for a limited set of activities.	
Evaluation and Review		Medium
Peer Review	The studies were reported in peer reviewed journal articles.	
Number and Agreement of Studies	There are three key studies that evaluated different activities in children and adults.	
Overall Rating		**Low**

7.3 SURFACE AREA

7.3.1 Key Body Surface Area Studies

7.3.1.1 *U.S. EPA, 1985 - Development of Statistical Distributions or Ranges of Standard Factors Used in Exposure Assessments*

The U.S. EPA (1985) summarized the direct measurements of the surface area of adults' and children's body parts provided by Boyd (1935) and Van Graan (1969) as a percentage of total surface area. These percentages are presented in Table 7-6. A total of 21 children less than 18 years of age were included. Because of the small sample size, it is unclear how accurately these estimates represent averages for the age groups. A total of 89 adults, 18 years and older were included, providing greater accuracy for the adult estimates. Note that the proportion of total body surface area contributed by the head decreases from childhood to adulthood, whereas the proportion contributed by the leg increases.

U.S. EPA (1985) analyzed the direct surface area measurement data of Gehan and George (1970) using the Statistical Processing System (SPS) software package of Buhyoff et al. (1982). Gehan and George (1970) selected 401 measurements made by Boyd (1935) that were complete for surface area, height, weight, and age for their analysis. Boyd (1935) had reported surface area estimates for 1,114 individuals using coating, triangulation, or surface integration methods (U.S. EPA, 1985).

U.S. EPA (1985) used SPS to generate equations to calculate surface area as a function of height and weight. These equations were subsequently used by U.S. EPA to calculate body surface area distributions of the U.S. population using the height and weight data obtained from the National Health and Nutrition Examination Survey, 1999-2000 (CDC, 2006) (see Section 7.3.1.2).

The equation proposed by Gehan and George (1970) was determined by U.S. EPA (1985) to be the best choice for estimating total body surface area. However, the paper by Gehan and George (1970) gave insufficient information to estimate the standard error about the regression. Therefore, U.S. EPA (1985) used the 401 direct measurements of children and adults and reanalyzed the data using the formula of Dubois and Dubois (1916) and SPS to obtain the standard error (U.S. EPA, 1985).

Regression equations were developed for specific body parts using the Dubois and Dubois (1916) formula and using the surface area of various body parts provided by Boyd (1935) and Van Graan (1969) in conjunction with SPS. Regression equations for adults were developed for the head, trunk (including the neck), upper extremities (arms and hands, upper arms, and forearms) and lower extremities (legs and feet, thighs, and lower legs) (U.S. EPA, 1985). Table 7-7 presents a summary of the equation parameters developed by U.S. EPA (1985) for calculating surface area of adult body parts. Equations to estimate the body part surface area of children were not developed because of insufficient data.

7.3.1.2 *U.S. EPA Analysis of NHANES 2005-2006 and 1999-2006 Data*

The U.S. EPA estimated total body surface areas using the empirical relationship shown in Appendix 7A and U.S. EPA (1985), and body weight and height data from the 1999-2006 NHANES for children and the 2005-2006 NHANES for adults. NHANES is conducted annually by the Center for Disease Control (CDC), National Center of Health Statistics (NCHS). The survey's target population is the civilian, noninstitutionalized U.S. population. The NHANES 1999-2006 survey was conducted on a nationwide probability sample of approximately 40,000 persons for all ages, of which approximately 20,000 were children. The survey is designed to obtain nationally representative information on the health and nutritional status of the population of the United States through interviews and direct physical examinations. A number of anthropometrical measurements were taken for each participant in the study, including body weight and height. Unit nonresponse to the household interview was 19 percent, and an additional 4 percent did not participate in the physical examinations (including body weight measurements).

The NHANES 1999-2006 survey includes over-sampling of low-income persons, adolescents 12 to 19 years, persons 60+ years of age, African Americans, and Mexican Americans. Sample data were assigned weights to account both for the disparity in sample sizes for these groups and for other inadequacies in sampling, such as the presence of non-respondents. For children's estimates, the U.S. EPA utilized four NHANES data sets in its analysis (NHANES 1999-2000, 2001-2002, 2003-2004, and 2005-2006) to ensure adequate sample size for the age groupings of interest. Sample weights were developed for the combined data set in accordance with CDC guidance from the NHANES'website (http://www.cdc.gov/nchs/about/major/nhanes/nhanes20052006/faqs05_06.htm#question%2012). For adult estimates, the U.S. EPA utilized NHANES years 2005-2006 in its estimates for currency.

Table 7-8 presents the mean and percentile estimates of body surface area by age category for males and females, combined. Tables 7-9 and 7-10 present the mean and percentiles of body surface area by age category for males and females, respectively. Tables 7-11 and 7-12 present the mean and percentile estimates of body surface area of specific body parts for males and females 21 years and older, respectively. An advantage of using the NHANES datasets to derive surface area estimates is that data are available for infants from birth and older. In addition, the NHANES data are nationally representative and remain the principal source of body weight and height data collected nationwide from a large number of subjects. It should be noted that in the NHANES surveys height measurements for children under 2 years of age were based on recumbent length while standing height information was collected for children aged 2 years and older. Some studies have reported differences between recumbent length and standing height measurements for the same individual, ranging from 0.5 to 2 cm, with recumbent length being the larger of the two measurements (Buyken et al., 2005). The use of height data obtained from two different types of height measurements to estimate surface area of children may potentially introduce errors into the estimates.

7.3.2 Relevant Body Surface Area Studies

7.3.2.1 *Murray and Burmaster, 1992 Estimated Distributions for Total Body Surface Area of Men and Women in the United States*

In this study, distributions of total body surface area for men and women ages 18 to 74 years were estimated using Monte Carlo simulations based on height and weight distribution data. Four different formulae for estimating body surface area as a function of height and weight were employed: Dubois and Dubois (1916); Boyd (1935); U.S. EPA (1985); and Costeff (1966). The formulae of Dubois and Dubois (1916); Boyd (1935); and U.S. EPA (1985) are based on height and weight. The formula developed by Costeff (1966) is based on 220 observations that estimate body surface area based on weight only. Formulae were compared and the effect of the correlation between height and weight on the body surface area distribution was analyzed.

Monte Carlo simulations were conducted to estimate body surface area distributions. They were based on the bivariate distributions estimated by Brainard and Burmaster (1992) for height and natural logarithm of weight and the formulae described above. A total of 5,000 random samples each for men and women were selected from the two correlated bivariate distributions. Body surface area calculations were made for each sample, and for each formula, resulting in body surface area distributions. Murray and Burmaster (1992), found that the body surface area frequency distributions were similar for the four models (Table 7-13). Using the U.S. EPA (1985) formula, the median surface area values were calculated to be 1.96 m^2 for men and 1.69 m^2 for women. The median value for women is identical to that generated by U.S. EPA (1985) but differs for men by approximately 1 percent. Body surface area was found to have lognormal distributions for both men and women (Figure 7-1). It was also found that assuming correlation between height and weight influences the final distribution by less than 1 percent.

7.3.2.2 *Phillips et al., 1993 - Distributions of Total Skin Surface Area to Body Weight Ratios*

Phillips et al. (1993) observed a strong correlation (0.986) between body surface area and body weight and studied the effect of using these factors as independent variables in the lifetime average daily dose (LADD) equation (See Chapter 1). The authors suggested that, because of the correlation between these two variables, the use of body surface area to body weight (SA/BW) ratios in human exposure assessments may be more appropriate than treating these factors as independent variables. Direct measurement data from the scientific literature were used to calculate SA/BW ratios for three age groups of the population (infants aged 0 to 2 years, children aged 2.1 to 17.9 years, and adults 18 years and older). These ratios were calculated by dividing body surface areas by corresponding body weights for the 401 individuals analyzed by Gehan and George (1970) and summarized by U.S. EPA (1985). Distributions of SA/BW ratios were developed, and summary statistics were calculated for the three age groups and the combined data set.

Summary statistics for both adults and children are presented in Table 7-14. The shapes of these SA/BW distributions were determined using D'Agostino's test, as described in D'Agostino et al. (1990). The results indicate that the SA/BW ratios for infants are lognormally distributed. The SA/BW ratios for adults and all ages combined were normaly distributed. SA/BW ratios for children were neither normally nor lognormally distributed. According to Phillips et al. (1993), SA/BW ratios may be used to calculate LADDs by replacing the body surface area factor in the numerator of the LADD equation with the SA/BW ratio and eliminating the body weight factor in the denominator of the LADD equation.

The effect of gender and age on SA/BW distribution was also analyzed by classifying the

401 observations by gender and age. Statistical analyses indicated no significant differences between SA/BW ratios for males and females. SA/BW ratios were found to decrease with increasing age. The advantage of this study is that it studied correlations between surface area and body weight. However, data could not be broken out by finer age categories.

7.3.2.3 *Wong et al., 2000 - Adult Proxy Responses to a Survey of Children's Dermal Soil Contact Activities*

Wong et al. (2000) reported on two surveys that gathered information on activity patterns related to dermal contact with soil. The first of these national phone surveys (also reported on by Garlock et al., 1999) was conducted in 1996 using random digit dialing. Information about 211 children was gathered from adults over the age of 18. For older children (those between the ages of 5 and 17 years), information was gathered on their participation in "gardening and yardwork," "outdoor sports," and "outdoor play activities." For children less than 5 years old, information was gathered on "outdoor play activities," including whether the activity occurred on a playground or yard with "bare dirt or mixed grass and dirt" surfaces. Information on the types of clothing worn while participating in these play activities during warm weather months (April though October) was obtained. The results of this survey indicate that most children wore short pants, a dress or skirt, short sleeve shirts, no socks, and leather or canvas shoes during the outdoor play activities of interest. Using the survey data on clothing and total body surface area data from U.S. EPA (1985), estimates were made of the skin area exposed (expressed as percentages of total body surface area) associated with various age ranges and activities. These estimates are provided in Table 7-15.

7.4 ADHERENCE OF SOLIDS TO SKIN

7.4.1 Key Adherence of Solids to Skin Studies

7.4.1.1 *Kissel et al., 1996a - Field Measurements of Dermal Soil Loading Attributable to Various Activities: Implications for Exposure Assessment*

Kissel et al. (1996a) collected direct measurements of soil loading on the surface of the skin of volunteers, before and after activities expected to result in soil contact. Soil adherence associated with the following indoor and outdoor activities were estimated: greenhouse gardening, tae kwon do karate, soccer, rugby, reed gathering, irrigation installation, truck farming, outdoor gardening and landscaping (Groundskeepers) and playing in mud. Skin surface areas monitored included hands, forearms, lower legs, faces and/or feet (Kissel et al., 1996a).

The activities, information on their duration, sample size and clothing worn by participants is provided in Table 7-16. The subjects' body surfaces (forearms, hands, lower legs for all sample groups; faces and/or feet pairs in some sample groups) were washed before and after the monitored activities. Paired samples were pooled into single ones. The mass recovered was converted to soil loading using allometric models of surface area.

Geometric means for post-activity soil adherence by activity and body region for the four groups of volunteers evaluated are presented in Table 7-17. Children playing in the mud had the highest soil loadings among the groups evaluated. The results also indicate that, in general, the amount of soil adherence to the hands is higher than for other parts of the body during the same activity.

An advantage of this study is that it provides information on soil adherence to various body parts resulting from unscripted activities. However, the study authors noted that, because the activities were unstaged, "control of variables such as specific behaviors within each activity, clothing worn by participants, and duration of activity was limited." In addition, soil adherence values were estimated based on a small number of observations and very young children and indoor activities were under-represented in the study.

7.4.1.2 *Holmes et al., 1999 - Field Measurements of Dermal Loadings in Occupational and Recreational Activities*

Holmes et al. (1999) collected pre- and post-activity soil loadings on various body parts of individuals within groups engaged in various occupational and recreational activities. These groups included: children at a daycare center (Daycare Kids), children playing indoors in a residential setting (Indoor Kids), individuals removing historical artifacts from a site (Archeologists), individuals erecting a corrugated metal wall (Construction Workers), heavy equipment operators (Equipment Operators), individuals playing rugby (Rugby Players), utility workers jack-hammering and excavating trenches (Utility Workers), individuals conducting landscaping and rockery (Landscape/Rockery), and individuals performing gardening work (Gardeners). This study was conducted as a follow up to previous field sampling of soil adherence on individuals participating in various activities (Kissel et al., 1996a). For this round of sampling, soil loading data were collected utilizing the same methods used and described in Kissel et al. (1996a). Information regarding the groups studied and their observed activities is presented in Table 7-16.

The daycare children studied were all at one location, and measurements were taken on three different days. The children freely played both indoors in the house and outdoors in the backyard. The number of children within each day's group and the clothing worn is described in Table 7-16. For the second observation day (Daycare Kids No. 2), postactivity data were collected for five children. All the activities on this day occurred indoors. For the third daycare group (Daycare Kids No. 3), four children were studied.

On two separate days, children playing indoors in a home environment were monitored. The first group (Indoor Kids No. 1) had four children while the second group (Indoor Kids No. 2) had six children. The play area was described by the authors as being primarily carpeted. The clothing worn by the children within each day's group is described in Table 7-16.

Seven individuals (Archeologists) were monitored while excavating, screening, sorting, and cataloging historical artifacts from an ancient Native American site during a single event. Eight rugby players were monitored on two occasions after playing or practicing rugby. Eight volunteers from a construction company were monitored one day while erecting corrugated metal walls. Four volunteers (Landscape/Rockery) were monitored while relocating a rock wall in a park. Four excavation workers (Equipment Operators) were monitored twice after operation of heavy equipment. Utility workers cleaning and fixing water mains, jack-hammering and excavating trenches (Utility Workers) were monitored on two days, five participated on the first day and four on the second. Eight volunteers (Gardeners), ages 16 to 35 years, were monitored while performing gardening activities (i.e., weeding, pruning, digging small irrigation trenches, picking and cleaning fruit). The clothing worn by these groups is described in Table 7-16.

The geometric means and standard deviations of the postactivity soil adherence for each group of individuals and for each body part are summarized in Table 7-17. According to the authors, variations in the soil loading data from the daycare participants reflect differences in the weather and access to the outdoors.

An advantage of this study is that it provides a supplement to soil loading data collected in a previous round of studies (Kissel et al., 1996a). Also, the data support the assumption that hand loading can be used as a conservative estimate of soil loading on other body surfaces for the same activity. The activities studied represent normal child play both indoors and outdoors, as well as different combinations of clothing. The small number of participants is a disadvantage of this study. Also, the children studied and the activity setting may not be representative of the U.S. population.

7.4.1.3 *Shoaf et al., 2005 - Child Dermal Sediment Loads Following Play in a Tide Flat*

The purpose of this study was to obtain sediment adherence data for children playing in a tidal flat (Shoreline Play). The study was conducted on one day in late September 2003 at a tidal flat in Jamestown, Rhode Island. Nine subjects (three females and six males) ages 7 to 12 years old participated in the study. Information on activity duration, sample size and clothing worn by participants is provided in Table 7-16. Participants' parents completed questionnaires regarding their child's typical activity patterns during tidal flat play, exposure frequency and duration, clothing choices, bathing practices and clothes laundering.

This study reported direct measurements of sediment loadings on five body parts (face, forearms, hands, lower legs, and feet) after play in a tide flat. Each of nine subjects participated in two timed sessions and pre- and post-activity sediment loading data were collected. Geometric mean (geometric standard deviations) dermal loadings (mg/cm^2) on the face, forearm, hands, lower legs, and feet for the combined sessions, as shown in Table 7-17, were 0.04 (2.9), 0.17 (3.1), 0.49 (8.2), 0.70 (3.6) and 21 (1.9), respectively.

The primary advantage of this study is that it provides adherence data specific to children and sediments which had previously been largely unavailable. Results will be useful to risk assessors considering exposure scenarios involving child activities at a coastal shoreline or tidal flat. The limited number of participants (9) and sampling during just one day and at one location, make extrapolation to other situations uncertain.

7.4.2 Relevant Adherence of Solids to Skin Studies

7.4.2.1 *Que Hee et al., 1985 - Evolution of Efficient Methods to Sample Lead Sources, Such as House Dust and Hand Dust, in the Homes of Children*

Que Hee et al. (1985) used soil having particle sizes ranging from ≤ 44 to 833 μm diameters, fractionated into six size ranges, to estimate the amount that adhered to the palm of the hand that are assumed to be approximately 160 cm^2 (test subject with an average total body surface area of 16,000 cm^2 and a total hand surface area of 400 cm^2). The amount of soil that adhered to skin was determined by applying approximately 5 g of soil for each size fraction, removing excess soil by shaking the hands, and then measuring the difference in weight before and after application. Several assumptions were made to apply these results to other soil types and exposure scenarios: (a) the soil is composed of particles of the indicated diameters; (b) all soil types and particle sizes adhere to the skin to the degree observed in this study; and an equivalent weight of particles of any diameter adhere to the same surface area of skin. On average, 31.2 mg of soil adhered to the palm of the hand.

7.4.2.2 *Driver et al., 1989 - Soil Adherence to Human Skin*

Driver et al. (1989) conducted soil adherence experiments using various soil types collected from sites in Virginia. A total of five soil types were collected: Hyde, Chapanoke, Panorama, Jackland, and Montalto. Both top soils and subsoils were collected for each soil type. The soils were also characterized by cation exchange capacity, organic content, clay mineralogy, and particle size distribution. The soils were dry sieved to obtain particle sizes of ≤250 µm and ≤150 µm. For each soil type, the amount of soil adhering to adult male hands, using both sieved and unsieved soils, was determined gravimetrically (i.e., measuring the difference in soil sample weight before and after soil application to the hands).

An attempt was made to measure only the minimal or "monolayer" of soil adhering to the hands. This was done by mixing a pre-weighed amount of soil over the entire surface area of the hands for a period of approximately 30 seconds, followed by removal of excess soil by gently rubbing the hands together after contact with the soil. Excess soil that was removed from the hands was collected, weighed, and compared to the original soil sample weight. The authors measured average adherence of 1.40 mg/cm^2 for particle sizes less than 150 µm, 0.95 mg/cm^2 for particle sizes less than 250 µm, and 0.58 mg/cm^2 for unsieved soils. Analysis of variance statistics showed that the most important factor affecting adherence variability was particle size ($p < 0.001$). The next most important factor is soil type and subtype ($p < 0.001$). The interaction of soil type and particle size was also significant, but at a lower significance level ($p < 0.01$).

Driver et al. (1989) found statistically significant increases in soil adherence with decreasing particle size; whereas, Que Hee et al. (1985) found relatively small changes with changes in particle size. The amount of soil adherence found by Driver et al. (1989) was greater than that reported by Que Hee et al. (1985).

7.4.2.3 *Sedman, 1989 - The Development of Applied Action Levels for Soil Contact: A Scenario for the Exposure of Humans to Soil in a Residential Setting*

Sedman (1989) used the estimate from Roels et al. (1980), 0.159 g, and the average surface area of the hand of an 11 year old, 307 cm^2 to estimate the amount of soil adhering per unit area of skin to be 0.9 mg/cm^2. This assumed that approximately 60 percent (185 cm^2) of the lead on the hands was recovered by the method employed by Roels et al. (1980).

Sedman (1989) used estimates from Lepow et al. (1975), Roels et al. (1980), and Que Hee et al. (1985) to develop a maximum soil load that could occur on the skin. A rounded arithmetic mean of 0.5 mg/cm^2 was calculated from these three studies. According to Sedman (1989), this was near the maximum load of soil that could occur on the skin but it is unlikely that most skin surfaces would be covered with this amount of soil (Sedman, 1989).

7.4.2.4 *Kissel et al., 1996b - Factors Affecting Soil Adherence to Skin in Hand-press Trials: Investigation of Soil Contact and Skin Coverage*

Kissel et al. (1996b) conducted soil adherence experiments using five soil types obtained locally in the Seattle, WA, area: sand, 2 types of loamy sand, sandy loam, and silt loam. All soils were analyzed by hydrometer (settling velocity) to determine composition. Clay content ranged from 0.5 to 7.0 percent. Organic carbon content, determined by combustion, ranged from 0.7 to 4.6 percent. Soils were dry-sieved to obtain particle size ranges of <150, 150-250, and >250 µm. For each soil type, the amount of soil adhering to an adult female hand, using both sieved and unsieved soils, was determined by measuring the soil sample weight before and after the hand was pressed into a pan containing the test soil. Loadings were estimated by dividing the recovered soil mass by total hand area, although loading occurred primarily on only one side of the hand. Results showed that generally, soil adherence to hands was directly correlated with moisture content, inversely correlated with particle size, and independent of clay content or organic carbon content. The advantage of this study is that it provides information on how soil type can affect adherence to the skin. However, the soil adherence data are for a single subject and the data are limited to five soil samples.

7.4.2.5 *Kissel et al., 1998 - Investigation of Dermal Contact with Soil in Controlled Trials*

Kissel et al. (1998) measured dermal exposure to soil from staged activities conducted in a greenhouse. A fluorescent marker was mixed in soil so that soil contact for a particular skin surface area could be identified. The subjects were video-imaged under a long-wave ultraviolet (UV) light before and after soil contact. In this manner, soil contact on hands, forearms, lower legs, and faces was assessed by presence of fluorescence. In addition to fluorometric data, gravimetric measurements for preactivity and postactivity were obtained from the different body parts examined.

The studied groups included adults transplanting 14 plants for 9 to 18 minutes, children playing for 20 minutes in a soil bed of varying moisture content representing wet and dry soils, and adults laying plastic pipes for 15, 30 or 45 minutes. The parameters describing each of these activities are summarized in Table 7-18. Before each trial, each participant was washed in order to obtain a preactivity or background gravimetric measurement.

For wet soil, postactivity fluorescence results indicated that the hand had a much higher fractional coverage than other body surfaces (see Figure 7-2).

As shown in Figure 7-3, postactivity gravimetric measurements for children playing and adults transplanting showed higher soil loading on hands and much lower amounts on other body surfaces, as was observed with fluorescence data. This was also observed in adults laying pipe. The arithmetic mean percent of hand surface area fluorescing was 65% after 15 minutes laying pipe in wet soil and 85% after 30 and 45 minutes laying pipe in wet soil. The arithmetic mean percent of lower leg surface area fluorescing was ~20% after 15 minutes of laying pipe in wet soil, 25% after 30 minutes and 40% after 45 minutes. According to Kissel et al. (1998), the relatively low loadings observed on non-hand body parts may be a result of a more limited area of contact for the body part rather than lower localized loadings. The highest soil loading observed was a geometric mean dermal loading of 1.1 mg/cm^2, found on the adult's hands following transplanting in wet soil. Mean loadings were lower on hands in the dry soil trial and on lower legs, forearms, and faces in both the wet and dry soil trials. Higher loadings were observed for all body surfaces with the higher moisture content soils.

This report is valuable in showing soil loadings from soils of different moisture content and providing evidence that dermal exposure to soil is not uniform for various body surfaces. This study also provides some evidence of the protective effect of clothing. Disadvantages of the study include the small number of study participants and a short activity duration.

7.5 REFERENCES FOR CHAPTER 7

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Table 7-6. Percentage of Total Body Surface Area by Body Part For Children (Genders Combined) and Adults by Gender

Age (years)	N M:F	Percent of Total											
		Head		Trunk		Arms		Hands		Legs		Feet	
		Mean	Min-Max	Mean	Min-Max	Mean	Min-Max	Mean	Min-Max	Mean	Min-Max	Mean	Min-Max
< 1	2:0	18.2	18.2-18.3	35.7	34.8-36.6	13.7	12.4-15.1	5.3	5.2-5.4	20.6	18.2-22.9	6.5	6.5-6.6
1 < 2	1:1	16.5	16.5-16.5	35.5	34.5-36.6	13.0	12.8-13.1	5.7	5.6-5.8	23.1	22.1-24.0	6.3	5.8-6.7
2 < 3	1:0	14.2		38.5		11.8		5.3		23.2		7.1	
3 < 4	0:5	13.6	13.3-14.0	31.9	29.9-32.8	14.4	14.2-14.7	6.1	5.8-6.3	26.8	26.0-28.6	7.2	6.8-7.9
4 < 5	1:3	13.8	12.1-15.3	31.5	30.5-32.4	14.0	13.0-15.5	5.7	5.2-6.6	27.8	26.0-29.3	7.3	6.9-8.1
5 < 6													
6 < 7	1:0	13.1		35.1		13.1		4.7		27.1		6.9	
7 < 8													
8 < 9													
9 < 10	0:2	12.0	11.6-12.5	34.2	33.4-34.9	12.3	11.7-12.8	5.3	5.2-5.4	28.7	28.5-28.8	7.6	7.4-7.8
10 < 11													
11 < 12													
12 < 13	1:0	8.7		34.7		13.7		5.4		30.5		7.0	
13 <14	1:0	10.0		32.7		12.1		5.1		32.0		8.0	
14 < 15													
15 < 16													
16 < 17	1:0	8.0		32.7		13.1		5.7		33.6		6.9	
17 < 18	1:0	7.6		31.7		17.5		5.1		30.8		7.3	
Males, 18+ years	32	7.8	6.1-10.6	35.9	30.5-41.4	14.1	12.5-15.5	5.2	4.6-7.0	31.2	26.1-33.4	7.0	6.0-7.9
Females, 18+ years	57	7.1	5.6-8.1	34.8	32.8-41.7	14.0[a]	12.4-14.8	5.1[b]	4.4-5.4	32.4[a]	29.8-35.3	6.5[a]	6.0-7.0

N = Number of subjects, (M:F = males:females).
Min. = Minimum percent.
Max. = Maximum percent.
[a] Sample size = 13
[b] Sample size = 12
Source: U.S. EPA, 1985.

Table 7-7. Summary of Equation Parameters for Calculating Adult Body Surface Area

Body Part	N	Equation for surface areas (m^2) a_o	W^{a1}	H^{a2}	P	R^2	S.E.
Head							
Female	57	0.0256	0.124	0.189	0.01	0.302	0.00678
Male	32	0.0492	0.339	-0.0950	0.01	0.222	0.0202
Trunk							
Female	57	0.188	0.647	-0.304	0.001	0.877	0.00567
Male	32	0.0240	0.808	-0.0131	0.001	0.894	0.0118
Upper Extremities							
Female	57	0.0288	0.341	0.175	0.001	0.526	0.00833
Male	48	0.00329	0.466	0.524	0.001	0.821	0.0101
Arms							
Female	13	0.00223	0.201	0.748	0.01	0.731	0.00996
Male	32	0.00111	0.616	0.561	0.001	0.892	0.0177
Upper Arms							
Male	6	8.70	0.741	-1.40	0.25	0.576	0.0387
Forearms							
Male	6	0.326	0.858	-0.895	0.05	0.897	0.0207
Hands							
Female	12[b]	0.0131	0.412	0.0274	0.1	0.447	0.0172
Male	32	0.0257	0.573	-0.218	0.001	0.575	0.0187
Lower Extremities[c]	105	0.00286	0.458	0.696	0.001	0.802	0.00633
Legs	45	0.00240	0.542	0.626	0.001	0.780	0.0130
Thighs	45	0.00352	0.629	0.379	0.001	0.739	0.0149
Lower legs	45	0.000276	0.416	0.973	0.001	0.727	0.0149
Feet	45	0.000618	0.372	0.725	0.001	0.651	0.0147

[a]SA = $a_o \; W^{a1} \; H^{a2}$
W = Weight in kilograms; H = Height in centimeters; P = Level of significance; R^2 = Coefficient of determination;
SA = Surface Area; S.E. = Standard error; N = Number of observations
[b] One observation for a female whose body weight exceeded the 95 percentile was not used.
[c] Although two separate regressions were marginally indicated by the F test, pooling was done for consistency with individual components of lower extremities.
Source: U.S. EPA, 1985.

Table 7-8. Mean and Percentile Skin Surface Area (m^2) Derived from U.S. EPA Analysis of NHANES 1999-2006 Males and Females Combined for Children < 21 Years and NHANES 2005-2006 for Adults > 21 Years.

Age Group	N	Mean	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Birth to <1 month	154	0.29	0.24	0.25	0.26	0.27	0.29	0.31	0.31	0.33	0.34
1 to <3 months	281	0.33	0.27	0.29	0.29	0.31	0.33	0.35	0.37	0.37	0.38
3 to <6 months	488	0.38	0.33	0.34	0.35	0.36	0.38	0.40	0.42	0.43	0.44
6 to <12 months	923	0.45	0.38	0.39	0.40	0.42	0.45	0.48	0.49	0.50	0.51
1 to <2 years	1159	0.53	0.45	0.46	0.47	0.49	0.53	0.56	0.58	0.59	0.61
2 to <3 years	1122	0.61	0.52	0.54	0.55	0.57	0.61	0.64	0.67	0.68	0.70
3 to <6 years	2303	0.76	0.61	0.64	0.66	0.68	0.74	0.81	0.85	0.89	0.95
6 to <11 years	3590	1.08	0.81	0.85	0.88	0.93	1.05	1.21	1.31	1.36	1.48
11 to <16 years	5294	1.59	1.19	1.25	1.31	1.4	1.57	1.75	1.86	1.94	2.06
16 to <21 years	4843	1.84	1.47	1.53	1.58	1.65	1.80	1.99	2.10	2.21	2.33
21 to <30 years	914	1.93	1.51	1.56	1.62	1.73	1.91	2.09	2.21	2.29	2.43
30 to <40 years	813	1.97	1.55	1.63	1.67	1.77	1.95	2.16	2.26	2.31	2.43
40 to < 50 years	806	2.01	1.59	1.66	1.71	1.80	1.99	2.21	2.31	2.40	2.48
50 to < 60 years	624	2.00	1.57	1.63	1.69	1.80	1.97	2.19	2.29	2.37	2.51
60 to < 70 years	645	1.98	1.58	1.63	1.70	1.78	1.98	2.15	2.26	2.33	2.43
70 to < 80 years	454	1.89	1.48	1.56	1.64	1.72	1.90	2.05	2.15	2.22	2.30
80 years and over	330	1.77	1.45	1.53	1.56	1.62	1.76	1.92	2.00	2.05	2.12

N = Number of observations.

Source: U.S. EPA Analysis of NHANES 1999-2006 data (children) NHANES 2005-2006 data (adults).

Table 7-9. Mean and Percentile Skin Surface Area (m^2) Derived from U.S. EPA Analysis of NHANES 1999-2006 for Children <21 Years and NHANES 2005-2006 for Adults >21 Years
Males

Age Group	N	Mean	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Birth to <1 month	85	0.29	0.24	0.25	0.26	0.27	0.29	0.31	0.33	0.34	0.36
1 to <3 months	151	0.33	0.28	0.29	0.30	0.31	0.34	0.36	0.37	0.37	0.38
3 to <6 months	255	0.39	0.34	0.35	0.36	0.37	0.39	0.41	0.42	0.43	0.44
6 to <12 months	471	0.45	0.39	0.41	0.42	0.43	0.46	0.48	0.49	0.50	0.51
1 to <2 years	620	0.53	0.46	0.47	0.48	0.50	0.53	0.57	0.58	0.59	0.62
2 to <3 years	548	0.62	0.54	0.56	0.56	0.58	0.62	0.65	0.67	0.68	0.70
3 to <6 years	1150	0.76	0.61	0.64	0.66	0.69	0.75	0.82	0.86	0.89	0.95
6 to <11 years	1794	1.09	0.82	0.86	0.89	0.94	1.06	1.21	1.29	1.34	1.46
11 to <16 years	2593	1.61	1.17	1.23	1.28	1.39	1.60	1.79	1.90	1.99	2.12
16 to <21 years	2457	1.94	1.61	1.66	1.7	1.76	1.91	2.08	2.22	2.30	2.42
21 to 30 years	361	2.05	1.70	1.76	1.81	1.87	2.01	2.18	2.30	2.39	2.52
30 to <40 years	390	2.10	1.74	1.81	1.85	1.93	2.08	2.24	2.31	2.39	2.50
40 to < 50 years	399	2.15	1.78	1.86	1.90	1.97	2.12	2.29	2.41	2.47	2.56
50 to < 60 years	310	2.11	1.68	1.81	1.86	1.94	2.12	2.26	2.34	2.46	2.55
60 to < 70 years	323	2.08	1.72	1.78	1.84	1.94	2.08	2.25	2.33	2.37	2.46
70 to < 80 years	249	2.05	1.71	1.80	1.84	1.92	2.05	2.18	2.23	2.31	2.45
80 years and over	163	1.92	1.67	1.71	1.74	1.80	1.92	2.02	2.08	2.13	2.22

N = Number of observations.

Source: U.S. EPA Analysis of NHANES 1999-2006 data (children) NHANES 2005-2006 data (adults).

Table 7-10. Mean and Percentile Skin Surface Area (m^2) Derived from U.S. EPA Analysis of NHANES 1999-2006 for Children <21 Years and NHANES 2005-2006 for Adults >21 Years
Females

Age Group	N	Mean	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Birth to <1 month	69	0.28	0.24	0.25	0.26	0.27	0.28	0.30	0.30	0.31	0.33
1 to <3 months	130	0.32	0.27	0.28	0.29	0.30	0.31	0.35	0.36	0.37	0.37
3 to <6 months	233	0.38	0.32	0.33	0.34	0.35	0.38	0.40	0.40	0.41	0.43
6 to <12 months	452	0.44	0.38	0.39	0.40	0.41	0.44	0.47	0.48	0.49	0.51
1 to <2 years	539	0.52	0.44	0.46	0.47	0.48	0.52	0.56	0.57	0.58	0.59
2 to <3 years	574	0.60	0.51	0.53	0.54	0.56	0.59	0.63	0.66	0.67	0.70
3 to <6 years	1153	0.75	0.61	0.64	0.66	0.68	0.74	0.80	0.84	0.88	0.94
6 to <11 years	1796	1.08	0.80	0.85	0.87	0.92	1.04	1.21	1.33	1.39	1.51
11 to <16 years	2701	1.57	1.20	1.28	1.34	1.42	1.55	1.69	1.8	1.88	2.00
16 to <21 years	2386	1.73	1.42	1.47	1.51	1.57	1.69	1.85	1.98	2.06	2.17
21 to 30 years	553	1.81	1.45	1.51	1.54	1.60	1.79	1.94	2.08	2.17	2.25
30 to <40 years	423	1.85	1.50	1.55	1.61	1.67	1.82	2.00	2.13	2.23	2.31
40 to < 50 years	407	1.88	1.54	1.59	1.63	1.70	1.83	2.04	2.19	2.27	2.36
50 to < 60 years	314	1.89	1.54	1.58	1.62	1.70	1.85	2.005	2.19	2.26	2.38
60 to < 70 years	322	1.88	1.49	1.59	1.62	1.70	1.85	2.04	2.14	2.20	2.34
70 to < 80 years	205	1.77	1.44	1.48	1.55	1.62	1.77	1.91	1.99	2.03	2.13
80 years and over	167	1.69	1.41	1.46	1.51	1.56	1.68	1.80	1.86	1.92	1.98

N = Number of observations.

Source: U.S. EPA Analysis of NHANES 1999-2006 data (children) NHANES 2005-2006 data (adults).

Table 7-11. Surface Area of Adult Males (21 Years and Older) in Square Meters										
		Percentile								
Body part	Mean	5	10	15	25	50	75	85	90	95
Total	2.06	1.73	1.80	1.84	1.93	2.07	2.23	2.34	2.41	2.52
Head	0.136	0.123	0.126	0.128	0.131	0.136	0.143	0.147	0.149	0.154
Trunk[a]	0.827	0.636	0.672	0.701	0.74	0.820	0.918	0.984	1.02	1.10
Upper Extremities	0.393	0.332	0.346	0.354	0.369	0.395	0.425	0.442	0.456	0.474
Arms	0.314	0.253	0.265	0.274	0.289	0.316	0.346	0.364	0.379	0.399
Upper Arms	0.172	0.139	0.145	0.149	0.156	0.169	0.185	0.196	0.205	0.220
Forearms	0.148	0.115	0.121	0.125	0.132	0.146	0.163	0.173	0.181	0.197
Hands	0.107	0.090	0.093	0.096	0.100	0.107	0.115	0.121	0.124	0.131
Lower Extremities	0.802	0.673	0.703	0.721	0.752	0.808	0.868	0.903	0.936	0.972
Legs	0.682	0.560	0.587	0.603	0.634	0.686	0.746	0.780	0.811	0.847
Thighs	0.412	0.334	0.349	0.360	0.379	0.4113	0.452	0.478	0.495	0.523
Lower Legs	0.268	0.225	0.234	0.241	0.252	0.271	0.292	0.302	0.312	0.324
Feet	0.137	0.118	0.123	0.125	0.130	0.138	0.147	0.152	0.156	0.161

[a] Trunk includes neck.

Source: Based on U.S. EPA (1985) and NHANES 2005-2006.

Table 7-12. Surface Area of Adult Females (21 Years and Older) in Square Meters										
		Percentile								
Body part	Mean	5	10	15	25	50	75	85	90	95
Total	1.85	1.49	1.55	1.59	1.66	1.82	1.99	2.12	2.21	2.33
Head	0.114	0.108	0.109	0.110	0.111	0.114	0.116	0.118	0.119	0.121
Trunk [a]	0.654	0.511	0.530	0.544	0.571	0.633	0.708	0.765	0.795	0.850
Upper Extremities	0.304	0.266	0.272	0.277	0.284	0.301	0.320	0.333	0.342	0.354
Arms	0.237	0.213	0.218	0.221	0.227	0.237	0.248	0.254	0.259	0.266
Hands	0.089	0.076	0.078	0.079	0.082	0.087	0.094	0.099	0.102	0.106
Lower Extremities	0.707	0.579	0.599	0.616	0.643	0.698	0.761	0.805	0.835	0.875
Legs	0.598	0.474	0.494	0.509	0.533	0.588	0.649	0.693	0.724	0.764
Thighs	0.364	0.281	0.294	0.303	0.319	0.356	0.397	0.428	0.450	0.479
Lower Legs	0.233	0.191	0.198	0.204	0.213	0.230	0.250	0.263	0.273	0.286
Feet	0.122	0.103	0.106	0.109	0.113	0.121	0.130	0.136	0.140	0.146

[a] Trunk includes neck.

Source: Based on U.S. EPA (1985) and NHANES 2005-2006.

Table 7-13. Statistical Results for Total Body Surface Area Distributions (m^2), for Adults

	Men			
	U.S. EPA	Boyd	DuBois and DuBois	Costeff
Mean	1.97	1.95	1.94	1.89
Median	1.96	1.94	1.94	1.89
Mode	1.96	1.91	1.90	1.90
Standard Deviation	0.19	0.18	0.17	0.16
Skewness	0.27	0.26	0.23	0.04
Kurtosis	3.08	3.06	3.02	2.92
	Women			
	U.S. EPA	Boyd	DuBois and DuBois	Costeff
Mean	1.73	1.71	1.69	1.71
Median	1.69	1.68	1.67	1.68
Mode	1.68	1.62	1.60	1.66
Standard Deviation	0.21	0.20	0.18	0.21
Skewness	0.92	0.88	0.77	0.69
Kurtosis	4.30	4.21	4.01	3.52

Source: Murray and Burmaster, 1992

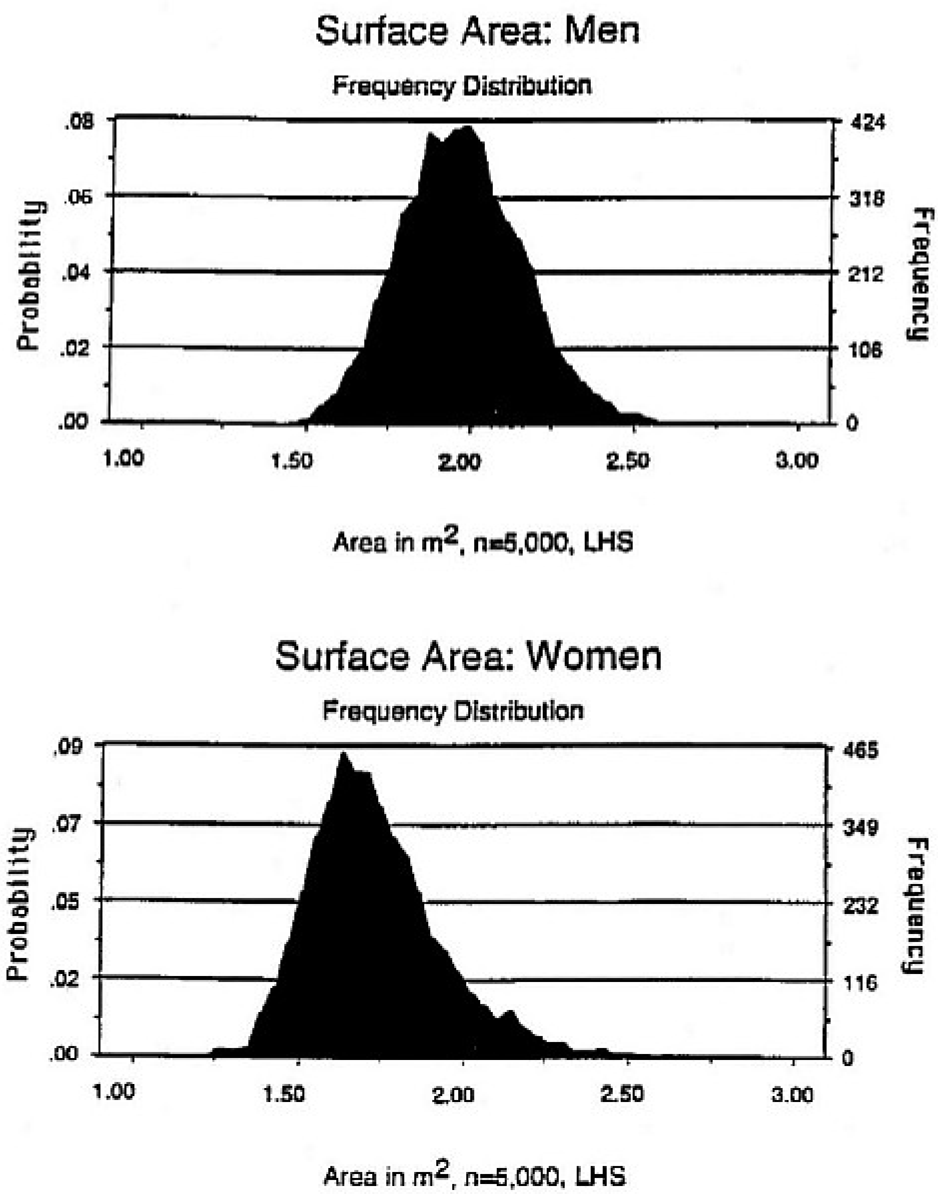

Figure 7-1. Frequency Distributions for the Surface Area of Men and Women.

Source: Murray and Burmaster, 1992.

Table 7-14. Descriptive Statistics For Surface Area/Body Weight (SA/BW) Ratios (m^2/kg)

Age (years)	Mean	Range Min-Max	SD	SE	Percentiles						
					5th	10th	25th	50th	75th	90th	95th
0 to 2	0.064	0.042-0.114	0.011	0.001	0.047	0.051	0.056	0.062	0.072	0.0784	0.0846
2.1 to 17.9	0.042	0.027-0.067	0.008	0.001	0.029	0.033	0.038	0.042	0.045	0.0501	0.0594
≥ 18	0.028	0.020-0.031	0.003	7.68e-6	0.024	0.024	0.027	0.029	0.030	0.032	0.033
All ages	0.049	0.020-0.114	0.019	9.33e-4	0.025	0.027	0.030	0.050	0.063	0.074	0.079

SD = Standard deviation.
SE = Standard error of the mean.

Source: Phillips et al., 1993.

Table 7-15. Estimated Skin Surface Exposed During Warm Weather Outdoor Activities

	Skin Area Exposed (% of total body surface area)		
	Play	Gardening/yardwork	Organized Team Sport
Age (years)	<5	5-17	5-17
N	41	437	65
Mean	38.0	33.8	29.0
Median	36.5	33.0	30.0
SD	6.0	8.3	10.5

N = Number of observations.
SD = Standard deviation.

Source: Wong et al., 2000.

Table 7-16. Summary of Field Studies									
Activity	Month	Event[a] (hrs)	N	M	F	Age (years)	Conditions	Clothing	Study
Indoor									
Tae Kwon Do	Feb.	1.5	7	6	1	8-42	Carpeted floor	All in long sleeve-long pants martial arts uniform, sleeves rolled back, barefoot	Kissel et al, 1996a
Greenhouse Workers	Mar.	5.25	2	1	1	37-39	Plant watering, spraying, soil blending, sterilization	Long pants, elbow length short sleeve shirt, no gloves	
Indoor Kids No. 1	Jan.	2	4	3	1	6-13	Playing on carpeted floor	3 or 4 short pants, 2 of 4 short sleeves, socks, no shoes	Holmes et al., 1999
Indoor Kids No. 2	Feb.	2	6	4	2	3-13	Playing on carpeted floor	5 of 6 long pants, 5 of 6 long sleeves, socks, no shoes	
Daycare Kids No. 1 a	Aug.	3.5	6	5	1	1-6.5	Indoors: linoleum surface; Outdoors: grass, bare earth, barked area	4 of 6 in long pants, 5 of 6 short sleeves, socks, shoes	
Daycare Kids No. 1 b	Aug.	4	6	5	1	1-6.5	Indoors: linoleum surface; Outdoors: grass, bare earth, barked area	4 of 6 long pants, 5 of 6 short sleeves, 3 of 6 barefoot all afternoon, others barefoot half the afternoon	
Daycare Kids No. 2[b]	Sept.	8	5	4	1	1-4	Indoors: low napped carpeting, linoleum surfaces	4 of 5 long pants, 3 of 5 long sleeves, all barefoot for part of the day	
Daycare Kids No. 3	Nov.	8	4	3	1	1-4.5	Indoors: linoleum surface, Outside: grass, bare earth, barked area	All long pants, 3 of 4 long sleeves, socks and shoes	
Outdoor									
Soccer No. 1	Nov.	0.67	8	8	0	13-15	Half grass-half bare earth	6 of 8 long sleeves, 4 of 8 long pants, 3 of 4 short pants and shin guards	Kissel et al., 1996a
Soccer No. 2	Mar.	1.5	8	0	8	24-34	All weather field (sand-ground tires)	All in short sleeve shirts, shorts, knee socks, shin guards	
Soccer No. 3	Nov.	1.5	7	0	7	24-34	All weather field (sand-ground tires)	All in short sleeve shirts, shorts, knee socks, shin guards	
Groundskeepers No. 1	Mar.	1.5	2	1	1	29-52	Campus grounds, urban horticulture center, arboretum	All in long pants, intermittent use of gloves	
Groundskeepers No. 2	Mar.	4.25	5	3	2	22-37	Campus grounds, urban horticulture center, arboretum	All in long pants, intermittent use of gloves	
Groundskeepers No. 3	Mar.	8	7	5	2	30-62	Campus grounds, urban horticulture center, arboretum	All in long pants, intermittent use of gloves	

Table 7-16. Summary of Field Studies (continued)

Activity	Month	Event[a] (hrs)	N	M	F	Age	Conditions	Clothing	Study
Groundskeepers No. 4	Aug.	4.25	7	4	3	22-38	Campus grounds, urban horticulture center, arboretum	5 of 7 in short sleeve shirts, intermittent use of gloves	Kissel et al., 1996a
Groundskeepers No. 5	Aug.	8	8	6	2	19-64	Campus grounds, urban horticulture center, arboretum	5 of 8 in short sleeve shirts, intermittent use of gloves	
Irrigation installers	Oct.	3	6	6	0	23-41	Landscaping, surface restoration	All in long pants, 3 of 6 short sleeve or sleeveless shirts	
Rugby No. 1	Mar.	1.75	8	8	0	20-22	Mixed grass-bare wet field	All in short sleeve shirts, shorts, variable sock lengths	
Farmers No. 1	May	2	4	2	2	39-44	Manual weeding, mechanical cultivation	All in long pants, heavy shoes, short sleeve shirts, no gloves	
Farmers No. 2	July	2	6	4	2	18-43	Manual weeding, mechanical cultivation	2 of 6 short, 4 of 6long pants, 1 of 6 long sleeve shirt, no gloves	
Reed Gatherers	Aug.	2	4	0	4	42-67	Tidal flats	2 of 4 short sleeve shirts/knee length pants, all wore shoes	
Kids-in-mud No. 1	Sept.	0.17	6	5	1	9-14	Lake shoreline	All in short sleeve T-shirts, shorts, barefoot	
Kids-in-mud No. 2	Sept.	0.33	6	5	1	9-14	Lake shoreline	All in short sleeve T-shirts, shorts, barefoot	
Gardeners No. 1	Aug.	4	8	1	7	16-35	Weeding, pruning, digging a trench	6 of 8 long pants, 7 of 8 short sleeves, 1 sleeveless, socks, shoes, intermittent use of gloves	Holmes et al., 1999
Gardeners No. 2	Aug.	4	7	2	5	26-52	Weeding, pruning, digging a trench, picking fruit, cleaning	3 of 7 long pants, 5 of 7 short sleeves, 1 sleeveless, socks, shoes, no gloves	
Rugby No. 2	July	2	8	8	0	23-33	Grass field (80% of time) and all-weather field (mix of gravel, sand, and clay) (20% of time)	All in shorts, 7 of 8 in short sleeve shirts, 6 of 8 in low socks	
Rugby No. 3	Sept.	2.75	7	7	0	24-30	Compacted mixed grass and bare earth field	All short pants, 7 of 8 short or rolled up sleeves, socks, shoes	
Archeologists	July	11.5	7	3	4	16-35	Digging with trowel, screening dirt, sorting	6 of 7 short pants, all short sleeves, 3 no shoes or socks, 2 sandals	
Construction Workers	Sept.	8	8	8	0	21-30	Mixed bare earth and concrete surfaces, dust and debris	5 of 8 pants,7 of 8 short sleeves, all socks and shoes	
Landscape/Rockery	June	9	4	3	1	27-43	Digging (manual and mechanical), rock moving	All long pants, 2 long sleeves, all socks and boots	

Table 7-16. Summary of Field Studies (continued)									
Activity	Month	Event[a] (hrs)	N	M	F	Age	Conditions	Clothing	Study
Utility Workers No.1	July	9.5	5	5	0	24-45	Cleaning, fixing mains, excavation (backhoe and shovel)	All long pants,short sleeves, socks, boots, gloves sometimes	Holmes et al., 1999
Utility Workers No.2	Aug.	9.5	6	6	0	23-44	Cleaning, fixing mains, excavation (backhoe and shovel)	All long pants, 5 of 6 short sleeves, socks, boots, gloves sometimes	
Equip. Operators No.1	Aug.	8	4	4	0	21-54	Earth scraping with heavy machinery, dusty conditions	All long pants, 3 of 4 short sleeves, socks, boots, 2 of 4 gloves	
Equip. Operators No.2	Aug.	8	4	4	0	21-54	Earth scraping with heavy machinery, dusty conditions	All long pants, 3 of 4 short sleeves, socks, boots, 1 gloves	
Shoreline Play	Sept.	0.33-1.0	9	6	3	7-12	Tidal flat	No shirt or short sleeve T-shirts, shorts, barefoot	Shoaf et al., 2005

a Event duration.
b Activities were confined to the house.
N = Number of subjects.
M = Male.
F = Female.

Table 7-17. Geometric Mean and Geometric Standard Deviations of Solids Adherence by Activity and Body Region[a]

Activity	N	Post-activity Dermal Solids Loadings (mg/cm^2)				
		Hands	Arms	Legs	Faces	Feet
Indoor						
Tae Kwon Do	7	0.0063 1.9	0.0019 4.1	0.0020 2.0		0.0022 2.1
Greenhouse workers	2	0.043 --	0.0064 --	0.0015 --	0.0050 --	
Indoor Kids No. 1	4	0.0073 1.9	0.0042 1.9	0.0041 2.3		0.012 1.4
Indoor Kids No. 2	6	0.014 1.5	0.0041 2.0	0.0031 1.5		0.0091 1.7
Daycare Kids No. 1a	6	0.11 1.9	0.026 1.9	0.030 1.7		0.079 2.4
Daycare Kids No. 1b	6	0.15 2.1	0.031 1.8	0.023 1.2		0.13 1.4
Daycare Kids No. 2	5	0.073 1.6	0.023 1.4	0.011 1.4		0.044 1.3
Daycare Kids No. 3	4	0.036 1.3	0.012 1.2	0.014 3.0		0.0053 5.1
Outdoor						
Soccer No. 1	8	0.11 1.8	0.011 2.0	0.031 3.8	0.012 1.5	
Soccer No. 2	8	0.035 3.9	0.0043 2.2	0.014 5.3	0.016 1.5	
Soccer No. 3	7	0.019 1.5	0.0029 2.2	0.0081 1.6	0.012 1.6	
Groundskeepers No. 1	2	0.15 --	0.005 --		0.0021 --	0.018 --
Groundskeepers No. 2	5	0.098 2.1	0.0021 2.6	0.0010 1.5	0.010 2.0	
Groundskeepers No. 3	7	0.030 2.3	0.0022 1.9	0.0009 1.8	0.0044 2.6	0.0040
Groundskeepers No. 4	7	0.045 1.9	0.014 1.8	0.0008 1.9	0.0026 1.6	0.018 --
Groundskeepers No. 5	8	0.032 1.7	0.022 2.8	0.0010 1.4	0.0039 2.1	
Irrigation Installers	6	0.19 1.6	0.018 3.2	0.0054 1.8	0.0063 1.3	

Table 7-17. Geometric Mean and Geometric Standard Deviations of Solids Adherence by Activity and Body Region[a] (continued)

Activity	N	Post-activity Dermal Solids Loadings (mg/cm^2)				
		Hands	Arms	Legs	Faces	Feet
Rugby No. 1	8	0.40 1.7	0.27 1.6	0.36 1.7	0.059 2.7	
Farmers No. 1	4	0.41 1.6	0.059 3.2	0.0058 2.7	0.018 1.4	
Farmers No. 2	6	0.47 1.4	0.13 2.2	0.037 3.9	0.041 3.0	
Reed Gatherers	4	0.66 1.8	0.036 2.1	0.16 9.2		0.63 7.1
Kids-in-mud No. 1	6	35 2.3	11 6.1	36 2.0		24 3.6
Kids-in-mud No. 2	6	58 2.3	11 3.8	9.5 2.3		6.7 12.4
Gardeners No. 1	8	0.20 1.9	0.050 2.1	0.072 --	0.058 1.6	0.17 --
Gardeners No. 2	7	0.18 3.4	0.054 2.9	0.022 2.0	0.047 1.6	0.26 --
Rugby No. 2	8	0.14 1.4	0.11 1.6	0.15 1.6	0.046 1.4	
Rugby No. 3	7	0.049 1.7	0.031 1.3	0.057 1.2	0.020 1.5	
Archeologists	7	0.14 1.3	0.041 1.9	0.028 4.1	0.050 1.8	0.24 1.4
Construction Workers	8	0.24 1.5	0.098 1.5	0.066 1.4	0.029 1.6	
Landscape/Rockery	4	0.072 2.1	0.030 2.1		0.0057 1.9	
Utility Workers No.1	5	0.32 1.7	0.20 2.7		0.10 1.5	
Utility Workers No. 2	6	0.27 2.1	0.30 1.8		0.10 1.5	
Equip. Operators No. 1	4	0.26 2.5	0.089 1.6		0.10 1.4	
Equip. Operators No. 2	4	0.32 1.6	0.27 1.4		0.23 1.7	
Shoreline Play	9	0.49 8.2	0.17 3.1	0.70 3.6	0.04 2.9	21 1.9

[a] Means are presented above the standard deviations. The standard deviations generally exceed the means by large amounts indicating high variability in the data.

N = Number of subjects.

Sources: Kissel et al., 1996a; Holmes et al., 1999; Shoaf et al., 2005.

Table 7-18. Summary of Controlled Greenhouse Trials

Activity	Ages (years)	Duration (min)	Soil Moisture (%)	Clothing[a]	N	Male	Female
Transplanting	Adults	~12[b]	17-19	L	4	2	2
			15-18	S	13	6	7
Playing	8 to 12	20	17-18	L	4	3	1
			16-18	S	9	5	4
			3-4	S	5	3	2
Pipe Laying	Adults	15, 30, 45	9-12	S	7	4	3
			5-7	S	6	3	3

[a] L, long sleeves and long pants; S, short sleeves and short pants.
[b] Arithmetic mean (range was 9 to 18 minutes). Activity was terminated after completion of the task rather than at a fixed time.

N = Number of subjects.

Source: Kissel et al., 1998.

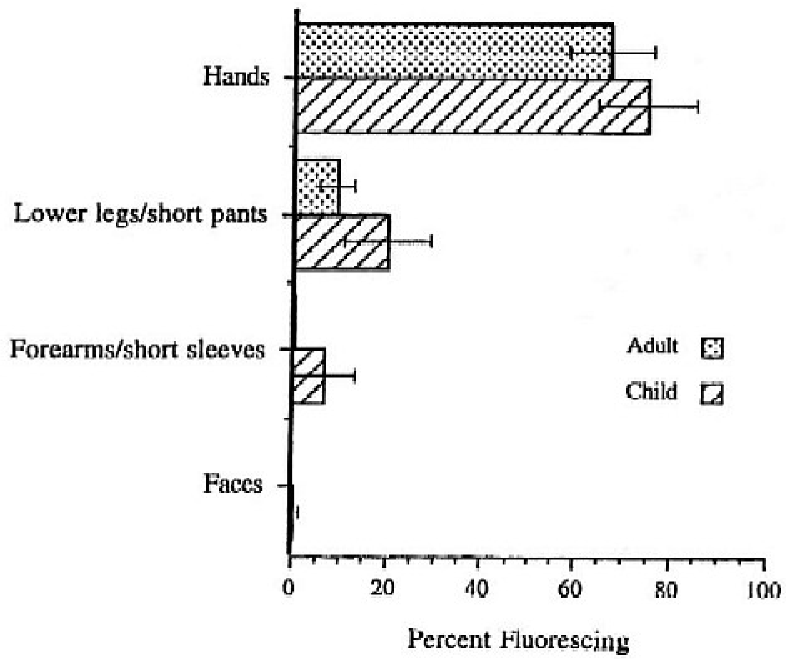

Figure 7-2. Skin Coverage as Determined by Fluorescence vs. Body Part for Adults Transplanting Plants and Children Playing in Wet Soils (bars are arithmetic means and corresponding 95% confidence intervals)

Source: Kissel et al., 1998.

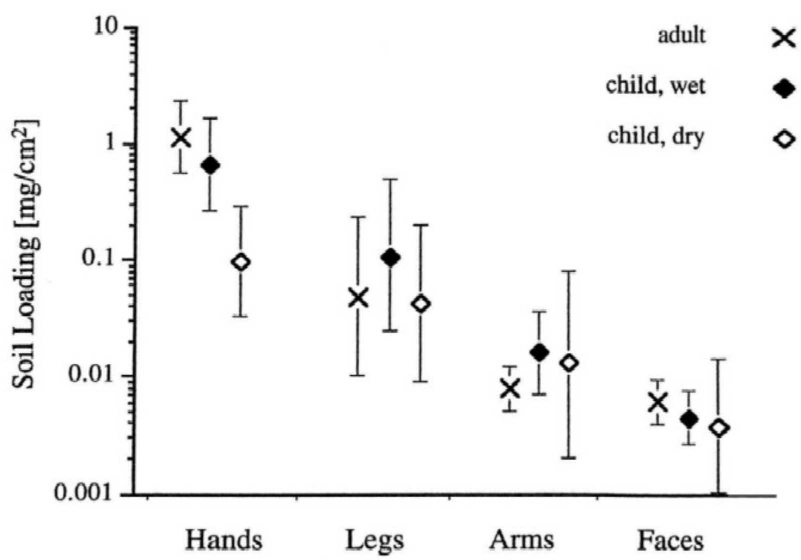

Figure 7-3. Gravimetric Loading vs. Body Part for Adults Transplanting Plants in Wet Soil and Children Playing in Wet and Dry Soils (symbols are geometric means and 95% confidence intervals)

Source: Kissel et al., 1998.

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APPENDIX 7A

FORMULAS FOR TOTAL BODY SURFACE AREA

APPENDIX 7A - FORMULAS FOR TOTAL BODY SURFACE AREA

Most formulas for estimating surface area (SA) relate height to weight to surface area. The following formula was proposed by Gehan and George (1970):

$$SA = KW^{2/3} \qquad \text{(Eqn. 7A-1)}$$

where:

SA = surface area in square meters;
W = weight in kg; and
K = constant.

While the above equation has been criticized because human bodies have different specific gravities and because the surface area per unit volume differs for individuals with different body builds, it gives a reasonably good estimate of surface area.

A formula published in 1916 that still finds wide acceptance and use is that of DuBois and DuBois (1916). Their model can be written:

$$SA = a_0 H^{a_1} W^{a_2} \qquad \text{(Eqn. 7A-2)}$$

where:

SA = surface area in square meters;
H = height in centimeters; and
W = weight in kg.

The values of a_0 (0.007182), a_1 (0.725), and a_2 (0.425) were estimated from a sample of only nine individuals for whom surface area was directly measured. Boyd (1935) stated that the Dubois formula was considered a reasonably adequate substitute for measuring surface area. Nomograms for determining surface area from height and mass presented in Volume I of the Geigy Scientific Tables (1981) are based on the DuBois and DuBois formula. In addition, a computerized literature search conducted for this report identified several articles written in the last 10 years in which the DuBois and DuBois formula was used to estimate body surface area.

Boyd (1935) developed new constants for the DuBois and DuBois model based on 231 direct measurements of body surface area found in the literature. These data were limited to measurements of surface area by coating methods (122 cases), surface integration (93 cases), and triangulation (16 cases). The subjects were Caucasians of normal body build for whom data on weight, height, and age (except for exact age of adults) were complete. Resulting values for the constants in the DuBois and DuBois model were a_0 = 0.01787, a_1 = 0.500, and a_2 = 0.4838. Boyd also developed a formula based exclusively on weight, which was inferior to the DuBois and DuBois formula based on height and weight.

Gehan and George (1970) proposed another set of constants for the DuBois and DuBois model. The constants were based on a total of 401 direct measurements of surface area, height, and weight of all postnatal subjects listed in Boyd (1935). The methods used to measure these subjects were coating (163 cases), surface integration (222 cases), and triangulation (16 cases).

Gehan and George (1970) used a least-squares method to identify the values of the constants. The values of the constants chosen are those that minimize the sum of the squared percentage errors of the predicted values of surface area. This approach was used because the importance of an error of 0.1 square meter depends on the surface area of the individual. Gehan and George (1970) used the 401 observations summarized in Boyd (1935) in the least-squares method. The following estimates of the constants were obtained: a_0 = 0.02350, a_1 = 0.42246, and a_2 = 0.51456. Hence, their equation for predicting SA is:

$$SA = 0.02350\ H^{0.42246} W^{0.51456} \qquad \text{(Eqn. 7A-3)}$$

or in logarithmic form:

$$\ln SA = -3.75080 + 0.42246 \ln H + 0.51456 \ln W \qquad \text{(Eqn. 7A-4)}$$

where:

SA = surface area in square meters;
H = height in centimeters; and
W = weight in kg.

This prediction explains more than 99 percent of the variations in surface area among the 401 individuals measured (Gehan and George, 1970).

The equation proposed by Gehan and George (1970) was determined by the U.S. EPA (1985) as the best choice for estimating total body surface area. However, the paper by Gehan and George gave insufficient information to estimate the standard error about the regression. Therefore, the 401 direct measurements of children and adults (i.e., Boyd, 1935) were reanalyzed in U.S. EPA (1985) using the formula of Dubois and Dubois (1916) and the Statistical Processing System (SPS) software package to obtain the standard error.

The Dubois and Dubois (1916) formula uses weight and height as independent variables to predict total body surface area (SA), and can be written as:

$$SA_1 = a_0 \, H_i^{a_1} \, W_i^{a_2} \, e_i \qquad \text{(Eqn. 7A-5)}$$

or in logarithmic form:

$$\ln(SA)_i = \ln a_0 + a_1 \ln H_i + a_2 \ln W_i + \ln e_i \qquad \text{(Eqn. 7A-6)}$$

where:

SA_i	=	surface area of the i-th individual (m^2);
H_i	=	height of the i-th individual (cm);
W_i	=	weight of the i-th individual (kg);
a_0, a_1, and a_2	=	parameters to be estimated; and
e_i	=	a random error term with mean zero and constant variance.

Using the least squares procedure for the 401 observations, the following parameter estimates and their standard errors were obtained:

a_0 = -3.73 (0.18), a_1 = 0.417 (0.054), a_2 = 0.517 (0.022)

The model is then:

$$SA = 0.0239 \, H^{0.417} \, W^{0.517} \qquad \text{(Eqn. 7A-7)}$$

or in logarithmic form:

$$\ln SA = 3.73 + 0.417 \ln H + 0.517 \ln W \qquad \text{(Eqn. 7A-8)}$$

with a standard error about the regression of 0.00374. This model explains more than 99 percent of the total variation in surface area among the observations, and is identical to two significant figures with the model developed by Gehan and George (1970).

When natural logarithms of the measured surface areas are plotted against natural logarithms of the surface predicted by the equation, the observed surface areas are symmetrically distributed around a line of perfect fit, with only a few large percentage deviations. Only five subjects differed from the measured value by 25 percent or more. Because each of the five subjects weighed less than 13 pounds, the amount of difference was small. Eighteen estimates differed from measurements by 15 to 24 percent. Of these, 12 weighed less than 15 pounds each, 1 was overweight (5 feet 7 inches, 172 pounds), 1 was very thin (4 feet 11 inches, 78 pounds), and 4 were of average build. Since the same observer measured surface area for these 4 subjects, the possibility of some bias in measured values cannot be discounted (Gehan and George 1970). Gehan and George (1970) also considered separate constants for different age groups: less than 5 years old, 5 years old to less than 20 years old, and greater than 20 years old. The different values for the constants are presented in Table 7A-1.

The surface areas estimated using the parameter values for all ages were compared to surface areas estimated by the values for each age group for subjects at the 3rd, 50th, and 97th percentiles of weight and height. Nearly all differences in surface area estimates were less than 0.01 square meter, and the largest difference was 0.03 m^2 for an 18-year-old at the 97th percentile. The authors concluded that there is no advantage in using separate values of a_0, a_1, and a_2 by age interval.

Haycock et al. (1978) without knowledge of the work by Gehan and George (1970), developed values for the parameters a_0, a_1, and a_2 for the DuBois and DuBois model. Their interest in making the DuBois and DuBois model more accurate resulted from their work in pediatrics and the fact that DuBois and DuBois (1916) included only one child in their study group, a severely undernourished girl who weighed only 13.8 pounds at age 21 months. Haycock et al. (1978) used their own geometric method for estimating surface area from 34 body measurements for 81 subjects. Their study included newborn infants (10 cases), infants (12 cases), children (40 cases), and adult members of the medical and secretarial staffs of 2 hospitals (19 cases). The subjects all had grossly normal body structure, but the sample included subjects of widely varying physique ranging from thin to obese. Black, Hispanic, and white children were included in their sample. The values of the model parameters were solved for the relationship between surface area and height and weight by multiple regression analysis. The least squares best fit for this equation yielded the following values for the three coefficients: a_0 = 0.024265, a_1 = 0.3964, and a_2 = 0.5378. The result was the following equation for estimating surface area:

$$SA = 0.024265 H^{0.3964} \, W^{0.5378} \qquad \text{(Eqn. 7A-9)}$$

expressed logarithmically as:

$$\ln SA = \ln 0.024265 + 0.3964 \ln H + 0.5378 \ln W$$ (Eqn. 7A-10)

The coefficients for this equation agree remarkably with those obtained by Gehan and George (1970) for 401 measurements.

George et al. (1979) agree that a model more complex than the model of DuBois and DuBois for estimating surface area is unnecessary. Based on samples of direct measurements by Boyd (1935) and Gehan and George (1970), and samples of geometric estimates by Haycock et al. (1978), these authors have obtained parameters for the DuBois and DuBois model that are different than those originally postulated in 1916. The DuBois and DuBois model can be written logarithmically as:

$$\ln SA = \ln a_0 + a_1 \ln H + a_2 \ln W$$ (Eqn. 7A-11)

The values for a_0, a_1, and a_2 obtained by the various authors discussed in this section are presented in Table 7A-2.

The agreement between the model parameters estimated by Gehan and George (1970) and Haycock et al. (1978) is remarkable in view of the fact that Haycock et al. (1978) were unaware of the previous work. Haycock et al. (1978) used an entirely different set of subjects, and used geometric estimates of surface area rather than direct measurements. It has been determined that the Gehan and George model is the formula of choice for estimating total surface area of the body since it is based on the largest number of direct measurements.

Sendroy and Cecchini (1954) proposed a method of creating a *nomogram*, a diagram relating height and weight to surface area. However, they do not give an explicit model for calculating surface area. The nomogram was developed empirically based on 252 cases, 127 of which were from the 401 direct measurements reported by Boyd (1935). In the other 125 cases the surface area was estimated using the linear method of DuBois and DuBois (1916). Because the Sendroy and Cecchini method is graphical, it is inherently less precise and less accurate than the formulas of other authors discussed above.

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Table 7A-1. Estimated Parameter Values for Different Age Intervals				
Age Group	Number of persons	a_0	a_1	a_2
All ages	401	0.02350	0.42246	0.51456
<5 years old	229	0.02667	0.38217	0.53937
≥5 to <20 years old	42	0.03050	0.35129	0.54375
≥20 years old	30	0.01545	0.54468	0.46336
Source: Gehan and George, 1970.				

Table 7A-2. Summary of Surface Area Parameter Values for the Dubois and Dubois Model				
Author (year)	Number of persons	a_0	a_1	a_2
DuBois and DuBois (1916)	9	0.007184	0.725	0.425
Boyd (1935)	231	0.01787	0.500	0.4838
Gehan and George (1970)	401	0.02350	0.42246	0.51456
Haycock et al. (1978)	81	0.024265	0.3964	0.5378

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8 BODY WEIGHT STUDIES

8.1 INTRODUCTION

There are several physiological factors needed to calculate potential exposures. These include skin surface area (Chapter 7), inhalation rate (Chapter 6) life expectancy (Chapter 18), and body weight. The average daily dose (ADD) is a dose that is typically normalized to the average body weight of the exposed population. If exposure occurs only during childhood years, the average child body weight during the exposure period should be used to estimate risk (U.S. EPA, 1989). Conversely, if adult exposures are being evaluated, an adult body weight value should be used.

The purpose of this chapter is to describe a published studies on body weight in the general U.S. population. The recommendations for body weight are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values are based on one key study identified by U.S. EPA for this factor. Following the recommendations, the key study on body weight is summarized. Relevant data on body weight are also provided. These relevant data are included because they may be useful for trend analysis. Since obesity is a growing concern and may increase the risk of chronic diseases during adulthood, information on body mass index (BMI) and height are also provided.

8.2 RECOMMENDATIONS

The key study described in this section was used in selecting recommended values for body weight. The recommendations for body weight are summarized in Table 8-1. The recommended values represent mean body weights in kilograms for the age groups for children recommended by U.S. EPA in *Guidance for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005) and for adults. Table 8-2 presents the confidence ratings for body weight recommendations.

The mean body weight for all adults (male and female, all age groups) combined is 80.0 kg as shown in Table 8-1. If percentile data are needed Tables 8-3 through. 8-5 can be used to select the appropriate data for percentiles or mean values.

The mean recommended value for adults (80 kg) is different from the 70 kg commonly assumed in EPA risk assessments. Assessors are encouraged to use values which most accurately reflect the exposed population. When using values other than 70 kg, however, the assessors should consider if the dose estimate will be used to estimate risk by combining it with a dose-response relationship which was derived assuming a body weight of 70 kg. If such an inconsistency exists, the assessor should adjust the dose-response relationship as described in the appendix to Chapter 1. The Integrated Risk Information System (IRIS) does not use a 70 kg body weight assumption in the derivation of RfCs and RfDs, but does make this assumption in the derivation of cancer slope factors and unit risks.

Use of upper percentile body weight values are not routinely recommended for calculating ADDs because inclusion of an upper percentile value in the denominator of the ADD equation would be a non-conservative approach. However, distributions of body weight data are provided in Section 8.3 of this chapter. These distributions may be useful if probabilistic methods are used to assess exposure. Also, if gender-specific data are needed, or if data for finer age bins are needed, the reader should refer to the tables in Section 8.3.

Table 8-1. Recommended Values for Body Weight			
Age Group	Mean kg	Multiple Percentiles	Source
Birth to <1 month	4.8	Tables 8-3 through 8-5	U.S. EPA analysis of NHANES, 1999-2006 data
1 to <3 months	5.9		
3 to <6 months	7.4		
6 to <11 months	9.2		
1 to <2 years	11.4		
2 to <3 years	13.8		
3 to <6 years	18.6		
6 to <11 years	31.8		
11 to <16 years	56.8		
16 to <21 years	71.6		
Adults	80.0		

Table 8-2. Confidence in Recommendations for Body Weight		
General Assessment Factors	Rationale	Rating
Soundness		High
Adequacy of Approach	The survey methodology and secondary data analysis was adequate. NHANES consisted of a large sample size; sample size varied with age. Direct measurements were taken during a physical examination.	
Minimal (or Defined) Bias	No significant biases were apparent.	
Applicability and Utility		High
Exposure Factor of Interest	The key study is directly relevant to body weight.	
Representativeness	NHANES was a nationally representative sample of the U.S. population; participants are selected using a complex, stratified, multi-stage probability cluster sampling design.	
Currency	The U.S. EPA analysis used the most current NHANES data.	
Data Collection Period	The U.S. EPA analysis was based on 4 data sets of NHANES data covering 1999-2006.	
Clarity and Completeness		High
Accessibility	NHANES data are available from NCHS; the U.S. EPA analysis of the NHANES data is available upon request.	
Reproducibility	The methods used were well-described; enough information was provided to allow for reproduction of results.	
Quality Assurance	Quality assurance of NHANES data was good; quality control of secondary data analysis was not well described.	
Variability and Uncertainty		High
Variability in Population	The full distributions were given in the key study.	
Uncertainty	No significant uncertainties were apparent in the NHANES data, nor in the secondary analyses of the data.	
Evaluation and Review		Medium
Peer Review	NHANES received a high level of peer review. The U.S. EPA analysis was not published in a peer-reviewed journal.	
Number and Agreement of Studies	The number of studies is 1.	
Overall Rating		**High**

8.3 KEY BODY WEIGHT STUDY

8.3.1 *U.S. EPA analysis of NHANES 1999-2006 data*

The U.S. EPA analyzed data from the 1999-2006 National Health and Nutrition Examination Survey (NHANES) to generate distributions of body weight for various age ranges of children and adults. NHANES is conducted annually by the Center for Disease Control (CDC), National Center of Health Statistics (NCHS). The survey's target population is the civilian, noninstitutionalized U.S. population. The NHANES 1999-2006 survey was conducted on a nationwide probability sample of approximately 40,000 persons for all ages, of which approximately 20,000 were children. The survey is designed to obtain nationally representative information on the health and nutritional status of the population of the United States through interviews and direct physical examinations. A number of anthropometric measurements, including body weight, were taken for each participant in the study. Unit non-response to the household interview was 19 percent, and an additional 4 percent did not participate in the physical examinations (including body weight measurements).

The NHANES 1999-2006 survey includes over-sampling of low-income persons, adolescents 12-19 years, persons 60+ years of age, African Americans and Mexican Americans. Sample data were assigned weights to account both for the disparity in sample sizes for these groups and for other inadequacies in sampling, such as the presence of non-respondents. Because the U.S. EPA utilized four NHANES data sets in its analysis (NHANES 1999-2000, 2001-2002, 2003-2004, and 2005-2006) sample weights were developed for the combined data set in accordance with CDC guidance from the NHANES' website (http://www.cdc.gov/nchs/about/major/nhanes/nhanes2005-2006/faqs05_06.htm#question%2012).

Using the data and the weighting factors from the four NHANES data sets, U.S. EPA calculated body weight statistics for the standard age categories. The mean value for a given group was calculated using the following formula:

$$\overline{x} = \frac{\sum_i w_i x_i}{\sum_i w_i} \qquad \text{(Eqn. 8-1)}$$

where:

$\overline{X}$ = sample mean;
x_i = the i^{th} observation;
w_i = sample weight assigned to observation x_i.

Percentile values were generated by first calculating the sum of the weights for all observations in a given group and multiplying this sum by the percentile of interest (e.g., multiplying by 0.25 to determine the 25th percentile). The observations were then ordered from least to greatest, and each observation was assigned a cumulative weight, equal to its own weight plus all weights listed before the observation. The first observation listed with a cumulative weight greater than the value calculated for the percentile of interest was selected.

Table 8-3 presents the body weight means and percentiles, by age category, for males and females combined. Tables 8-4 and 8-5 present the body weight means and percentiles for males and females, respectively.

The advantage of this study is that it provides body weight distributions ranging from infancy to adults. A limitation of the study is that the data in Tables 8-3 to 8-5 may underestimate current body weights due to an observed upward trend in body weights (Ogden et al., 2004). However, the NHANES data are nationally representative and remain the principal source of body weight data collected nationwide from a large number of subjects.

8.4 RELEVANT BODY WEIGHT STUDIES

8.4.1 *National Center for Health Statistics, 1987 - Anthropometric reference data and prevalence of overweight, United States, 1976-80*

The National Center for Health Statistics (1987) collected anthropometric measurement data for body weight for the U.S. population as part of the second National Health and Nutrition Examination Survey (NHANES II). NHANES II began in February 1976 and was completed in February 1980. The survey was conducted on a nationwide probability sample of 27,801 persons aged 6 months to 74 years from the civilian, noninstitutionalized population of the United States. A total of 20,322 individuals in the sample were interviewed and examined, resulting in a response rate of 73.1 percent. The sample was selected so that certain subgroups thought to be at high risk of malnutrition (persons with low incomes, preschool children, and the elderly) were over sampled. The estimates were weighted to reflect national population estimates. The weighting was accomplished by inflating examination results for each subject by the reciprocal of selection probabilities, adjusted to account for those who were not examined, and-post stratifying by race, age, and sex.

NHANES II collected standard body measurements of sample subjects, including height and weight, that were made at various times of the day and in different seasons of the year. This technique was used because an individual's weight may vary between winter and summer and may fluctuate with patterns of food and water intake and other daily activities (NCHS, 1987). NCHS (1987) provided descriptive statistics of the body weight data. Means and percentiles, by age category, are presented in Table 8-6 for males, and in Table 8-7 for females. The limitation of the study is the age of the data.

8.4.2 *Brainard and Burmaster, 1992 - Bivariate Distributions for Height and Weight of Men and Women in the United States*

Brainard and Burmaster (1992) examined data on the height and weight of adults published by the U.S. Public Health Service and fit bivariate distributions to the tabulated values for men and women, separately. Height and weight of 5,916 men and 6,588 women in the age range of 18 to 74 years were taken from the NHANES II (1976-1980) study and statistically adjusted to represent the U.S. population aged 18 to 74 years with regard to age structure, sex, and race. Estimation techniques were used to fit normal distributions to the cumulative marginal data and goodness-of-fit tests were used to test the hypothesis that height and lognormal weight follow a normal distribution for each sex. It was found that the marginal data and goodness-of-fit tests were used to test the hypothesis that height and lognormal weight follow a normal distribution for each sex. It was found that the marginal distributions of height and lognormal weight for both men and women are Gaussian (normal) in form. This conclusion was reached by visual observation and the high R^2 values for best-fit lines obtained using linear regression. The R^2 values for men's height and lognormal weight are reported to be 0.999. The R^2 values for women's height and lognormal weight are 0.999 and 0.985, respectively.

Brainard and Burmaster (1992) fit bivariate distributions to estimated numbers of men and women aged 18 to 74 years in cells representing 1 inch height intervals and 10 pound weight intervals. Adjusted height and lognormal weight data for men were fit to a single bivariate normal distribution with an estimated mean height of 1.75 meters (69.2 inches) and an estimated mean weight of 78.6 kg (173.2 pounds). For women, height and lognormal weight data were fit to a pair of superimposed bivariate normal distributions (Brainard and Burmaster, 1992). The average height and weight for women were estimated from the combined bivariate analyses. Mean height for women was estimated to be 1.62 meters (63.8 inches) and mean weight was estimated to be 65.8 kg (145.0 pounds). For women, a calculation using a single bivarite normal distribution gave poor results (Brainard and Burmaster, 1992). According to Brainard and Burmaster (1992), the distributions are suitable for use in Monte Carlo simulation. These distributions are based on dated information.

8.4.3 *Burmaster and Crouch, 1997 - Lognormal distributions for body weight as a function of age for males and females in the United States, 1976-1980*

Burmaster and Crouch (1997) performed data analysis to fit normal and lognormal distributions to the body weights of females and males aged 9 months to 70 years. The data used in this analysis were from the second survey of the National Center for Health Statistics, NHANES II, which was based on a national probability sample of 27,801 persons 6 months to 74 years of age in the U.S. (Burmaster and Crouch, 1997). The NHANES II data had been statistically adjusted for non-response and probability of selection, and stratified by age, sex, and race to reflect the entire U.S. population prior to reporting. Burmaster and Crouch (1997) conducted exploratory and quantitative data analyses and fit normal and lognormal distributions to percentiles of body weights as a function of age. Cumulative distribution functions were plotted for female and male body weights on both linear and logarithmic scales.

Burmaster and Crouch (1997) used "maximum likelihood" estimation to fit lognormal distributions to the data. Linear and quadratic regression lines were fitted to the data. A number of goodness-of-fit measures were conducted on the data generated. The investigators found that lognormal distributions gave strong fits to the data for each gender across all age groups. The statistics for the lognormal probability plots for females and males aged 9 months to 74 years are presented in Tables 8-8 and 8-9, respectively. These data can be used for further analyses of body weight distribution (i.e., application of Monte Carlo analysis).

The advantage of this study is that NHANES data were used for the analysis and the data are representative nationally. It also provides statistics for probability plot regression analyses for females and males from 6 months to 70 years of age. However, the analysis is based on an older set of NHANES data.

8.4.4 *U.S. EPA, 2000 - Body weight estimates on NHANES III Data*

U.S. EPA's Office of Water has estimated body weights by age and gender using data from NHANES III, which was conducted from 1988 to 1994. NHANES III collected body weight data for approximately 30,000 individuals between the ages of 2 months and 44 years. Table 8-10 presents the body weight estimates in kilograms by age and gender. Table 8-11 shows the body weight estimates for infants under the age of 3 months.

The limitations of this analysis are that data were not available for infants under 2 months old, and that the data are roughly 15 to 20 years old. With the upward trends in body weight from NHANES II (1976-1980) to NHANES III, which may still be valid, the data in Tables 8-10 and 8-11 may underestimate current body weights. However, the data are national in scope and represent the general population.

8.4.5 *Kuczmarski et al., 2002 - 2000 CDC growth charts for the United States: methods and development*

NCHS published growth charts for infants, birth to 36 months of age, and children and adolescents, 2 to 20 years of age (Kuczmarski et al., 2002). Growth charts were developed with data from five national health examination surveys: National Health Examination Survey (NHES) II (1963-65) for ages 6-11 years, NHES III (1966-70) for ages 12-17 years, National Health and Nutrition Examination Survey (NHANES) I (1971-74) for ages 1-17 years, NHANES II (1976-80) beginning at 6 months of age, and NHANES III (1988-94) beginning at 2 months of age. Data from these national surveys were pooled because no single survey had enough observations to develop these charts. For the infant charts, a limited number of additional data points were obtained from other sources where national data were either not available or insufficient. Birth weights <1,500 grams were excluded when generating the charts for weights and lengths. Also, the length-for-age charts exclude data from NHANES III for ages <3.5 months. Supplemental birth certificate data from the U.S. vital statistics were used in the weight-for-age charts and supplemental birth certificate data from Wisconsin and Missouri vital statistics, CDC Pediatric Nutrition Surveillance System data were used for ages 0.5, 1.5, 2.5, 3.5, and 4.5 months for the length-for-age charts. The Missouri and Wisconsin birth certificate data were also used to supplement the surveys for the weight-for-length charts. Table 8-12 presents the percentiles of weight by gender and age. Figures 8-1 and 8-2 present weight by age percentiles for boys and girls, aged birth to 36 months, respectively. Figures 8-3 and 8-4 present weight by length percentiles for boys and girls, respectively. Figures 8-5 and 8-6 provide the Body Mass Index (BMI) for boys and girls aged 2 to 20 years old.

A limitation of this analysis is that trends in the weight data cannot be assessed because data from various years were combined. The advantages of this analysis are that it is based on a nationally representative sample of the U.S. population and it provides body weight on a month-by-month basis up to 36 months of age, as well as BMI data for children through age 20 years.

8.4.6 *U.S.EPA, 2004 - Estimated Per Capita Water Ingestion and body Weight in the United States - An Update*

U.S EPA (2004) developed estimates from empirical distributions of body weights, based on data from the USDA's 1994-1996 and 1998 CSFII. The weights recorded in the survey, and consequently the estimates reported are based on self-reported data by the participants.

When viewed across genders and all age categories, the average self-reported body weight for individuals in the United States during the 1994-1996 and 1998 period is 65 kg, or 143 lb. The estimated median body weight for all individuals is 67 kg (147 lb). Table 8-13 provides the estimated distribution of body weights for all individuals.

For the fine age categories reported in the summary data, the mean and median estimated body weights are the same for children in categories less than 2 years of age. This suggests that body weights follow an approximately normal distribution. After the age of 2 years, estimated mean body weights are higher than estimated median body weights as age categories increase. This suggests that the distributions of body weights are skewed to the right. When viewed across ages, the estimated median body weight is higher than the estimated mean body weight. This suggests that the body weight distribution across the entire survey weighted sample is slightly skewed to the left. The limitation of this analysis is that body weights were self reported.

8.4.7 *Ogden et al., 2004 - Mean body weight, height, and body mass index, United States 1960-2002*

Ogden et al. (2004) analyzed trends in body weight measured by the National Health Examination Surveys II and III (NHES II and III), the National Health and Nutrition Examination Surveys I, II, and III (NHANES I, II, and III), and NHANES 1999-2002. The surveys covered the period from 1960 to

2002. Table 8-14 presents the measured body weights for various age groups as measured in NHES and NHANES. Tables 8-15 and 8-16 present the mean height and BMI data for the same population, respectively. The BMI data were calculated as weight in kilograms divided by the square of height in meters. Population means were calculated using sample weights to account for variation in sampling for certain subsets of the U.S. population, non-response, and non-coverage (Ogden et al., 2004). The data indicate that mean body weight has increased over the period analyzed.

There is some uncertainty inherent in such an analysis, however, because of changes in sampling methods during the 42 year time span covered by the studies. Because this study is based on an analysis of NHANES data, its limitations are the same as those for that study. However, it serves to illustrate the importance of the use of timely data when analyzing body weight.

8.4.8 *Freedman et al., 2006 - Racial and ethnic differences in secular trends for childhood BMI, weight, and height*

Freedman et al. (2006) examined sex and race/ethnicity differences in secular trends for childhood BMI, overweight, weight, and height in the United States using data from NHANES I (1971 to 1974), NHANES II (1976- 1980), NHANES III (1988 to 1994) and NHANES 1999-2002. The analyses included children 2 to 17 years old. Persons with missing weight or height information were excluded from the analyses (Freedman et al., 2006). The authors categorized the data across the four examinations and presented the data for non-Hispanic White, non-Hispanic Black, or Mexican American. Freedman et al. (2006) excluded other categories of race/ethnicity such as other Hispanics, because the sample sizes were small. Height and weight data were obtained for each survey and BMI was calculated as weight in kilograms divided by height in meters square. Sex specific z-scores and percentiles of weight-for-age, height-for-age, and BMI-for-age were calculated. Childhood overweight was defined as BMI-for-age $\geq 95^{th}$ percentile and childhood obesity was defined as children with a BMI-for-age $\geq 99^{th}$ percentile.

In the analyses, sample weights were used to account for differential probabilities, non-selection, non response, and non-coverage. The sample sizes used in the analyses by age, race and survey are presented in Table 8-17. Mean BMI levels for ages 2 to 17 are provided in Table 8-18. BMI mean levels for adults 20 years and older are shown in Table 8-19 (Ogden et al., 2004). Table 8-18 shows that in 1971-1974 survey total population, Mexican American children had the highest mean BMI level (18.6 kg/m^2). However the greatest increase throughout the survey occurred among Black children increasing from 17.8 to 20 kg/m^2 (Freedman et al., 2006). The prevalence of overweight and obesity for children 2 to 17 years old is shown in Table 8-20. These results show that 2 to 5 year old White children had slightly larger increases in overweight, but among the older children, the largest increases were among the Black and Mexican American children (Freedman et al., 2006). Overall, in most sex-age groups, Mexican Americans experienced the greater increase in BMI and overweight than what was experienced by Black and White Children (Freedman et al., 2006). Black children experienced larger secular increases in BMI, weight, and height than did White children (Freedman et al., 2006). According to Freedman et al. (2006) racial/ethnicity differences were less marked in the 2 to 5 years old children.

The advantages of the study are that the sample size is large and the analysis was designed to represent the general population of the racial and ethnic groups studied. The disadvantage is that some ethnic population groups were excluded because of small sample sizes.

8.4.9 *Martin et al., 2007 - Births: final data for 2005*

Martin et al.(2007) provided statistics on the percentage of live births categorized as having low or very low birth weights in the U.S. Low birth weight was defined as <2,500 grams (<5 pounds 8 ounces) and very low birth weight was defined as <1,500 grams (<3 pounds 4 ounces). The data used in the analysis were from birth certificates registered in all states and the District of Columbia for births occurring in 2005. Data were presented for maternal demographic characteristics including race ethnicity: non-Hispanic White, non-Hispanic Black, and Hispanic.

The numbers of live births within various weight ranges, and the percentages of live births with low or very low birth weights are presented in Table 8-21. The percentage of live births with low birth weights was 8.2, and the percentage of very low birth weights was 1.5 in 2005. Non-Hispanic Blacks had the highest percentage of low birth weights (14.0 percent) and very low birth weights (3.3 percent). Martin et al. (2007) also provided statistics on the numbers and percentages of pre-term live births in the U.S. Of the 4,138,349 live births in the U.S. in 2005, 522,913 were defined as pre-term (i.e., less than 37 weeks gestation). A total of 43.3 percent of these pre-term infants had low birth weights an 11.3

percent had very low birth weights. The advantage of this data set is that it is nationally representative and provides data for infants. It provides data on prevalence of low birth weight in the population.

8.4.10 *Portier et al., 2007 - Body weight distributions for risk assessment*

Portier et al. (2007) provided age-specific distributions of body weight based on NHANES II, III, and IV data. The number of observations in these surveys was 20,322, 33,311, and 9,965, respectively. Portier et al. (2007) computed the means and standard deviations of body weight as back transformations of the weighted means and standard deviations of natural log-transformed body weights. Body weight distributions were computed by gender and various age brackets (Portier et al., 2007). The estimated mean body weights are shown in Tables 8-22, 8-23, and 8-24 using NHANES II, III, and IV data, respectively. The sample size (N) shown in the tables is the observed number of individuals and not the expected population size (sum of the sample weights) in each age category (Portier et al., 2007). The authors noted that the age groups are defined as starting at the birth month and include the next eleven months (i.e., age group 2 includes children 24-35 months at the time of the health assessment). Table 8-25 provides estimates for age groups that are often considered in risk assessments (Portier et al., 2007). The authors concluded that the data show changes in the average body weight over time and that the changes are not constant for all ages. The reader is referred to Portier et al. (2007) for equations suggested by the authors to be used when performing risk assessments where shifts and changes in body weight distributions need factoring in.

The advantages of this study are that it represents the U.S. general population, it provides distribution data, and can be used for trend analysis. In addition, the data are provided for both genders and for single-year age groups. The study results are also based on a large sample size.

8.4.11 *Kahn and Stralka, 2008 - Estimated daily average per capita water ingestion by child and adult age categories based on USDA's 1994-96 and 1998 Continuing Survey of Food Intakes*

As part of an analysis of water ingestion, Kahn and Stralka (2008) provided body weight distributions for the U.S. Population. The analysis was based on self reported body weights from the 1994 - 1996, 1998 Continuing Survey of Food Intake Among Individuals (CSFII). The average body weight across all individuals was 65 kilograms. According to Kahn and Stralka (2008), 10 kilograms, which is often used as the default body weight for babies, is the 95th value of the distribution of body weight for children in the 3 to <6 months category. The median weight is 9 kilograms for the 6 to 12 month age category and 11 kilograms for the 1 to 2 year old category (Kahn and Stralka, 2008). The body weight distributions are presented in Table 8-26 and the intervals around the mean and 90th and 95th percentiles are presented in Table 8-27.

The advantages of the study are its large sample size and that it is representative of the U.S. population for the age groups presented. A limitation of the study is that the data are based on self reporting from the participants.

8.5 RELEVANT FETAL WEIGHT STUDIES

8.5.1 *Brenner et al., 1976 - A Standard of Fetal Growth for the United States of America*

Brenner et al. (1976) determined fetal weights for 430 fetuses aborted at 8 to 20 weeks of gestation and for 30,772 liveborn infants delivered at 21 to 44 weeks of gestation. Gestational age for the aborted fetuses was determined through a combination of the physician's estimate of uterine size and the patient's stated last normal menstrual period. Data were not used when these two estimates differed by more than 2 weeks. To determine fetal growth, the fetuses were weighed and measured (crown-to-rump and crown-to heel lengths). All abortions were legally performed at Memorial Hospital, University of North Carolina at Chapel Hill from 1972 to 1975. For the liveborn infants, data were analyzed from single birth deliveries with the infant living at the onset of labor, among pregnancies not complicated by pre-eclampsia, diabetes or other disorders. Infants were weighed on a balance scale immediately after delivery. The liveborn infants were delivered at MacDonald House, University Hospitals of Cleveland, Ohio from 1962 to 1969.

Percentiles for fetal weight were calculated from the data at each week of gestation and are shown in Table 8-28. The resulting percentile curves were smoothed with two-point weighted means. Variables associated with significant differences in fetal weight in the latter part of pregnancy (after 34-38 weeks of gestation) included maternal parity and race, and fetal gender.

The advantage of this study is the large sample size. Limitations of the study are that the data were collected more than 30 years ago in only two U.S. states. In addition, a number of variables which may affect fetal weight (i.e., maternal smoking, disease, nutrition, and addictions) were not evaluated in this study.

8.5.2 *Doubilet et al., 1997 - Improved Birth Weight Table for Neonates Developed from Gestations Dated by Early Ultrasonography*

Doubilet et al. (1997) matched a database of obstetrical ultrasonograms over a period of 5 years from 1988 to 1993 to birth records for 3,718 infants (1,857 males and 1,861 females). The study population included 1,514 Whites, 770 Blacks, 1,256 Hispanics, and 178 who were either unclassified, or classified as "other." Birth weights were obtained from hospital records and a gestational age was assigned based on the earliest first trimester sonogram. The database was screened for possible outliers, defined as infants with birth weights that exceeded 5000 grams. Labor and delivery records and mother-infant medical records were retrieved to correct any errors in data entry for infants with birth weights exceeding 5000 grams. The mean gestational age at initial sonogram was 9.5 ± 2.3 weeks. Regression analysis techniques were used to derive weight tables for neonates at each gestational age for 25 weeks of gestation onward. Weights for each gestational age were found to conform to a natural logarithm distribution. Polynomial equations were derived from the regression analysis to estimate mean weight by gestational age for males, females, and males and females combined. Table 8-29 provides the distribution of neonatal weights by gestational age from 25 weeks of gestation onward.

8.6 REFERENCES FOR CHAPTER 8

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Table 8-3. Mean and Percentile Body Weights (kilograms) Derived from NHANES 1999-2006, Males and Females Combined

Age Group	N	Mean	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Birth to <1 month	158	4.8	3.6	3.9	4.1	4.2	4.8	5.1	5.5	5.8	6.2
1 to <3 months	284	5.9	4.5	4.7	4.9	5.2	5.9	6.6	6.9	7.1	7.3
3 to <6 months	489	7.4	5.7	6.1	6.3	6.7	7.3	8.0	8.4	8.7	9.1
6 to <12 months	927	9.2	7.1	7.5	7.9	8.3	9.1	10.1	10.5	10.8	11.3
1 to <2 years	1,176	11.4	8.9	9.3	9.7	10.3	11.3	12.4	13.0	13.4	14.0
2 to <3 years	1,144	13.8	10.9	11.5	11.9	12.4	13.6	14.9	15.8	16.3	17.1
3 to <6 years	2,318	18.6	13.5	14.4	14.9	15.8	17.8	20.3	22.0	23.6	26.2
6 to <11 years	3,593	31.8	19.7	21.3	22.3	24.4	29.3	36.8	42.1	45.6	52.5
11 to <16 years	5,297	56.8	34.0	37.2	40.6	45.0	54.2	65.0	73.0	79.3	88.8
16 to <21 years	4,851	71.6	48.2	52.0	54.5	58.4	67.6	80.6	90.8	97.7	108.0
21 to <30 years	3,232	78.4	50.8	54.7	57.9	63.3	75.2	88.2	98.5	106.0	118.0
30 to <40 years	3,176	80.8	53.5	57.4	60.1	66.1	77.9	92.4	101.0	107.0	118.0
40 to <50 years	3,121	83.6	54.3	58.8	62.1	68.3	81.4	95.0	104.0	111.0	122.0
50 to <60 years	2,387	83.4	54.7	59.0	62.8	69.1	80.8	95.5	104.0	110.0	120.0
60 to <70 years	2,782	82.6	55.2	59.8	63.3	69.0	80.5	94.2	103.0	109.0	116.0
70 to <80 years	2,033	76.4	52.0	56.5	59.7	64.4	74.9	86.8	93.8	98.0	106.0
Over 80 years	1,430	68.5	46.9	51.4	53.8	58.2	67.4	77.4	82.6	87.2	93.6

Source: U.S. EPA Analysis of NHANES 1999-2006 data.

Table 8-4. Mean and Percentile Body Weights (kilograms) for Males Derived from NHANES 1999-2006

Age Group	N	Mean	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Birth to <1 month	88	4.9	3.6	3.6	4.0	4.4	4.8	5.5	5.8	6.2	6.8
1 to <3 months	153	6.0	4.6	5.0	5.1	5.4	6.1	6.8	7.0	7.2	7.3
3 to <6 months	255	7.6	5.9	6.4	6.6	6.9	7.5	8.2	8.6	8.8	9.1
6 to <12 months	472	9.4	7.3	7.9	8.2	8.5	9.4	10.3	10.6	10.8	11.5
1 to <2 years	632	11.6	9.0	9.7	10.0	10.5	11.5	12.6	13.2	13.5	14.3
2 to <3 years	558	14.1	11.4	12.0	12.2	12.8	14.0	15.2	15.9	16.4	17.0
3 to <6 years	1,158	18.8	13.5	14.4	14.9	15.9	18.1	20.8	22.6	23.8	26.2
6 to <11 years	1,795	31.9	20.0	21.8	22.9	24.8	29.6	36.4	41.2	45.2	51.4
11 to <16 years	2,593	57.6	33.6	36.3	38.9	44.2	55.5	66.5	75.5	81.2	91.8
16 to <21 years	2,462	77.3	54.5	57.6	60.0	63.9	73.1	86.0	96.8	104.0	113.0
21 to <30 years	1,359	84.9	58.7	63.0	66.2	70.7	81.2	94.0	103.0	111.0	123.0
30 to <40 years	1,445	87.0	61.1	65.7	68.7	73.8	84.0	96.5	104.0	110.0	124.0
40 to <50 years	1,545	90.5	64.9	69.5	73.0	77.7	87.4	99.7	109.0	114.0	125.0
50 to <60 years	1,189	89.5	64.1	68.8	71.4	77.0	87.8	99.8	107.0	112.0	123.0
60 to <70 years	1,360	89.1	63.4	67.5	71.6	77.2	86.9	99.4	108.0	113.0	120.0
70 to <80 years	1,079	83.9	60.6	64.6	68.3	73.1	82.1	93.8	98.6	104.0	113.0
Over 80 years	662	76.1	56.7	60.6	63.9	67.2	75.1	84.0	89.4	92.5	100.0

Source: U.S. EPA Analysis of NHANES 1999-2006 data.

Table 8-5. Mean and Percentile Body Weights (kilograms) for Females Derived from NHANES 1999-2006

Age Group	N	Mean	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Birth to <1 month	70	4.6	3.6	4.0	4.1	4.2	4.6	4.9	5.0	5.2	5.9
1 to <3 months	131	5.7	4.3	4.6	4.74	5.1	5.5	6.4	6.6	6.9	7.3
3 to <6 months	234	7.2	5.5	5.9	6.2	6.4	7.2	7.9	8.2	8.4	9.0
6 to <12 months	455	9.0	7.1	7.3	7.6	8.0	8.9	9.8	10.3	10.6	11.2
1 to <2 years	544	11.1	8.7	9.1	9.4	10.0	11.1	12.2	12.9	13.2	13.7
2 to <3 years	586	13.5	10.5	11.0	11.5	12.1	13.2	14.6	15.5	16.2	17.1
3 to <6 years	1,160	18.3	13.5	14.3	14.7	15.6	17.5	19.7	21.3	23.2	26.2
6 to <11 years	1,798	31.7	19.3	20.9	22.0	23.9	29.0	37.3	43.1	46.7	53.4
11 to <16 years	2,704	55.9	34.9	38.6	41.6	45.7	53.3	62.8	70.7	76.5	86.3
16 to <21 years	2,389	65.9	46.2	48.6	51.1	54.5	61.5	73.3	83.4	89.9	99.7
21 to <30 years	1,873	71.9	48.0	51.4	53.8	57.8	67.9	81.4	90.2	98.7	109.0
30 to <40 years	1,731	74.8	50.9	54.0	56.2	60.0	70.2	85.0	95.1	104.0	113.0
40 to <50 years	1,576	77.1	51.7	54.7	57.3	61.7	72.7	88.0	97.8	105.0	118.0
50 to <60 years	1,198	77.5	52.2	55.7	57.9	62.8	73.6	87.7	97.7	105.0	117.0
60 to <70 years	1,422	76.8	51.9	56.5	59.2	63.9	73.9	86.6	95.4	102.0	112.0
70 to <80 years	954	70.8	49.6	53.3	55.7	60.3	69.0	79.4	85.6	91.4	98.2
Over 80 years	768	64.1	45.5	48.7	51.3	54.9	62.8	71.8	77.0	80.5	89.1

Source: U.S. EPA Analysis of NHANES 1999-2006 data.

Table 8-6. Weight in Kilograms for Males 2 Months-21 Years of Age– Number Examined, Mean, and Selected Percentiles, by Age Category: United States, 1976-1980[a]

Age Group	Number of Persons Examined	Mean (kg)	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Birth to <1 month	-	-	-	-	-	-	-	-	-	-	-
1 to <2 months	-	-	-	-	-	-	-	-	-	-	-
2 to <3 months	103	6.6	5.3	5.5	5.7	5.9	6.8	7.2	7.6	7.8	8.4
3 to <6 months	287	7.7	6.3	6.6	6.7	7.0	7.7	8.4	8.9	9.2	9.6
6 to <12 months	589	9.4	7.5	7.9	8.1	8.6	9.4	10.2	10.6	10.9	11.4
1 to <2 years	613	11.7	9.4	9.8	10.1	10.8	11.7	12.6	13.1	13.7	14.5
2 to <3 years	627	13.7	11.4	11.8	12.2	12.6	13.6	14.6	15.2	15.8	16.5
3 to <6 years	1,556	18.0	13.7	14.6	14.9	15.7	17.5	19.7	21.0	22.0	24.0
6 to <11 years	1,373	30.7	19.5	21.1	22.1	24.0	28.5	35.2	40.5	43.5	48.7
11 to <16 years	1,037	55.2	34.0	36.5	38.7	42.8	53.0	63.0	69.4	74.8	84.3
16 to <21 years	890	71.8	54.1	56.6	58.3	61.8	68.7	77.9	84.3	89.7	101.0

[a] Includes clothing weight, estimated as ranging from 0.09 to 0.28 kilogram.
\- No data available for infants less than two months old.

Source: National Center for Health Statistics, 1987.

Table 8-7. Weight in Kilograms for Females 6 Months-21 Years of Age– Number Examined, Mean, and Selected Percentiles, by Age Category: United States, 1976-1980[a]

Age Group	Number of Persons Examined	Mean (kg)	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Birth to <1 month	-	-	-	-	-	-	-	-	-	-	-
1 to <2 months	-	-	-	-	-	-	-	-	-	-	-
2 to <3 months	131	6.0	4.7	5.1	5.2	5.6	6.0	6.5	7.1	7.3	7.8
3 to <6 months	269	7.1	5.8	5.9	6.1	6.4	7.1	7.7	7.9	8.4	8.7
6 to <12 months	574	8.8	7.2	7.5	7.7	8.0	8.7	9.4	10.1	10.4	10.8
1 to <2 years	617	11.0	9.1	9.4	9.6	9.9	10.9	11.9	12.6	12.9	13.4
2 to <3 years	597	13.4	10.8	11.2	11.6	12.1	13.2	14.6	15.4	15.6	16.3
3 to <6 years	1,658	18.0	13.3	14.0	14.5	15.4	17.2	19.7	21.1	22.6	25.1
6 to <11 years	1,321	30.6	19.0	20.5	21.3	23.4	28.9	35.0	39.6	44.3	50.2
11 to <16 years	1,144	53.2	34.1	37.2	40.4	45.2	51.6	60.0	67.2	70.6	78.2
16 to <21 years	1,001	62.2	46.7	48.2	49.7	52.2	58.9	68.3	74.7	80.8	92.6

[a] Includes clothing weight, estimated as ranging from 0.09 to 0.28 kilogram.
\- No data available for infants less than two months old.

Source: National Center for Health Statistics, 1987.

Table 8-8. Statistics for Probability Plot Regression Analyses: Females Body Weights 6 Months to 70 Years of Age		
Age Midpoint (years)	Lognormal Probability Plots Linear Curve	
	Φ_2[a]	σ_2[a]
0.75	2.16	0.145
1.5	2.38	0.129
2.5	2.56	0.112
3.5	2.69	0.136
4.5	2.83	0.134
5.5	2.98	0.164
6.5	3.10	0.174
7.5	3.19	0.174
8.5	3.31	0.156
9.5	3.46	0.214
10.5	3.57	0.199
11.5	3.71	0.226
12.5	3.82	0.213
13.5	3.92	0.215
14.5	3.99	0.187
15.5	4.00	0.156
16.5	4.05	0.167
17.5	4.08	0.165
18.5	4.07	0.147
19.5	4.10	0.149
21.5	4.10	0.168
30	4.15	0.204
40	4.19	0.207
50	4.20	0.208
60	4.20	0.205
70	4.18	0.198

[a] Φ_2, σ_2 - correspond to the mean and standard deviation, respectively, of the lognormal distribution of body weight (kg).

Source: Burmaster and Crouch, 1997.

Table 8-9. Statistics for Probability Plot Regression Analyses: Males Body Weights 6 Months to 70 Years of Age

Age Midpoint (years)	Lognormal Probability Plots Linear Curve	
	Φ_2[a]	σ_2[a]
0.75	2.23	0.131
1.5	2.46	0.120
2.5	2.60	0.120
3.5	2.75	0.114
4.5	2.87	0.133
5.5	2.98	0.138
6.5	3.13	0.145
7.5	3.21	0.151
8.5	3.33	0.181
9.5	3.43	0.165
10.5	3.59	0.195
11.5	3.69	0.252
12.5	3.78	0.224
13.5	3.88	0.215
14.5	4.02	0.181
15.5	4.09	0.159
16.5	4.20	0.168
17.5	4.19	0.167
18.5	4.25	0.159
19.5	4.26	0.154
21.5	4.29	0.163
30	4.35	0.163
40	4.38	0.165
50	4.38	0.166
60	4.35	0.157
70	4.29	0.174

[a] Φ_2, σ_2 - correspond to the mean and standard deviation, respectively, of the lognormal distribution of body weight (kg).

Source: Burmaster and Crouch, 1997.

Table 8-10. Body Weight Estimates (kilograms) by Age and Gender, U.S. Population Derived From NHANES III (1988-94)

Age Group	Sample Size	Population	Male and Female		Male		Female	
			Median	Mean	Median	Mean	Median	Mean
2 to 6 months	1,020	1,732,702	7.4	7.4	7.6	7.7	7.0	7.0
7 to 12 months	1,072	1,925,573	9.4	9.4	9.7	9.7	9.1	9.1
1 year	1,258	3,935,114	11.3	11.4	11.7	11.7	10.9	11.0
2 years	1,513	4,459,167	13.2	12.9	13.5	13.1	13.0	12.5
3 years	1,309	4,317,234	15.3	15.1	15.5	15.2	15.1	14.9
4 years	1,284	4,008,079	17.2	17.1	17.2	17.0	17.3	17.2
5 years	1,234	4,298,097	19.6	19.4	19.7	19.3	19.6	19.4
6 years	750	3,942,457	21.3	21.7	21.5	22.1	20.9	21.3
7 years	736	4,064,397	25.0	25.5	25.4	25.5	24.1	25.6
8 years	711	3,863,515	27.4	28.1	27.2	28.4	27.9	27.9
9 years	770	4,385,199	31.8	32.7	32.0	32.3	31.1	33.0
10 years	751	3,991,345	35.2	35.6	35.9	36.0	34.3	35.2
11 years	754	4,270,211	40.6	41.5	38.8	40.0	43.4	42.8
12 years	431	3,497,661	47.2	46.9	48.1	49.1	45.7	48.6
13 years	428	3,567,181	53.0	55.1	52.6	54.5	53.7	55.9
14 years	415	4,054,117	56.9	61.1	61.3	64.5	53.7	57.9
15 years	378	3,269,777	59.6	62.8	62.6	66.9	57.1	59.2
16 years	427	3,652,041	63.2	65.8	66.6	69.4	56.3	61.6
17 years	410	3,719,690	65.1	67.5	70.0	72.4	60.7	62.2
1 and older	31,311	251,097,002	66.5	64.5	73.9	89.0	80.8	80.3
1 to 3 years	4,080	12,711,515	13.2	13.1	13.4	13.4	13.0	12.9
1 to 14 years	12,344	56,653,796	24.9	29.9	25.1	30.0	24.7	29.7
15 to 44 years	10,393	118,430,653	70.8	73.5	77.5	80.2	63.2	67.3

Source: U.S. EPA, 2000.

Table 8-11. Body Weight Estimates (in kilograms) by Age, U.S. Population Derived From NHANES III (1988-94)

Age Group	Sample Size	Population	Male and Female		
			Median	Mean	95% CI
2 months	243	408,837	6.3	6.3	6.1-6.4
3 months	190	332,823	7.0	6.9	6.7-7.1
3 months and younger	433	741,660	6.6	6.6	6.4-6.7

CI = Confidence Interval.

Source: U.S. EPA, 2000.

Table 8-12. Observed Mean, Standard Deviation and Selected Percentiles for Weight (kilograms) by Gender and Age: Birth to 36 Months								
Age Group	Mean	SD	Percentile					
			10th	25th	50th	75th	90th	95th
Boys								
Birth	3.4	0.6	2.7	3.1	3.4	3.8	4.1	4.3
0 < 1 months	-	-	-	-	-	-	-	-
1< 2 months	-	-	-	-	-	-	-	-
2 < 3 months	6.5	0.8	5.6	5.8	6.7	6.9	7.4	7.5
3 < 4 months	7.0	0.9	5.9	6.5	7.0	7.5	8.2	8.5
4 < 5 months	7.2	0.8	6.3	6.7	7.2	7.7	8.0	8.4
5 < 6 months	7.9	0.9	6.7	7.5	7.8	8.6	9.4	9.6
6 < 7 months	8.4	1.1	7.3	7.6	8.4	9.0	10.2	10.7
7 < 8 months	8.6	1.1	7.1	7.8	8.6	9.5	10.1	10.4
8 < 9 months	9.3	1.1	7.9	8.6	9.2	10.1	10.5	11.0
9 < 10 months	9.3	0.9	8.2	8.6	9.3	10.0	10.8	10.9
10 < 11 months	9.5	1.1	8.3	8.7	9.3	10.1	11.3	11.5
11 < 12 months	10.0	1.0	8.7	9.5	10.0	10.6	11.1	11.6
12 < 15 months	10.6	1.2	9.2	9.8	10.6	11.3	12.1	12.4
15 < 18 months	11.4	1.9	9.9	10.5	11.3	12.0	12.8	13.5
18 < 21 months	12.1	1.5	10.4	11.0	11.9	12.7	13.9	15.5
21 < 24 months	12.4	1.3	10.9	11.6	12.4	13.1	14.4	14.7
24 < 30 months	13.1	1.7	11.3	12.1	12.9	14.1	15.1	15.9
30 < 36 months	14.0	1.5	12.0	13.0	13.8	14.7	16.0	16.6
Girls								
Birth	3.3	0.5	2.6	3.0	3.3	3.6	3.9	4.1
0 < 1 months	-	-	-	-	-	-	-	-
1< 2 months	-	-	-	-	-	-	-	-
2 < 3 months	5.4	0.5	4.8	5.0	5.6	5.9	6.0	-
3 < 4 months	6.3	0.7	5.6	5.8	6.3	6.8	7.4	7.8
4 < 5 months	6.7	0.9	5.8	6.1	6.6	7.4	8.0	8.3
5 < 6 months	7.3	0.9	6.3	6.7	7.1	7.7	8.5	8.8
6 < 7 months	7.7	0.8	6.6	7.1	7.6	8.1	8.9	9.0
7 < 8 months	8.0	1.4	6.7	7.4	7.8	8.6	9.4	9.8
8 < 9 months	8.3	0.9	7.3	7.8	8.3	8.9	9.4	9.8
9 < 10 months	8.9	0.9	7.8	8.1	8.7	9.4	10.1	10.5
10 < 11 months	9.0	1.1	7.8	8.4	9.0	9.5	10.4	10.9
11 < 12 months	9.3	1.0	7.9	8.6	9.2	10.1	10.6	10.9
12 < 15 months	9.8	1.1	8.5	9.1	9.8	10.4	11.3	11.6
15 < 18 months	10.4	1.1	9.1	9.7	10.3	11.2	11.8	12.0
18 < 21 months	11.1	1.4	9.6	10.2	11.0	11.9	12.8	13.5
21 < 24 months	11.8	1.3	10.1	10.9	11.8	12.8	13.5	13.9
24 < 30 months	12.5	1.5	10.8	11.5	12.4	13.3	14.5	15.1
30 < 36 months	13.6	1.7	11.8	12.5	13.4	14.52	15.7	16.4

-     No data available.

Source: Kuczmarski et al., 2002.

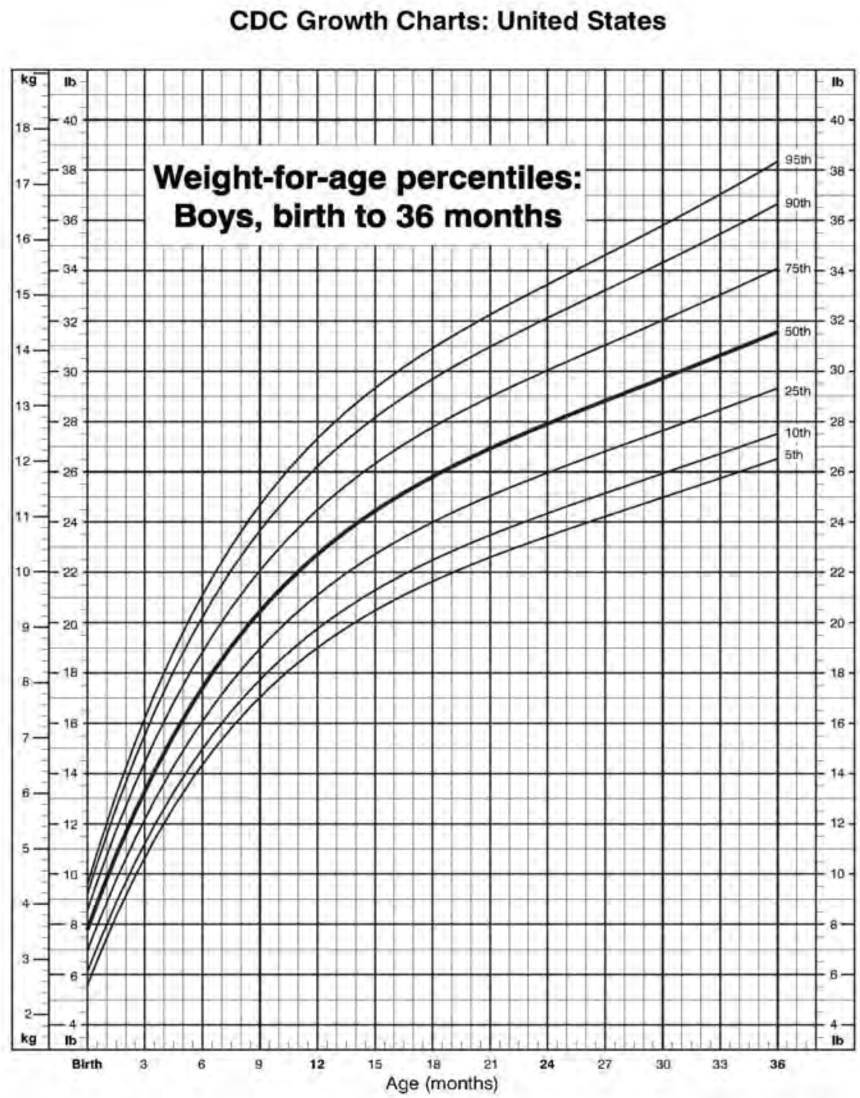

Figure 8-1. Weight by Age Percentiles for Boys Aged Birth to 36 Months

Source: Kuczmarski et al., 2002.

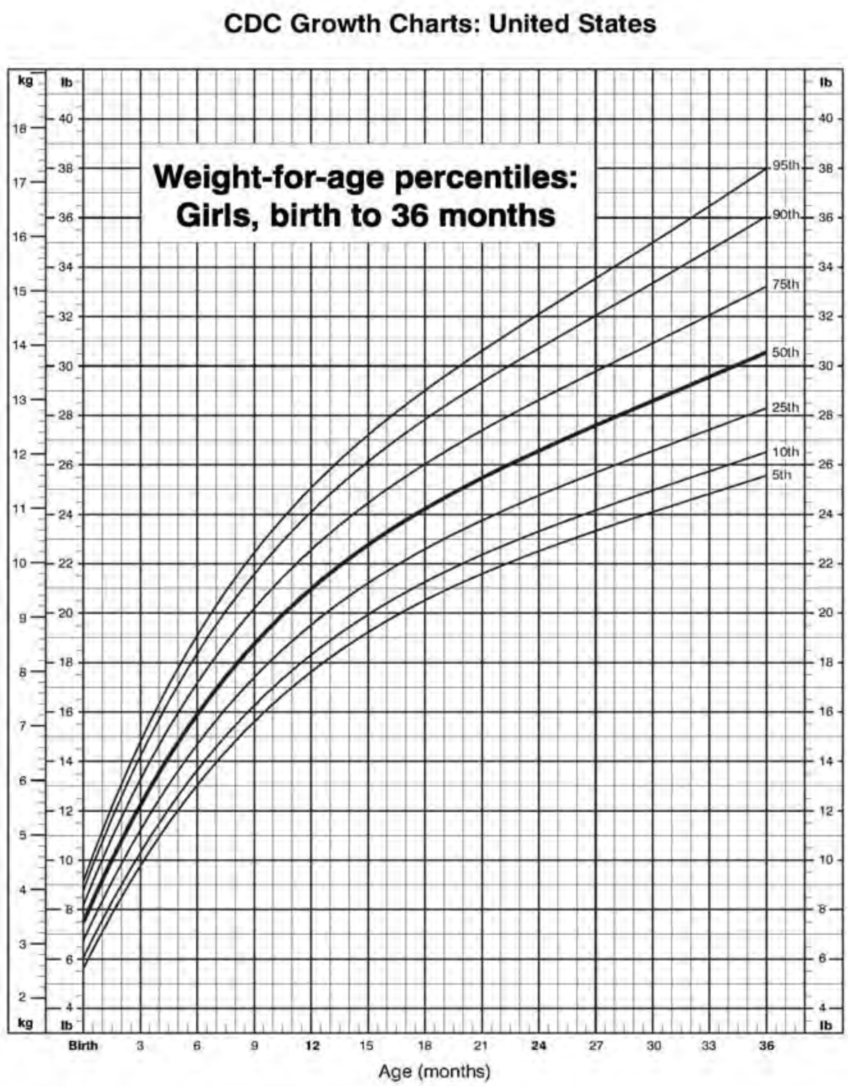

Figure 8-2. Weight by Age Percentiles for Girls Aged Birth to 36 Months

Source: Kuczmarski et al., 2002.

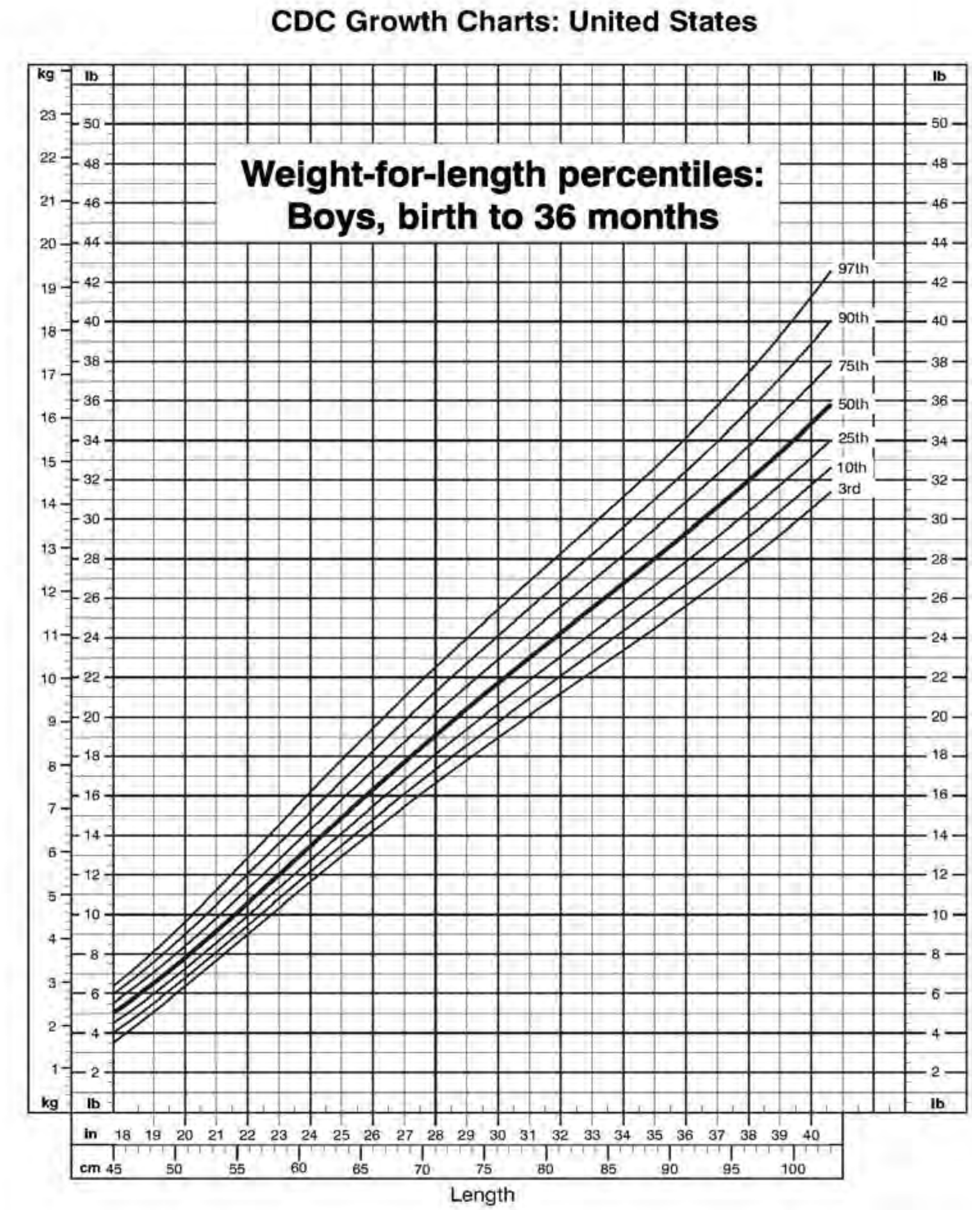

Figure 8-3. Weight by Length Percentiles for Boys Aged Birth to 36 Months

Source: Kuczmarski et al., 2002.

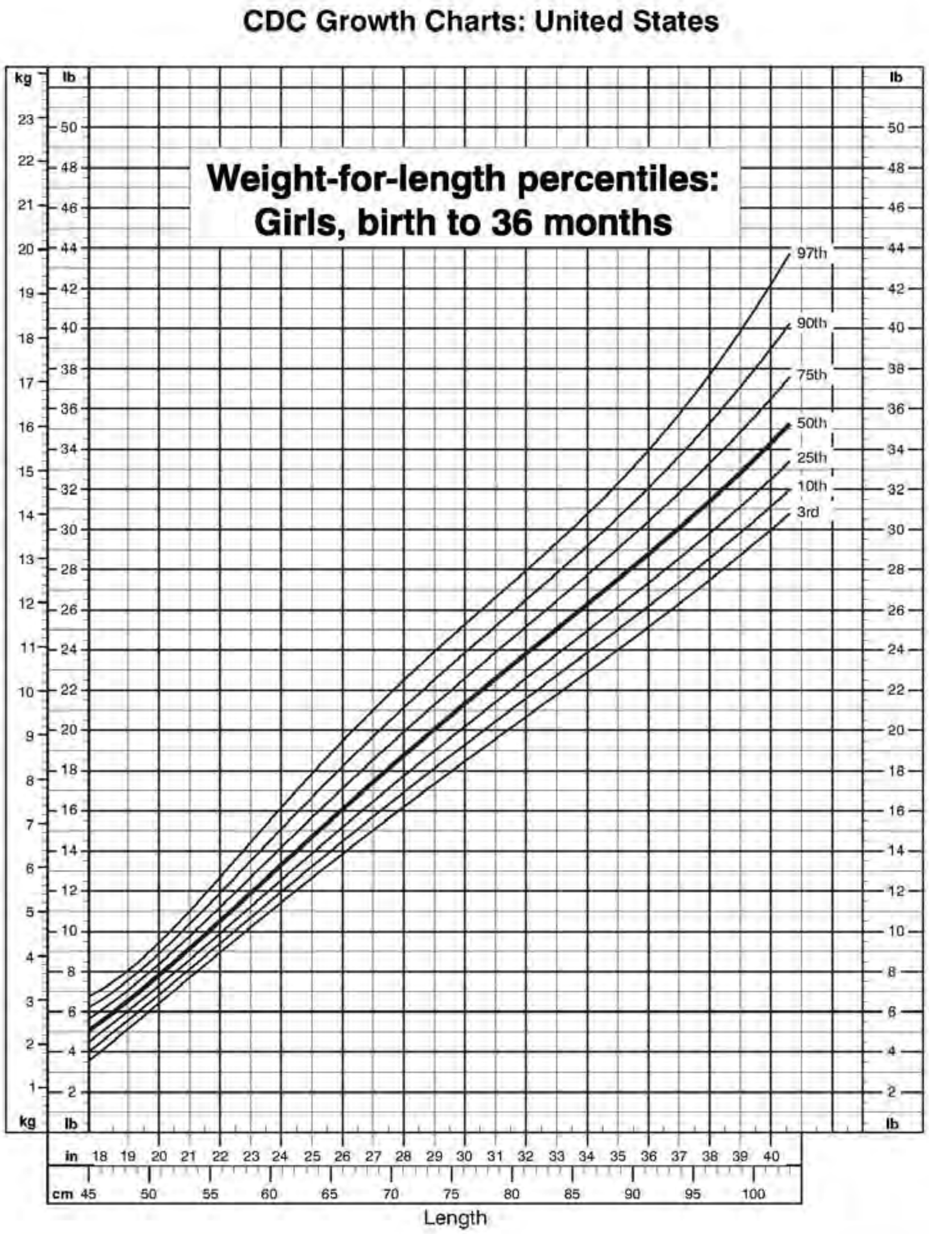

Figure 8-4. Weight by Length Percentiles for Girls Aged Birth to 36 Months

Source: Kuczmarski et al., 2002.

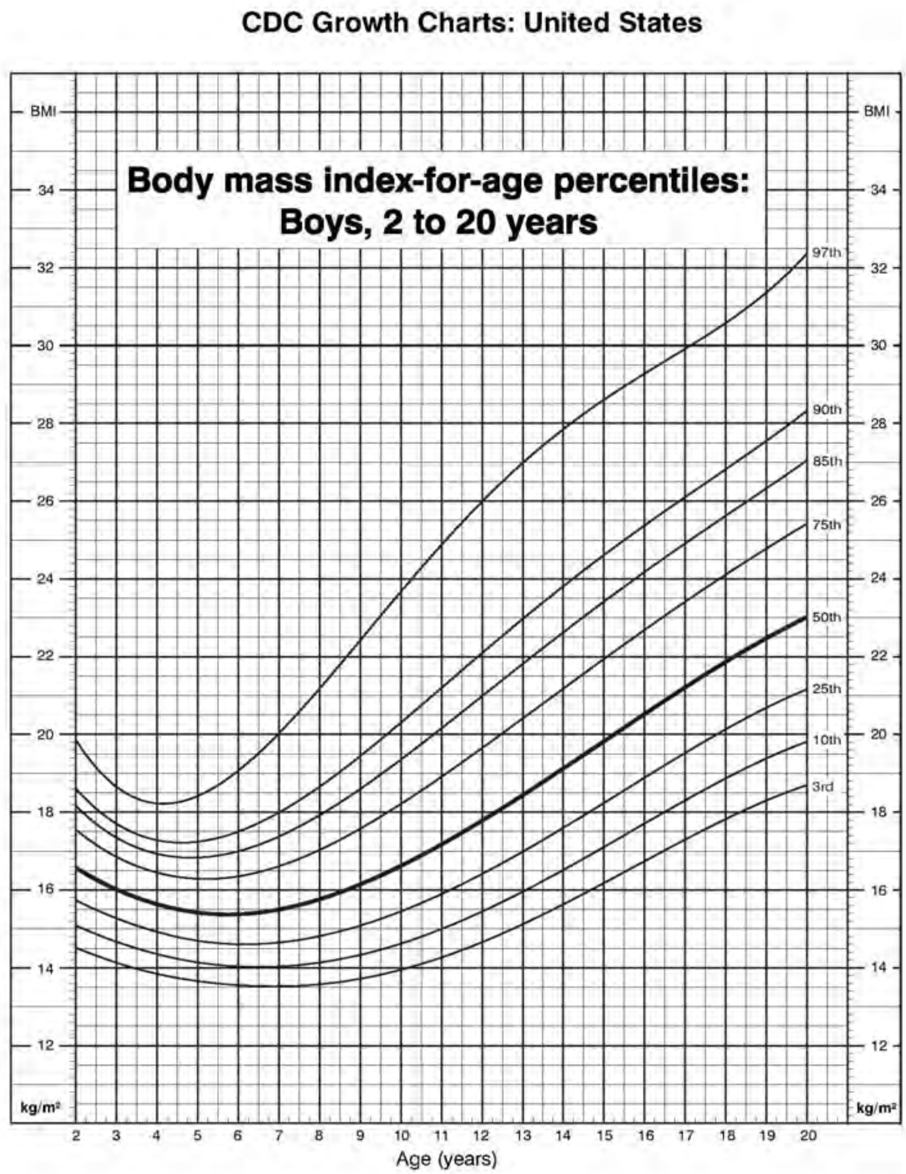

Figure 8-5. Body Mass Index-for-Age Percentiles: Boys, 2 to 20 Years

Source: Kuczmarski et al., 2002.

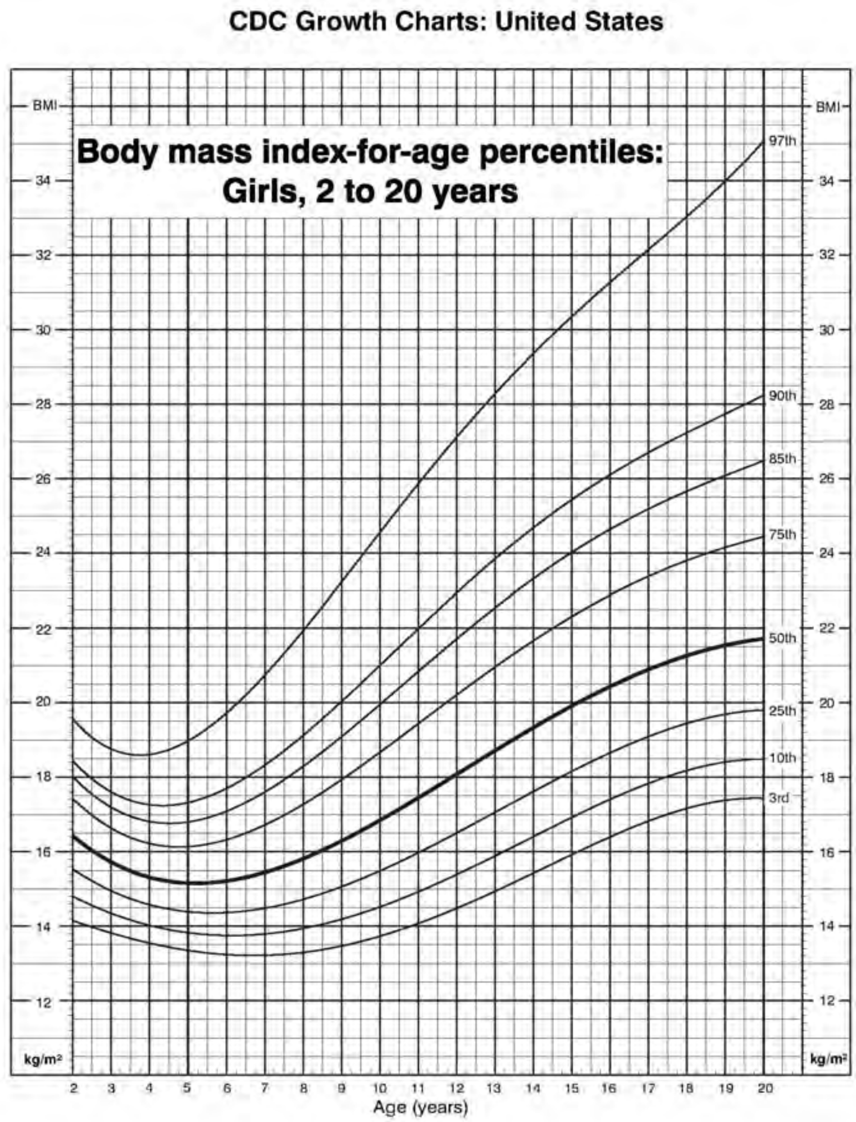

Figure 8-6. Body Mass Index-for-Age Percentiles: Girls, 2 to 20 Years

Source: Kuczmarski et al., 2002.

Table 8-13. Estimated Distribution of Body Weight by Fine Age Categories All Individuals, Males and Females Combined (kilograms)

Ages	Sample Size	Population	Mean	Percentiles					
				10th	25th	50th	75th	90th	95th
‹ 0.5	744	1,890,461	6	3	4	6	7	8	9
0.5 - 0.9	678	1,770,700	9	7	8	9	10	11	12
1 - 3	3,645	11,746,146	14	10	11	13	16	18	19
4 - 6	2,988	11,570,747	21	16	17	20	22	26	28
7 - 10	1,028	14,541,011	32	22	26	29	36	43	48
11 - 14	790	15,183,156	51	35	42	50	58	68	79
15 - 19	816	17,825,164	67	50	56	63	73	85	99
20 - 24	676	18,402,877	72	53	59	68	81	94	104
25 - 54	4,830	111,382,877	77	54	63	75	86	100	109
55 - 64	1,516	20,691,260	77	57	65	75	87	99	105
65 +	2,139	30,578,210	72	54	62	71	81	93	100
		Summary Data							
20 +	9,161	181,055,224	76	54	63	73	86	98	107
‹ 2	2,424	7,695,535	10	5	7	10	11	13	14
2 - 15	7,449	49,006,686	33	15	19	28	43	56	63
15 +	9,977	198,880,388	75	54	61	72	84	97	106
‹ 6	7,530	23,160,174	15	8	11	14	18	21	23
6 - 15	2,343	33,542,047	40	22	27	36	50	59	68
All ages	**19,850**	**255,582,609**	**65**	**22**	**52**	**67**	**81**	**95**	**104**

NOTE: 757 individuals did not report body weight. They represent 6,314,627 individuals in the population.

Source: U.S. EPA, 2004 (based on 1994 – 1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII)),

Table 8-14. Mean Body Weight (kilograms) by Age and Gender Across Multiple Surveys															
Gender and Age (years)	NHES II, 1963-65			NHES III, 1966-70			NHANES II, 1976-80			NHANES III, 1988-94			NHANES 1999-2002		
	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
Male															
2	-	-	-	-	-	-	370	13.4	0.1	644	13.6	0.1	262	13.7	0.1
3	-	-	-	-	-	-	421	15.5	0.1	516	15.8	0.2	216	15.9	0.2
4	-	-	-	-	-	-	405	17.6	0.1	549	17.6	0.2	179	18.5	0.2
5	-	-	-	-	-	-	393	19.7	0.1	497	20.1	0.2	147	21.3	0.5
6	575	22.0	0.1	-	-	-	146	22.8	0.4	283	23.2	0.6	182	23.5	0.4
7	632	24.7	0.2	-	-	-	150	24.9	0.4	269	26.3	0.4	185	27.2	0.4
8	618	27.8	0.2	-	-	-	145	28.0	0.6	266	30.2	0.8	214	32.7	1.0
9	603	31.2	0.4	-	-	-	141	30.7	0.6	281	34.4	1.0	174	36.0	0.7
10	576	33.7	0.3	-	-	-	165	36.2	0.7	297	37.3	0.9	187	38.6	0.8
11	595	38.2	0.3	-	-	-	153	39.7	0.9	281	42.5	0.9	182	43.7	1.1
12	-	-	-	643	42.9	0.4	147	44.1	1.0	203	49.1	1.1	299	50.4	1.3
13	-	-	-	626	50.0	0.5	165	49.5	1.2	187	54.0	1.0	298	53.9	1.9
14	-	-	-	618	56.7	0.6	188	56.4	0.9	188	64.1	3.6	266	63.9	1.6
15	-	-	-	613	61.6	0.4	180	61.2	1.0	187	66.9	1.9	283	68.3	1.1
16	-	-	-	556	64.8	0.6	180	66.5	1.2	194	68.7	1.6	306	74.4	1.4
17	-	-	-	458	68.1	0.4	183	66.7	0.8	196	72.9	1.3	313	75.6	1.4
18	-	-	-	-	-	-	156	71.1	1.2	176	71.3	1.7	284	75.6	1.1
19	-	-	-	-	-	-	150	71.8	0.8	168	73.0	2.2	270	78.2	1.3
20-29	-	-	-	-	-	-	1,261	76.3	0.5	1,638	78.4	0.6	712	83.4	0.7
30-39	-	-	-	-	-	-	871	79.8	0.4	1,468	82.9	0.9	704	86.0	0.9
40-49	-	-	-	-	-	-	695	81.7	0.5	1,220	85.1	0.8	776	89.1	0.7
50-59	-	-	-	-	-	-	691	80.0	0.6	851	86.0	0.5	598	88.8	0.9
60-74	-	-	-	-	-	-	2,086	76.1	0.5	1,683	82.2	0.5	1,001	87.1	0.6
75+	-	-	-	-	-	-	-	-	-	895	75.4	0.7	523	78.5	0.6

Table 8-14. Mean Body Weight (kilograms) by Age and Gender Across Multiple Surveys (continued)

Gender and Age (years)	NHES II, 1963-65			NHES III, 1966-70			NHANES II, 1976-80			NHANES III, 1988-94			NHANES 1999-2002		
	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
Female															
2	-	-	-	-	-	-	330	12.8	0.1	624	13.2	0.1	248	13.3	0.1
3	-	-	-	-	-	-	367	14.8	0.1	587	15.4	0.1	178	15.2	0.2
4	-	-	-	-	-	-	388	16.8	0.2	537	17.9	0.3	191	17.9	0.3
5	-	-	-	-	-	-	369	19.4	0.3	554	20.2	0.2	186	20.6	0.6
6	536	21.5	0.2	-	-	-	150	21.9	0.4	272	22.6	0.6	171	22.4	0.5
7	609	24.2	0.2	-	-	-	154	24.6	0.5	274	26.4	0.8	196	25.9	0.5
8	613	27.5	0.2	-	-	-	125	27.5	0.4	248	29.9	0.6	184	31.9	1.2
9	581	31.4	0.4	-	-	-	154	31.7	0.7	280	34.4	1.2	183	35.4	0.7
10	584	35.2	0.4	-	-	-	128	35.7	0.6	258	37.9	1.2	164	40.0	1.0
11	525	39.8	0.4	-	-	-	143	41.4	0.9	275	44.1	1.1	194	47.9	1.3
12	-	-	-	547	46.6	0.4	146	46.1	0.9	236	49.0	1.2	316	52.0	1.1
13	-	-	-	582	50.5	0.5	155	50.9	1.2	220	55.8	1.6	321	57.7	1.4
14	-	-	-	586	54.2	0.4	181	54.3	1.0	218	58.5	1.4	324	59.9	1.0
15	-	-	-	503	56.5	0.5	144	55.0	0.8	191	58.1	1.1	266	61.1	1.7
16	-	-	-	536	58.1	0.7	167	57.7	0.9	208	61.3	1.4	273	63.0	1.2
17	-	-	-	442	57.6	0.6	134	59.6	1.0	201	62.4	1.2	256	61.7	1.2
18	-	-	-	-	-	-	156	59.0	1.0	175	61.2	1.9	243	65.2	1.5
19	-	-	-	-	-	-	158	59.8	1.0	177	63.2	1.9	225	67.9	1.2
20-29	-	-	-	-	-	-	1,290	61.7	0.5	1,663	64.4	0.6	656	71.1	0.9
30-39	-	-	-	-	-	-	964	66.1	0.6	1,773	70.2	0.8	699	74.1	0.9
40-49	-	-	-	-	-	-	765	67.6	0.6	1,355	71.6	0.8	787	76.5	1.1
50-59	-	-	-	-	-	-	793	68.4	0.6	996	74.3	0.8	593	76.9	1.1
60-74	-	-	-	-	-	-	2,349	66.8	0.4	1,674	70.1	0.5	1,010	74.9	0.6
75+	-	-	-	-	-	-	-	-	-	1,022	63.4	0.6	554	66.6	0.9

\- Data not available.
N = Number of individuals.
SE = Standard error.

Source: Ogden et al., 2004.

Table 8-15. Mean Height (centimeters) by Age and Gender Across Multiple Surveys

Gender and Age (years)	NHES II, 1963-65			NHES III, 1966-70			NHANES II, 1976-80			NHANES III, 1988-94			NHANES 1999-2002		
	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
Male															
2	-	-	-	-	-	-	350	91.1	0.2	589	90.9	0.2	254	91.2	0.3
3	-	-	-	-	-	-	421	98.7	0.3	513	98.8	0.3	222	98.6	0.3
4	-	-	-	-	-	-	405	105.5	0.4	551	105.2	0.4	183	106.5	0.4
5	-	-	-	-	-	-	393	112.3	0.3	497	112.3	0.3	156	113.0	0.5
6	575	118.9	0.2	-	-	-	146	119.1	0.5	283	118.9	0.7	188	119.2	0.5
7	632	124.5	0.3	-	-	-	150	124.5	0.5	270	125.9	0.6	187	126.2	0.6
8	618	130.0	0.3	-	-	-	145	129.6	0.7	269	131.3	0.6	217	1325.	0.7
9	603	135.5	0.4	-	-	-	141	135.0	0.6	280	137.7	0.7	177	138.1	0.4
10	576	140.2	0.3	-	-	-	165	141.3	0.6	297	142.0	1.1	188	141.4	0.6
11	595	145.5	0.3	-	-	-	153	145.5	0.6	285	147.4	0.7	187	148.7	0.9
12	-	-	-	643	152.3	0.4	147	152.5	0.7	207	155.5	1.1	301	154.8	0.7
13	-	-	-	626	159.8	0.4	165	158.3	0.8	190	161.6	0.8	298	160.1	0.8
14	-	-	-	618	166.7	0.5	188	166.8	0.6	191	169.0	0.9	267	168.5	0.9
15	-	-	-	613	171.4	0.3	180	171.2	0.7	188	172.8	1.0	287	173.8	0.6
16	-	-	-	556	174.3	0.4	180	173.4	0.5	197	175.0	0.9	310	175.3	0.6
17	-	-	-	458	175.6	0.4	183	174.8	0.5	196	176.5	0.9	317	175.3	0.6
18	-	-	-	-	-	-	156	177.3	0.6	176	177.3	1.0	289	176.4	0.7
19	-	-	-	-	-	-	150	176.1	0.5	169	175.5	0.6	275	176.7	0.6
20-29	-	-	-	-	-	-	1,261	177.1	0.3	1,639	176.1	0.3	724	176.7	0.3
30-39	-	-	-	-	-	-	871	176.3	0.3	1,468	176.6	0.3	717	176.4	0.3
40-49	-	-	-	-	-	-	695	175.9	0.3	1,220	176.3	0.3	784	177.2	0.3
50-59	-	-	-	-	-	-	691	174.7	0.3	851	175.8	0.3	601	175.8	0.3
60-74	-	-	-	-	-	-	2,086	172.1	0.2	1,684	173.6	0.2	1,010	174.4	0.3
75+	-	-	-	-	-	-	-	-	-	895	170.7	0.3	505	171.3	0.4

Table 8-15. Mean Height (centimeters) by Age and Gender Across Multiple Surveys (continued)

Gender and Age (years)	NHES II, 1963-65			NHES III, 1966-70			NHANES II, 1976-80			NHANES III, 1988-94			NHANES 1999-2002		
	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
Female															
2	-	-	-	-	-	-	314	89.4	0.3	564	89.7	0.2	233	90.1	0.4
3	-	-	-	-	-	-	367	97.1	0.2	590	98.2	0.2	187	97.6	0.5
4	-	-	-	-	-	-	388	104.2	0.4	535	105.1	0.3	195	105.9	0.5
5	-	-	-	-	-	-	369	111.2	0.4	557	112.2	0.5	190	112.4	0.7
6	536	117.8	0.3	-	-	-	150	117.9	0.6	274	117.9	0.6	172	117.1	0.7
7	609	123.5	0.2	-	-	-	154	123.4	0.7	275	124.3	0.7	200	124.4	0.5
8	613	129.4	0.3	-	-	-	125	129.5	0.5	247	131.1	0.6	184	130.9	0.6
9	581	135.5	0.3	-	-	-	154	134.1	0.5	282	136.6	0.7	189	136.9	0.7
10	584	140.9	0.3	-	-	-	128	141.7	0.6	262	142.7	0.6	164	143.3	0.9
11	525	147.3	0.3	-	-	-	143	147.4	0.7	275	150.2	0.7	194	151.4	0.7
12	-	-	-	547	46.6	0.3	146	143.8	0.6	239	155.5	0.7	318	156.0	0.7
13	-	-	-	582	50.5	0.3	155	158.7	0.5	225	159.9	0.9	324	159.1	0.6
14	-	-	-	586	54.2	0.3	181	160.7	0.7	224	161.2	0.7	326	161.8	0.6
15	-	-	-	503	56.5	0.5	144	163.3	0.5	195	162.8	0.6	271	162.0	0.6
16	-	-	-	536	58.1	0.3	167	162.8	0.5	214	163.0	0.7	275	161.9	0.5
17	-	-	-	442	57.6	0.3	134	163.5	0.6	201	163.6	0.6	258	163.2	0.6
18	-	-	-	-	-	-	156	162.8	0.5	175	163.2	0.9	249	163.0	0.5
19	-	-	-	-	-	-	158	163.2	0.4	178	163.4	0.7	231	163.1	0.7
20-29	-	-	-	-	-	-	1,290	163.3	0.2	1,665	162.8	0.2	663	162.8	0.3
30-39	-	-	-	-	-	-	964	163.1	0.2	1,776	163.4	0.3	708	163.0	0.3
40-49	-	-	-	-	-	-	765	162.3	0.3	1,354	162.8	0.3	794	163.4	0.2
50-59	-	-	-	-	-	-	793	160.5	0.3	998	161.8	0.3	601	162.3	0.3
60-74	-	-	-	-	-	-	2,349	158.8	0.2	1,680	159.8	0.2	1,004	160.0	0.2
75+	-	-	-	-	-	-	-	-	-	1,025	156.2	0.4	538	157.4	0.3

- Data not available.
N = Number of individuals.
SE = Standard error.

Source: Ogden et al., 2004.

Table 8-16. Mean Body Mass Index (BMI) (kg/m^2) by Age and Gender Across Multiple Surveys

Gender and Age (years)	NHES II, 1963-65			NHES III, 1966-70			NHANES I, 1971-74			NHANES II, 1976-80			NHANES III, 1988-94			NHANES 1999-2002		
	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
Male																		
2	-	-	-	-	-	-	298	16.3	0.1	350	16.2	0.1	588	16.5	0.1	225	16.6	0.1
3	-	-	-	-	-	-	308	16.0	0.1	421	15.9	0.1	512	16.1	0.2	209	16.2	0.1
4	-	-	-	-	-	-	304	15.7	0.1	405	15.8	0.1	547	15.9	0.1	178	16.3	0.2
5	-	-	-	-	-	-	273	15.6	0.1	393	15.6	0.1	495	15.9	0.1	147	16.5	0.3
6	575	15.6	0.1	-	-	-	179	15.7	0.2	146	16.0	0.2	282	16.3	0.3	182	16.4	0.2
7	632	15.9	0.1	-	-	-	164	15.8	0.2	150	16.0	0.2	269	16.5	0.2	185	17.0	0.2
8	618	16.3	0.1	-	-	-	152	15.8	0.2	145	16.5	0.2	266	17.3	0.4	214	18.4	0.4
9	603	16.9	0.2	-	-	-	169	17.1	0.3	141	16.8	0.2	279	18.0	0.7	174	18.7	0.3
10	576	17.1	0.1	-	-	-	184	17.3	0.2	165	18.0	0.3	297	18.4	0.3	187	19.1	0.3
11	595	17.9	0.1	-	-	-	178	18.0	0.3	153	18.6	0.3	280	19.4	0.3	182	19.6	0.4
12	-	-	-	643	18.4	0.1	200	18.7	0.2	147	18.8	0.3	203	20.1	0.3	299	20.7	0.4
13	-	-	-	626	19.4	0.1	174	19.6	0.3	165	19.5	0.4	187	20.5	0.3	298	20.7	0.5
14	-	-	-	618	20.2	0.2	174	20.2	0.3	188	20.2	0.2	188	22.3	1.1	266	22.3	0.4
15	-	-	-	613	20.9	0.1	171	20.5	0.3	180	20.8	0.3	187	22.3	0.5	283	22.5	0.3
16	-	-	-	556	21.3	0.1	169	21.8	0.3	180	22.0	0.3	194	22.3	0.5	306	24.1	0.4
17	-	-	-	458	22.1	0.1	176	21.9	0.3	183	21.8	0.2	196	23.4	0.4	313	24.5	0.4
18	-	-	-	-	-	-	124	23.7	0.3	156	22.6	0.4	176	22.6	0.5	284	24.2	0.3
19	-	-	-	-	-	-	136	23.3	0.5	150	23.1	0.3	168	23.7	0.6	269	24.9	0.4
20-29	-	-	-	-	-	-	986	24.5	0.1	1261	24.3	0.1	1638	25.2	0.2	712	26.6	0.2
30-39	-	-	-	-	-	-	654	26.1	0.2	871	25.6	0.1	1468	26.5	0.2	704	27.5	0.3
40-49	-	-	-	-	-	-	715	26.2	0.2	695	26.4	0.2	1220	27.3	0.2	774	28.4	0.3
50-59	-	-	-	-	-	-	717	26.0	0.2	691	26.2	0.2	851	27.8	0.2	594	28.7	0.3
60-74	-	-	-	-	-	-	1920	25.4	0.1	2086	25.7	0.1	1683	27.2	0.2	991	28.6	0.2
75+	-	--	-	--	-	-	-	-	-	-	-	-	895	25.9	0.2	487	26.8	0.2

Table 8-16. Mean Body Mass Index (BMI) (kg/m^2) by Age and Gender Across Multiple Surveys (continued)

Gender and Age (years)	NHES II, 1963-65			NHES III, 1966-70			NHANES I, 1971-74			NHANES II, 1976-80			NHANES III, 1988-94			NHANES 1999-2002		
	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
Female																		
2	-	-	-	-	-	-	272	15.9	0.1	314	16.1	0.1	562	16.5	0.1	214	16.4	0.1
3	-	-	-	-	-	-	292	15.7	0.1	367	15.6	0.1	582	15.9	0.1	173	16.0	0.1
4	-	-	-	-	-	-	281	15.5	0.1	388	15.5	0.1	533	16.0	0.2	190	15.9	0.2
5	-	-	-	-	-	-	314	15.5	0.1	369	15.6	0.1	554	15.9	0.1	186	16.1	0.3
6	536	115.4	0.1	-	-	-	176	15.4	0.1	150	15.6	0.2	272	16.1	0.3	170	16.2	0.2
7	609	15.8	0.1	-	-	-	169	15.6	0.2	154	16.1	0.2	274	16.9	0.3	196	16.6	0.2
8	613	16.4	0.1	-	-	-	152	16.4	0.2	125	16.3	0.2	247	17.3	0.3	184	18.3	0.5
9	581	17.0	0.1	-	-	-	171	17.2	0.2	154	17.5	0.3	280	18.2	0.5	183	18.7	0.3
10	584	17.6	0.2	-	-	-	197	17.1	0.2	128	17.7	0.3	258	18.4	0.4	163	19.3	0.3
11	525	18.2	0.2	-	-	-	166	18.6	0.3	143	18.9	0.3	275	19.4	0.4	194	20.7	0.4
12	-	-	-	547	19.2	0.1	177	19.5	0.4	146	19.3	0.3	236	20.2	0.5	315	21.2	0.4
13	-	-	-	582	19.9	0.1	198	20.4	0.3	155	20.1	0.4	220	21.8	0.6	321	22.6	0.4
14	-	-	-	586	20.8	0.1	184	21.1	0.3	181	21.0	0.3	218	22.4	0.5	324	22.9	0.4
15	-	-	-	503	21.4	0.2	167	21.1	0.3	144	20.6	0.3	191	21.9	0.4	266	23.2	0.5
16	-	-	-	536	21.9	0.2	171	21.7	0.3	167	21.8	0.3	208	23.0	0.5	273	24.0	0.4
17	-	-	-	442	21.7	0.2	150	22.6	0.5	134	22.3	0.4	201	23.3	0.5	255	23.1	0.4
18	-	-	-	-	-	-	141	21.5	0.3	156	22.3	0.4	175	22.9	0.6	243	24.4	0.5
19	-	-	-	-	-	-	130	22.5	0.6	158	22.4	0.3	177	23.7	0.8	225	25.5	0.4
20-29	-	-	-	-	-	-	2122	23.0	0.1	1290	23.1	0.2	1663	24.3	0.2	654	26.8	0.3
30-39	-	-	-	-	-	-	1654	24.7	0.2	964	24.9	0.2	1773	26.3	0.3	698	27.9	0.3
40-49	-	-	-	-	-	-	1232	25.7	0.2	765	25.7	0.2	1354	27.1	0.3	783	28.6	0.4
50-59	-	-	-	-	-	-	780	26.2	0.2	793	26.5	0.2	996	28.4	0.3	591	29.2	0.4
60-74	-	-	-	-	-	-	2131	26.5	0.2	2349	26.5	0.1	1673	27.4	0.2	993	29.2	0.2
75+	-	-	-	-	-	-	-	-	-	-	-	-	1021	25.9	0.2	524	26.8	0.4

\- Data not available.
N = Number of individuals.
SE = Standard error.

Source: Ogden et al., 2004.

Table 8-17. Sample Sizes by Age, Sex, Race, and Examination

Age Group	Sex	Race[a]	NHANES Examination II (1976-1980)	NHANES Examination III (1988-1994)	NHANES Examination 1999-2002
Overall (2 to 17 years)			6395 (10.6)[b]	9610 (9.9)	6710 (10.1)
2 to 5 years	Boys	White	1082 (4.1)	605 (4.0)	226 (3.9)
		Black	273 (4.1)	693 (3.9)	234 (4.0)
		Mexican American	105 (4.2)	732 (4.0)	231 (3.9)
	Girls	White	1028 (4.0)	639 (4.0)	235 (4.1)
		Black	234 (4.0)	684 (3.9)	222 (4.0)
		Mexican American	102 (4.2)	800 (3.9)	238 (4.1
6 to 11 years	Boys	White	667 (9.0)	446 (8.9)	298 (8.9)
		Black	137 (9.0)	584 (9.0)	371 (9.0)
		Mexican American	60 (9.2)	565 (9.0)	384 (9.0)
	Girls	White	631 (9.1)	428 (9.1)	293 (8.9)
		Black	155 (9.0)	538 (9.0)	363 (9.1)
		Mexican American	40 (9.3)	581 (8.9)	361 (9.0)
12 to 17 years	Boys	White	786 (15.1)	282 (14.9)	449 (14.9)
		Black	155 (15.1)	412 (15.0)	543 (14.9)
		Mexican American	49 (15.0)	406 (15.0)	648 (15.0)
	Girls	White	695 (15.1)	344 (15.0)	456 (14.9)
		Black	159 (15.0)	450 (14.9)	528 (14.8)
		Mexican American	37 (15.2)	421 (14.8)	631 (14.9)
20 to 39 years[c]	Males	White	-	-	607
		Black	-	-	279
		Mexican American	-	-	399
	Females	White	-	-	569
		Black	-	-	298
		Mexican American	-	-	358
40-59 years[c]	Males	White	-	-	676
		Black	-	-	289
		Mexican American	-	-	310
	Females	White	-	-	632
		Black	-	-	297
		Mexican American	-	-	332
60 years and over[c]	Males	White	-	-	866
		Black	-	-	256
		Mexican American	-	-	318
	Females	White	-	-	862
		Black	-	-	275
		Mexican American	-	-	329

[a] Race was recoded in the first two examinations (using data concerning ancestry/national origin) to create comparable categories in all surveys.

[b] Mean ages are shown in parentheses. There are no mean ages available for the older age group data (ages 20 and above).

[c] Data from Ogden et al., 2004.

\- No data available.

Source: Freeman et al., 2006 and Ogden et al, 2004.

Table 8-18. Mean BMI (kg/m^2) Levels and Change in the Mean Z-Scores by Race-Ethnicity and Sex (Ages 2-17)									
			Examination Year[a]				Increase in Mean z-score From 1971-1974 to 1999-2002		
		Race	1971-1974	1976-1980	1988-1994	1999-2002	BMI	Weight	Height
Overall		White	18.0[b]	18.0	18.8	19.0	+0.33	+0.36	+0.20
		Black	17.8	18.2	19.1	20.0	+0.61	+0.63	+0.31
		Mexican-American	18.6	18.8	19.5	20.1	+0.32	+0.52	+0.39
Sex									
	Boys	White	17.9	18.0	18.8	19.0	+0.37	+0.42	+0.25
		Black	17.7	17.8	18.8	19.6	+0.53	+0.58	+0.32
		Mexican-American	18.6	18.9	19.4	20.3	+0.38	+0.67	+0.57
	Girls	White	18.0	18.0	18.7	19.0	+0.30	+0.32	+0.16
		Black	17.9	18.6	19.5	20.4	+0.71	+0.69	+0.30
		Mexican-American	18.5	18.6	19.6	19.9	+0.25	+0.35	+0.21
Age (years)									
	2 to 5	White	15.8	15.7	16.0	16.2	+0.21	+0.22	+0.13
		Black	15.8	15.7	15.9	16.2	+0.34	+0.32	+0.18
		Mexican-American	16.5	16.2	16.5	16.5	-0.02	+0.29	+0.43
	6 to 11	White	16.7	16.9	17.6	17.9	+0.42	+0.47	+0.30
		Black	16.5	17.1	17.9	18.7	+0.67	+0.69	+0.36
		Mexican-American	16.9	17.7	18.5	18.8	+0.50	+0.65	+0.41
	12 to 17	White	20.7	20.6	21.8	22.0	+0.32	+0.35	+0.15
		Black	20.4	20.9	22.4	23.7	+0.72	+9,77	+0.33
		Mexican-American	21.6	21.5	22.6	24.0	+0.37	+0.55	+0.34

[a] Secular trends for BMI, BMI-for-age, weight-for-age, and height-for-age were each statistically significant at the 0.001 level. Trends in BMI, BMI-for-age, and weight also differed ($p < 0.001$) by race.

[b] Mean BMI levels have been adjusted for differences in age and sex across exams.

Source: Freedman et al., 2006.

Table 8-19. Mean body mass index (BMI) (kg/m^2) by survey, sex, race/ethnicity, and age group; adults: United States

Sex, race/ethnicity, and age	HHANES, 1982-84			NHANES III, 1988-94			NHANES, 1999-2002		
	Sample Size	Mean	Standard error of the mean	Sample Size	Mean	Standard error of the mean	Sample Size	Mean	Standard error of the mean
Male									
Non-Hispanic white:[a]									
20 years and over	-	-	-	3,152	26.8	0.1	2,116	27.9	0.2
20–39 years	-	-	-	846	25.9	0.2	607	27.1	0.2
40–59 years	-	-	-	842	27.6	0.2	673	28.7	0.3
60 years and over	-	-	-	1,464	27.0	0.1	836	28.3	0.1
Non-Hispanic black:									
20 years and over[a]	-	-	-	2,091	26.6	0.1	820	27.5	0.2
20–39 years[a]	-	-	-	985	26.3	0.2	279	27.1	0.3
40–59 years	-	-	-	583	27.1	0.2	289	27.7	0.4
60 years and over[a]	-	-	-	523	26.4	0.3	252	28.0	0.3
Mexican American:[a]									
20 years and over	-	-	-	2,229	27.3	0.1	1,018	28.0	0.2
20–74 years	2,273	26.2	0.2	2,127	27.3	0.1	959	28.1	0.2
20–39 years	1,133	25.6	0.3	1,143	26.1	0.2	399	27.1	0.3
40–59 years	856	26.9	0.1	558	28.6	0.2	309	28.9	0.3
60–74 years	284	26.3	0.2	426	27.4	0.3	251	28.6	0.3
60 years and over	-	-	-	528	27.1	0.3	310	28.1	0.3
Female									
Non-Hispanic white:[a]									
20 years and over	-	-	-	3,554	26.1	0.2	2,026	27.6	0.2
20–39 years	-	-	-	1,030	24.7	0.2	567	26.7	0.3
40–59 years	-	-	-	950	27.2	0.3	629	28.3	0.4
60 years and over	-	-	-	1,574	26.7	0.2	830	28.2	0.2
Non-Hispanic black:[a]									
20 years and over	-	-	-	2,451	29.1	0.2	863	31.1	0.3
20–39 years	-	-	-	1,191	27.6	0.3	298	30.2	0.5
40–59 years	-	-	-	721	30.4	0.3	294	32.1	0.5
60 years and over	-	-	-	539	29.4	0.4	271	31.1	0.6
Mexican American:									
20 years and over	-	-	-	2,106	28.4	0.2	1,012	29.0	0.3
20–74 years[a]	3,039	27.1	0.1	2,013	28.5	0.2	960	29.1	0.3
20–39 years[a]	1,482	25.6	0.2	1,063	27.2	0.2	358	27.8	0.4
40–59 years[a]	1,159	28.2	0.2	557	29.7	0.3	332	30.4	0.5
60–74 years[a]	398	28.1	0.3	393	29.2	0.4	270	29.5	0.3
60 years and over	-	-	-	486	28.7	0.4	322	28.9	0.4

NOTES: BMI is calculated as weight in kilograms divided by square of height in meters. HHANES: Hispanic Health and Nutrition Examination Survey; and NHANES: National Health and Nutrition Examination Survey.

[a] Statistically significant trend or difference $p<0.05$ for all years available.

\- Data not available.

Source: Ogden et al., 2004.

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Table 8-20. Prevalence of Overweight and Obesity[a] Among Children

			Examination year				Increase in Prevalence From 1971-1974 to 1999-2002	
		Race	1971-1974	1976-1980	1988-1994	1999-2002	Overweight	Obesity
Overall		White	5% (1)[b]	5% (1)	9% (2)	12% (3)	+8	+2
		Black	6% (1)	7% (2)	12% (3)	18% (5)	+12	+4
		Mexican-American	8% (1)	10% (1)	14% (4)	21% (5)	+12	+4
Sex								
	Boys	White	5% (1)	5% (1)	10% (2)	13% (4)	+8	+3
		Black	6% (2)	5% (1)	11% (3)	16% (5)	+10	+3
		Mexican-American	8% (1)	12% (1)	15% (4)	24% (4)	+16	+6
	Girls	White	5% (1)	5% (1)	9% (2)	12% (2)	+7	+1
		Black	6% (1)	9% (2)	14% (3)	21% (6)	+14	+5
		Mexican-American	8% (2)	7% (0)	14% (3)	17% (4)	+9	+2
Age (years)								
	2 to 5	White	4% (1)	3% (1)	5% (1)	9% (3)	+5	+2
		Black	7% (3)	4% (0)	8% (3)	9% (4)	+2	+1
		Mexican-American	10% (5)	11% (3)	12% (5)	13% (5)	+3	0
	6 to 11	White	4% (0)	6% (1)	11% (3)	13% (4)	+10	+3
		Black	4% (0)	9% (3)	15% (3)	20% (5)	+15	+4
		Mexican-American	6% (0)	11% (0)	17% (4)	22% (5)	+16	+5
	12 to 17	White	6% (1)	4% (0)	11% (2)	13% (2)	+7	+1
		Black	8% (1)	8% (1)	13% (3)	22% (6)	+14	+5
		Mexican-American	9% (0)	8% (1)	14% (2)	25% (5)	+15	+5

[a] Overweight is defined as a BMI $\geq$ 95th percentile or $\geq$ 30 kg/m^2; obesity is defined as a BMI $\geq$ 99th percentile or $\geq$ 40 kg/m^2.
[b] Values are percentage of overweight children (percentage of obese children).

Source: Freedman et al., 2006.

Table 8-21. Numbers of Live Births by Weight and Percentages of Live Births with Low and Very Low Birth Weights, by Race and Hispanic Origin of Mother: United States, 2005

	All Races[a]	Non-Hispanic White[b]	Non-Hispanic Black[b]	Hispanic[c]
Total Births	4,138,349	2,279,768	583,759	985,505
Weight (grams)	Number of Live Births			
< 500	6,599	2,497	2,477	1,212
500-999	23,864	10,015	8,014	4,586
1,000-1,499	31,325	14,967	8,573	5,988
1,500-1,999	66,453	33,687	15,764	12,710
2,000-2,499	210,324	104,935	46,846	43,300
2,500-2,999	748,042	364,726	144,803	176,438
3,000-3,499	1,596,944	857,136	221,819	399,295
3,500-3,999	1,114,887	672,270	108,698	266,338
4,000-4499	289,098	167,269	22,149	64,704
4,500-4999	42,119	27,541	3,203	9,167
>5,000	4,715	2,840	405	1,174
Not stated	3,979	1,885	1,008	593
	Percent of Total			
Low Birth Weight[d]	8.2	7.3	14.0	6.9
Very Low Birth Weight[e]	1.5	1.2	3.3	1.2

[a] All Races includes White, Black, and races other than White and Black and origin not stated.
[b] Race categories are consistent with the 1977 Office of Management and Budget standards.
[c] Hispanic includes all persons of Hispanic origin of any race.
[d] Low birth weight is birth weight less than 2,500 grams (5 lb 8 oz).
[e] Very low birth weight is birth weight less than 1,500grams (3 lb 4 oz).

Source: Martin et al., 2007.

Table 8-22. Estimated Mean Body Weights of Males and Females by Single-Year Age Groups Using NHANES II Data

Age Group[a]	Males (kg)			Females (kg)			Overall (kg)		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
0 to 1 year	9.4	1.3	179	8.8	1.3	177	9.1	1.2	356
1 to 2 years	11.8	1.6	370	10.8	1.4	336	11.3	1.5	706
2 to 3 years	13.6	1.8	375	13.0	1.5	336	13.3	1.6	711
3 to 4 years	15.6	1.9	418	14.9	2.1	366	15.2	1.8	784
4 to 5 years	17.8	2.4	404	17.0	2.3	396	17.4	2.4	800
5 to 6 years	19.8	2.8	397	19.6	3.2	364	19.7	2.8	761
6 to 7 years	23.0	3.7	133	22.1	3.9	135	22.5	3.6	268
7 to 8 years	25.1	3.8	148	24.7	4.6	157	24.8	3.8	305
8 to 9 years	28.2	5.6	147	27.8	4.8	123	28.1	5.6	270
9 to 10 years	31.1	5.8	145	31.8	7.3	149	31.4	5.9	294
10 to 11 years	36.4	7.2	157	36.1	7.7	136	36.2	7.1	293
11 to 12 years	40.2	9.8	155	41.8	10.1	140	41.0	9.9	295
12 to 13 years	44.2	9.8	145	46.4	10.1	147	45.4	10.0	292
13 to 14 years	49.8	11.4	173	50.9	11.2	162	50.4	11.5	335
14 to 15 years	57.1	10.7	186	54.7	10.7	178	55.9	10.5	364
15 to 16 years	61.0	10.4	184	55.1	9.0	145	58.0	9.9	329
16 to 17 years	67.1	11.7	178	58.1	9.6	170	62.4	10.9	348
17 to 18 years	66.7	11.3	173	59.6	10.4	134	63.3	10.7	307
18 to 19 years	71.0	12.0	164	59.0	10.2	170	64.6	10.9	334
19 to 20 years	71.7	11.3	148	60.1	10.1	158	65.3	10.3	306
20 to 21 years	71.6	12.0	114	60.5	10.7	162	65.2	10.9	276
21 to 22 years	74.76	12.73	150	60.39	11.14	170	66.71	11.35	320
22 to 23 years	76.10	12.88	135	60.51	10.11	150	67.30	11.39	285
23 to 24 years	75.93	11.76	148	61.21	11.48	133	68.43	10.60	281
24 to 25 years	75.18	11.65	129	62.71	13.44	123	68.43	10.60	252
25 to 26 years	76.34	11.52	118	62.64	12.46	120	68.80	10.38	238
26 to 27 years	79.49	14.18	127	61.74	11.77	118	70.57	12.59	245
27 to 28 years	76.17	12.34	112	62.83	12.18	130	68.24	11.06	242
28 to 29 years	79.80	14.15	104	63.79	14.34	138	69.79	12.38	242
29 to 30 years	77.64	11.63	124	63.33	12.92	122	69.97	10.48	246
30 to 31 years	78.63	13.63	103	64.90	13.71	139	70.44	12.21	242
31 to 32 years	78.19	14.19	108	67.71	14.45	116	72.33	13.13	224
32 to 33 years	79.15	12.99	102	68.94	17.51	104	73.43	12.05	206
33 to 34 years	80.73	12.67	86	63.43	11.77	92	71.82	11.27	178
34 to 35 years	81.24	14.83	83	63.03	14.43	91	70.91	12.94	174
35 to 36 years	79.04	12.81	91	67.30	15.62	113	72.24	11.71	204
36 to 37 years	80.41	14.10	79	65.41	11.27	84	72.03	12.63	163
37 to 38 years	79.06	12.41	83	66.81	13.08	97	71.82	11.27	180
38 to 39 years	83.01	15.40	65	66.56	15.72	71	74.14	13.76	136
39 to 40 years	79.85	13.02	71	67.21	13.85	79	73.19	11.94	150
40 to 41 years	84.20	13.22	76	70.56	17.70	77	76.49	12.01	153
41 to 42 years	81.20	15.07	73	65.25	12.91	70	73.47	13.63	143
42 to 43 years	79.67	11.86	74	65.81	12.14	98	71.23	10.60	172
43 to 44 years	81.50	14.04	68	68.45	14.89	84	73.38	12.64	152
44 to 45 years	82.76	13.41	65	66.96	15.19	71	73.70	11.94	136
45 to 46 years	80.91	13.77	62	65.18	14.78	65	72.33	12.31	127
46 to 47 years	82.83	15.28	68	70.45	15.91	82	75.24	13.89	150
47 to 48 years	82.29	11.83	55	68.02	13.67	73	73.42	10.55	128
48 to 49 years	81.52	12.63	77	67.39	15.71	67	74.28	11.51	144
49 to 50 years	80.60	13.31	77	66.83	14.54	79	73.07	12.06	156
50 to 51 years	81.14	14.23	79	70.81	14.67	98	75.12	13.17	177
51 to 52 years	81.25	11.27	69	67.20	11.99	67	73.81	10.23	136
52 to 53 years	82.38	15.03	73	66.07	14.58	88	72.70	13.27	161
53 to 54 years	79.37	12.94	69	68.83	14.83	73	73.71	12.02	142

Table 8-22. Estimated Mean Body Weights of Males and Females by Single-Year Age Groups Using NHANES II Data (continued)

Age Group[a]	Males (kg)			Females (kg)			Overall (kg)		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
54 to 55 years	76.63	13.36	61	67.62	14.64	71	71.52	12.47	132
55 to 56 years	81.92	15.12	62	71.93	16.17	90	75.32	13.90	152
56 to 57 years	77.36	11.28	69	70.82	15.40	67	73.59	10.73	136
57 to 58 years	79.85	13.02	64	66.87	14.41	99	71.60	11.68	163
58 to 59 years	79.23	12.52	73	68.73	13.60	70	73.28	11.58	143
59 to 60 years	80.00	12.47	72	64.43	12.88	70	71.45	11.14	142
60 to 61 years	79.76	12.92	183	67.28	12.83	218	72.75	11.79	401
61 to 62 years	78.42	11.75	169	68.12	13.83	176	72.68	10.89	345
62 to 63 years	77.06	12.33	188	66.09	13.69	184	71.00	11.36	372
63 to 64 years	77.07	11.31	162	66.41	14.03	178	70.72	10.38	340
64 to 65 years	77.27	13.63	185	67.45	13.77	177	72.26	12.74	362
65 to 66 years	77.36	13.25	158	68.48	14.68	185	71.84	12.30	343
66 to 67 years	75.35	13.21	138	67.36	13.95	182	70.40	12.34	320
67 to 68 years	73.98	12.82	143	65.98	13.47	149	69.19	11.99	292
68 to 69 years	74.14	14.60	124	68.87	13.63	161	71.02	13.98	285
69 to 70 years	74.40	13.20	129	65.59	13.39	119	69.37	12.30	248
70 to 71 years	75.17	13.03	128	65.04	12.47	136	69.32	12.01	264
71 to 72 years	74.45	12.60	115	65.62	13.53	139	69.00	11.67	254
72 to 73 years	73.47	12.36	100	64.89	11.58	135	68.17	11.46	235
73 to 74 years	72.80	12.17	82	65.59	12.71	108	68.36	11.43	190
74+	75.89	13.38	82	67.20	14.48	102	70.55	12.44	184

[a] Data were converted from ages in months to ages in years. For instance, age 1–2 years represents ages from 12 to 23 months.
SD = Standard Deviation.
N = Number of individuals.

Source: Portier et al., 2007.

Table 8-23. Estimated Mean Body Weights of Males and Females by Single-Year Age Groups Using NHANES III Data									
Age Group[a]	Males (kg)			Females (kg)			Overall (kg)		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
0 to 1 years	8.5	1.5	902	7.8	1.6	910	8.17	1.7	1,812
1 to 2 years	11.6	1.5	660	10.9	1.4	647	11.2	1.5	1,307
2 to 3 years	13.6	1.5	644	13.2	1.8	624	13.4	1.8	1,268
3 to 4 years	15.8	2.3	516	15.4	2.2	587	15.6	2.2	1,103
4 to 5 years	17.6	2.4	549	17.9	3.2	537	17.8	3.2	1,086
5 to 6 years	20.1	3.0	497	20.2	3.5	554	20.2	3.5	1,051
6 to 7 years	23.2	5.0	283	22.6	4.7	272	22.9	4.8	555
7 to 8 years	26.3	5.0	269	26.3	6.2	274	26.4	6.2	543
8 to 9 years	30.1	6.9	266	29.8	6.7	248	30.0	6.7	514
9 to 10 years	34.4	7.9	281	34.3	9.0	280	34.4	9.0	561
10 to 11 years	37.3	8.6	297	37.9	9.5	258	37.7	9.4	555
11 to 12 years	42.5	10.5	281	44.2	10.5	275	43.4	10.3	556
12 to 13 years	49.1	11.1	203	49.1	11.6	236	49.1	11.7	439
13 to 14 years	54.0	12.9	187	55.7	13.2	220	54.8	13.0	407
14 to 15 years	63.7	17.1	188	58.3	11.8	220	60.6	12.2	408
15 to 16 years	66.8	14.9	187	58.3	10.1	197	61.7	10.7	384
16 to 17 years	68.6	14.9	194	61.5	12.8	215	65.2	13.6	409
17 to 18 years	72.7	13.3	196	62.4	11.9	217	67.6	12.9	413
18 to 19 years	71.2	14.3	176	61.5	14.2	193	66.4	15.3	369
19 to 20 years	73.0	12.8	168	63.6	14.5	193	68.3	15.6	361
20 to 21 years	72.5	13.4	149	61.7	12.9	180	66.1	13.8	329
21 to 22 years	72.92	12.86	161	65.01	16.03	188	69.24	17.08	349
22 to 23 years	76.34	14.72	160	64.07	13.61	193	69.48	14.75	353
23 to 24 years	77.85	14.37	172	66.99	16.24	205	72.72	17.63	377
24 to 25 years	78.56	15.38	187	62.79	12.62	200	70.16	14.10	387
25 to 26 years	80.33	17.89	171	66.19	16.05	157	74.11	17.97	328
26 to 27 years	75.88	12.84	143	64.89	15.19	184	69.73	16.33	327
27 to 28 years	81.17	14.90	176	65.10	14.43	184	73.33	16.25	360
28 to 29 years	81.10	18.23	154	66.97	15.26	190	73.28	16.70	344
29 to 30 years	81.93	16.89	156	65.89	13.65	177	73.33	15.19	333
30 to 31 years	83.56	16.71	163	67.76	16.85	202	75.11	18.68	365
31 to 32 years	79.48	13.12	155	72.48	19.32	204	77.04	20.54	359
32 to 33 years	81.65	15.82	159	67.53	17.22	179	74.33	18.95	338
33 to 34 years	84.03	16.63	153	68.49	16.03	176	75.09	17.58	329
34 to 35 years	82.95	15.56	162	67.55	14.27	186	76.47	16.16	348
35 to 36 years	81.24	16.16	143	71.45	17.47	188	76.02	18.59	331
36 to 37 years	87.67	21.26	163	66.02	14.29	180	77.32	16.74	343
37 to 38 years	83.33	17.61	123	72.04	17.69	202	76.42	18.77	325
38 to 39 years	82.53	14.47	136	71.58	17.43	183	76.85	18.71	319
39 to 40 years	82.62	12.46	122	74.57	19.41	157	79.34	20.65	279
40 to 41 years	85.84	15.23	152	68.70	15.80	198	75.55	17.37	350
41 to 42 years	86.19	18.93	148	70.11	13.80	183	78.34	15.42	331
42 to 43 years	85.12	16.76	161	72.72	19.46	171	79.25	21.21	332
43 to 44 years	86.37	17.71	139	68.94	15.35	123	77.80	17.33	262
44 to 45 years	90.62	20.37	120	72.61	17.15	152	79.13	18.69	272
45 to 46 years	83.58	13.46	108	71.78	15.76	125	78.22	17.18	233
46 to 47 years	80.70	13.00	102	72.07	15.53	113	76.30	16.44	215
47 to 48 years	85.54	17.28	116	72.09	15.98	102	79.28	17.57	218
48 to 49 years	82.29	14.93	93	75.80	16.09	95	79.21	16.82	188
49 to 50 years	82.25	16.11	85	73.41	18.26	106	77.95	19.39	191
50 to 51 years	81.69	13.24	77	74.05	18.03	118	77.31	18.82	195
51 to 52 years	85.78	15.39	84	79.48	19.60	85	83.81	20.67	169
52 to 53 years	87.02	13.66	93	72.00	16.86	100	79.97	18.72	193
53 to 54 years	89.44	14.86	86	73.92	17.08	97	81.86	18.91	183

Table 8-23. Estimated Mean Body Weights of Males and Females by Single-Year Age Groups Using NHANES III Data (continued)

Age Group[a]	Males (kg)			Females (kg)			Overall (kg)		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
54 to 55 years	86.02	16.76	86	74.63	19.97	113	79.88	21.38	199
55 to 56 years	83.10	14.99	82	72.56	14.06	102	76.59	14.84	184
56 to 57 years	87.16	15.10	96	77.69	16.74	105	83.15	17.91	201
57 to 58 years	86.31	15.04	89	75.65	17.87	97	82.12	19.40	186
58 to 59 years	83.54	15.67	81	72.26	16.47	100	76.89	17.52	181
59 to 60 years	87.93	16.14	74	74.00	15.33	82	80.48	16.67	156
60 to 61 years	83.54	14.22	130	68.73	13.60	104	75.88	15.02	234
61 to 62 years	81.91	15.03	119	72.26	15.42	141	76.50	16.32	260
62 to 63 years	81.98	15.47	116	72.97	17.54	114	77.18	18.55	230
63 to 64 years	84.15	14.50	118	71.32	14.48	111	76.88	15.61	229
64 to 65 years	84.28	15.73	116	74.34	17.40	126	78.86	18.46	242
65 to 66 years	85.10	14.75	127	67.47	16.08	118	76.14	18.14	245
66 to 67 years	81.43	15.03	102	71.82	14.58	118	76.49	15.53	220
67 to 68 years	84.35	15.22	117	68.98	15.22	95	76.08	16.78	212
68 to 69 years	80.60	11.75	98	70.72	16.56	110	76.07	17.81	208
69 to 70 years	84.81	18.18	113	66.57	11.74	97	74.84	13.20	210
70 to 71 years	80.18	14.14	92	68.36	15.72	124	72.95	16.78	216
71 to 72 years	79.34	14.64	126	70.74	17.89	98	75.64	19.13	224
72 to 73 years	78.97	13.36	119	66.70	13.89	101	72.76	15.15	220
73 to 74 years	82.07	17.26	109	68.24	14.14	115	74.37	15.41	224
74 to 75 years	79.32	15.37	84	69.08	13.67	97	73.57	14.56	181
75 to 76 years	77.18	10.47	75	68.58	13.50	85	72.89	14.35	160
76 to 77 years	79.30	14.88	64	65.68	13.88	94	70.38	14.87	158
77 to 78 years	80.70	13.98	64	67.33	14.16	86	72.43	15.23	150
78 to 79 years	75.21	11.34	50	63.67	14.31	63	67.94	15.27	113
79 to 80 years	78.75	11.32	45	60.21	14.41	61	67.28	16.10	106
80 to 81 years	76.94	15.15	108	63.55	13.10	101	68.77	14.18	209
81 to 82 years	73.70	13.30	96	63.17	12.70	112	66.94	13.45	208
82 to 83 years	73.25	12.32	81	61.96	12.01	69	67.05	12.99	150
83 to 84 years	72.10	15.31	63	62.78	12.23	63	65.80	12.82	126
84 to 85 years	72.09	10.73	62	63.68	11.43	57	66.74	11.97	119
85+	70.08	11.64	189	59.67	11.69	240	63.11	12.36	429

[a] Data were converted from ages in months to ages in years. For instance, age 1–2 years represents ages from 12 to 23 months.

SD = Standard Deviation.

N = Number of individuals.

Source: Portier et al., 2007.

Table 8-24. Estimated Mean Body Weights of Males and Females by Single-Year Age Groups Using NHANES IV Data

Age Group[a]	Males (kg)			Females (kg)			Overall (kg)		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
0 to 1 year	9.3	1.8	116	9.3	1.5	101	9.3	1.5	217
1 to 2 years	11.3	1.4	144	11.5	1.9	98	11.4	1.8	242
2 to 3 years	13.7	2.0	130	13.3	1.9	113	13.5	2.0	243
3 to 4 years	16.4	2.3	105	15.2	2.1	77	15.9	2.2	182
4 to 5 years	18.8	2.6	95	18.1	3.2	87	18.5	3.3	182
5 to 6 years	20.2	3.3	65	20.7	4.9	92	20.6	4.9	157
6 to 7 years	22.9	4.3	94	22.0	4.5	74	22.5	4.6	168
7to 8 years	28.1	5.6	100	26.0	6.2	82	27.4	6.5	182
8 to 9 years	31.9	8.6	100	30.8	7.2	89	31.3	7.3	189
9 to 10 years	36.1	7.5	76	36.0	8.4	84	36.2	8.5	160
10 to 11 years	39.5	9.0	92	39.4	10.2	84	39.5	10.2	176
11 to 12 years	42.0	10.2	84	47.2	12.2	97	44.6	11.6	181
12 to 13 years	49.4	12.7	158	51.6	12.3	160	50.3	11.9	318
13 to 14 years	54.9	16.2	161	59.8	15.3	156	56.9	14.6	317
14 to 15 years	65.1	19.9	137	59.9	13.3	158	61.5	13.7	295
15 to 16 years	68.2	15.7	142	63.4	13.9	126	65.9	14.4	268
16 to 17 years	72.5	18.6	153	63.4	16.0	142	68.0	17.1	295
17 to 18 years	75.4	17.9	146	59.9	11.9	128	66.6	13.2	274
18 to 19 years	74.8	15.9	131	65.0	15.2	139	70.2	16.4	270
19 to 20 years	80.1	17.2	129	68.7	17.4	132	74.6	19.0	261
20 to 21 years	80.0	15.5	37	66.3	15.5	44	74.3	17.4	81
21 to 22 years	73.84	12.87	33	65.89	15.49	47	69.40	16.32	80
22 to 23 years	89.62	23.98	37	67.27	15.47	49	75.85	17.44	86
23 to 24 years	83.39	18.31	36	73.58	23.21	53	80.27	25.32	89
24 to 25 years	80.26	19.38	20	71.81	21.27	54	75.04	22.23	74
25 to 26 years	87.47	14.89	27	71.64	20.31	44	80.45	22.80	71
26 to 27 years	72.11	14.64	33	78.09	20.98	47	75.63	20.32	80
27 to 28 years	85.78	22.69	30	72.48	18.10	49	78.75	19.67	79
28 to 29 years	88.04	26.64	36	76.18	16.18	34	81.29	17.26	70
29 to 30 years	84.02	15.16	35	71.88	16.60	50	78.10	18.04	85
30 to 31 years	80.10	22.28	29	74.00	22.71	48	77.01	23.63	77
31 to 32 years	84.65	18.59	33	79.12	22.51	49	82.51	23.48	82
32 to 33 years	90.99	15.77	35	77.53	18.15	55	83.82	19.62	90
33 to 34 years	90.90	18.74	37	76.60	22.28	29	85.94	25.00	66
34 to 35 years	79.09	19.50	33	73.26	16.92	49	75.72	17.49	82
35 to 36 years	91.15	25.45	33	79.91	22.74	37	84.60	24.07	70
36 to 37 years	88.96	17.15	29	72.10	20.29	38	80.17	22.55	67
37 to 38 years	84.62	17.62	47	70.75	15.39	35	79.21	17.23	82
38 to 39 years	80.52	17.26	29	80.86	22.32	40	81.18	22.41	69
39 to 40 years	84.77	14.26	37	78.08	19.34	43	81.92	20.29	80
40 to 41 years	92.21	26.63	40	73.87	18.14	47	82.13	20.17	87
41 to 42 years	83.11	14.06	37	75.91	17.38	37	79.56	18.21	74
42 to 43 years	91.94	15.56	46	82.03	21.78	41	88.15	23.41	87
43 to 44 years	89.48	16.15	40	71.59	17.81	27	83.18	20.69	67
44 to 45 years	87.00	14.63	34	74.86	18.15	42	80.04	19.41	76
45 to 46 years	84.61	17.53	33	81.15	23.52	50	83.21	24.12	83
46 to 47 years	93.27	20.48	28	74.94	16.84	34	82.90	18.63	62
47 to 48 years	80.87	11.38	29	68.24	16.97	38	74.29	18.48	67
48 to 49 years	85.58	17.91	21	82.10	29.55	34	84.51	30.42	55
49 to 50 years	88.84	24.90	28	75.55	21.74	24	82.17	23.64	52
50 to 51 years	90.09	14.51	26	83.22	27.42	27	88.10	29.03	53
51 to 52 years	90.63	18.22	35	76.89	16.09	36	83.63	17.50	71
52 to 53 years	90.62	19.52	24	80.89	19.78	42	85.03	20.79	66
53 to 54 years	92.42	21.93	28	76.12	16.64	32	82.96	18.13	60

Table 8-24. Estimated Mean Body Weights of Males and Females by Single-Year Age Groups Using NHANES IV Data (continued)

Age Group[a]	Males (kg)			Females (kg)			Overall (kg)		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
54 to 55 years	90.51	21.10	32	75.19	18.07	36	81.46	19.58	68
55 to 56 years	84.84	18.72	20	79.87	16.71	25	82.39	17.24	45
56 to 57 years	84.48	18.55	26	80.68	20.24	32	82.72	20.75	58
57 to 58 years	86.02	20.50	26	73.07	13.79	24	80.20	15.13	50
58 to 59 years	89.11	21.33	19	71.21	16.01	17	79.97	17.97	36
59 to 60 years	83.82	16.33	25	76.28	16.36	17	80.76	17.32	42
60 to 61 years	89.53	17.90	60	75.97	18.66	43	83.70	20.56	103
61 to 62 years	86.04	15.44	34	77.01	16.67	37	81.12	17.56	71
62 to 63 years	84.46	16.28	41	75.78	13.13	45	79.50	13.78	86
63 to 64 years	86.51	20.07	24	77.95	16.96	39	80.73	17.56	63
64 to 65 years	91.45	16.88	39	76.75	18.29	42	83.98	20.01	81
65 to 66 years	89.46	18.44	41	72.95	18.37	41	80.38	20.24	82
66 to 67 years	90.40	20.13	49	79.00	17.67	26	86.09	19.26	75
67 to 68 years	85.34	19.18	36	77.76	18.21	35	81.18	19.01	71
68 to 69 years	84.48	12.92	26	73.28	14.12	35	78.20	15.07	61
69 to 70 years	92.35	16.95	24	69.94	9.20	32	80.53	10.59	56
70 to 71 years	81.91	16.38	47	70.50	12.94	32	76.06	13.96	79
71 to 72 years	79.65	21.31	25	66.22	13.04	35	68.99	13.58	60
72 to 73 years	84.67	17.45	32	76.89	15.30	21	81.08	16.13	53
73 to 74 years	89.70	15.36	35	72.75	16.80	27	81.69	18.87	62
74 to 75 years	80.85	17.00	17	69.21	16.35	31	73.34	17.32	48
75 to 76 years	84.26	11.94	25	68.61	10.42	21	75.14	11.41	46
76 to 77 years	86.13	15.45	20	67.42	11.34	25	73.62	12.38	45
77 to 78 years	81.68	14.15	18	78.35	17.45	21	80.09	17.84	39
78 to 79 years	81.99	16.39	26	72.30	14.16	17	77.77	15.23	43
79 to 80 years	80.18	10.39	19	67.95	12.54	21	73.39	13.54	40
80 to 81 years	75.90	12.07	27	60.97	14.46	23	65.39	15.51	50
81 to 82 years	73.77	7.40	31	68.76	13.75	25	71.28	14.25	56
82 to 83 years	81.01	13.46	20	62.93	9.81	20	68.51	10.68	40
83 to 84 years	76.07	10.63	12	66.24	11.68	12	70.90	12.50	24
84 to 85 years	73.06	12.88	12	66.29	15.04	17	68.79	15.60	29
85+	74.10	12.23	46	59.68	10.04	59	64.45	10.84	105

[a] Data were converted from ages in months to ages in years. For instance, age 1–2 years represents ages from 12 to 23 months.

SD = Standard Deviation.

N = Number of individuals.

Source: Portier et al., 2007.

Table 8-25. Estimated Body Weights of Typical Age Groups of Interest in U.S. EPA Risk Assessments[a]										
Age Group	NHANES	Males (kg)			Females (kg)			Overall (kg)		
		Mean	SD	N	Mean	SD	N	Mean	SD	N
1 to 6 years	II	17.0	4.6	2,097	16.3	4.7	1,933	16.7	4.5	4,030
	III	16.9	4.7	3,149	16.5	4.9	3,221	16.8	5.0	6,370
	IV	17.1	4.9	633	17.5	5.0	541	17.3	5.0	1,174
7 to 16 years	II	45.2	17.6	1,618	43.9	15.9	1,507	44.8	17.5	3,125
	III	49.3	20.9	2,549	46.8	18.0	2,640	47.8	18.4	5,189
	IV	47.9	20.1	1,203	47.9	19.2	1,178	47.7	19.1	2,381
18 to 65 years	II	78.65	13.23	4,711	65.47	13.77	5,187	71.23	11.97	9,898
	III	82.19	16.18	6,250	69.45	16.55	7,182	75.61	18.02	13,462
	IV	85.47	19.03	1,908	74.55	19.32	2,202	79.96	20.73	4,110
65 years +	II	74.45	13.05	1,041	66.26	13.25	1,231	69.56	12.20	2,272
	III	79.42	14.66	1,857	66.76	14.52	1,986	72.25	15.71	3,843
	IV	83.50	16.35	547	69.59	14.63	535	75.54	15.88	1,082

[a] Estimates were weighted using the sample weights provided with each survey.
SD = Standard Deviation.
N = Number of individuals.

Source: Portier et al., 2007.

Table 8-26. Estimated Percentile Distribution of Body Weight by Fine Age Categories Derived From 1994-96, 1998 CSFII											
			Weight (kilograms)								
Age Group	Sample Size	Mean	Percentile								
			1st	5th	10th	25th	50th	75th	90th	95th	99th
Birth to 1 month	88	4	1[a]	2[a]	3[a]	3	3	4	4[a]	5[a]	5[a]
1 to <3 months	245	5	2[a]	3[a]	4	4	5	6	6	7[a]	8[a]
3 to <6 months	411	7	4[a]	5	5	6	7	8	9	10	12[a]
6 to <12 months	678	9	6[a]	7	7	8	9	10	11	12	13[a]
1 to <2 years	1,002	12	8[a]	9	9	10	11	13	14	15	19[a]
2 to <3 years	994	14	10[a]	10	11	12	14	16	18	19	22[a]
3 to <6 years	4,112	18	11	13	13	16	18	20	23	25	32
6 to <11 years	1,553	30	16[a]	18	20	23	27	35	41	45	57[a]
11 to <16 years	975	54	29[a]	33	36	44	52	61	72	82	95[a]
16 to <18 years	360	67	41[a]	46[a]	50	56	63	73	86	100[a]	114[a]
18 to <21 years	383	69	45[a]	48[a]	51	58	66	77	89	100[a]	117[a]
21 years and older	9,049	76	45	51	54	63	74	86	99	107	126
65 years and older	2,139	72	44	50	54	62	71	81	93	100	113
All ages	19,850	65	8	15	22	52	67	81	95	104	122

[a] Sample size does meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States" (LSRO, 1995).

Source: Kahn and Stralka, 2008.

Table 8-27. Estimated Percentile Distribution of Body Weight By Fine Age Categories With Confidence Interval

Age Group	Sample Size	Weight (Kilograms)								
		Mean			90th Percentile			95th Percentile		
		Estimate	90% CI		Estimate	90% BI		Estimate	90% BI	
			Lower Bound	Upper Bound		Lower Bound	Upper Bound		Lower Bound	Upper Bound
Birth to 1 month	88	4	3	4	4[a]	4[a]	5[a]	5[a]	5[a]	5[a]
1 to <3 months	245	5	5	5	6	6	7	7[a]	7	7
3 to <6 months	411	7	7	7	9	9	9	10	10	10
6 to <12 months	678	9	9	9	11	11	11	12	12	12
1 to <2 years	1,002	12	12	12	14	14	15	15	15	16
2 to <3 years	994	14	14	14	18	17	18	19	18	19
3 to <6 years	4,112	18	18	18	23	23	23	25	25	25
6 to <11 years	1,553	30	29	30	41	41	43	45	44	48
11 to <16 years	975	54	53	55	72	70	75	82	81	84
16 to <18 years	360	67	66	68	86	84	95	100[a]	95[a]	109[a]
18 to <21 years	383	69	68	70	89	88	95	100[a]	95[a]	104[a]
21 years and older	9,049	76	-	-	99	-	-	107	-	-
65 years and older	2,139	72	-	-	93	-	-	100	-	-
All ages	19,850	65	-	-	95	-	-	104	-	-

[a] Sample size does meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States"(Vol. I). Interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of variance.
CI = Confidence interval.
BI = Percentile intervals estimated using percentile bootstrap method with 1,000 bootstrap replications.
\- = Data unavailable.

Source: Kahn and Stralka, 2008.

Gestational Age (weeks)	Number of Women	10th	25th	50th	75th	90th
8	6	–[a]	–	6.1[b]	–	–
9	7	–	–	7.3[b]	–	–
10	15	–	–	8.1[b]	–	–
11	13	–	–	11.9[b]	–	–
12	18	–	11	21	34	–
13	43	–	23	35	55	–
14	61	–	3,405	51	77	–
15	63	–	51	77	108	–
16	59	–	80	117	151	–
17	36	–	125	166	212	–
18	58	–	172	220	298	–
19	31	–	217	283	394	–
20	21	–	255	325	460	–
21	43	280	330	410	570	860
22	69	320	410	480	630	920
23	71	370	460	550	690	990
24	74	420	530	640	780	1,080
25	48	490	630	740	890	1,180
26	86	570	730	860	1,020	1,320
27	76	660	840	990	1,160	1,470
28	91	770	980	1,150	1,350	1,660
29	88	890	1,100	1,310	1,530	1,890
30	128	1,030	1,260	1,460	1,710	2,100
31	113	1,180	1,410	1,630	1,880	2,290
32	210	1,310	1,570	1,810	2,090	2,500
33	242	1,480	1,720	2,010	2,280	2,690
34	373	1,670	1,910	2,220	2,510	2,880
35	492	1,870	2,130	2,430	2,730	3,090
36	1,085	2,190	2,470	2,650	2,950	3,290
37	1,798	2,310	2,580	2,870	3,160	3,470
38	3,908	2,510	2,770	3,030	3,320	3,610
39	5,413	2,680	2,910	3,170	3,470	3,750
40	10,586	2,750	3,010	3,280	3,590	3,870
41	3,399	2,800	3,070	3,360	3,680	3,980
42	1,725	2,830	3,110	3,410	3,740	4,060
43	507	2,840	3,110	3,420	3,780	4,100
44	147	2,790	3,050	3,390	3,770	4,110

Table 8-28. Fetal Weight (grams) Percentiles Throughout Pregnancy

[a] Data not available.

[b] Median fetal weights may be overestimated. They were derived from only a small proportion of the fetuses delivered at these weeks' gestation.

Source: Brenner et al., 1976.

Table 8-29. Neonatal Weight by Gestational Age for Males and Females Combined

Gestational Age (weeks)	Weight (g)						
	5th	10th	25th	50th	75th	90th	95th
25	450	490	564	660	772	889	968
26	523	568	652	760	885	1,016	1,103
27	609	660	754	875	1,015	1,160	1,257
28	707	765	870	1,005	1,162	1,322	1,430
29	820	884	1,003	1,153	1,327	1,504	1,623
30	947	1,020	1,151	1,319	1,511	1,706	1,836
31	1,090	1,171	1,317	1,502	1,713	1,928	2,070
32	1,249	1,338	1,499	1,702	1,933	2,167	2,321
33	1,422	1,519	1,696	1,918	2,169	2,421	2,587
34	1,608	1,714	1,906	2,146	2,416	2,687	2,865
35	1,804	1,919	2,125	2,383	2,671	2,959	3,148
36	2,006	2,129	2,349	2,622	2,927	3,230	3,428
37	2,210	2,340	2,572	2,859	3,177	3,493	3,698
38	2,409	2,544	2,786	3,083	3,412	3,736	3,947
39	2,595	2,735	2,984	3,288	3,622	3,952	4,164
40	2,762	2,904	3,155	3,462	3,798	4,127	4,340
41	2,900	3,042	3,293	3,597	3,930	4,254	4,462
42	3,002	3,142	3,388	3,685	4,008	4,322	4,523
43	3,061	3,195	3,432	3,717	4,026	4,324	4,515

Source: Doubilet et al., 1997.

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9 INTAKE OF FRUITS AND VEGETABLES

9.1 INTRODUCTION

The American food supply is generally considered to be one of the safest in the world. Nevertheless, fruits and vegetables may become contaminated with toxic chemicals by several different pathways. Ambient pollutants from the air may be deposited on or absorbed by the plants, or dissolved in rainfall or irrigation waters that contact the plants. Pollutants may also be absorbed through plant roots from contaminated soil and ground water. The addition of pesticides, soil additives, and fertilizers may also result in contamination of fruits and vegetables. To assess exposure through this pathway, information on fruit and vegetable ingestion rates is needed.

A variety of terms may be used to define intake of fruits and vegetables (e.g., consumer-only intake, per capita intake, total fruit intake, total vegetable intake, as-consumed intake, dry weight intake). These terms are defined below to assist the reader in interpreting and using the intake rates that are appropriate for the exposure scenario being assessed.

Consumer-only intake is defined as the quantity of fruits and vegetables consumed by individuals during the survey period. These data are generated by averaging intake across only the individuals in the survey who consumed these food items. Per capita intake rates are generated by averaging consumer-only intakes over the entire population (including those individuals that reported no intake). In general, per capita intake rates are appropriate for use in exposure assessments for which average dose estimates are of interest because they represent both individuals who ate the foods during the survey period and individuals who may eat the food items at some time, but did not consume them during the survey period. Per capita intake, therefore, represents an average across the entire population of interest, but does so at the expense of underestimating consumption for the subset of the population that consumed the food in question. Total fruit intake refers to the sum of all fruits consumed in a day including canned, dried, frozen, and fresh fruits. Likewise, total vegetable intake refers to the sum of all vegetables consumed in a day including canned, dried, frozen, and fresh vegetables.

Intake rates may be expressed on the basis of the as-consumed weight (e.g., cooked or prepared) or on the uncooked or unprepared weight. As-consumed intake rates are based on the weight of the food in the form that it is consumed and should be used in assessments where the basis for the contaminant concentrations in foods is also indexed to the as-consumed weight. The food ingestion values provided in this chapter are expressed as as-consumed intake rates because this is the fashion in which data were reported by survey respondents. This is of importance because concentration data to be used in the dose equation are often measured in uncooked food samples. It should be recognized that cooking can either increase or decrease food weight. Similarly, cooking can increase the mass of contaminant in food (due to formation reactions, or absorption from cooking oils or water) or decrease the mass of contaminant in food (due to vaporization, fat loss or leaching). The combined effects of changes in weight and changes in contaminant mass can result in either an increase or decrease in contaminant concentration in cooked food. Therefore, if the as-consumed ingestion rate and the uncooked concentration are used in the dose equation, dose may be under-estimated or over-estimated. Ideally, after-cooking food concentrations should be combined with the as-consumed intake rates. In the absence of data, it is reasonable to assume that no change in contaminant concentration occurs after cooking. It is important for the assessor to be aware of these issues and choose intake rate data that best match the concentration data that are being used. For more information on cooking losses and conversions necessary to account for such losses, the reader is referred to Chapter 13 of this handbook.

Sometimes contaminant concentrations in food are reported on a dry weight basis. When these data are used in an exposure assessment, it is recommended that dry-weight intake rates also be used. Dry-weight food concentrations and intake rates are based on the weight of the food consumed after the moisture content has been removed. For information on converting the intake rates presented in this chapter to dry weight intake rates, the reader is referred to Section 9.4.

The purpose of this chapter is to provide intake data for fruits and vegetables. The recommendations for fruit and vegetable ingestion rates are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values are based on the key study identified by U.S. EPA for this factor. Following the recommendations, the key study on fruit and vegetable ingestion is summarized. Relevant data on ingestion of fruits and vegetables are also provided. These data are presented to provide the reader with added perspective on the current state-of-knowledge pertaining to ingestion of fruits and vegetables.

9.2 RECOMMENDATIONS

Table 9-1 presents a summary of the recommended values for per capita and consumer-only intake of fruits and vegetables, on an as-consumed basis. Confidence ratings for the fruit and vegetable intake recommendations are provided in Table 9-2.

The U.S. EPA analysis of data from the 1994-96 and 1998 Continuing Survey of Food Intake by Individuals (CSFII) was used in selecting recommended intake rates for general population children. The U.S. EPA analysis was conducted using childhood age groups that differed slightly from U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, for the purposes of the recommendations presented here, childhood data were placed in the standardized age categories closest to those used in the analysis. Also, the CSFII data on which the recommendations are based are short-term survey data and may not necessarily reflect the long-term distribution of average daily intake rates. However, since broad categories of food (i.e., total fruits and total vegetables), are eaten on a daily basis throughout the year with minimal seasonality, the short term distribution may be a reasonable approximation of the long-term distribution, although it will display somewhat increased variability. This implies that the upper percentiles shown here may tend to overestimate the corresponding percentiles of the true long-term distribution. It should also be noted that because these recommendations are based on 1994-96 and 1998 CSFII data, they may not reflect the most recent changes that may have occurred in consumption patterns. More current data from the National Health and Nutrition Survey (NHANES) will be incorporated as the data become available and are analyzed.

Table 9-1. Recommended Values for Intake of Fruits and Vegetables, As Consumed[a]						
Age Group	Per Capita		Consumers Only		Multiple Percentiles	Source
	Mean	95th Percentile	Mean	95th Percentile		
	g/kg-day	g/kg-day	g/kg-day	g/kg-day		
Total Fruits						
Birth to 1 year	5.7	21.3	10.1	26.4	See Tables 9-3 and 9-4	U.S. EPA Analysis of CSFII, 1994-96 and 1998, based on USDA (2000) and U.S. EPA (2000).
1 to <2 years	6.2	18.5	6.9	19.0		
2 to < 3 years	6.2	18.5	6.9	19.0		
3 to <6 years	4.6	14.4	5.1	15.0		
6 to <11 years	2.4	8.8	2.7	9.3		
11 to <16 years	0.8	3.5	1.1	3.7		
16 to <21 years	0.8	3.5	1.1	3.7		
20 to <50 years	0.9	3.9	1.2	4.4		
≥50 years	1.4	4.8	1.6	5.0		
Total Vegetables						
Birth to 1 year	4.5	14.8	6.2	16.1	See Tables 9-3 and 9-4	U.S. EPA Analysis of CSFII, 1994-96 and 1998, based on USDA (2000) and U.S. EPA (2000).
1 to <2 years	6.9	17.1	6.9	17.1		
2 to <3 years	6.9	17.1	6.9	17.1		
3 to <6 years	5.9	14.7	5.9	14.7		
6 to <11 years	4.1	9.9	4.1	9.9		
11 to <16 years	2.9	6.9	2.9	6.9		
16 to <21 years	2.9	6.9	2.9	6.9		
20 to <50 years	2.9	6.8	2.9	6.8		
≥50 years	3.1	7.0	3.1	7.0		
Individual Fruits and Vegetables - See Tables 9-5 and 9-6						

[a] Analysis was conducted using slightly different childhood age groups than those recommended in *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA. 2005). Data were placed in the standardized age categories closest to those used in the analysis.

Table 9-2. Confidence in Recommendations for Intake of Fruits and Vegetables		
General Assessment Factors	Rationale	Rating
Soundness		High for total fruits and vegetables, low for some individual fruits and vegetables with small sample size
Adequacy of Approach	The survey methodology and data analysis was adequate. The survey sampled more than 20,000 individuals. However, samples size for some individual fruits and vegetables for some of the age groups are small. An analysis of primary data was conducted.	
Minimal (or Defined) Bias	No physical measurements were taken. The method relied on recent recall of fruits and vegetables eaten.	
Applicability and Utility		Medium
Exposure Factor of Interest	The key study was directly relevant to fruit and vegetable intake.	
Representativeness	The data were demographically representative of the U.S. population (based on stratified random sample).	
Currency	Data were collected between 1994 and 1998.	
Data Collection Period	Data were collected for two non-consecutive days.	
Clarity and Completeness		High
Accessibility	The CSFII data are publicly available.	
Reproducibility	The methodology used was clearly described; enough information was included to reproduce the results.	
Quality Assurance	Quality assurance of the CSFII data was good; quality control of the secondary data analysis was not well described.	
Variability and Uncertainty		Medium
Variability in Population	Full distributions were provided for total fruits and total vegetables. Means were provided for individual fruits and vegetables.	
Uncertainty	Data collection was based on recall of consumption for a 2-day period; the accuracy of using these data to estimate long-term intake (especially at the upper percentiles) is uncertain. However, use of short-term data to estimate chronic ingestion can be assumed for broad categories of foods such as total fruits and total vegetables. Uncertainty is likely to be greater for individual fruits and vegetables.	
Evaluation and Review		Medium
Peer Review	The USDA CSFII survey received a high level of peer review. The U.S. EPA analysis of these data has not been peer reviewed outside the Agency.	
Number and Agreement of Studies	There was 1 key study.	
Overall Rating		**Medium-High** confidence in the averages; **Low** for some individual fruits and vegetables with small sample size **Low** confidence in the long-term upper percentiles

9.3 INTAKE STUDIES

The primary source of recent information on consumption rates of fruits and vegetables is the U.S. Department of Agriculture's (USDA) CSFII. Data from the 1994-96 CSFII and the 1998 Children's supplement to the 1994-96 CSFII have been used in various studies to generate consumer-only and per capita intake rates for both individual fruits and vegetables and total fruits and vegetables. The CSFII is a series of surveys designed to measure the kinds and amounts of foods eaten by Americans. The CSFII 1994-96 was conducted between January 1994 and January 1997 with a target population of non-institutionalized individuals in all 50 states and Washington, D.C. In each of the 3 survey years, data were collected for a nationally representative sample of individuals of all ages. The CSFII 1998 was conducted between December 1997 and December 1998 and surveyed children 9 years of age and younger. It used the same sample design as the CSFII 1994-96 and was intended to be merged with CSFII 1994-96 to increase the sample size for children. The merged surveys are designated as CSFII 1994-96, 1998 (USDA, 2000). Additional information on these surveys can be obtained at http://www.ars.usda.gov/Services/docs.htm?docid=14531.

The CSFII 1994-96, 1998 collected dietary intake data through in-person interviews on 2 non-consecutive days. The data were based on 24-hour recall. A total of 21,662 individuals provided data for the first day; of those individuals, 20,607 provided data for a second day. The 2-day response rate for the 1994-1996 CSFII was approximately 76 percent. The 2-day response rate for CSFII 1998 was 82 percent.

The CSFII 1994-96, 98 surveys were based on a complex multistage area probability sample design. The sampling frame was organized using 1990 U.S. population census estimates, and the stratification plan took into account geographic location, degree of urbanization, and socioeconomic characteristics. Several sets of sampling weights are available for use with the intake data. By using appropriate weights, data for all four years of the surveys can be combined. USDA recommends that all 4 years be combined in order to provide an adequate sample size for children.

9.3.1 Key Fruits and Vegetables Intake Study

9.3.1.1 *U.S. EPA Analysis of CSFII 1994-96, 1998 based on USDA (2000) and U.S. EPA (2000)*

For many years, the U.S. EPA's Office of Pesticide Programs (OPP) has used food consumption data collected by the U.S. Department of Agriculture (USDA) for its dietary risk assessments. Most recently, OPP, in cooperation with USDA's Agricultural Research Service (ARS), used data from the 1994-96, 1998 CSFII to develop the Food Commodity Intake Database (FCID) (U.S. EPA, 2000, USDA, 2000). CSFII data on the foods people reported eating were converted to the quantities of agricultural commodities eaten. "Agricultural commodity" is a term used by U.S. EPA to mean plant (or animal) parts consumed by humans as food; when such items are raw or unprocessed, they are referred to as "raw agricultural commodities." For example, an apple pie may contain the commodities apples, flour, fat, sugar and spices. FCID contains approximately 553 unique commodity names and 8-digit codes. The FCID commodity names and codes were selected and defined by U.S. EPA and were based on the U.S. EPA Food Commodity Vocabulary (http://www.epa.gov/pesticides/foodfeed/).

The fruit and vegetable items/groups selected for the U.S. EPA analysis included total fruits and total vegetables, and individual fruits such as: apples, bananas, peaches, pears, strawberries, citrus fruits, pome fruit, stone fruit, and tropical fruits; and individual vegetables such as: asparagus, beets, broccoli, cabbage, carrots, corn, cucumbers, lettuce, okra, onions, peas, peppers, pumpkin, beans, tomatoes, white potatoes, bulb vegetables, fruiting vegetables, leafy vegetables, legumes, and small stalk stem vegetables. Appendix 9A presents the food codes and definitions used to determine the various fruits and vegetables used in the analysis. Intake rates for these food items/groups represent intake of all forms of the product (e.g., both home produced and commercially produced). Individuals who provided data for two days of the survey were included in the intake estimates. Individuals who did not provide information on body weight or for whom identifying information was unavailable were excluded from the analysis. Two-day average intake rates were calculated for all individuals in the database for each of the food items/groups. These average daily intake rates were divided by each individual's reported body weight to generate intake rates in units of grams per kilogram of body weight per day (g/kg-day). The data were weighted according to the four-year, two-day sample weights provided in the 1994-96, 1998 CSFII to adjust the data for the sample population to reflect the national population.

Summary statistics were generated on both a per capita and a consumer only basis. For per capita intake, both users and non-users of the food item were included in the analysis. Consumer only intake rates were calculated using data for only those individuals who ate the food item of interest during the survey period. Intake data from the CSFII were based on as- consumed (i.e., cooked or prepared) forms of the food items/groups. Summary statistics, including: number of observations, percentage of the population consuming the fruits or vegetables being analyzed, mean intake rate, and standard error of the mean intake rate were calculated for total fruits, total vegetables, and selected individual fruits and vegetables. Percentiles of the intake rate distribution (i.e., 1st, 5th, 10th, 25th, 50th, 75th, 90th, 95th, 99th, and the maximum value) were also provided for total fruits and total vegetables. Data were provided for the following age groups: birth to 1 year, 1 to 2 years, 3 to 5 years, 6 to 12 years, 13 to 19 years, 20 to 49 years, and ≥50 years. Because these data were developed for use in U.S. EPA's pesticide registration program, the childhood age groups used are slightly different than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005).

Table 9-3 presents as-consumed per capita intake data for total fruits and vegetables in g/kg-day; as-consumed consumer only intake data for total fruits and vegetables in g/kg-day are provided in Table 9-4. Table 9-5 provides per capita intake data for individual fruits and vegetables and Table 9-6 provides consumer only intake data for individual fruits and vegetables. Data for exposed/protected and root food items are presented in Tables 9-7 through 9-11. These five tables were created using only CSFII 1994-96.

The results are presented in units of g/kg-day. Thus, use of these data in calculating potential dose does not require the body weight factor to be included in the denominator of the average daily dose (ADD) equation. It should be noted that converting these intake rates into units of g/day by multiplying by a single average body weight is inappropriate, because individual intake rates were indexed to the reported body weights of the survey respondents. It should be noted that the distribution of average daily intake rates generated using short-term data (e.g., 2-day) do not necessarily reflect the long-term distribution of average daily intake rates. The distributions generated from short-term and long-term data will differ to the extent that each individual's intake varies from day to day; the distributions will be similar to the extent that individuals' intakes are constant from day to day. Day-to-day variation in intake among individuals will be high for fruits and vegetables that are highly seasonal and for fruits and vegetables that are eaten year-round, but that are not typically eaten every day. For these fruits and vegetables, the intake distribution generated from short-term data will not be a good reflection of the long-term distribution. On the other hand, for broad categories of foods (e.g., total fruits and total vegetables) that are eaten on a daily basis throughout the year, the short-term distribution may be a reasonable approximation of the true long-term distribution, although it will show somewhat more variability. In this chapter, distributions are provided only for broad categories of fruits and vegetables (i.e., total fruits and total vegetables). Because of the increased variability of the short-term distribution, the short-term upper percentiles shown here may overestimate the corresponding percentiles of the long-term distribution. For individual foods, only the mean, standard error, and percent consuming are provided.

The strengths of U.S. EPA's analysis are that it provides distributions of intake rates for various age groups of children and adults, normalized by body weight. The analysis uses the 1994-96, 1998 CSFII data set which was designed to be representative of the U.S. population. The data set includes four years of intake data combined, and is based on a two-day survey period. As discussed above, short-term dietary data may not accurately reflect long-term eating patterns and may under-represent infrequent consumers of a given food. This is particularly true for the tails (extremes) of the distribution of food intake. Also, the analysis was conducted using slightly different childhood age groups than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, given the similarities in the age groups used, the data should provide suitable intake estimates for the age groups of interest.

9.3.2 Relevant Fruit and Vegetable Intake Studies

9.3.2.1 *USDA (1980, 1992, 1996a, 1996b) - Food and Nutrient Intakes of Individuals in One Day in the U.S.*

USDA calculated mean intake rates for total fruits and total vegetables using data from the 1977-78 and 1987-88 Nationwide Food Consumption Surveys (NFCS) (USDA, 1980; USDA, 1992) and CSFII data from 1994 and 1995 (USDA, 1996a; 1996b). The mean per capita total intake rates for total fruits and total vegetables from the 1977-78 NFCS are presented in Table 9-12. Table 9-13 presents similar data from the 1987-88 NFCS and the 1994 and 1995 CSFII. Note that the age classifications used in these surveys were slightly different than those used in the 1977-78 NFCS. Tables 9-12 and 9-13 include both per capita intake rates and intake rates for consumers-only for various ages of individuals. Intake rates for consumers-only were calculated by dividing the per capita consumption rate by the fraction of the population using vegetables or fruits in a day.

The advantages of using these data are that they provide intake estimates for all fruits or all vegetables, combined. Again, these estimates are based on one-day dietary data which may not reflect usual consumption patterns.

9.3.2.2 *USDA (1993) - Food Consumption, Prices, and Expenditures, 1970-92*

The USDA's Economic Research Service (ERS) calculates the amount of food available for human consumption in the United States on an annual basis (USDA, 1993). Supply and utilization balance sheets are generated based on the flow of food items from production to end uses for the years 1970 to 1992. Total available supply is estimated as the sum of production and imports (USDA, 1993). The availability of food for human use commonly termed as "food disappearance" is determined by subtracting exported foods from the total available supply (USDA, 1993). USDA (1993) calculates the per capita food consumption by dividing the total food disappearance by the total U.S. population. USDA (1993) estimated per capita consumption data for various fruit and vegetable products from 1970-1992 (1992 data are published). Retail weight per capita data are presented in Table 9-14. These data have been derived from the annual per capita values in units of pounds per year, presented by USDA (1993), by converting to units of g/day.

One of the limitations of this study is that disappearance data do not account for losses from the food supply from waste or spoilage. As a result, intake rates based on these data may overestimate daily consumption because they are based on the total quantity of marketable commodity utilized. Thus, these data represent bounding estimates of intake rates only. It should also be noted that per capita estimates based on food disappearance are not a direct measure of actual consumption or quantity ingested, instead the data are used as indicators of changes in usage over time (USDA, 1993). An advantage of this study is that it provides per capita consumption rates for fruits and vegetables that are representative of long-term intake because disappearance data are generated annually.

9.3.2.3 *USDA, 1999 - Food and Nutrient Intakes by Children 1994-96, 1998, Table Set 17*

USDA (1999) calculated national probability estimates of food and nutrient intake by children based on all 4 years of the CSFII (1994-96 and 1998) for children age 9 years and under, and on CSFII 1994-96 only for children age 10 years and over. Sample weights were used to adjust for non-response, to match the sample to the U.S. population in terms of demographic characteristics, and to equalize intakes over the 4 quarters of the year and the 7 days of the week. A total of 503 breast-fed children were excluded from the estimates, but both consumers and non-consumers were included in the analysis.

USDA (1999) provided data on the mean per capita quantities (grams) of various food products/groups consumed per individual for one day, and the percent of individuals consuming those foods in one day of the survey. Tables 9-15 through 9-18 present data on the mean quantities (grams) of fruits and vegetables consumed per individual for one day, and the percentage of survey individuals consuming fruits and vegetables on that survey day. Data on mean intakes or mean percentages are based on respondents' day-1 intakes.

The advantage of the USDA (1999) study is that it uses the 1994-96, 98 CSFII data set, which includes four years of intake data, combined, and includes the supplemental data on children. These data are expected to be generally representative of the U.S. population and they include data on a wide variety of fruits and vegetables. The data set is one of a series of USDA data sets that are publicly available. One limitation of this data set is that it is based on a one-day, and short-term dietary data may not accurately reflect long-term eating patterns. Other limitations of this study are that it only provides mean values of food intake rates, consumption is not normalized by body weight, and presentation of results is not consistent with U.S. EPA's recommended age groups.

9.3.2.4 *Smiciklas-Wright et al., 2002 - Foods Commonly Eaten in the United States: Quantities Consumed per Eating Occasion and in a Day, 1994-1996*

Using data gathered in the 1994-96 USDA CSFII, Smiciklas-Wright et al. (2002) calculated distributions for the quantities of fruits and vegetables consumed per eating occasion by members of the U.S. population (i.e., serving sizes). The estimates of serving size were based on data obtained from 14,262 respondents, ages 2 years and above, who provided 2 days of dietary intake information. Only dietary intake data from users of the specified food were used in the analysis (i.e., consumers only data).

Table 9-19 presents serving size data for selected fruits and vegetables and Table 9-20 presents serving size data by age group. These data are presented on an as-consumed basis (grams) and represent the quantity of fruits and vegetables consumed per eating occasion. These estimates may be useful for assessing acute exposures to contaminants in specific foods, or other assessments where the amount consumed per eating occasion is necessary. Only the mean and standard deviation serving size data and percent of the population consuming the food during the 2-day survey period are presented in this handbook. Percentiles of serving sizes of the foods consumed by these age groups of the U.S. population can be found in Smiciklas-Wright et al. (2002).

The advantages of using these data are that they were derived from the USDA CSFII and are representative of the U.S. population. The analysis conducted by Smiciklas-Wright et al. (2002) accounted for individual foods consumed as ingredients of mixed foods. Mixed foods were disaggregated via recipe files so that the individual ingredients could be grouped together with similar foods that were reported separately. Thus, weights of foods consumed as ingredients were combined with weights of foods reported separately to provide a more thorough representation of consumption. However, it should be noted that since the recipes for the mixed foods consumed were not provided by the respondents, standard recipes were used. As a result, the estimates of quantity consumed for some food types are based on assumptions about the types and quantities of ingredients consumed as part of mixed foods. This study used data from the 1994 to 1996 CSFII; data from the 1998 children's supplement were not included.

9.3.2.5 *Vitolins et al. (2002) - Quality of Diets Consumed by Older Rural Adults*

Vitolins et al. (2002) conducted a survey to evaluate the dietary intake, by food groups, of older (>70 years) rural adults. The sample consisted of 130 community dwelling residents from two rural counties in North Carolina. Data on dietary intake over the preceding year were obtained in face-to-face interviews conducted in participants' homes, or in a few cases, a senior center. The food frequency questionnaire used in the survey was a modified version of the National Cancer Institute Health Habits and History Questionnaire (HHHQ); this modified version included an expanded food list containing a greater number of ethnic foods than the original food frequency form. Demographic and personal data collected included gender, ethnicity, age, education, denture use, marital status, chronic disease, and weight.

Food items reported in the survey were grouped into food groups similar to the USDA Food Guide Pyramid and the National Cancer Institute's 5 A Day for Better Health program. These groups are: (1) fruits and vegetables; (2) bread, cereal, rice, and pasta; (3) milk, yogurt and cheese; (4) meat, fish, poultry, beans and eggs; and (5) fats, oils, sweets, and snacks. Medians, ranges, frequencies and percentages were used to summarize intake of each food group, broken down by demographic and health characteristics. To assess the univariate associations of these characteristics with consumption, Wilcoxon rank-sum tests were used. In addition, multiple regression models were used to determine which demographic and health factors were jointly predictive of intake of each of the five food groups.

Thirty-four percent of the survey participants were African American, 36% were European American, and 30% were Native American. Sixty-two percent were female, 62% were not married at the time of the interview, and 65% had some high school education or were high school graduates. Almost all of the participants (95%) had one or more chronic diseases. Sixty percent of the respondents were between 70 and 79 years of age; the median age was 78 years old. The median servings of fruits and vegetables broken down by demographic and health characteristic are presented in Table 9-21. The only variable predictive of fruit and vegetable intake was ethnicity ($p = 0.02$), with European Americans consuming significantly more than either African Americans or Native Americans. The multiple regression model indicated a statistically significant interaction between gender and ethnicity ($p = 0.04$) and a significant main effect for chronic disease ($p = 0.04$) for fruit and vegetable consumption. Among males, European Americans consumed significantly more fruits and vegetables than either African Americans or Native Americans. Men and women did not differ significantly in their fruit and vegetable consumption, except for African Americans, where women had a significantly greater intake ($p = 0.01$).

One limitation of the study, as noted by the study authors, is that the study did not collect information on the length of time the participants had been practicing the dietary behaviors reported in the survey. Also, the survey results are based on dietary recall; the questionnaire required participants to report the frequency of food consumption during the past year. The study authors noted that, currently, there are no dietary assessment tools that allow collecting comprehensive dietary data over years of food consumption. Another limitation of the study is that the small sample size used makes associations by gender and ethnicity difficult.

9.3.2.6 *Fox et al., 2004 - Feeding Infants and Toddlers study: What Foods Are Infants and Toddlers Eating*

Fox et al. (2004) used data from the Feeding Infants and Toddlers study (FITS) to assess food consumption patterns in infants and toddlers. The FITS was sponsored by Gerber Products Company and was conducted to obtain current information on food and nutrient intakes of children, ages 4 to 24 months old, in the 50 states and the District of Columbia. The FITS is described in detail in Devaney et al. (2004). FITS was based on a random sample of 3,022 infants and toddlers for which dietary intake data were collected by telephone from their parents or caregivers between March and July 2002. An initial recruitment and household interview was conducted, followed by an interview to obtain information on intake based on 24-hour recall. The interview also addressed growth, development and feeding patterns. A second dietary recall interview was conducted for a subset of 703 randomly selected respondents. The study over-sampled children in the 4 to 6 and 9 to 11 months age groups; sample weights were adjusted for non-response, over-sampling, and under-coverage of some subgroups. The response rate for the FITS was 73 percent for the recruitment interview. Of the recruited households, there was a response rate of 94 percent for the dietary recall interviews (Devaney et al., 2004). The characteristics of the FITS study population is shown in Table 9-22.

Fox et al. (2004) analyzed the first set of 24-hour recall data collected from all study participants. For this analysis, children were grouped into six age categories: 4 to 6 months, 7 to 8 months, 9 to 11 months, 12 to 14 months, 15 to 18 months, and 19 to 24 months. Table 9-23 provides the percentage of infants and toddlers consuming different types of vegetables at least once in a day. The percentages of children eating any type of vegetable ranged from 39.9 percent for 4 to 6 month olds to 81.6 percent for 19 to 24 month olds. Table 9-24 provides the top five vegetables consumed by age group. Some of the highest percentages ranged from baby food carrots (9.6 percent) in the 4 to 6 month old group to french fries (25.5 percent) in the 19 to 24 month old group. Table 9-25 provides the percentage of children consuming different types of fruit at least once per day. The percentages of children eating any type of fruit ranged from 41.9 percent to 4 to 6 month olds to 77.2 percent for 12 to 14 month olds. Table 9-26 provides information on the top five fruits eaten by infants and toddlers at least once per day. The highest percentages were for bananas among infants 9 to 24 months, and baby food applesauce among infants 4 to 8 months old.

The advantages of this study were that the study population represented the U.S. population and the sample size was large. One limitation of the analysis done by Fox et al. (2004) was that only frequency data were provided; no information on actual intake rates was included. In addition, Devaney et al. (2004) noted several limitations associated with the FITS data. For the FITS, a commercial list of infants and toddlers was used to obtain the sample used in the study. Since many of the households could not be located and did not have children in the target population, a lower response rate than would have occurred in a true national sample was obtained (Devaney et al., 2004). In addition, the sample was likely from a higher socioeconomic status when compared with all U.S. infants in this age group (4 to 24 months old) and the use of a telephone survey may have omitted lower-income households without telephones (Devaney et al., 2004).

9.3.2.7 *Ponza et al., 2004 - Nutrient Food Intakes and Food Choices of Infants and Toddlers Participating in WIC*

Ponza et al. (2004) conducted a study using selected data from the FITS to assess feeding patterns, food choices and nutrient intake of infants and toddlers participating in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Ponza et al. (2004) evaluated FITS data for the following age groups: 4 to 6 months (N = 862), 7 to 11 months (N = 1,159) and 12 to 24 months (N= 996). The total sample size described by WIC participants and non-participants is shown in Table 9-27.

The foods consumed were analyzed by tabulating the percentage of infants who consumed specific foods/food groups per day (Ponza et al., 2004). Weighted data were used in all of the analyses used in the study (Ponza et al., 2004). Table 9-27 presents the demographic data for WIC participants and non-participants. Table 9-28 provides information on the food choices for the infants and toddlers studied. There was little difference in vegetable choices among WIC participants and non-participants (Table 9-28). However, there were some differences for fruits.

An advantage of this study is that it had a relatively large sample size and was representative of the U.S. general population of infants and children. A limitation of the study is that intake values for foods were not provided. Other limitations are those associated with the FITS data, as described previously in Section 9.3.2.6.

9.3.2.8 *Fox et al., 2006 - Average Portion of Foods Commonly Eaten by Infants and Toddlers in the United States*

Fox et al. (2006) estimated average portion sizes consumed per eating occasion by children 4 to 24 months of age who participated in the Feeding Infant and Toddlers Study (FITS). The FITS is a cross-sectional study designed to collect and analyze data on feeding practices, food consumption, and usual nutrient intake of U.S. infants and toddlers and is described in Section 9.3.2.6 of this chapter. It included a stratified random sample of 3,022 children between 4 and 24 months of age.

Using the 24-hour recall data, Fox et al. (2006) derived average portion sizes for major food groups, including fruits and vegetables. Average portion sizes for select individual foods within these major groups were also estimated. For this analysis, children were grouped into six age categories: 4 to 5 months, 6 to 8 months, 9 to 11 months, 12 to 14 months, 15 to 18 months, and 19 to 24 months. Tables 9-29 and 9-30 present the average portion sizes for fruits and vegetables for infants and toddlers, respectively.

9.3.2.9 *Menella et al., 2006 - Feeding Infants and Toddlers Study: The Types of Foods Fed to Hispanic Infants and Toddlers*

Menella et al. (2006) investigated the types of food and beverages consumed by Hispanic infants and toddlers in comparison to the non-Hispanic infants and toddlers in the United States. The FITS 2002 data for children between 4 and 24 months of age were used for the study. The data represent a random sample of 371 Hispanic and 2,367 non-Hispanic infants and toddlers (Menella et al., 2006). Menella et al. (2006) grouped the infants as follows: 4 to 5 months (N = 84 Hispanic; 538 non-Hispanic), 6 to 11 months (N = 163 Hispanic and 1,228 non-Hispanic), and 12 to 24 months (N = 124 Hispanic and 871 non-Hispanic) of age.

Table 9-31 provides the percentages of Hispanic and non-Hispanic infants and toddlers consuming fruits and vegetables. In most instances the percentages consuming the different types of fruits and vegetables were similar. However, 4 to 5 month old Hispanic infants were more likely to eat fruits than non-Hispanic infants in this age group. Table 9-32 provides the top five fruits and vegetables consumed and the percentage of children consuming these foods at least once in a day. Apples and bananas were the foods with the highest percent consuming for both the Hispanic and non-Hispanic study groups. Potatoes and carrots were the vegetables with the highest percentage of infants and toddlers consuming in both study groups.

The advantage of the study is that it provides information on food preferences for Hispanic and non-Hispanic infants and toddlers. A limitation is that the study did not provide food intake data, but provided frequency of use data instead. Other limitations are those noted previously in Section 9.3.2.6 for the FITS data.

9.4 CONVERSION BETWEEN WET AND DRY WEIGHT INTAKE RATES

The intake data presented in this chapter are reported in units of wet weight (i.e., as-consumed fruits and vegetables consumed per day or per eating occasion). However, data on the concentration of contaminants in fruits and vegetables may be reported in units of either wet or dry weight.(e.g., mg contaminant per gram-dry-weight of fruits and vegetables.) It is essential that exposure assessors be aware of this difference so that they may ensure consistency between the units used for intake rates and those used for concentration data (i.e., if the contaminant concentration is measured in dry weight of fruits and vegetables, then the dry weight units should be used for their intake values).

If necessary, wet weight (e.g., as-consumed) intake rates may be converted to dry weight intake rates using the moisture content percentages presented in Table 9-33 (USDA, 2007) and the following equation:

$$IR_{dw} = IR_{ww}\left[\frac{100-W}{100}\right] \quad \text{(Eqn. 9-1)}$$

where:

IR_{dw} = dry weight intake rate;
IR_{ww} = wet weight intake rate; and
W = percent water content

Alternatively, dry weight residue levels in fruits and vegetables may be converted to wet weight residue levels for use with wet weight (e.g., as-consumed) intake rates as follows:

$$C_{ww} = C_{dw}\left[\frac{100-W}{100}\right] \quad \text{(Eqn. 9-2)}$$

where:

C_{ww} = wet weight intake rate;
C_{dw} = dry weight intake rate; and
W = percent water content.

The moisture data presented in Table 9-33 are for selected fruits and vegetables taken from USDA (2007).

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Table 9-3. Per Capita Intake of Fruits and Vegetables (g/kg-day as consumed)

Domain	N	Percent Consuming	Mean	SE	Percentiles									
					1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Fruits														
Whole Population	20,607	80.0	1.6	0.0	0.0	0.0	0.0	0.0	0.5	2.0	4.2	6.5	14.0	73.8
Age Group														
Birth to 1 year	1,486	56.4	5.7	0.3	0.0	0.0	0.0	0.0	1.5	9.6	17.1	21.3	32.2	73.8
1 to 2 years	2,096	89.5	6.2	0.2	0.0	0.0	0.0	0.5	4.7	9.4	14.6	18.5	26.4	44.0
3 to 5 years	4,391	90.0	4.6	0.1	0.0	0.0	0.0	0.2	3.2	7.0	11.4	14.4	22.3	45.5
6 to 12 years	2,089	88.3	2.4	0.1	0.0	0.0	0.0	0.1	1.3	3.3	6.4	8.8	14.3	25.0
13 to 19 years	1,222	73.2	0.8	0.1	0.0	0.0	0.0	0.0	0.1	1.1	2.4	3.5	6.9	12.8
20 to 49 years	4,677	75.3	0.9	0.0	0.0	0.0	0.0	0.0	0.2	1.3	2.7	3.9	6.2	16.7
≥50 years	4,646	85.8	1.4	0.0	0.0	0.0	0.0	0.1	0.9	2.1	3.6	4.8	7.6	18.4
Season														
Fall	4,687	79.6	1.5	0.1	0.0	0.0	0.0	0.0	0.5	2.0	4.2	6.4	13.3	43.8
Spring	5,308	80.2	1.6	0.1	0.0	0.0	0.0	0.0	0.5	1.9	4.2	6.7	14.7	73.8
Summer	5,890	78.3	1.5	0.1	0.0	0.0	0.0	0.0	0.4	1.9	4.0	6.2	12.8	53.2
Winter	4,722	81.7	1.7	0.0	0.0	0.0	0.0	0.0	0.7	2.1	4.4	6.6	14.3	37.5
Race														
Asian, Pacific Islander	557	78.8	2.1	0.2	0.0	0.0	0.0	0.0	1.1	3.2	6.0	7.4	14.7	43.5
American Indian, Alaskan Native	177	77.8	1.9	0.3	0.0	0.0	0.0	0.0	0.9	1.9	5.3	9.6	16.4	20.9
Black	2,740	71.3	1.2	0.1	0.0	0.0	0.0	0.0	0.1	1.2	3.6	5.6	13.3	40.0
Other/NA	1,638	78.5	2.2	0.2	0.0	0.0	0.0	0.0	0.9	2.9	6.1	10.0	18.5	45.5
White	15,495	81.5	1.6	0.0	0.0	0.0	0.0	0.0	0.6	2.0	4.1	6.3	13.4	73.8
Region														
Midwest	4,822	82.3	1.6	0.0	0.0	0.0	0.0	0.0	0.6	2.0	4.1	6.2	13.1	43.5
Northeast	3,692	83.4	1.7	0.1	0.0	0.0	0.0	0.0	0.8	2.2	4.2	6.3	14.1	40.0
South	7,208	74.7	1.3	0.1	0.0	0.0	0.0	0.0	0.2	1.5	3.5	5.7	13.0	73.8
West	4,885	82.7	2.0	0.1	0.0	0.0	0.0	0.0	0.9	2.6	5.2	8.0	15.3	45.5
Urbanization														
City Center	6,164	79.0	1.6	0.0	0.0	0.0	0.0	0.0	0.5	2.0	4.4	6.3	14.1	45.5
Suburban	9,598	82.5	1.7	0.0	0.0	0.0	0.0	0.0	0.7	2.1	4.5	6.9	14.5	43.8
Nonmetropolitan	4,845	75.9	1.3	0.1	0.0	0.0	0.0	0.0	0.3	1.6	3.6	5.4	12.8	73.8

Table 9-3. Per Capita Intake of Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Percent Consuming	Mean	SE	Percentiles									
					1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
					Vegetables									
Whole Population	20,607	99.5	3.4	0.0	0.0	0.4	0.8	1.6	2.7	4.3	6.4	8.3	14.8	58.2
Age Group														
Birth to 1 year	1,486	72.1	4.5	0.2	0.0	0.0	0.0	0.0	2.7	7.4	12.2	14.8	25.3	56.8
1 to 2 years	2,096	99.7	6.9	0.2	0.0	0.7	1.5	3.2	5.6	9.3	13.9	17.1	26.5	58.2
3 to 5 years	4,391	100.0	5.9	0.1	0.0	0.8	1.4	2.8	4.7	7.7	11.7	14.7	23.4	50.9
6 to 12 years	2,089	99.9	4.1	0.1	0.1	0.6	1.0	1.8	3.2	5.3	7.8	9.9	17.4	53.7
13 to 19 years	1,222	100.0	2.9	0.1	0.0	0.4	0.7	1.4	2.4	3.8	5.5	6.9	11.4	29.5
20 to 49 years	4,677	99.9	2.9	0.0	0.1	0.5	0.8	1.5	2.5	3.8	5.4	6.8	10.0	42.7
≥50 years	4,646	99.9	3.1	0.0	0.0	0.5	0.9	1.6	2.6	4.0	5.7	7.0	10.6	38.7
Season														
Fall	4,687	99.6	3.3	0.1	0.0	0.5	0.8	1.6	2.7	4.3	6.2	7.6	13.0	58.2
Spring	5,308	99.5	3.4	0.1	0.0	0.4	0.8	1.5	2.6	4.2	6.6	8.8	16.0	53.7
Summer	5,890	99.5	3.6	0.1	0.0	0.4	0.8	1.6	2.9	4.6	7.2	9.5	15.8	50.9
Winter	4,722	99.5	3.2	0.1	0.0	0.5	0.9	1.6	2.6	4.2	5.8	7.5	12.8	56.8
Race														
Asian, Pacific Islander	557	99.0	4.4	0.3	0.0	0.8	1.3	2.3	3.9	5.6	8.2	10.2	15.9	32.3
American Indian, Alaskan Native	177	99.7	3.9	0.3	0.0	0.5	0.8	1.6	2.8	5.2	8.1	9.8	18.4	34.5
Black	2,740	99.5	3.0	0.1	0.0	0.2	0.5	1.2	2.1	3.9	6.2	8.4	16.1	56.8
Other/NA	1,638	98.8	4.1	0.2	0.0	0.5	0.9	1.7	3.0	5.1	8.2	11.6	21.1	58.2
White	15,495	99.6	3.3	0.0	0.0	0.5	0.8	1.6	2.7	4.3	6.2	8.0	13.5	50.9
Region														
Midwest	4,822	99.6	3.4	0.1	0.0	0.5	0.8	1.6	2.7	4.3	6.5	8.6	14.1	53.7
Northeast	3,692	99.7	3.3	0.1	0.0	0.4	0.7	1.5	2.6	4.3	6.2	8.2	14.4	42.7
South	7,208	99.5	3.2	0.1	0.0	0.4	0.8	1.6	2.6	4.1	6.2	7.9	14.2	58.2
West	4,885	99.3	3.6	0.1	0.0	0.5	0.9	1.7	2.9	4.6	7.0	8.8	15.5	50.9
Urbanization														
City Center	6,164	99.5	3.3	0.1	0.0	0.4	0.7	1.5	2.7	4.3	6.4	8.5	15.3	58.2
Suburban	9,598	99.5	3.4	0.0	0.0	0.5	0.9	1.6	2.7	4.3	6.5	8.3	14.0	53.7
Nonmetropolitan	4,845	99.6	3.3	0.1	0.0	0.5	0.8	1.6	2.6	4.2	6.4	8.1	14.9	49.4

N = Sample size.
SE = Standard error.

Source: Based on unpublished U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 9-4. Consumer Only Intake of Fruits and Vegetables (g/kg-day as consumed)

Domain	N	Mean	SE	Percentiles									
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Fruits													
Whole Population	16,762	2.0	0.0	0.0	0.0	0.0	0.1	1.0	2.5	4.9	7.3	15.0	73.8
Age Group													
Birth to 1 year	830	10.1	0.4	0.0	0.4	1.2	3.7	8.5	14.4	20.4	26.4	34.7	73.8
1 to 2 years	1,878	6.9	0.2	0.0	0.0	0.1	2.2	5.4	10.1	15.3	19.0	27.1	44.0
3 to 5 years	3,957	5.1	0.1	0.0	0.0	0.0	1.0	3.8	7.5	11.9	15.0	22.8	45.5
6 to 12 years	1,846	2.7	0.1	0.0	0.0	0.0	0.3	1.7	3.7	6.7	9.3	14.8	25.0
13 to 19 years	898	1.1	0.1	0.0	0.0	0.0	0.0	0.5	1.5	2.9	3.7	7.6	12.8
20 to 49 years	3,458	1.2	0.0	0.0	0.0	0.0	0.1	0.7	1.7	3.2	4.4	6.6	16.7
≥50 years	3,895	1.6	0.0	0.0	0.0	0.0	0.3	1.1	2.3	3.8	5.0	8.0	18.4
Season													
Fall	3,796	1.9	0.1	0.0	0.0	0.0	0.1	0.9	2.4	4.9	7.1	14.4	43.8
Spring	4,289	2.0	0.1	0.0	0.0	0.0	0.2	1.0	2.4	4.9	7.5	16.1	73.8
Summer	4,744	1.9	0.1	0.0	0.0	0.0	0.1	0.9	2.4	4.7	7.1	14.5	53.2
Winter	3,933	2.0	0.1	0.0	0.0	0.0	0.2	1.1	2.6	4.9	7.6	15.3	37.5
Race													
Asian, Pacific Islander	427	2.7	0.2	0.0	0.0	0.0	0.5	1.7	3.8	6.6	7.8	14.7	43.5
American Indian, Alaskan Native	146	2.4	0.4	0.0	0.0	0.0	0.4	1.1	2.9	5.8	10.0	17.6	20.9
Black	2,065	1.7	0.1	0.0	0.0	0.0	0.0	0.6	2.0	4.6	6.7	15.7	40.0
Other/NA	1,323	2.9	0.2	0.0	0.0	0.0	0.3	1.5	3.6	7.7	11.2	19.3	45.5
White	12,801	1.9	0.0	0.0	0.0	0.0	0.2	1.0	2.4	4.7	7.0	14.5	73.8
Region													
Midwest	4,023	1.9	0.1	0.0	0.0	0.0	0.1	1.0	2.3	4.7	6.7	14.4	43.5
Northeast	3,145	2.0	0.1	0.0	0.0	0.0	0.2	1.1	2.6	4.6	6.9	14.8	40.0
South	5,531	1.7	0.1	0.0	0.0	0.0	0.1	0.7	2.1	4.5	6.9	14.4	73.8
West	4,063	2.4	0.1	0.0	0.0	0.0	0.3	1.3	3.0	5.8	8.9	16.4	45.5
Urbanization													
City Center	4,985	2.0	0.1	0.0	0.0	0.0	0.1	1.0	2.7	4.9	7.1	14.8	45.5
Suburban	8,046	2.1	0.1	0.0	0.0	0.0	0.2	1.1	2.5	5.1	7.7	15.6	43.8
Nonmetropolitan	3,731	1.7	0.1	0.0	0.0	0.0	0.1	0.8	2.1	4.1	6.3	13.9	73.8

Table 9-4. Consumer Only Intake of Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Mean	SE	Percentiles									
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Vegetables													
Whole Population	20,163	3.4	0.0	0.0	0.5	0.8	1.6	2.7	4.3	6.4	8.4	14.8	58.2
Age Group													
Birth to 1 year	1,062	6.2	0.3	0.0	0.1	0.1	2.0	4.9	9.4	13.4	16.1	26.4	56.8
1 to 2 years	2,090	6.9	0.2	0.0	0.7	1.5	3.2	5.6	9.3	13.9	17.1	26.5	58.2
3 to 5 years	4,389	5.9	0.1	0.0	0.8	1.4	2.8	4.7	7.7	11.7	14.7	23.4	50.9
6 to 12 years	2,087	4.1	0.1	0.1	0.6	1.0	1.8	3.2	5.3	7.8	9.9	17.4	53.7
13 to 19 years	1,222	2.9	0.1	0.0	0.4	0.7	1.4	2.4	3.8	5.5	6.9	11.4	29.5
20 to 49 years	4,673	2.9	0.0	0.1	0.5	0.8	1.5	2.5	3.8	5.4	6.8	10.0	42.7
≥50 years	4,640	3.1	0.0	0.0	0.5	0.9	1.6	2.6	4.0	5.7	7.0	10.6	38.7
Season													
Fall	4,606	3.3	0.1	0.1	0.5	0.8	1.6	2.8	4.3	6.2	7.7	13.0	58.2
Spring	5,185	3.4	0.1	0.0	0.5	0.8	1.5	2.6	4.2	6.7	8.8	16.0	53.7
Summer	5,740	3.6	0.1	0.1	0.4	0.8	1.7	2.9	4.6	7.2	9.5	15.8	50.9
Winter	4,632	3.2	0.1	0.0	0.6	0.9	1.6	2.7	4.2	5.9	7.5	12.8	56.8
Race													
Asian, Pacific Islander	530	4.4	0.3	0.1	1.0	1.4	2.4	3.9	5.6	8.2	10.2	15.9	32.3
American Indian, Alaskan Native	174	3.9	0.3	0.0	0.5	0.9	1.7	2.9	5.2	8.1	9.8	18.4	34.5
Black	2,683	3.1	0.1	0.0	0.2	0.5	1.2	2.1	3.9	6.2	8.4	16.1	56.8
Other/NA	1,577	4.2	0.2	0.1	0.6	0.9	1.8	3.0	5.2	8.3	11.7	21.3	58.2
White	15,199	3.3	0.0	0.1	0.5	0.9	1.6	2.7	4.3	6.2	8.0	13.6	50.9
Region													
Midwest	4,721	3.4	0.1	0.1	0.5	0.8	1.6	2.7	4.3	6.5	8.6	14.2	53.7
Northeast	3,634	3.3	0.1	0.0	0.4	0.8	1.5	2.6	4.3	6.2	8.2	14.4	42.7
South	7,078	3.3	0.1	0.0	0.5	0.8	1.6	2.6	4.1	6.2	7.9	14.2	58.2
West	4,730	3.6	0.1	0.1	0.5	0.9	1.7	2.9	4.6	7.1	8.9	15.6	50.9
Urbanization													
City Center	6,029	3.4	0.1	0.0	0.4	0.8	1.5	2.7	4.3	6.4	8.6	15.4	58.2
Suburban	9,381	3.4	0.0	0.1	0.5	0.9	1.7	2.8	4.4	6.5	8.4	14.0	53.7
Nonmetropolitan	4,753	3.3	0.1	0.0	0.5	0.9	1.6	2.7	4.2	6.4	8.1	14.9	49.4

N = Sample size.
SE = Standard error.

Source: Based on unpublished U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables (g/kg-day as consumed)

Domain	N	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Apples			Asparagus			Bananas			Beans		
Whole Population	20,607	30.5	0.45	0.01	1.4	0.01	0.00	48.1	0.35	0.01	44.9	0.27	0.01
Age Group													
Birth to 1 year	1,486	34.6	2.32	0.13	0.2	0.01	0.00	40.7	1.24	0.06	21.6	0.43	0.04
1 to 2 years	2,096	44.8	1.79	0.09	0.8	0.02	0.01	62.8	1.77	0.09	46.8	0.76	0.04
3 to 5 years	4,391	44.6	1.64	0.05	0.5	0.01	0.00	60.7	0.93	0.04	43.0	0.52	0.02
6 to 12 years	2,089	38.2	0.83	0.05	0.7	0.01	0.00	57.7	0.38	0.03	38.8	0.32	0.02
13 to 19 years	1,222	22.5	0.20	0.02	0.6	0.00	0.00	42.1	0.13	0.02	36.0	0.18	0.02
20 to 49 years	4,677	25.7	0.21	0.01	1.3	0.01	0.00	41.7	0.21	0.01	45.5	0.22	0.01
≥50 years	4,646	34.5	0.32	0.02	2.5	0.02	0.00	54.1	0.35	0.01	51.4	0.26	0.01
Season													
Fall	4,687	35.0	0.55	0.03	1.2	0.01	0.00	45.6	0.36	0.02	47.3	0.29	0.01
Spring	5,308	29.6	0.45	0.02	1.9	0.02	0.00	49.8	0.35	0.02	43.3	0.25	0.01
Summer	5,890	25.5	0.34	0.02	0.9	0.01	0.00	49.6	0.33	0.02	43.6	0.28	0.01
Winter	4,722	32.2	0.46	0.02	1.6	0.02	0.00	47.3	0.38	0.01	45.5	0.26	0.01
Race													
Asian, Pacific Islander	557	33.5	0.53	0.06	1.0	0.01	0.00	45.4	0.43	0.04	52.0	0.25	0.02
American Indian, Alaskan Native	177	31.0	0.60	0.12	2.5	0.02	0.01	44.1	0.39	0.05	37.8	0.26	0.06
Black	2,740	22.0	0.36	0.02	0.4	0.00	0.00	45.4	0.43	0.04	45.2	0.32	0.02
Other/NA	1,638	27.7	0.55	0.05	0.2	0.00	0.00	44.1	0.26	0.02	60.6	0.43	0.03
White	15,495	32.0	0.45	0.01	1.7	0.01	0.00	47.5	0.58	0.07	43.6	0.25	0.01
Region													
Midwest	4,822	34.5	0.47	0.02	1.5	0.01	0.00	51.1	0.35	0.02	43.6	0.26	0.01
Northeast	3,692	32.7	0.48	0.03	1.3	0.01	0.00	52.9	0.36	0.01	36.7	0.21	0.01
South	7,208	25.3	0.36	0.01	1.1	0.01	0.00	42.4	0.30	0.02	48.8	0.33	0.01
West	4,885	32.7	0.55	0.02	1.9	0.01	0.00	49.6	0.44	0.03	47.5	0.25	0.02
Urbanization													
City Center	6,164	28.9	0.42	0.02	1.7	0.01	0.00	48.4	0.36	0.02	46.2	0.29	0.01
Suburban	9,598	33.2	0.49	0.02	1.1	0.01	0.00	50.5	0.38	0.01	42.4	0.25	0.01
Nonmetropolitan	4,845	27.0	0.39	0.02	1.5	0.01	0.00	42.3	0.28	0.03	48.7	0.30	0.02

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Beets			Berries and Small Fruit			Broccoli			Bulb Vegetables		
Whole Population	20,607	2.2	0.01	0.00	58.7	0.23	0.01	13.9	0.11	0.01	95.3	0.20	0.00
Age Group													
Birth to 1 year	1,486	0.4	0.01	0.01	16.5	0.13	0.02	3.5	0.07	0.02	33.4	0.07	0.01
1 to 2 years	2,096	0.7	0.01	0.00	66.2	0.91	0.05	12.0	0.25	0.03	93.3	0.30	0.01
3 to 5 years	4,391	0.8	0.01	0.00	72.7	0.72	0.03	10.7	0.18	0.01	95.8	0.27	0.01
6 to 12 years	2,089	0.8	0.01	0.00	73.4	0.40	0.03	11.0	0.14	0.02	97.3	0.21	0.01
13 to 19 years	1,222	0.7	0.00	0.00	55.4	0.15	0.02	8.3	0.06	0.01	97.7	0.19	0.01
20 to 49 years	4,677	1.9	0.00	0.00	53.1	0.14	0.01	14.7	0.10	0.01	97.4	0.21	0.01
≥50 years	4,646	4.6	0.02	0.00	63.0	0.19	0.01	17.3	0.11	0.01	93.4	0.17	0.00
Season													
Fall	4,687	2.0	0.01	0.00	57.4	0.18	0.01	14.6	0.12	0.01	95.8	0.21	0.01
Spring	5,308	2.3	0.01	0.00	60.6	0.27	0.02	13.5	0.11	0.02	95.4	0.20	0.01
Summer	5,890	2.3	0.01	0.00	60.4	0.29	0.02	13.7	0.11	0.01	94.3	0.19	0.01
Winter	4,722	2.3	0.01	0.00	56.6	0.20	0.01	13.7	0.10	0.01	95.5	0.21	0.01
Race													
Asian, Pacific Islander	557	2.7	0.00	0.00	41.7	0.28	0.06	25.7	0.23	0.06	95.0	0.38	0.03
American Indian, Alaskan Native	177	0.3	0.00	0.00	49.6	0.13	0.02	9.1	0.11	0.07	99.3	0.25	0.04
Black	2,740	0.9	0.00	0.00	50.6	0.14	0.01	13.2	0.14	0.02	92.9	0.16	0.01
Other/NA	1,638	1.3	0.01	0.00	47.5	0.21	0.03	8.2	0.09	0.02	95.0	0.31	0.02
White	15,495	2.5	0.01	0.00	61.6	0.25	0.01	14.0	0.10	0.01	95.6	0.19	0.00
Region													
Midwest	4,822	2.3	0.01	0.00	63.1	0.25	0.02	13.0	0.09	0.01	96.2	0.19	0.01
Northeast	3,692	2.4	0.01	0.00	63.2	0.24	0.02	15.3	0.13	0.01	94.5	0.19	0.01
South	7,208	1.7	0.01	0.00	53.3	0.19	0.01	13.1	0.11	0.01	94.4	0.18	0.01
West	4,885	2.8	0.01	0.00	58.7	0.28	0.03	14.6	0.12	0.02	96.3	0.25	0.01
Urbanization													
City Center	6,164	2.3	0.01	0.00	57.3	0.22	0.01	15.1	0.13	0.01	95.0	0.21	0.01
Suburban	9,598	2.2	0.01	0.00	62.0	0.27	0.02	14.9	0.12	0.01	95.7	0.20	0.01
Nonmetropolitan	4,845	2.4	0.01	0.00	53.6	0.17	0.02	9.7	0.06	0.01	94.7	0.19	0.01

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Cabbage			Carrots			Citrus Fruits			Corn		
Whole Population	20,607	15.5	0.08	0.01	49.8	0.17	0.00	19.3	0.19	0.01	94.6	0.44	0.01
Age Group													
Birth to 1 year	1,486	1.0	0.01	0.00	12.3	0.17	0.03	2.5	0.07	0.02	46.0	0.48	0.03
1 to 2 years	2,096	8.0	0.06	0.01	46.8	0.41	0.02	15.5	0.47	0.05	96.5	1.13	0.05
3 to 5 years	4,391	8.9	0.07	0.01	46.2	0.34	0.02	18.2	0.50	0.03	98.7	1.24	0.03
6 to 12 years	2,089	9.5	0.06	0.01	44.4	0.22	0.01	16.0	0.26	0.02	98.9	0.87	0.03
13 to 19 years	1,222	9.0	0.04	0.01	40.3	0.11	0.01	12.3	0.11	0.02	95.7	0.43	0.02
20 to 49 years	4,677	16.0	0.07	0.01	50.2	0.14	0.01	18.1	0.12	0.01	94.7	0.32	0.01
≥50 years	4,646	22.8	0.12	0.01	58.1	0.17	0.01	27.1	0.23	0.01	94.2	0.26	0.01
Season													
Fall	4,687	16.2	0.07	0.01	53.9	0.19	0.01	16.6	0.16	0.01	94.2	0.42	0.01
Spring	5,308	15.1	0.08	0.01	46.5	0.17	0.01	20.3	0.20	0.01	94.5	0.44	0.02
Summer	5,890	14.5	0.08	0.01	44.3	0.14	0.01	15.8	0.08	0.01	95.1	0.50	0.02
Winter	4,722	16.3	0.08	0.01	54.5	0.18	0.01	24.6	0.33	0.02	94.8	0.41	0.02
Race													
Asian, Pacific Islander	557	33.9	0.24	0.04	59.4	0.28	0.04	23.4	0.35	0.07	85.6	0.32	0.04
American Indian, Alaskan Native	177	15.8	0.05	0.04	47.3	0.12	0.02	20.4	0.33	0.13	93.6	0.51	0.06
Black	2,740	15.9	0.14	0.03	36.6	0.10	0.01	13.0	0.15	0.02	93.7	0.49	0.02
Other/NA	1,638	9.5	0.02	0.01	46.2	0.21	0.02	22.4	0.37	0.06	92.6	0.70	0.05
White	15,495	15.2	0.07	0.00	51.9	0.18	0.01	20.0	0.18	0.01	95.3	0.42	0.01
Region													
Midwest	4,822	15.5	0.08	0.01	50.9	0.17	0.01	18.9	0.16	0.01	96.6	0.46	0.02
Northeast	3,692	13.4	0.08	0.01	53.8	0.18	0.01	22.4	0.21	0.02	93.3	0.40	0.01
South	7,208	16.8	0.09	0.01	44.9	0.14	0.01	15.1	0.14	0.01	94.4	0.44	0.01
West	4,885	15.5	0.06	0.01	52.8	0.21	0.01	23.7	0.28	0.02	94.1	0.47	0.02
Urbanization													
City Center	6,164	16.4	0.09	0.01	48.8	0.16	0.01	19.8	0.20	0.01	93.8	0.44	0.01
Suburban	9,598	16.0	0.07	0.00	52.3	0.19	0.01	20.0	0.19	0.01	94.8	0.45	0.01
Nonmetropolitan	4,845	13.4	0.06	0.01	45.7	0.15	0.01	17.0	0.17	0.01	95.5	0.43	0.02

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Cucumbers			Cucurbits			Fruiting Vegetables			Leafy Vegetables		
Whole Population	20,607	40.1	0.10	0.01	48.9	0.40	0.02	93.8	0.82	0.01	90.1	0.59	0.01
Age Group													
Birth to 1 year	1,486	1.7	0.00	0.00	14.0	0.45	0.04	25.5	0.32	0.04	44.2	0.29	0.05
1 to 2 years	2,096	20.5	0.11	0.01	31.3	0.72	0.06	92.1	1.56	0.06	82.1	0.71	0.04
3 to 5 years	4,391	29.3	0.16	0.02	38.7	0.83	0.07	95.4	1.46	0.03	86.9	0.67	0.02
6 to 12 years	2,089	32.6	0.14	0.02	39.9	0.54	0.06	95.9	1.05	0.03	89.5	0.55	0.03
13 to 19 years	1,222	41.3	0.11	0.03	46.7	0.32	0.08	96.1	0.79	0.03	90.3	0.43	0.02
20 to 49 years	4,677	44.8	0.09	0.01	52.8	0.29	0.01	96.0	0.75	0.02	92.2	0.58	0.02
≥50 years	4,646	41.0	0.08	0.01	52.8	0.43	0.03	92.0	0.66	0.02	90.7	0.66	0.02
Season													
Fall	4,687	36.7	0.08	0.01	45.4	0.21	0.01	92.6	0.81	0.03	89.7	0.59	0.02
Spring	5,308	43.3	0.10	0.01	51.8	0.48	0.04	94.3	0.77	0.02	90.9	0.60	0.02
Summer	5,890	43.2	0.14	0.02	55.6	0.73	0.06	94.5	0.88	0.02	90.1	0.56	0.02
Winter	4,722	37.2	0.07	0.01	43.0	0.16	0.01	93.7	0.80	0.02	89.6	0.59	0.02
Race													
Asian, Pacific Islander	557	34.9	0.24	0.16	46.9	0.90	0.39	88.4	0.86	0.06	92.8	1.13	0.12
American Indian, Alaskan Native	177	41.0	0.09	0.03	51.3	0.53	0.13	98.2	0.91	0.08	89.3	0.52	0.17
Black	2,740	39.1	0.06	0.01	43.4	0.27	0.04	91.9	0.69	0.04	89.5	0.65	0.04
Other/NA	1,638	33.4	0.10	0.01	46.1	0.53	0.09	93.6	1.25	0.05	85.3	0.50	0.03
White	15,495	40.9	0.10	0.01	50.1	0.39	0.02	94.3	0.80	0.01	90.4	0.56	0.01
Region													
Midwest	4,822	42.1	0.10	0.01	49.6	0.37	0.03	94.8	0.81	0.02	92.1	0.55	0.03
Northeast	3,692	39.4	0.10	0.01	50.7	0.43	0.05	92.3	0.82	0.02	87.4	0.62	0.03
South	7,208	39.7	0.09	0.01	46.7	0.33	0.03	93.3	0.76	0.03	90.1	0.55	0.02
West	4,885	39.3	0.11	0.03	50.1	0.50	0.06	94.9	0.91	0.03	90.3	0.64	0.03
Urbanization													
City Center	6,164	39.7	0.09	0.00	48.3	0.34	0.02	93.9	0.84	0.03	89.2	0.64	0.02
Suburban	9,598	40.6	0.11	0.01	49.9	0.44	0.04	93.5	0.81	0.01	90.5	0.60	0.02
Nonmetropolitan	4,845	39.7	0.10	0.01	47.8	0.37	0.03	94.3	0.80	0.04	90.5	0.46	0.03

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Legumes			Lettuce			Okra			Onions		
Whole Population	20,607	95.5	0.43	0.01	52.2	0.24	0.01	1.4	0.01	0.00	94.9	0.19	0.00
Age Group													
Birth to 1 year	1,486	51.7	1.21	0.06	1.1	0.00	0.00	0.2	0.00	0.00	32.8	0.07	0.01
1 to 2 years	2,096	96.9	1.30	0.08	23.3	0.14	0.01	1.3	0.01	0.00	93.0	0.29	0.01
3 to 5 years	4,391	98.3	0.85	0.06	33.4	0.21	0.01	0.8	0.01	0.00	95.6	0.26	0.01
6 to 12 years	2,089	98.1	0.48	0.03	41.7	0.22	0.01	1.3	0.01	0.00	96.8	0.20	0.01
13 to 19 years	1,222	94.9	0.27	0.02	55.2	0.22	0.02	0.8	0.00	0.00	97.3	0.18	0.01
20 to 49 years	4,677	95.7	0.34	0.01	60.1	0.27	0.01	1.3	0.01	0.00	97.1	0.20	0.01
≥50 years	4,646	96.2	0.40	0.01	51.4	0.23	0.01	2.1	0.01	0.00	93.2	0.16	0.00
Season													
Fall	4,687	96.0	0.44	0.02	50.6	0.23	0.01	1.7	0.01	0.00	95.5	0.20	0.01
Spring	5,308	95.3	0.40	0.02	54.5	0.25	0.01	1.1	0.01	0.00	95.0	0.19	0.01
Summer	5,890	95.2	0.43	0.02	51.7	0.23	0.01	1.7	0.01	0.00	94.0	0.18	0.00
Winter	4,722	95.5	0.44	0.02	52.1	0.24	0.01	1.0	0.01	0.00	95.3	0.20	0.01
Race													
Asian, Pacific Islander	557	96.1	0.76	0.09	48.1	0.28	0.05	4.8	0.01	0.01	94.9	0.37	0.03
American Indian, Alaskan Native	177	97.5	0.42	0.07	61.3	0.21	0.04	0.6	0.00	0.00	99.3	0.25	0.04
Black	2,740	95.6	0.50	0.04	42.7	0.15	0.01	2.4	0.01	0.00	92.6	0.16	0.01
Other/NA	1,638	93.5	0.55	0.04	52.1	0.25	0.02	0.6	0.00	0.00	95.0	0.30	0.02
White	15,495	95.6	0.40	0.01	53.8	0.25	0.01	1.2	0.01	0.00	95.3	0.18	0.00
Region													
Midwest	4,822	96.9	0.40	0.02	53.3	0.25	0.02	0.4	0.00	0.00	96.0	0.18	0.01
Northeast	3,692	93.4	0.38	0.02	49.3	0.24	0.01	0.8	0.00	0.00	94.0	0.18	0.01
South	7,208	96.1	0.47	0.02	50.7	0.21	0.01	2.6	0.01	0.00	94.1	0.18	0.01
West	4,885	95.0	0.44	0.02	56.0	0.27	0.01	1.2	0.00	0.00	96.1	0.24	0.01
Urbanization													
City Center	6,164	95.1	0.47	0.02	51.3	0.24	0.01	1.8	0.01	0.00	94.8	0.20	0.01
Suburban	9,598	95.4	0.41	0.01	53.0	0.26	0.01	1.0	0.01	0.00	95.3	0.19	0.01
Nonmetropolitan	4,845	96.2	0.41	0.02	51.6	0.20	0.01	1.7	0.01	0.00	94.3	0.19	0.01

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Peaches			Pears			Peas			Peppers		
Whole Population	20,607	40.8	0.11	0.00	8.2	0.09	0.00	22.3	0.11	0.01	83.0	0.06	0.00
Age Group													
Birth to 1 year	1,486	24.4	0.85	0.08	15.9	0.73	0.07	29.5	0.47	0.04	15.6	0.01	0.00
1 to 2 years	2,096	50.7	0.47	0.04	17.2	0.40	0.04	28.3	0.34	0.03	77.5	0.05	0.01
3 to 5 years	4,391	55.4	0.26	0.02	16.6	0.26	0.03	20.5	0.21	0.02	84.6	0.05	0.00
6 to 12 years	2,089	54.7	0.14	0.02	17.5	0.14	0.01	17.2	0.12	0.01	85.1	0.05	0.00
13 to 19 years	1,222	39.1	0.06	0.01	5.9	0.03	0.01	14.0	0.07	0.01	84.8	0.04	0.00
20 to 49 years	4,677	34.5	0.05	0.00	4.4	0.04	0.00	21.3	0.08	0.01	86.9	0.08	0.01
≥50 years	4,646	44.1	0.10	0.01	9.0	0.07	0.01	28.4	0.10	0.01	78.9	0.06	0.01
Season													
Fall	4,687	35.9	0.07	0.01	9.6	0.11	0.01	24.1	0.10	0.01	81.3	0.07	0.01
Spring	5,308	42.9	0.10	0.01	7.7	0.07	0.00	20.2	0.10	0.01	84.8	0.06	0.00
Summer	5,890	46.6	0.17	0.01	6.8	0.07	0.01	19.8	0.10	0.01	83.1	0.06	0.00
Winter	4,722	37.9	0.09	0.01	8.7	0.10	0.01	24.9	0.13	0.01	83.0	0.06	0.00
Race													
Asian, Pacific Islander	557	32.2	0.07	0.02	9.2	0.13	0.03	41.0	0.15	0.02	70.9	0.08	0.01
American Indian, Alaskan Native	177	38.0	0.20	0.06	11.2	0.15	0.06	22.5	0.13	0.03	89.3	0.08	0.02
Black	2,740	39.4	0.10	0.01	5.6	0.06	0.01	20.9	0.13	0.02	82.8	0.04	0.01
Other/NA	1,638	35.2	0.13	0.02	8.3	0.11	0.02	19.8	0.07	0.01	81.7	0.12	0.01
White	15,495	41.8	0.11	0.01	8.6	0.09	0.00	21.9	0.10	0.01	83.6	0.06	0.00
Region													
Midwest	4,822	45.3	0.11	0.01	9.1	0.09	0.01	22.1	0.10	0.01	85.6	0.06	0.01
Northeast	3,692	44.0	0.10	0.01	9.4	0.10	0.01	24.7	0.13	0.02	79.0	0.07	0.01
South	7,208	35.8	0.11	0.01	6.5	0.07	0.01	19.9	0.10	0.01	82.1	0.05	0.00
West	4,885	41.1	0.11	0.01	8.9	0.10	0.01	24.0	0.10	0.01	85.4	0.08	0.01
Urbanization													
City Center	6,164	39.9	0.11	0.01	8.1	0.09	0.01	24.0	0.12	0.01	83.4	0.07	0.01
Suburban	9,598	43.1	0.11	0.01	8.8	0.10	0.01	22.3	0.11	0.01	82.2	0.06	0.00
Nonmetropolitan	4,845	37.1	0.10	0.00	7.2	0.06	0.01	19.6	0.09	0.01	84.4	0.06	0.01

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Pome Fruit			Pumpkins			Root Tuber Vegetables			Stalk, Stem Vegetables		
Whole Population	20,607	34.7	0.54	0.01	1.8	0.01	0.00	99.2	1.42	0.02	19.4	0.05	0.00
Age Group													
Birth to 1 year	1,486	40.0	3.04	0.17	0.3	0.00	0.00	61.7	2.60	0.15	1.9	0.01	0.00
1 to 2 years	2,096	52.0	2.19	0.10	0.7	0.01	0.00	99.6	3.38	0.09	13.2	0.06	0.01
3 to 5 years	4,391	51.7	1.90	0.06	0.9	0.01	0.00	100.0	2.96	0.07	10.9	0.04	0.00
6 to 12 years	2,089	47.9	0.97	0.06	1.8	0.01	0.00	100.0	2.09	0.07	10.7	0.03	0.01
13 to 19 years	1,222	26.5	0.23	0.02	1.3	0.01	0.00	99.9	1.36	0.06	16.6	0.03	0.01
20 to 49 years	4,677	27.9	0.25	0.01	1.7	0.00	0.00	99.7	1.12	0.02	24.5	0.05	0.00
≥50 years	4,646	39.0	0.39	0.02	2.3	0.01	0.00	99.7	1.13	0.02	18.3	0.05	0.00
Season													
Fall	4,687	39.5	0.66	0.04	4.9	0.01	0.00	99.4	1.49	0.04	18.5	0.04	0.00
Spring	5,308	33.6	0.52	0.03	0.4	0.00	0.00	99.3	1.41	0.03	20.1	0.05	0.00
Summer	5,890	29.1	0.41	0.02	0.7	0.00	0.00	99.2	1.34	0.03	17.0	0.03	0.00
Winter	4,722	36.7	0.56	0.03	1.0	0.00	0.00	99.0	1.45	0.04	21.8	0.06	0.01
Race													
Asian, Pacific Islander	557	36.5	0.66	0.08	1.0	0.00	0.00	97.3	1.31	0.10	36.5	0.11	0.01
American Indian, Alaskan Native	177	39.5	0.75	0.14	1.2	0.00	0.00	99.7	1.71	0.30	21.6	0.05	0.02
Black	2,740	24.8	0.42	0.03	0.5	0.00	0.00	99.0	1.31	0.09	8.1	0.01	0.00
Other/NA	1,638	32.7	0.67	0.06	3.5	0.01	0.00	98.0	1.47	0.05	14.5	0.03	0.00
White	15,495	36.4	0.54	0.01	1.9	0.01	0.00	99.4	1.44	0.02	20.9	0.05	0.00
Region													
Midwest	4,822	38.9	0.55	0.03	2.4	0.01	0.00	99.5	1.57	0.05	22.1	0.05	0.00
Northeast	3,692	37.3	0.57	0.02	2.0	0.01	0.00	99.4	1.33	0.05	17.2	0.05	0.01
South	7,208	28.9	0.43	0.02	1.1	0.00	0.00	99.2	1.40	0.04	16.4	0.04	0.00
West	4,885	37.2	0.65	0.03	1.9	0.01	0.00	98.8	1.38	0.05	23.1	0.06	0.00
Urbanization													
City Center	6,164	33.2	0.51	0.02	1.5	0.00	0.00	99.0	1.34	0.04	19.6	0.05	0.00
Suburban	9,598	37.6	0.59	0.02	1.8	0.00	0.00	99.3	1.44	0.03	20.0	0.05	0.00
Nonmetropolitan	4,845	30.7	0.45	0.03	2.0	0.01	0.00	99.4	1.52	0.06	17.8	0.04	0.00

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Strawberries			Stone Fruit			Tomatoes			Tropical Fruits		
Whole Population	20,607	32.4	0.06	0.00	44.5	0.17	0.01	84.4	0.74	0.01	58.3	0.43	0.01
Age Group													
Birth to 1 year	1,486	6.8	0.02	0.00	29.2	1.15	0.10	21.5	0.30	0.03	42.2	1.31	0.07
1 to 2 years	2,096	33.5	0.19	0.03	53.6	0.60	0.04	80.7	1.50	0.05	70.1	1.97	0.10
3 to 5 years	4,391	37.1	0.14	0.01	57.5	0.38	0.02	85.7	1.40	0.03	69.7	1.10	0.04
6 to 12 years	2,089	37.3	0.10	0.01	56.8	0.23	0.02	86.9	1.00	0.03	67.0	0.50	0.04
13 to 19 years	1,222	26.8	0.05	0.01	41.1	0.09	0.01	90.2	0.74	0.03	54.5	0.19	0.02
20 to 49 years	4,677	29.8	0.05	0.00	38.1	0.09	0.01	87.1	0.66	0.01	52.8	0.27	0.01
≥50 years	4,646	37.7	0.06	0.00	49.4	0.17	0.01	80.1	0.57	0.01	63.1	0.41	0.01
Season													
Fall	4,687	26.8	0.03	0.00	39.3	0.11	0.01	83.5	0.73	0.03	56.5	0.42	0.02
Spring	5,308	36.8	0.11	0.01	46.8	0.17	0.01	84.3	0.69	0.02	59.4	0.43	0.02
Summer	5,890	36.1	0.06	0.01	50.3	0.28	0.02	85.1	0.80	0.02	58.2	0.41	0.02
Winter	4,722	29.9	0.05	0.01	41.6	0.12	0.01	84.5	0.72	0.02	58.9	0.45	0.02
Race													
Asian, Pacific Islander	557	23.9	0.07	0.03	36.5	0.16	0.04	74.1	0.73	0.06	55.4	0.61	0.07
American Indian, Alaskan Native	177	28.2	0.03	0.02	39.2	0.24	0.07	89.2	0.82	0.07	54.1	0.43	0.05
Black	2,740	21.1	0.02	0.00	40.7	0.14	0.02	78.1	0.63	0.03	53.6	0.36	0.03
Other/NA	1,638	22.3	0.05	0.01	38.2	0.19	0.03	89.6	1.11	0.05	60.9	0.77	0.09
White	15,495	35.3	0.07	0.00	45.9	0.17	0.01	85.4	0.73	0.01	59.0	0.41	0.01
Region													
Midwest	4,822	34.9	0.07	0.01	49.9	0.18	0.01	85.5	0.74	0.02	60.1	0.40	0.03
Northeast	3,692	37.1	0.06	0.01	47.5	0.15	0.01	83.4	0.73	0.02	62.4	0.47	0.02
South	7,208	27.2	0.05	0.00	38.9	0.15	0.01	82.7	0.69	0.02	53.1	0.36	0.02
West	4,885	33.9	0.08	0.01	44.8	0.20	0.01	86.6	0.81	0.02	60.8	0.53	0.03
Urbanization													
City Center	6,164	29.7	0.05	0.01	43.5	0.17	0.01	84.1	0.75	0.02	58.8	0.46	0.02
Suburban	9,598	36.2	0.08	0.00	46.9	0.18	0.01	84.5	0.73	0.01	60.2	0.44	0.01
Nonmetropolitan	4,845	28.1	0.05	0.01	40.6	0.15	0.01	84.4	0.73	0.03	53.0	0.34	0.03

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Percent Consuming	Mean	SE
		White Potatoes		
Whole Population	20,607	91.3	0.89	0.02
Age Group				
Birth to 1 year	1,486	39.9	0.64	0.07
1 to 2 years	2,096	91.2	1.95	0.08
3 to 5 years	4,391	95.1	1.75	0.06
6 to 12 years	2,089	93.9	1.21	0.06
13 to 19 years	1,222	92.6	0.93	0.05
20 to 49 years	4,677	91.5	0.74	0.02
≥ 50 years	4,646	91.7	0.72	0.02
Season				
Fall	4,687	91.5	0.91	0.04
Spring	5,308	91.3	0.87	0.03
Summer	5,890	91.3	0.86	0.03
Winter	4,722	91.1	0.90	0.03
Race				
Asian, Pacific Islander	557	82.3	0.72	0.09
American Indian, Alaskan Native	177	92.7	1.29	0.32
Black	2,740	88.5	0.81	0.07
Other/NA	1,638	86.5	0.86	0.07
White	15,495	92.4	0.90	0.02
Region				
Midwest	4,822	94.5	1.00	0.03
Northeast	3,692	88.6	0.79	0.04
South	7,208	91.8	0.90	0.04
West	4,885	89.6	0.82	0.06
Urbanization				
City Center	6,164	89.5	0.81	0.04
Suburban	9,598	91.2	0.87	0.02
Nonmetropolitan	4,845	94.2	1.02	0.06

SE =Standard Error
Note: Data for fruits and vegetables for which only small percentages of the population reported consumption may be less reliable than data for fruits and vegetables with higher percentages consuming.

Source: Based on unpublished U.S. EPA analysis of 1994-96, 1998 CSFH

Table 9-6. Consumer Only Intake of Individual Fruits and Vegetables (g/kg-day as consumed)

Domain	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
	Apples			Asparagus			Bananas			Beans			Beets		
Whole Population	7,193	1.47	0.03	233	0.85	0.04	10,734	0.73	0.02	9,086	0.60	0.01	374	0.35	0
Age Group															
Birth to 1 year	496	6.71	0.31	3	2.59	1.16	605	3.04	0.12	313	2.00	0.16	6	1.42	0.9
1 to 2 years	947	4.00	0.15	19	1.99	0.54	1,328	2.82	0.12	996	1.63	0.08	13	0.98	0.3
3 to 5 years	1,978	3.68	0.08	23	1.37	0.32	2,746	1.54	0.06	1,909	1.22	0.04	36	0.9	0.2
6 to 12 years	792	2.17	0.12	13	1.77	0.43	1,214	0.66	0.05	833	0.82	0.05	16	0.66	0.3
13 to 19 years	271	0.90	0.06	4	0.56	0.08	511	0.30	0.04	472	0.49	0.03	9	0.2	0.1
20 to 49 years	1,171	0.82	0.03	58	0.79	0.08	1,887	0.50	0.01	2,153	0.48	0.01	93	0.23	0
≥ 50 years	1,538	0.92	0.04	113	0.77	0.07	2,443	0.65	0.02	2,410	0.52	0.02	201	0.38	0
Season															
Fall	1,841	1.57	0.06	44	0.80	0.13	2,292	0.79	0.04	2,122	0.60	0.02	90	0.25	0
Spring	1,818	1.52	0.07	91	0.90	0.07	2,856	0.70	0.03	2,311	0.59	0.02	92	0.45	0.1
Summer	1,801	1.32	0.06	36	0.66	0.12	3,124	0.66	0.03	2,539	0.65	0.02	104	0.34	0.1
Winter	1,733	1.44	0.05	62	0.94	0.10	2,462	0.80	0.03	2,114	0.57	0.02	88	0.33	0.1
Race															
Asian, Pacific Islander	182	1.59	0.12	5	0.62	0.15	265	0.95	0.10	265	0.48	0.05	16	0.04	0
American Indian, Alaskan Native	58	1.93	0.27	2	0.81	-	88	0.87	0.15	74	0.70	0.12	1	0.02	-
Black	762	1.62	0.12	8	1.01	0.64	1,288	0.59	0.05	1,205	0.71	0.04	18	0.29	0.1
Other/NA	536	2.00	0.13	5	0.31	0.09	865	1.21	0.11	911	0.71	0.04	16	0.39	0.2
White	5,655	1.42	0.03	213	0.86	0.05	8,228	0.71	0.02	6,631	0.58	0.01	323	0.36	0
Region															
Midwest	1,792	1.35	0.06	63	0.91	0.08	2,589	0.68	0.04	2,071	0.59	0.02	90	0.35	0.1
Northeast	1,385	1.46	0.05	43	0.72	0.10	2,122	0.68	0.02	1,342	0.56	0.02	78	0.42	0.1
South	2,201	1.44	0.05	64	1.07	0.09	3,356	0.70	0.04	3,465	0.68	0.02	99	0.29	0
West	1,815	1.67	0.06	63	0.69	0.04	2,667	0.89	0.03	2,208	0.52	0.03	107	0.33	0.1
Urbanization															
City Center	2,091	1.46	0.05	81	0.85	0.07	3,182	0.75	0.03	2,840	0.62	0.02	110	0.28	0
Suburban	3,647	1.49	0.05	97	0.78	0.07	5,303	0.75	0.02	3,957	0.58	0.01	171	0.39	0.1
Nonmetropolitan	1,455	1.45	0.03	55	0.98	0.11	2,249	0.67	0.04	2,289	0.61	0.01	93	0.35	0

Table 9-6. Consumer Only Intake of Individual Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
	Berries and Small Fruits			Broccoli			Bulb Vegetables			Cabbage			Carrots		
Whole Population	12,206	0.40	0.01	2,474	0.80	0.03	18,738	0.21	0.00	2,633	0.50	0.03	9,513	0.34	0.01
Age Group															
Birth to 1 year	229	0.81	0.07	49	2.09	0.33	489	0.22	0.02	15	0.61	0.41	179	1.39	0.20
1 to 2 years	1,396	1.38	0.06	242	2.11	0.16	1,957	0.32	0.01	160	0.73	0.11	999	0.87	0.05
3 to 5 years	3,166	0.99	0.04	475	1.67	0.09	4,207	0.28	0.01	369	0.78	0.07	2,048	0.74	0.03
6 to 12 years	1,523	0.54	0.04	213	1.29	0.16	2,040	0.22	0.01	190	0.63	0.11	904	0.50	0.03
13 to 19 years	679	0.27	0.03	102	0.69	0.07	1,194	0.20	0.01	106	0.40	0.06	482	0.27	0.02
20 to 49 years	2,393	0.27	0.02	640	0.68	0.04	4,546	0.22	0.01	746	0.45	0.03	2,289	0.28	0.01
≥ 50 years	2,820	0.31	0.01	753	0.63	0.03	4,305	0.18	0.00	1,047	0.52	0.02	2,612	0.29	0.01
Season															
Fall	2,706	0.31	0.02	582	0.81	0.05	4,310	0.22	0.01	623	0.44	0.03	2,338	0.35	0.02
Spring	3,202	0.45	0.03	651	0.82	0.07	4,835	0.21	0.01	684	0.52	0.03	2,345	0.36	0.02
Summer	3,558	0.48	0.02	660	0.79	0.05	5,280	0.20	0.01	676	0.56	0.07	2,440	0.33	0.01
Winter	2,740	0.35	0.02	581	0.76	0.07	4,313	0.22	0.01	650	0.48	0.04	2,390	0.34	0.01
Race															
Asian, Pacific Islander	252	0.66	0.13	118	0.89	0.12	481	0.40	0.03	152	0.69	0.09	329	0.47	0.05
American Indian, Alaskan Native	85	0.26	0.04	16	1.18	0.43	169	0.25	0.04	18	0.34	0.13	82	0.26	0.03
Black	1,430	0.27	0.02	286	1.06	0.12	2,438	0.18	0.01	359	0.87	0.11	958	0.28	0.02
Other/NA	782	0.45	0.06	131	1.09	0.10	1,484	0.33	0.02	144	0.24	0.05	749	0.45	0.03
White	9,657	0.41	0.01	1,923	0.73	0.03	14,166	0.20	0.00	1,960	0.43	0.02	7,395	0.34	0.01
Region															
Midwest	3,042	0.40	0.03	533	0.66	0.03	4,457	0.20	0.01	629	0.49	0.04	2,313	0.34	0.02
Northeast	2,383	0.37	0.03	511	0.84	0.07	3,324	0.20	0.01	413	0.56	0.06	1,843	0.34	0.01
South	3,896	0.35	0.02	810	0.83	0.04	6,497	0.19	0.01	978	0.52	0.06	2,981	0.31	0.01
West	2,885	0.48	0.03	620	0.83	0.08	4,460	0.26	0.01	613	0.41	0.03	2,376	0.40	0.01
Urbanization															
City Center	3,525	0.38	0.02	741	0.83	0.06	5,547	0.22	0.01	794	0.58	0.07	2,759	0.34	0.01
Suburban	6,039	0.44	0.02	1,283	0.81	0.03	8,768	0.21	0.01	1,251	0.45	0.02	4,690	0.36	0.01
Nonmetropolitan	2,642	0.31	0.03	450	0.64	0.05	4,423	0.20	0.01	588	0.48	0.04	2,064	0.32	0.01

Table 9-6. Consumer Only Intake of Individual Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
	Citrus Fruits			Corn			Cucumbers			Cucurbits			Fruiting Vegetables		
Whole Population	3,656	0.99	0.03	19,059	0.47	0.01	6,779	0.24	0.02	8,763	0.81	0.04	18,407	0.87	0.01
Age Group															
Birth to 1 year	37	2.79	0.53	671	1.05	0.07	25	0.28	0.11	213	3.19	0.29	371	1.24	0.11
1 to 2 years	336	3.06	0.20	2,027	1.17	0.05	439	0.52	0.05	682	2.29	0.17	1,927	1.70	0.06
3 to 5 years	751	2.75	0.15	4,334	1.26	0.03	1,266	0.56	0.05	1,694	2.15	0.17	4,180	1.53	0.03
6 to 12 years	324	1.60	0.12	2,064	0.88	0.03	667	0.43	0.06	833	1.34	0.15	2,014	1.10	0.03
13 to 19 years	157	0.90	0.15	1,176	0.45	0.01	500	0.26	0.06	563	0.69	0.16	1,176	0.82	0.03
20 to 49 years	841	0.68	0.04	4,415	0.34	0.01	2,033	0.20	0.01	2,400	0.55	0.03	4,489	0.78	0.02
≥ 50 years	1,210	0.84	0.03	4,372	0.28	0.01	1,849	0.21	0.01	2,378	0.81	0.05	4,250	0.71	0.02
Season															
Fall	761	0.93	0.06	4,342	0.44	0.01	1,374	0.22	0.02	1,778	0.46	0.03	4,186	0.87	0.03
Spring	1,002	0.97	0.05	4,909	0.47	0.02	1,906	0.23	0.01	2,408	0.94	0.07	4,755	0.82	0.02
Summer	815	0.53	0.04	5,423	0.52	0.02	2,070	0.32	0.05	2,855	1.32	0.10	5,262	0.93	0.02
Winter	1,078	1.32	0.06	4,385	0.44	0.02	1,429	0.20	0.02	1,722	0.36	0.03	4,204	0.85	0.03
Race															
Asian, Pacific Islander	117	1.50	0.19	454	0.37	0.05	134	0.68	0.43	217	1.92	0.79	439	0.98	0.06
American Indian, Alaskan Native	41	1.61	0.17	165	0.55	0.06	60	0.23	0.06	75	1.04	0.32	162	0.93	0.08
Black	369	1.15	0.08	2,502	0.52	0.02	858	0.17	0.01	987	0.62	0.08	2,398	0.75	0.04
Other/NA	347	1.66	0.16	1,475	0.76	0.05	413	0.30	0.03	633	1.14	0.19	1,447	1.34	0.05
White	2,782	0.89	0.03	14,463	0.44	0.01	5,314	0.24	0.01	6,851	0.77	0.03	13,961	0.85	0.01
Region															
Midwest	842	0.84	0.06	4,562	0.48	0.02	1,693	0.23	0.02	2,091	0.75	0.05	4,379	0.85	0.02
Northeast	754	0.94	0.06	3,377	0.43	0.01	1,191	0.25	0.02	1,614	0.85	0.08	3,254	0.88	0.02
South	998	0.94	0.04	6,648	0.46	0.01	2,356	0.22	0.02	2,905	0.70	0.06	6,416	0.81	0.03
West	1,062	1.20	0.07	4,472	0.49	0.02	1,539	0.29	0.07	2,153	0.99	0.12	4,358	0.96	0.03
Urbanization															
City Center	1,146	1.01	0.04	5,641	0.47	0.01	1,965	0.22	0.01	2,570	0.71	0.05	5,477	0.89	0.03
Suburban	1,738	0.97	0.04	8,886	0.47	0.01	3,151	0.26	0.03	4,119	0.89	0.07	8,563	0.86	0.01
Nonmetropolitan	772	0.99	0.07	4,532	0.45	0.02	1,663	0.25	0.03	2,074	0.78	0.06	4,367	0.85	0.04

Table 9-6. Consumer Only Intake of Individual Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
	Leafy Vegetables			Legumes			Lettuce			Okra			Onions		
Whole Population	17,637	0.65	0.01	19,258	0.45	0.01	8,430	0.46	0.01	272	0.51	0.04	18,678	0.20	0.00
Age Group															
Birth to 1 year	639	0.65	0.11	754	2.34	0.11	15	0.17	0.02	4	1.50	0.54	481	0.22	0.02
1 to 2 years	1,729	0.87	0.05	2,037	1.34	0.08	481	0.58	0.04	29	0.64	0.19	1,948	0.31	0.01
3 to 5 years	3,815	0.77	0.03	4,308	0.86	0.06	1,415	0.62	0.03	34	1.16	0.32	4,200	0.27	0.01
6 to 12 years	1,860	0.62	0.03	2,045	0.49	0.03	858	0.53	0.02	21	0.62	0.15	2,030	0.21	0.01
13 to 19 years	1,101	0.47	0.02	1,168	0.29	0.02	669	0.40	0.03	12	0.43	0.13	1,190	0.19	0.01
20 to 49 years	4,308	0.63	0.02	4,477	0.36	0.01	2,693	0.45	0.01	62	0.44	0.06	4,533	0.21	0.01
≥ 50 years	4,185	0.72	0.02	4,469	0.41	0.01	2,299	0.45	0.01	110	0.50	0.05	4,296	0.17	0.00
Season															
Fall	4,046	0.66	0.03	4,412	0.46	0.02	1,894	0.46	0.02	58	0.39	0.04	4,300	0.21	0.01
Spring	4,579	0.66	0.02	4,952	0.42	0.02	2,279	0.46	0.02	66	0.47	0.09	4,815	0.20	0.01
Summer	4,964	0.62	0.02	5,476	0.45	0.02	2,325	0.45	0.01	106	0.65	0.08	5,265	0.19	0.01
Winter	4,048	0.66	0.02	4,418	0.46	0.02	1,932	0.46	0.02	42	0.53	0.13	4,298	0.21	0.01
Race															
Asian, Pacific Islander	469	1.22	0.12	503	0.79	0.09	191	0.58	0.09	15	0.20	0.06	480	0.39	0.03
American Indian, Alaskan Native	151	0.59	0.19	170	0.44	0.08	88	0.34	0.04	2	0.40	-	169	0.25	0.04
Black	2,367	0.73	0.04	2,563	0.52	0.04	884	0.35	0.02	67	0.63	0.08	2,431	0.17	0.01
Other/NA	1,329	0.59	0.04	1,478	0.58	0.05	643	0.49	0.04	15	0.70	0.25	1,484	0.32	0.02
White	13,321	0.62	0.01	14,544	0.42	0.01	6,624	0.47	0.01	173	0.51	0.05	14,114	0.19	0.00
Region															
Midwest	4,226	0.60	0.03	4,577	0.41	0.02	2,035	0.47	0.03	24	0.42	0.20	4,448	0.19	0.01
Northeast	3,081	0.71	0.03	3,421	0.40	0.02	1,396	0.49	0.02	22	0.50	0.18	3,308	0.19	0.01
South	6,174	0.61	0.02	6,771	0.49	0.02	2,830	0.41	0.02	178	0.58	0.05	6,479	0.19	0.01
West	4,156	0.71	0.04	4,489	0.47	0.03	2,169	0.49	0.03	48	0.30	0.07	4,443	0.25	0.01
Urbanization															
City Center	5,232	0.72	0.03	5,735	0.50	0.02	2,414	0.46	0.02	96	0.49	0.07	5,531	0.21	0.01
Suburban	8,220	0.67	0.02	8,950	0.43	0.02	3,999	0.49	0.01	102	0.59	0.07	8,739	0.20	0.01
Nonmetropolitan	4,185	0.51	0.03	4,573	0.43	0.02	2,017	0.39	0.02	74	0.42	0.04	4,408	0.20	0.01

Table 9-6. Consumer Only Intake of Individual Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
	Peaches			Pears			Peas			Peppers			Pome Fruit		
Whole Population	9,069	0.26	0.01	2,355	1.06	0.04	4,661	0.48	0.02	16,093	0.08	0.00	8,316	1.55	0.03
Age Group															
Birth to 1 year	344	3.47	0.28	217	4.55	0.28	417	1.60	0.09	224	0.05	0.01	572	7.60	0.34
1 to 2 years	1,067	0.93	0.08	354	2.33	0.16	609	1.21	0.06	1,627	0.06	0.01	1,097	4.21	0.13
3 to 5 years	2,461	0.48	0.03	711	1.59	0.12	888	1.02	0.07	3,706	0.06	0.00	2,291	3.68	0.08
6 to 12 years	1,150	0.26	0.03	382	0.81	0.07	346	0.68	0.06	1,784	0.05	0.01	1,012	2.03	0.10
13 to 19 years	480	0.15	0.03	72	0.45	0.09	168	0.48	0.06	1,041	0.05	0.00	320	0.87	0.06
20 to 49 years	1,544	0.14	0.01	205	0.80	0.05	959	0.37	0.02	4,068	0.09	0.01	1,274	0.88	0.03
≥ 50 years	2,023	0.22	0.01	414	0.81	0.04	1,274	0.37	0.02	3,643	0.08	0.01	1,750	1.00	0.03
Season															
Fall	1,841	0.20	0.02	596	1.15	0.08	1,172	0.43	0.02	3,643	0.08	0.01	2,102	1.67	0.07
Spring	2,439	0.23	0.02	590	0.86	0.05	1,120	0.51	0.03	4,212	0.07	0.01	2,102	1.54	0.06
Summer	2,815	0.37	0.02	585	1.05	0.06	1,213	0.48	0.02	4,568	0.08	0.01	2,092	1.40	0.06
Winter	1,974	0.22	0.02	584	1.14	0.09	1,156	0.52	0.04	3,670	0.07	0.01	2,020	1.53	0.06
Race															
Asian, Pacific Islander	200	0.23	0.04	56	1.43	0.21	192	0.35	0.04	344	0.11	0.01	209	1.82	0.14
American Indian, Alaskan Native	68	0.54	0.17	23	1.31	0.60	51	0.59	0.10	144	0.09	0.03	73	1.89	0.29
Black	1,146	0.25	0.03	244	1.09	0.15	612	0.64	0.05	2,150	0.05	0.01	878	1.68	0.12
Other/NA	590	0.38	0.07	171	1.39	0.22	323	0.38	0.04	1,233	0.15	0.01	624	2.05	0.14
White	7,065	0.26	0.01	1,861	1.02	0.04	3,483	0.48	0.02	12,222	0.07	0.00	6,532	1.48	0.03
Region															
Midwest	2,283	0.25	0.02	625	0.96	0.06	1,108	0.46	0.02	3,920	0.07	0.01	2,094	1.42	0.07
Northeast	1,778	0.22	0.02	470	1.04	0.06	923	0.52	0.05	2,711	0.08	0.01	1,598	1.54	0.05
South	2,849	0.30	0.02	648	1.08	0.10	1,526	0.51	0.03	5,579	0.06	0.01	2,535	1.50	0.05
West	2,159	0.26	0.02	612	1.17	0.08	1,104	0.43	0.04	3,883	0.10	0.01	2,089	1.74	0.07
Urbanization															
City Center	2,640	0.27	0.02	686	1.06	0.06	1,480	0.50	0.03	4,780	0.09	0.01	2,408	1.54	0.05
Suburban	4,457	0.26	0.01	1,205	1.12	0.06	2,179	0.48	0.03	7,436	0.07	0.00	4,224	1.58	0.06
Nonmetropolitan	1,972	0.27	0.01	464	0.89	0.05	1,002	0.45	0.04	3,877	0.07	0.01	1,684	1.48	0.03

Table 9-6. Consumer Only Intake of Individual Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
	Pumpkins			Root Tuber Vegetables			Stalk, Stem Vegetables			Strawberries			Stone Fruit		
Whole Population	299	0.30	0.02	19,997	1.44	0.02	3,095	0.24	0.01	6,675	0.20	0.01	9,786	0.38	0.01
Age Group															
Birth to 1 year	3	1.06	0.71	916	4.21	0.19	24	0.56	0.22	96	0.26	0.06	418	3.95	0.25
1 to 2 years	15	1.08	0.51	2,087	3.40	0.09	272	0.48	0.05	729	0.57	0.08	1,130	1.13	0.08
3 to 5 years	36	0.56	0.10	4,388	2.96	0.07	502	0.38	0.03	1,710	0.38	0.03	2,556	0.66	0.03
6 to 12 years	37	0.52	0.11	2,089	2.09	0.07	218	0.32	0.04	783	0.28	0.02	1,194	0.41	0.03
13 to 19 years	14	0.42	0.16	1,221	1.36	0.06	190	0.20	0.03	326	0.18	0.03	508	0.21	0.03
20 to 49 years	89	0.24	0.02	4,664	1.12	0.02	1,079	0.20	0.01	1,330	0.15	0.02	1,715	0.23	0.01
≥ 50 years	105	0.22	0.01	4,632	1.14	0.02	810	0.27	0.02	1,701	0.15	0.01	2,265	0.34	0.02
Season															
Fall	193	0.29	0.02	4,565	1.50	0.04	720	0.22	0.02	1,250	0.13	0.01	1,987	0.27	0.02
Spring	22	0.65	0.18	5,151	1.43	0.03	825	0.25	0.01	1,911	0.30	0.03	2,627	0.35	0.02
Summer	40	0.22	0.06	5,690	1.35	0.03	796	0.20	0.01	2,060	0.17	0.02	3,029	0.56	0.03
Winter	44	0.25	0.04	4,591	1.46	0.03	754	0.26	0.02	1,454	0.16	0.02	2,143	0.29	0.02
Race															
Asian, Pacific Islander	4	0.33	0.07	518	1.35	0.10	158	0.29	0.03	149	0.29	0.11	218	0.44	0.08
American Indian, Alaskan Native	3	0.11	0.01	174	1.71	0.30	32	0.25	0.05	50	0.11	0.04	73	0.60	0.18
Black	12	0.34	0.05	2,642	1.32	0.09	188	0.18	0.03	550	0.11	0.02	1,184	0.34	0.04
Other/NA	43	0.21	0.08	1,561	1.50	0.05	172	0.21	0.02	367	0.22	0.06	649	0.50	0.08
White	237	0.31	0.02	15,102	1.45	0.02	2,545	0.24	0.01	5,559	0.20	0.01	7,662	0.38	0.01
Region															
Midwest	87	0.31	0.01	4,709	1.58	0.05	883	0.22	0.02	1,668	0.20	0.01	2,469	0.36	0.02
Northeast	62	0.30	0.09	3,598	1.34	0.05	467	0.26	0.03	1,381	0.16	0.02	1,912	0.32	0.02
South	70	0.28	0.03	6,998	1.41	0.04	908	0.24	0.02	1,952	0.18	0.02	3,060	0.39	0.02
West	80	0.30	0.05	4,692	1.40	0.05	837	0.24	0.02	1,674	0.23	0.03	2,345	0.45	0.03
Urbanization															
City Center	76	0.31	0.05	5,961	1.36	0.04	891	0.25	0.02	1,772	0.18	0.02	2,845	0.38	0.02
Suburban	137	0.26	0.02	9,315	1.45	0.03	1,492	0.23	0.01	3,517	0.22	0.01	4,808	0.38	0.02
Nonmetropolitan	86	0.36	0.04	4,721	1.53	0.07	712	0.24	0.02	1,386	0.17	0.03	2,133	0.36	0.01

Table 9-6. Consumer Only Intake of Individual Fruits and Vegetables (g/kg-day as consumed) (continued)

Domain	N	Mean	SE	N	Mean	SE	N	Mean	SE
	Tomatoes			Tropical Fruits			White Potatoes		
Whole Population	16,403	0.87	0.01	12,539	0.73	0.02	18,261	0.97	0.02
Age Group									
Birth to 1 year	315	1.42	0.13	630	3.09	0.12	577	1.60	0.15
1 to 2 years	1,684	1.86	0.06	1,476	2.81	0.12	1,918	2.14	0.09
3 to 5 years	3,764	1.63	0.03	3,106	1.57	0.05	4,147	1.84	0.06
6 to 12 years	1,832	1.15	0.03	1,407	0.75	0.05	1,963	1.29	0.06
13 to 19 years	1,098	0.82	0.03	652	0.35	0.04	4,271	0.81	0.02
20 to 49 years	4,053	0.75	0.02	2,428	0.51	0.02	2,664	0.75	0.02
≥ 50 years	3,657	0.72	0.01	2,840	0.64	0.02	4,254	0.78	0.02
Season									
Fall	3,732	0.87	0.03	2,748	0.75	0.03	4,205	1.00	0.04
Spring	4,173	0.82	0.02	3,291	0.72	0.03	4,703	0.96	0.03
Summer	4,731	0.94	0.02	3,595	0.70	0.02	5,190	0.94	0.03
Winter	3,767	0.86	0.03	2,905	0.77	0.03	4,163	0.99	0.03
Race									
Asian, Pacific Islander	373	0.99	0.08	314	1.10	0.13	428	0.88	0.09
American Indian, Alaskan Native	146	0.92	0.08	103	0.79	0.12	162	1.40	0.33
Black	2,017	0.80	0.04	1,541	0.67	0.05	2,365	0.92	0.08
Other/NA	1,369	1.24	0.05	1,034	1.26	0.10	1,353	1.00	0.06
White	12,498	0.85	0.01	9,547	0.69	0.02	13,953	0.98	0.02
Region									
Midwest	3,915	0.87	0.02	2,989	0.67	0.04	4,436	1.06	0.04
Northeast	2,906	0.88	0.02	2,412	0.75	0.02	3,199	0.90	0.03
South	5,629	0.83	0.02	4,016	0.67	0.03	6,415	0.98	0.04
West	3,953	0.93	0.02	3,122	0.87	0.03	4,211	0.92	0.06
Urbanization									
City Center	4,867	0.89	0.02	3,750	0.79	0.03	5,337	0.91	0.04
Suburban	7,647	0.87	0.01	6,092	0.73	0.02	8,488	0.96	0.02
Nonmetropolitan	3,889	0.86	0.03	2,697	0.64	0.05	4,436	1.08	0.06

SE =Standard Error

Note: Data for fruits and vegetables for which only small percentages of the population reported consumption may be less reliable than data for fruits and vegetables with higher percentages consuming.

Source: Based on unpublished U.S. EPA analysis of 1994-96, 1998 CSFII

Table 9-7. Per Capita Intake of Exposed Fruits (g/kg-day as consumed)

Population Group	Percent consuming	Mean	SE	Percentile 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	39.9	1.5	0.06	0	0	0	0	0	1.3	3.8	7.0	22.6	101.3
Age Group													
0 to 5 months	32.8	6.4	1.6	0	0	0	0	0	6.9	23.7	40.2	48.5	63.4
6 to 12 months	79.9	14.1	1.2	0	0	0	4.5	11.8	19.3	32.7	37.1	63.7	69.6
<1 years	54.9	10.0	1.0	0	0	0	0	4.5	16.5	30.1	38.8	58.5	69.6
1 to 2 years	69.2	10.9	0.47	0	0	0	0	5.7	15.7	29.4	39.0	65.8	101.3
3 to 5 years	59.8	5.6	0.28	0	0	0	0	2.7	8.1	15.8	22.2	35.0	77.1
6 to 11 years	50	2.2	0.14	0	0	0	0	0	3.1	6.3	8.8	17.6	32.2
12 to 19 years	32.7	0.87	0.09	0	0	0	0	0	1.1	2.9	4.9	8.8	14.9
20 to 39 years	29.6	0.58	0.05	0	0	0	0	0	0.60	2.0	3.1	6.2	16.0
40 to 69 years	40	0.69	0.03	0	0	0	0	0	0.94	2.2	3.3	6.3	18.6
≥70 years	51.6	0.97	0.06	0	0	0	0	0.11	1.3	2.8	4.1	7.5	18.6
Season													
Fall	40.7	1.6	0.11	0	0	0	0	0	1.4	4.0	7.0	22.5	101.3
Spring	40.4	1.5	0.10	0	0	0	0	0	1.3	3.8	7.1	20.9	77.1
Summer	39.7	1.5	0.11	0	0	0	0	0	1.3	3.7	6.9	23.7	81.1
Winter	38.6	1.5	0.12	0	0	0	0	0	1.2	3.4	7.1	21.2	83.6
Urbanization													
Central City	39.6	1.6	0.11	0	0	0	0	0	1.4	4.3	7.3	23.6	83.6
Nonmetropolitan	33.6	1.1	0.10	0	0	0	0	0	0.8	2.8	5.4	16.5	65.8
Suburban	42.9	1.6	0.08	0	0	0	0	0	1.4	3.9	7.5	23.7	101.3
Race													
Asian	41.6	1.7	0.35	0	0	0	0	0	1.8	5.0	6.4	22.1	61.9
Black	29	1.3	0.17	0	0	0	0	0	0.67	3.3	6.3	22.4	101.3
Native American	33.2	1.2	0.57	0	0	0	0	0	0.99	3.8	6.4	14.0	40.8
Other/NA	38.2	1.9	0.29	0	0	0	0	0	1.4	4.3	8.8	28.4	69.6
White	41.7	1.5	0.06	0	0	0	0	0	1.3	3.7	7.1	21.6	83.6
Region													
Midwest	42.2	1.5	0.11	0	0	0	0	0	1.4	3.7	6.7	21.0	101.3
Northeast	45.3	1.8	0.13	0	0	0	0	0	1.5	4.5	7.5	24.6	81.1
South	33.3	1.3	0.10	0	0	0	0	0	0.86	3.2	6.4	20.4	81.3
West	42.9	1.6	0.12	0	0	0	0	0	1.6	4.2	7.5	22.1	83.6

SE = Standard error.

Source: Based on U.S. EPA's analyses of the 1994-96 CSFII.

Table 9-8. Per Capita Intake of Protected Fruits (g/kg-day as consumed)

Population Group	Percent consuming	Mean	SE	Percentile 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	53	1.9	0.04	0	0	0	0	0.38	2.6	5.4	8.1	16.3	113.4
Age Group													
0 to 5 months	10.8	0.5	0.34	0	0	0	0	0	0	1.3	4.3	7.7	12.5
6 to 12 months	49	3.1	0.58	0	0	0	0	0	4.4	8.3	11.2	26.8	30.3
<1 years	28.7	1.7	0.39	0	0	0	0	0	2.0	6.0	8.3	16.6	30.3
1 to 2 years	61.8	6.5	0.31	0	0	0	0	3.6	9.2	17.8	24.2	39.0	113.4
3 to 5 years	56.2	4.4	0.22	0	0	0	0	2.1	6.7	12.1	17.2	27.9	66.5
6 to 11 years	50.7	2.7	0.17	0	0	0	0	0.17	3.8	8.1	11.4	19.8	31.7
12 to 19 years	47.3	1.8	0.12	0	0	0	0	0	2.6	5.4	8.4	15.4	27.0
20 to 39 years	48	1.4	0.07	0	0	0	0	0	1.9	4.3	6.3	11.8	39.3
40 to 69 years	56.5	1.4	0.04	0	0	0	0	0.61	2.2	4.1	5.5	9.7	45.8
≥70 years	68.7	1.8	0.07	0	0	0	0	1.3	2.8	4.7	5.9	9.2	27.6
Season													
Fall	50.8	1.8	0.08	0	0	0	0	0.06	2.3	5.0	7.3	16.1	75.7
Spring	53.5	2.0	0.08	0	0	0	0	0.46	2.6	5.4	8.8	18.7	47.4
Summer	52.4	2.0	0.08	0	0	0	0	0.29	2.7	5.5	8.4	15.9	113.4
Winter	55.4	1.9	0.07	0	0	0	0	0.61	2.6	5.5	8.0	15.1	52.0
Urbanization													
Central City	55.5	2.1	0.07	0	0	0	0	0.67	2.8	5.8	8.5	17.2	66.5
Nonmetropolitan	45.6	1.5	0.08	0	0	0	0	0	1.9	4.4	7.0	14.9	61.9
Suburban	54.6	2.0	0.06	0	0	0	0	0.59	2.7	5.5	8.3	16.6	113.4
Race													
Asian	62.3	3.0	0.30	0	0	0	0	1.5	4.1	8.1	11.7	18.7	64.0
Black	48.1	1.8	0.11	0	0	0	0	0	2.2	5.4	8.1	16.6	50.1
Native American	44.1	2.0	0.65	0	0	0	0	0	2.5	6.8	7.9	17.0	61.9
Other/NA	60.3	2.8	0.21	0	0	0	0	0.98	3.9	7.5	10.8	22.4	113.4
White	53	1.8	0.04	0	0	0	0	0.37	2.5	5.1	7.7	15.7	75.7
Region													
Midwest	51	1.8	0.08	0	0	0	0	0.08	2.4	5.3	7.8	16.5	75.7
Northeast	62.5	2.4	0.09	0	0	0	0	1.1	3.2	6.2	9.5	19.5	66.5
South	47.6	1.6	0.06	0	0	0	0	0	2.1	4.7	7.1	14.9	65.7
West	55.3	2.0	0.09	0	0	0	0	0.61	2.8	5.8	8.4	15.3	113.4

SE = Standard error.

Source: Based on U.S. EPA's analyses of the 1994-96 CSFII.

Table 9-9. Per Capita Intake of Exposed Vegetables (g/kg-day as consumed)														
Population Group	Percent consuming	Mean	SE	Percentile										
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	79.2	1.3	0.02	0	0	0	0.11	0.80	1.9	3.4	4.4	7.6	45.0
Age Group													
0 to 5 months	6	0.48	0.62	0	0	0	0	0	0	0	4.6	11.8	12.5
6 to 12 months	40.8	2.0	0.49	0	0	0	0	0	3.1	5.8	10.3	14.7	19.0
<1 years	22.3	1.2	0.37	0	0	0	0	0	0	5.0	7.4	14.7	19.0
1 to 2 years	63.3	2.0	0.11	0	0	0	0	0.59	2.7	5.8	8.6	14.9	45.0
3 to 5 years	67.8	1.6	0.08	0	0	0	0	0.67	2.2	4.4	6.4	12.8	25.1
6 to 11 years	70.8	1.2	0.06	0	0	0	0	0.60	1.6	3.4	4.8	8.1	19.6
12 to 19 years	77.4	0.97	0.04	0	0	0	0.06	0.53	1.3	2.5	3.6	5.8	13.0
20 to 39 years	82.6	1.3	0.03	0	0	0	0.15	0.81	1.8	3.2	4.1	6.9	18.4
40 to 69 years	84	1.4	0.02	0	0	0	0.28	0.97	2.0	3.3	4.3	6.4	16.4
≥70 years	83.2	1.5	0.05	0	0	0	0.31	1.09	2.1	3.6	4.4	7.2	20.1
Season													
Fall	79.6	1.3	0.03	0	0	0	0.12	0.79	1.9	3.4	4.4	7.3	45.0
Spring	78.8	1.3	0.03	0	0	0	0.09	0.79	1.8	3.3	4.3	7.9	25.1
Summer	81.2	1.5	0.03	0	0	0	0.16	0.92	2.1	3.5	4.8	8.6	25.1
Winter	77.4	1.2	0.03	0	0	0	0.08	0.74	1.7	3.2	4.2	7.0	20.9
Urbanization													
Central City	79.5	1.4	0.03	0	0	0	0.12	0.83	2.0	3.5	4.5	8.1	25.1
Nonmetropolitan	78	1.2	0.03	0	0	0	0.08	0.69	1.6	2.9	4.1	6.9	45.0
Suburban	79.6	1.4	0.02	0	0	0	0.12	0.85	1.9	3.4	4.5	7.8	25.1
Race													
Asian	82.2	2.1	0.15	0	0	0	0.34	1.39	3.0	4.9	7.1	13.0	20.1
Black	76.3	1.2	0.04	0	0	0	0.04	0.66	1.7	3.3	4.1	7.2	20.9
Native American	70.7	1.3	0.40	0	0	0	0	0.45	1.5	2.0	4.5	9.5	45.0
Other/NA	73.8	1.3	0.08	0	0	0	0	0.73	1.8	3.3	4.7	10.4	24.8
White	80.1	1.3	0.02	0	0	0	0.13	0.82	1.9	3.3	4.4	7.2	25.1
Region													
Midwest	80.2	1.3	0.03	0	0	0	0.12	0.81	1.8	3.3	4.4	7.1	24.8
Northeast	79.4	1.4	0.04	0	0	0	0.12	0.91	2.1	3.5	4.6	7.9	25.1
South	79.6	1.3	0.03	0	0	0	0.12	0.78	1.8	3.2	4.2	7.1	25.1
West	77.5	1.3	0.04	0	0	0	0.08	0.78	1.8	3.4	4.6	8.9	45.0

SE = Standard error.

Source: Based on U.S. EPA's analyses of the 1994-96 CSFII.

Table 9-10. Per Capita Intake of Protected Vegetables (g/kg-day as consumed)

Population Group	Percent consuming	Mean	SE	1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	38.0	0.63	0.02	0	0	0	0	0	0.73	2.0	3.1	6.6	45.8
Age Group													
0 to 5 months	10.3	0.49	0.41	0	0	0	0	0	0	1.4	3.9	9.2	11.0
6 to 12 months	34.8	2.2	0.55	0	0	0	0	0	4.4	7.3	9.6	19.5	23.1
<1 years	21.8	1.3	0.37	0	0	0	0	0	0	5.4	7.8	11.9	23.1
1 to 2 years	40.8	1.5	0.13	0	0	0	0	0	1.9	4.4	7.0	14.2	27.8
3 to 5 years	38.2	1.1	0.09	0	0	0	0	0	1.4	3.5	5.4	10.3	18.0
6 to 11 years	38.8	0.78	0.07	0	0	0	0	0	1.0	2.6	3.9	7.5	26.5
12 to 19 years	30.4	0.46	0.06	0	0	0	0	0	0.44	1.5	2.4	5.8	21.6
20 to 39 years	36.7	0.53	0.04	0	0	0	0	0	0.61	1.7	2.7	5.5	23.6
40 to 69 years	41.2	0.56	0.03	0	0	0	0	0	0.73	1.7	2.6	4.8	45.8
≥70 years	42.2	0.65	0.05	0	0	0	0	0	0.86	2.0	3.1	5.7	21.5
Season													
Fall	37.9	0.62	0.04	0	0	0	0	0	0.71	2.1	3.2	5.9	21.6
Spring	37.8	0.62	0.04	0	0	0	0	0	0.67	1.8	2.9	7.6	23.6
Summer	39.3	0.67	0.04	0	0	0	0	0	0.85	1.9	3.1	6.3	45.8
Winter	37.1	0.61	0.04	0	0	0	0	0	0.71	1.9	3.0	6.9	27.8
Urbanization													
Central City	38.9	0.70	0.04	0	0	0	0	0	0.78	2.1	3.4	7.3	45.8
Nonmetropolitan	39.7	0.62	0.04	0	0	0	0	0	0.75	1.9	3.1	6.0	25.8
Suburban	36.6	0.59	0.03	0	0	0	0	0	0.68	1.9	2.9	5.9	27.8
Race													
Asian	45.4	0.85	0.14	0	0	0	0	0	1.1	2.7	4.1	7.8	23.3
Black	36.2	0.72	0.07	0	0	0	0	0	0.77	2.2	3.5	7.9	45.8
Native American	32.0	0.34	0.13	0	0	0	0	0	0.13	1.6	2.0	3.5	5.3
Other/NA	50.4	1.1	0.10	0	0	0	0	0.04	1.5	3.4	5.2	10.0	26.5
White	37.2	0.57	0.02	0	0	0	0	0	0.68	1.8	2.8	5.9	27.8
Region													
Midwest	36.3	0.57	0.04	0	0	0	0	0	0.62	1.8	2.9	5.6	21.5
Northeast	37.5	0.61	0.05	0	0	0	0	0	0.75	1.8	2.9	6.3	27.8
South	38.5	0.66	0.03	0	0	0	0	0	0.78	2.1	3.1	6.3	45.8
West	39.5	0.67	0.04	0	0	0	0	0	0.75	2.1	3.3	7.8	23.1

SE = Standard error.

Source: Based on U.S. EPA's analyses of the 1994-96 CSFII.

Table 9-11. Per Capita Intake of Root Vegetables (g/kg-day as consumed)

Population Group	Percent consuming	Mean	SE	Percentile 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	75.4	1.2	0.02	0	0	0	0.03	0.75	1.7	3.0	4.1	7.6	83.3
Age Group													
0 to 5 months	12	0.96	0.61	0	0	0	0	0	0	3.9	8.3	11.9	21.9
6 to 12 months	56.9	2.8	0.45	0	0	0	0	0.80	4.6	8.0	10.4	16.6	32.9
<1 years	33	1.8	0.36	0	0	0	0	0	2.3	6.9	9.6	15.6	32.9
1 to 2 years	67.5	2.6	0.13	0	0	0	0	1.5	3.6	6.8	8.3	16.8	83.3
3 to 5 years	71.9	2.2	0.09	0	0	0	0	1.4	3.2	5.5	7.1	14.1	32.1
6 to 11 years	73.8	1.6	0.06	0	0	0	0	1.0	2.3	4.2	5.3	9.5	20.6
12 to 19 years	76.4	1.3	0.05	0	0	0	0.09	0.82	1.8	3.0	4.0	7.7	22.5
20 to 39 years	77.5	1.1	0.03	0	0	0	0.10	0.73	1.6	2.7	3.5	6.0	16.6
40 to 69 years	77.2	0.99	0.02	0	0	0	0.08	0.68	1.5	2.5	3.2	4.8	15.1
≥70 years	73.2	1.1	0.04	0	0	0	0	0.70	1.6	2.7	3.4	5.3	9.8
Season													
Fall	77.3	1.3	0.04	0	0	0	0.09	0.83	1.8	3.1	4.2	8.1	83.3
Spring	75.9	1.2	0.03	0	0	0	0.05	0.73	1.7	3.1	4.3	7.7	30.0
Summer	74	1.2	0.03	0	0	0	0	0.73	1.6	2.9	3.9	7.4	25.8
Winter	74.4	1.2	0.03	0	0	0	0	0.74	1.7	3.0	4.1	7.4	34.3
Urbanization													
Central City	71.9	1.2	0.03	0	0	0	0	0.66	1.6	2.9	4.2	7.3	83.3
Nonmetropolitan	78.5	1.4	0.04	0	0	0	0.14	0.89	1.9	3.2	4.5	9.5	34.3
Suburban	76.4	1.2	0.02	0	0	0	0.07	0.77	1.7	3.0	4.0	7.2	26.1
Race													
Asian	64.2	0.97	0.10	0	0	0	0	0.37	1.3	2.8	4.0	7.1	17.3
Black	68.9	1.1	0.05	0	0	0	0	0.62	1.4	2.9	4.2	7.6	32.9
Native American	71.1	1.4	0.27	0	0	0	0	1.0	1.9	2.8	3.0	11.2	34.3
Other/NA	67	1.1	0.10	0	0	0	0	0.50	1.4	2.8	3.7	9.6	83.3
White	77.5	1.3	0.02	0	0	0	0.09	0.81	1.8	3.1	4.2	7.5	32.1
Region													
Midwest	79.4	1.4	0.04	0	0	0	0.16	0.90	2.0	3.4	4.6	8.6	26.1
Northeast	72.3	1.1	0.03	0	0	0	0	0.64	1.5	2.9	3.8	7.1	20.7
South	77	1.3	0.03	0	0	0	0.09	0.81	1.8	3.0	4.1	7.6	83.3
West	71.3	1.1	0.03	0	0	0	0	0.61	1.5	2.8	3.7	6.9	34.3

SE = Standard error.

Source: Based on U.S. EPA's analyses of the 1994-96 CSFII.

Table 9-12. Mean Total Fruit and Total Vegetable Intake (as consumed) in a Day by Sex and Age (1977-1978)[a]			
Age (years)	Per Capita Intake (g/day)	Percent of Population Using in a Day	Consumer Only Intake (g/day) [b]
		Fruits	
Males and Females			
≤ 1	169	86.8	196
1 to 2	146	62.9	231
3 to 5	134	56.1	239
6 to 8	152	60.1	253
Males			
9 to 11	133	50.5	263
12 to 14	120	51.2	236
15 to 18	147	47.0	313
19 to 22	107	39.4	271
23 to 34	141	46.4	305
35 to 50	115	44.0	262
51 to 64	171	62.4	275
65 to 74	174	62.2	281
≥75	186	62.6	197
Females			
9 to 11	148	59.7	247
12 to 14	120	48.7	247
15 to 18	126	49.9	251
19 to 22	133	48.0	278
23 to 34	122	47.7	255
35 to 50	133	52.8	252
51 to 64	171	66.7	256
65 to 74	179	69.3	259
≥75	189	64.7	292
Males and Females			
All ages	142	54.2	263
		Vegetables	
Males and Females			
≤ 1	76	62.7	121
1 to 2	91	78.0	116
3 to 5	100	79.3	126
6 to 8	136	84.3	161
Males			
9 to 11	138	83.5	165
12 to 14	184	84.5	217
15 to 18	216	85.9	251
19 to 22	226	84.7	267
23 to 34	248	88.5	280
35 to 50	261	86.8	300
51 to 64	285	90.3	316
65 to 74	265	88.5	300
≥75	264	93.6	281
Females			
9 to 11	139	83.7	166
12 to 14	154	84.6	183
15 to 18	178	83.8	212
19 to 22	184	81.1	227
23 to 34	187	84.7	221
35 to 50	187	84.6	221
51 to 64	229	89.8	255
65 to 74	221	87.2	253
≥75	198	88.1	226
Males and Females			
All ages	201	85.6	235

[a] Based on USDA Nationwide Food Consumption Survey (1977-1978) data for one day.

[b] Intake for users only was calculated by dividing the per capita intake rate by the fraction of the population using fruit in a day.

Source: USDA, 1980.

Table 9-13. Mean Total Fruit and Total Vegetable Intake (as consumed) in a Day by Sex and Age (1987-88, 1994, and 1995)[a]

Age (yr)	Per Capita Intake (g/day)			Percent of Population Using in 1 Day			Consumer Only Intake (g/day)[b]		
	1987-88	1994	1995	1987-88	1994	1995	1987-88	1994	1995
Fruits									
Males and Females									
5 and under	157	230	221	59.2	70.6	72.6	265	326	304
Males									
6 to 11	182	176	219	63.8	59.8	62.2	285	294	352
12 to 19	158	169	210	49.4	44.0	47.1	320	384	446
≥ 20	133	175	170	46.5	50.2	49.6	286	349	342
Females									
6 to 11	154	174	172	58.3	59.3	63.6	264	293	270
12 to 19	131	148	167	47.1	47.1	44.4	278	314	376
≥ 20	140	157	155	52.7	55.1	54.4	266	285	285
Males and Females									
All Ages	142	171	173	51.4	54.1	54.2	276	316	319
Vegetables									
Males and Females									
5 and under	81	80	83	74.0	75.2	75.0	109	106	111
Males									
6 to 11	129	118	111	86.8	82.4	80.6	149	143	138
12 to 19	173	154	202	85.2	74.9	79.0	203	206	256
≥ 20	232	242	241	85.0	85.9	86.4	273	282	278
Females									
6 to 11	129	115	108	80.6	82.9	79.1	160	139	137
12 to 19	129	132	144	75.8	78.5	76.0	170	168	189
≥ 20	183	190	189	82.9	84.7	83.2	221	224	227
Males and Females									
All Ages	182	186	188	82.6	83.2	82.6	220	223	228

[a] Based on USDA NFCS (1987-88) and CSFII (1994 and 1995) data for one day.
[b] Intake for users only was calculated by dividing the per capita intake rate by the fraction of the population using fruits in a day.

Source: USDA, 1996a; 1996b.

Table 9-14. Per Capita Consumption of Fresh Fruits and Vegetables in 1991[a]

Fresh Fruits		Fresh Vegetables	
Food Item	Per Capita Consumption (g/day)[b]	Food Item	Per Capita Consumption (g/day)[b]
Citrus		Artichokes	0.62
Oranges (includes Temple oranges)	10.2	Asparagus	0.75
Tangerines and Tangelos	1.6	Snap Beans	1.4
Lemons	3.1	Broccoli	3.5
Limes	0.9	Brussel Sprouts	0.4
Grapefruit	7.1	Cabbage	9.5
Total Fresh Citrus	22.9	Carrots	9.0
		Cauliflower	2.2
Non-citrus		Celery	7.8
Apples	21.8	Sweet Corn	6.6
Apricots	0.1	Cucumber	5.2
Avocados	1.7	Eggplant	0.5
Bananas	31.2	Escarole/Endive	0.3
Cherries	0.5	Garlic	1.6
Cranberries	0.4	Head Lettuce	30.2
Grapes	8.2	Onions	18.4
Kiwi Fruit	0.5	Bell Peppers	5.8
Mangoes	1.0	Radishes	0.6
Peaches & Nectarines	7.6	Spinach	0.9
Pears	3.7	Tomatoes	16.3
Pineapple	2.2	Total Fresh Vegetables	126.1
Papayas	0.3		
Plums and Prunes	1.7		
Strawberries	4.1		
Total Fresh Non-citrus	85.0		
Total Fresh Fruits	107.7		

[a] Based on retail-weight equivalent. Includes imports; excludes exports and foods grown in home gardens. Data for 1991 used.

[b] Original data were presented in lbs/yr; data were converted to g/day by multiplying by a factor of 454 g/lb and dividing by 365 days/yr.

Source: USDA, 1993.

Table 9-15. Mean Quantities of Vegetables Consumed Daily by Sex and Age, for Children, Per Capita (g/day)

Age Group	Sample Size	Total	White Potatoes		Dark Green Vegetables	Deep Yellow Vegetables	Tomatoes	Lettuce, lettuce-based salads	Green beans	Corn, green peas, lima beans	Other vegetables
			Total	Fried							
Males and Females											
Under 1 year	1,126	57	9	1	2	19	1[a]	[a,b]	6	5	16
1 year	1,016	79	26	11	5	9	7	1	8	9	16
2 years	1,102	87	32	17	4	5	11	2	7	10	17
1 to 2 years	2,118	83	29	14	5	7	9	1	7	9	17
3 years	1,831	91	34	17	5	5	13	2	5	11	16
4 years	1,859	97	37	19	6	5	11	3	5	12	18
5 years	884	103	44	22	4	6	12	3	6	12	17
3 to 5 years	4,574	97	38	20	5	5	12	3	5	11	17
≤ 5 years	7,818	88	31	16	4	7	10	2	6	10	17
Males											
6 to 9 years	787	110	47	26	4	5	16	5	5	11	16
6 to 11 years	1,031	115	50	27	5	5	16	5	5	11	18
12 to 19 years	737	176	85	44	6	6	28	12	3[a]	10	25
Females											
6 to 9 years	704	110	42	22	5	4	14	6	5	13	21
6 to 11 years	969	116	46	25	5	4	15	7	5	12	22
12 to 19 years	732	145	61	31	9	4	18	12	4	8	28
Males and Females											
≤ 9 years	9,309	97	37	19	4	6	12	3	6	11	18
≤ 19 years	11,287	125	53	27	6	6	17	7	5	10	22

[a] Estimate is not statistically reliable due to small samples size reporting intake.

[b] Value less than 0.5 but greater than 0.

Note: Consumption amounts shown are representative of the first day of each participant's survey response.

Source: USDA, 1999.

Table 9-16. Percentage of Individuals Consuming Vegetables, by Sex and Age, for Children (%)

Age Group	Sample Size	Total	White Potatoes		Dark Green Vegetables	Deep Yellow Vegetables	Tomatoes	Lettuce, lettuce-based salads	Green beans	Corn, green peas, lima beans	Other vegetables
			Total	Fried							
Males and Females											
Under 1 year	1,126	47.2	12.3	4.3	2.3	20.5	1.8	0.2[a]	7.8	8.5	14.8
1 year	1,016	73.3	40.4	25.2	6.4	13.3	18.0	3.9	13.7	17.6	19.4
2 years	1,102	78.4	46.7	34.5	7.6	10.5	30.8	7.5	11.5	15.0	22.3
1 to 2 years	2,118	75.9	43.6	29.9	7.0	11.8	24.6	5.7	12.6	16.2	20.9
3 years	1,831	80.5	46.7	34.7	7.0	10.7	34.1	8.3	10.1	14.6	24.7
4 years	1,859	80.7	47.3	34.8	7.2	12.0	33.0	10.0	9.0	16.4	26.5
5 years	884	83.0	50.7	38.3	4.6	13.3	36.5	13.4	10.4	16.1	28.8
3 to 5 years	4,574	81.4	48.2	35.9	6.3	12.0	34.5	10.6	9.9	15.7	26.7
≤ 5 years	7,818	75.4	42.3	30.1	6.1	13.0	27.2	7.6	10.5	15.0	23.3
Males											
6 to 9 years	787	78.8	47.9	38.0	6.3	12.5	38.2	13.1	7.8	15.0	29.7
6 to 11 years	1,031	79.3	48.7	38.4	6.1	12.4	38.7	13.9	6.7	13.8	30.8
12 to 19 years	737	78.2	49.5	38.6	3.6	8.0	43.0	23.8	3.5	7.4	33.2
Females											
6 to 9 years	704	80.5	48.2	36.3	5.9	11.9	33.8	15.8	8.4	15.9	26.6
6 to 11 years	969	81.7	50.8	38.9	5.4	11.4	33.5	17.1	7.8	15.1	29.2
12 to 19 years	732	79.5	46.4	34.6	7.0	10.6	35.3	25.1	4.4	7.4	34.5
Males and Females											
≤ 9 years	9,309	77.1	44.6	32.9	6.1	12.7	30.7	10.3	9.6	15.2	25.2
≤ 19 years	11,287	78.3	46.8	35.3	5.6	11.2	34.6	16.6	7.0	11.9	29.4

[a] Estimate is not statistically reliable due to small samples size reporting intake.

Note: Consumption amounts shown are representative of the first day of each participant's survey response.

Source: USDA, 1999.

Table 9-17. Mean Quantities of Fruits Consumed Daily by Sex and Age, for Children, Per Capita (g/day)

Age Group	Sample Size	Total	Citrus Fruits and Juices		Dried fruits	Other fruits, mixtures, and juices					
			Total	Juices		Total	Apples	Bananas	Melons and berries	Other fruits and mixtures (mainly fruit)	Non-citrus juices and nectars
Males and Females											
Under 1 year	1,126	131	4	4	-[a,b]	126	14	10	1[a]	39	61
1 year	1,016	267	47	42	2	216	22	23	8	29	134
2 years	1,102	276	65	56	2	207	27	20	10	20	130
1 to 2 years	2,118	271	56	49	2	212	24	22	9	24	132
3 years	1,831	256	61	51	1	191	27	18	13	24	110
4 years	1,859	243	62	52	1	177	31	17	14	22	92
5 years	884	218	55	44	-[a,b]	160	31	14	13	24	78
3 to 5 years	4,574	239	59	49	1	176	30	16	13	23	93
≤ 5 years	7,818	237	52	44	1	182	26	17	10	26	103
Males											
6 to 9 years	787	194	58	51	-[a,b]	133	32	11	21	20	50
6 to 11 years	1,031	183	67	60	-[a,b]	113	28	11	16	19	40
12 to 19 years	737	174	102	94	1[a]	70	13	8	11[a]	10	29
Females											
6 to 9 years	704	180	63	54	1[a]	113	23	10	10	25	46
6 to 11 years	969	169	64	54	-[a,b]	103	21	8	8	23	42
12 to 19 years	732	157	72	67	-[a,b]	83	13	5	15	14	35
Males and Females											
≤ 9 years	9,309	217	55	47	1	159	27	15	12	24	81
≤ 19 years	11,287	191	70	62	1	118	21	11	12	19	56

[a] Estimate is not statistically reliable due to small samples size reporting intake.
[b] Value less than 0.5, but greater than 0.
\- Indicates value as not statistically significant or less than 0.5, but greater than 0
Note: Consumption amounts shown are representative of the first day of each participant's survey response

Source: USDA, 1999.

Table 9-18. Percentage of Individuals Consuming, Fruits by Sex and Age, for Children (%)

Age Group	Sample Size	Total	Citrus Fruits and Juices		Dried fruits	Other fruits, mixtures, and juices					
			Total	Juices		Total	Apples	Bananas	Melons and berries	Other fruits and mixtures (mainly fruit)	Non-citrus juices and nectars
Males and Females											
Under 1 year	1,126	59.7	3.6	2.7	0.4[a]	59.0	15.7	13.3	1.8	29.9	33.0
1 year	1,016	81.0	23.6	19.0	5.9	73.0	23.4	25.1	6.9	26.5	43.2
2 years	1,102	76.6	30.6	23.4	5.3	64.7	24.0	20.2	8.5	19.4	37.0
1 to 2 years	2,118	78.8	27.2	21.3	5.6	68.8	23.7	22.6	7.7	22.9	40.0
3 years	1,831	74.5	27.9	21.4	4.1	64.2	22.4	17.5	7.8	20.1	33.3
4 years	1,859	72.6	28.0	21.8	3.0	62.1	23.7	15.7	7.6	20.0	30.8
5 years	884	67.6	26.9	19.5	1.3[a]	56.9	21.9	12.6	7.4	19.0	24.5
3 to 5 years	4,574	71.6	27.6	20.9	2.8	61.0	22.7	15.3	7.6	19.7	29.5
≤ 5 years	7,818	72.6	24.6	18.8	3.5	63.5	22.2	17.6	6.9	22.0	33.5
Males											
6 to 9 years	787	59.0	24.8	20.5	0.8[a]	49.1	20.3	8.7	7.3	16.8	15.5
6 to 11 years	1,031	56.5	25.2	21.6	1.1[a]	44.2	18.2	8.0	6.6	15.4	12.7
12 to 19 years	737	44.5	24.7	21.7	1.0[a]	27.1	8.2	6.0	4.1	7.1	8.2
Females											
6 to 9 years	704	64.9	27.9	22.3	1.5[a]	50.4	17.3	8.8	7.4	20.4	17.3
6 to 11 years	969	62.1	27.7	21.5	1.1[a]	47.2	16.2	7.3	7.4	19.0	14.9
12 to 19 years	732	45.6	22.4	18.1	1.1[a]	30.2	8.2	4.4	6.0	11.3	9.7
Males and Females											
≤ 9 years	9,309	68.3	25.2	19.8	2.5	58.0	20.9	14.0	7.1	20.6	26.7
≤ 19 years	11,287	57.8	24.8	20.1	1.8	44.4	15.2	9.7	6.2	15.5	17.9

[a] Estimate is not statistically reliable due to small samples size reporting intake.

Note: Percentages shown are representative of the first day of each participant's survey response.

Source: USDA, 1999.

Table 9-19. Quantity (as consumed) of Fruits and Vegetables Consumed Per Eating Occasion and the Percentage of Individuals Using These Foods in Two Days

Food category	PC	Quantity consumed per eating occasion (g)		Consumers-only Quantity consumed per eating occasion at specified percentiles (g)[a]						
		Average	SE	5	10	25	50	75	90	95
Raw vegetables										
Cucumbers	10.8	48	3	7	14	16	29	54	100	157
Lettuce	53.3	41	1	7	8	13	27	55	91	110
Mixed lettuce-based salad	2.2	97	6	11	18	55	74	123	167	229
Carrots	14.1	33	1	5	7	14	27	40	61	100
Tomatoes	32.0	53	1	15	20	27	40	61	93	123
Coleslaw	5.0	102	3	18	32	55	91	134	179	183
Onions	14.4	23	1	3	7	10	15	28	41	60
Cooked vegetables										
Broccoli	7.3	119	4	23	35	61	92	156	232	275
Carrots	5.8	72	2	13	19	36	65	78	146	156
Total tomato sauce	54.3	34	1	1	2	7	17	40	80	124
String beans	13.2	90	2	17	31	52	68	125	136	202
Peas	6.1	86	3	11	21	40	80	120	167	170
Corn	15.1	101	2	20	33	55	82	123	171	228
French-fried potatoes	25.5	83	1	28	35	57	70	112	125	140
Home-fried and hash-browned	8.9	135	3	36	47	70	105	192	284	308
potatoes	12.4	120	2	48	61	92	106	143	184	217
Baked potatoes	5.3	157	5	34	52	91	123	197	308	368
Boiled potatoes	15.0	188	3	46	61	105	156	207	397	413
Mashed potatoes	8.0	133	3	22	33	64	101	173	259	345
Dried beans and peas	4.7	171	6	24	47	84	126	235	314	385
Baked beans										
Fruits										
Raw oranges	7.9	132	2	42	64	95	127	131	183	253
Orange juice	27.2	268	4	124	124	187	249	311	447	498
Raw apples	15.6	135	2	46	68	105	134	137	209	211
Applesauce and cooked apples	4.6	134	4	31	59	85	121	142	249	254
Apple juice	7.0	271	7	117	120	182	242	307	481	525
Raw bananas	20.8	111	1	55	58	100	117	118	135	136

PC = Percent consuming at least once in 2 days.
SE = Standard error of the mean.

Source: Smiciklas-Wright et al., 2002 (based on 1994-1996 CSFII data).

Table 9-20. Quantity (as consumed) of Fruits and Vegetables Consumed Per Eating Occasion and Percentage of Individuals Using These Foods in Two Days, by Age

Food category	Quantity consumed per eating occasion (grams)											
	2 to 5 years			6 to 11 years			12 to 19 years					
	Male and Female (N = 2,109)			Male and Female (N = 1,432)			Male (N = 696)			Female (N = 702)		
	PC	Mean.	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE
Raw Vegetables												
Carrots	10.4	27	2	17.8	32	2	9.2	35	6	11.9	32	4
Cucumbers	6.4	32	4	6.6	39	6	6.1	71[a]	22[a]	6.8	48	11
Lettuce	34.0	17	1	40.8	26	1	56.0	32	3	52.3	34	2
Onions	3.9	9	2	4.5	17	2	11.1	28	4	7.9	23	4
Tomatoes	14.8	31	2	14.0	42	4	25.7	49	5	23.9	44	3
Cooked Vegetables												
Beans (string)	16.8	50	2	12.1	71	6	8.3	85	9	7.6	78	5
Broccoli	7.2	61	3	5.6	102	16	3.9	127[a]	17[a]	5.7	109[a]	14[a]
Carrots	6.0	48	4	3.8	46	5	2.8	81[a]	16[a]	2.1	75[a]	17[a]
Corn	18.9	68	3	22.2	79	4	12.8	125	9	12.3	100	6
Peas	8.4	48	3	6.8	72	9	3.6	115[a]	15[a]	2.4	93[a]	17[a]
Potatoes (French-fried)	32.7	52	1	33.7	67	2	41.7	97	3	38.1	81	4
Potatoes (home-fried and hash-browned)	9.3	85	5	10.1	93	6	10.1	145	13	6.1	138	13
Potatoes (baked)	7.6	70	4	8.2	95	6	8.6	152	15	8.8	115	10
Potatoes (boiled)	4.8	81	9	2.7	103[a]	17[a]	2.0	250[a]	40[a]	3.2	144[a]	16[a]
Potatoes (mashed)	14.8	118	6	13.3	162	12	14.6	245	16	11.9	170	17
Fruits												
Apples (raw)	26.8	106	2	21.9	123	3	11.7	149	9	12.4	129	5
Apples (cooked and applesauce)	10.1	118	5	9.0	130	7	2.3	153[a]	19[a]	2.6	200[a]	47[a]
Apple juice	26.3	207	5	12.2	223	10	7.8	346	22	8.5	360	44
Bananas (raw)	25.0	95	2	16.5	105	3	10.3	122	6	8.4	119	5
Oranges (raw)	11.1	103	5	10.5	114	5	4.3	187[a]	38[a]	5.4	109[a]	8[a]
Orange juice	34.4	190	4	30.9	224	6	30.8	354	16	29.5	305	11

[a] Indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation
PC = Percent consuming at least once in 2 days.
SE = Standard error of the mean.

Source: Smiciklas-Wright et al., 2002 (based on 1994-1996 CSFII data).

Table 9-20. Quantity (as consumed) of Fruits and Vegetables Consumed Per Eating Occasion and Percentage of Individuals Using These Foods in Two Days, by Age (continued)

Food category	Quantity consumed per eating occasion (grams)																	
	20 to <40 years						40 to <60 years						>=60 years					
	Male (N = 1,543)			Female (N = 1,449)			Male (N = 1,663)			Female (N = 1,694)			Male (N = 1,545)			Female (N = 1,429)		
	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE
Raw Vegetables																		
Carrots	12.3	35	4	15.4	38	4	14.4	35	2	18.1	31	2	13.6	29	2	12.7	27	1
Cucumbers	10.5	62	12	10.4	45	4	12.5	47	4	15.7	41	3	14.2	51	4	13.2	45	3
Lettuce	63.4	40	2	57.6	44	2	55.5	48	2	59.1	48	1	48.1	47	2	46.1	42	2
Onions	17.9	27	2	14.7	22	1	19.6	26	1	18.3	19	1	19.0	19	1	15.6	19	1
Tomatoes	33.1	57	2	32.3	49	2	38.1	60	2	42.4	53	1	40.0	62	3	41.0	52	2
Cooked Vegetables																		
Beans (string)	10.6	111	5	12.5	89	6	13.7	114	6	13.4	93	4	18.3	99	4	19.7	78	3
Broccoli	7.6	152	13	6.7	129	13	7.8	127	7	7.6	114	7	8.5	117	7	10.9	107	6
Carrots	5.0	79	7	5.3	69	6	6.7	83	7	6.4	66	4	9.6	78	4	9.0	75	4
Corn	12.7	122	5	15.3	98	5	17.1	133	6	13.5	90	3	14.2	109	4	13.0	83	5
Peas	4.4	109	10	4.9	82	9	7.4	113	7	6.3	79	7	8.4	88	7	9.4	73	5
Potatoes (French-fried)	35.3	107	2	23.9	79	3	20.6	89	2	16.8	72	3	11.2	76	3	8.1	58	3
Potatoes (home-fried/hash-browned)	9.5	160	10	8.8	129	7	11.	174	10	6.4	119	7	10.4	152	8	7.1	110	9
Potatoes (baked)	11.4	154	7	11.1	126	5	13.0	133	3	16.5	112	3	17.9	115	3	18.1	100	4
Potatoes (boiled)	3.9	185	16	2.9	162	15	6.3	209	12	7.0	142	9	11.0	166	6	10.2	131	5
Potatoes (mashed)	14.7	269	12	13.5	167	5	16.0	225	11	14.3	156	7	19.7	173	6	18.1	140	5
Fruits																		
Apples (raw)	6.6	153	8	6.3	126	6	7.4	148	8	8.3	132	5	8.9	133	5	11.2	129	4
Apples (cooked and applesauce)	24.3	373	20	23.2	289	12	24.1	285	10	25.2	231	6	30.2	213	5	31.7	196	5
Apple juice	12.1	161	6	12.9	134	3	14.1	145	3	16.2	136	4	17.6	145	8	16.1	128	3
Bananas (raw)	1.3	153 [a]	31 [a]	2.4	155 [a]	21 [a]	3.1	142	12	3.9	125	10	8.1	135	10	9.2	121	7
Oranges (raw)	4.2	345	20	4.7	302	19	4.7	358	33	3.2	259	21	4.8	233	11	5.0	225	13
Orange juice	14.4	126	2	18.5	112	2	21.9	125	3	24.4	111	2	36.5	105	2	34.0	96	2

[a] Indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation
PC = Percent consuming at least once in 2 days.
SE = Standard error of the mean.

Source: Smiciklas-Wright et al., 2002 (based on 1994-1996 CSFII data).

Table 9-21. Consumption of Major Food Groups: Median Servings (and Ranges) by Demographic and Health Characteristics, for Older Adults

Subject Characteristic		N	Fruits and Vegetables
Gender			
	Female	80	5.7 (1.5 - 8.1)
	Male	50	4.5 (0.8 - 8.8)
Ethnicity			*
	African American	44	4.5 (0.8 - 8.0)
	European American	47	6.0 (1.5 - 8.0)
	Native American	39	4.5 (1.6 - 8.8)
Age			
	70 to 74	42	4.5 (1.6 - 8.1)
	75 to 79	36	5.6 (0.8 - 8.0)
	80 to 84	36	5.6 (1.5 - 8.8)
	≥ 85	16	5.4 (1.8 - 8.0)
Marital Status			
	Married	49	4.5 (1.6 - 8.0)
	Not Married	81	5.6 (0.8 - 8.8)
Education			
	8^{th} grade or less	37	5.0 (1.5 - 8.1)
	9^{th} to 12^{th} grades	47	4.5 (0.8 - 8.0)
	> High School	46	6.0 (1.5 - 8.8)
Dentures			
	Yes	83	5.4 (1.5 - 8.8)
	No	47	4.7 (0.8 - 8.0)
Chronic Diseases			
	0	7	7.0 (5.2 - 8.8)
	1	31	5.4 (1.5 - 8.0)
	2	56	5.4 (1.6 - 8.1)
	3	26	4.5 (2.0 - 8.0)
	4+	10	5.5 (0.8 - 8.0)
Weight[a]			
	130	18	6.0 (1.8 - 8.0)
	131 to 150	32	5.5 (1.5 - 8.0)
	151 to 170	27	5.7 (1.7 - 8.1)
	171 to 190	22	5.6 (1.8 - 8.8)
	191	29	4.5 (0.8 - 8.0)

N = Number of individuals.
[a] Two missing values.
* $p < 0.05$.

Source: Vitolins et al., 2002.

Table 9-22. Characteristics of the FITS Sample Population

	Sample Size	Percentage of Sample
Gender		
Male	1,549	51.3
Female	1,473	48.7
Age of Child		
4 to 6 months	862	28.5
7 to 8 months	483	16.0
9 to 11 months	679	22.5
12 to 14 months	374	12.4
15 to 18 months	308	10.2
19 to 24 months	316	10.4
Child's Ethnicity		
Hispanic or Latino	367	12.1
Non-Hispanic or Latino	2,641	87.4
Missing	14	0.5
Child's Race		
White	2,417	80.0
Black	225	7.4
Other	380	12.6
Urbanicity		
Urban	1,389	46.0
Suburban	1,014	33.6
Rural	577	19.1
Missing	42	1.3
Household Income		
Under $10,000	48	1.6
$10,000 to $14,999	48	1.6
$15,000 to $24,999	221	7.3
$25,000 to $34,999	359	11.9
$35,000 to $49,999	723	23.9
$50,000 to $74,999	588	19.5
$75,000 to $99,999	311	10.3
$100,000 and Over	272	9.0
Missing	452	14.9
Receives WIC		
Yes	821	27.2
No	2,196	72.6
Missing	5	0.2
Sample Size (Unweighted)	3,022	100.0

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Devaney et al., 2004.

Table 9-23. Percentage of Infants and Toddlers Consuming Different Types of Vegetables

Food Group/Food	Percentage of Infants and Toddlers Consuming at Least Once in a Day					
	4 to 6 months	7 to 8 months	9 to 11 months	12 to 14 months	15 to 18 months	19 to 24 months
Any Vegetable	39.9	66.5	72.6	76.5	79.2	81.6
Baby Food Vegetables	35.7	54.5	34.4	12.7	3.0	1.6
Cooked Vegetables	5.2	17.4	45.9	66.3	72.9	75.6
Raw Vegetables	0.5	1.6	5.5	7.9	14.3	18.6
Types of Vegetables[a]						
Dark Green Vegetables[b]	0.1	2.9	4.2	5.0	10.4	7.8
Deep Yellow Vegetables[c]	26.5	39.3	29.0	24.0	13.6	13.4
White Potatoes	3.6	12.4	24.1	33.2	42.0	40.6
French Fries and Other Fried Potatoes	0.7	2.9	8.6	12.9	19.8	25.5
Other Starchy Vegetables[d]	6.5	10.9	16.9	17.3	20.8	24.2
Other Vegetables	11.2	25.9	35.1	39.1	45.6	43.3

[a] Totals include commercial baby food, cooked vegetables, and raw vegetables.
[b] Reported dark green vegetables include broccoli, spinach and other greens, and romaine lettuce.
[c] Reported deep yellow vegetables include carrots, pumpkin, sweet potatoes, and winter squash.
[d] Reported starchy vegetables include corn, green peas, immature lima beans, black-eyed peas (not dried), cassava, and rutabaga.

Source: Fox et al., 2004.

Table 9-24. Top Five Vegetables Consumed by Infants and Toddlers

Top Vegetables by Age Group[a]	Percentage Consuming at Least Once in a Day
4 to 6 months	
Baby Food Carrots	9.6
Baby Food Sweet Potatoes	9.1
Baby Food Squash	8.1
Baby Food Green Beans	7.2
Baby Food Peas	5.0
7 to 8 months	
Baby Food Carrots	14.2
Baby Food Sweet Potatoes	12.9
Baby Food Squash	12.9
Baby Food Green Beans	11.2
Baby Food Mixed/Garden Vegetables	10.1
9 to 11 months	
Cooked Green Beans	9.7
Mashed/Whipped Potatoes	9.0
French Fries/Other Fried Potatoes	8.6
Baby Food Mixed/Garden Vegetables	8.4
Cooked Carrots	8.0
12 to 14 months	
Cooked Green Beans	18.2
French Fries/Other Fried Potatoes	12.9
Cooked Carrots	11.5
Mashed/Whipped Potatoes	10.3
Cooked Peas	8.4
15 to 18 months	
French Fries/Other Fried Potatoes	19.8
Cooked Green Beans	16.7
Cooked Peas	13.9
Cooked Tomatoes/Tomato Sauce	13.7
Mashed/Whipped Potatoes	12.4
19 to 24 months	
French Fries/Other Fried Potatoes	25.5
Cooked Green Beans	16.8
Cooked Corn	15.2
Cooked Peas	11.4
Cooked Tomatoes/Tomato Sauce	9.4

[a] Baby food vegetables include single vegetables (majority of vegetables reported) as well as mixtures with the named vegetables the predominant vegetable, e.g., broccoli and cauliflower or broccoli and carrots.

Source: Fox et al., 2004.

Table 9-25. Percentage of Infants and Toddlers Consuming Different Types of Fruits						
	Percentage of Infants and Toddlers Consuming at Least Once in a Day					
Food Group/Food	4 to 6 months	7 to 8 months	9 to 11 months	12 to 14 months	15 to 18 months	19 to 24 months
Any Fruit	41.9	75.5	75.8	77.2	71.8	67.3
Baby Food Fruit	39.1	67.9	44.8	16.2	4.2	1.8
Non-baby Food Fruit	5.3	14.3	44.2	67.1	69.4	66.8
Types of Non-baby Food Fruit						
Canned Fruit	1.4	5.8	21.6	31.9	25.1	20.2
Packed in Syrup	0.7	0.7	8.1	14.9	12.7	8.1
Packed in Juice or Water	0.7	4.5	13.5	18.5	11.3	11.4
Unknown Pack	0.0	0.7	1.5	1.2	3.1	1.2
Fresh Fruit	4.4	9.5	29.5	52.1	55.0	54.6
Dried Fruit	0.0	0.4	2.1	3.5	7.1	9.4
Types of Fruit[a]						
Apples	18.6	33.1	31.6	27.5	19.8	22.4
Bananas	16.0	30.6	34.5	37.8	32.4	30.0
Berries	0.1	0.6	5.3	6.6	11.3	7.7
Citrus Fruits	0.2	0.4	1.6	4.9	7.3	5.1
Melons	0.6	1.0	4.4	7.3	7.2	9.6

[a] Totals include all baby food and non-baby food fruits.

Source: Fox et al., 2004.

Table 9-26. Top Five Fruits Consumed by Infants and Toddlers	
Top Fruits by Age Group[a]	Percentage Consuming at Least Once in a Day
4 to 6 months	
Baby Food Applesauce	17.5
Baby Food Bananas	13.0
Baby Food Pears	7.5
Baby Food Peaches	7.4
Fresh Banana	0.3
7 to 8 months	
Baby Food Applesauce	29.0
Baby Food Bananas	25.2
Baby Food Pears	18.2
Baby Food Peaches	13.1
Fresh Banana	6.6
9 to 11 months	
Fresh Banana	19.0
Baby Food Applesauce	17.7
Baby Food Bananas	16.8
Baby Food Pears	12.4
Canned Applesauce	11.1
12 to 14 months	
Fresh Banana	33.0
Canned Applesauce	15.2
Fresh Grapes	9.0
Fresh Apple	8.8
Canned Peaches	7.2
Canned Fruit Cocktail	7.2
15 to 18 Months	
Fresh Banana	30.5
Fresh Grapes	13.2
Fresh Apple	11.2
Fresh Strawberries	10.6
Canned peaches	8.9
19 to 24 months	
Fresh Banana	29.6
Fresh Apple	15.0
Fresh Grapes	11.2
Raisins	9.0
Fresh Strawberries	7.6

[a] Baby food fruits include single fruits (majority of fruits reported) as well as mixtures with the named fruit as the predominant fruit, e.g., pears and raspberries or prunes with pears. Baby food fruits with tapioca and other baby food dessert fruits were counted as desserts.

Source: Fox et al., 2004.

Table 9-27. Characteristics of WIC Participants and Non-participants[a] (Percentages)

	Infants 4 to 6 months		Infants 7 to 11 months		Toddlers 12 to 24 months	
	WIC Participant	Non-participant	WIC Participant	Non-participant	WIC Participant	Non-participant
Gender						
Male	55	54	55	51	57	52
Female	45	46	45	49	43	48
Child's Ethnicity		**		**		**
Hispanic or Latino	20	11	24	8	22	10
Non-Hispanic or Latino	80	89	76	92	78	89
Child's Race		**		**		**
White	63	84	63	86	67	84
Black	15	4	17	5	13	5
Other	22	11	20	9	20	11
Child In Day Care				**		*
Yes	39	38	34	46	43	53
No	61	62	66	54	57	47
Age of Mother		**		**		**
14 to 19	18	1	13	1	9	1
20 to 24	33	13	38	11	33	14
25 to 29	29	29	23	30	29	26
30 to 34	9	33	15	36	18	34
>35	9	23	11	21	11	26
Missing	2	2	1	1	0	1
Mother's Education		**		**		**
11th Grade or Less	23	2	15	2	17	3
Completed High School	35	19	42	20	42	19
Some Postsecondary	33	26	32	27	31	28
Completed College	7	53	9	51	9	48
Missing	2	1	2	0	1	2
Parent's Marital Status		**		**		**
Married	49	93	57	93	58	88
Not Married	50	7	42	7	41	11
Missing	1	1	1	0	1	1
Mother or Female Guardian Works				**		*
Yes	46	51	45	60	55	61
No	53	48	54	40	45	38
Missing	1	1	1	0	0	1
Urbanicity		**		**		**
Urban	34	55	37	50	35	48
Suburban	36	31	31	34	35	35
Rural	28	13	30	15	28	16
Missing	2	1	2	1	2	2
Sample Size (Unweighted)	265	597	351	808	205	791

[a] X^2 test were conducted to test for statistical significance in the differences between WIC participants and non-participants within each age group for each variable. The results of X^2 test are listed next to the variable under the column labeled non-participants for each of the three age groups.

* P<0.05 non-participants significantly different from WIC participants on the variable.

** P>0.01 non-participants significantly different from WIC participants on the variable.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Ponza et al., 2004.

Table 9-28. Food Choices for Infants and Toddlers by WIC Participation Status

	Infants 4 to 6 months		Infants 7 to 11 months		Toddlers 12 to 24 months	
	WIC Participant	Non-participant	WIC Participant	Non-participant	WIC Participant	Non-participant
Vegetables						
Any Vegetable	40.2	39.8	68.2	70.7	77.5	80.2
Baby Food Vegetables	32.9	37.0	38.2	45.0	4.8	4.7
Cooked Vegetables	8.0	3.9*	33.8	33.8	73.1	72.3
Raw Vegetables	1.4	0.1**	3.6	4.1	11.8	15.4
Dark Green Vegetables	0.4	0.0	2.9	4.0	6.3	8.4
Deep Yellow Vegetables	23.2	28.1	30.1	34.8	12.5	16.9
Other Starchy Vegetables	6.5	6.4	12.9	15.2	21.1	21.5
Potatoes	6.0	2.4*	20.7	18.2	43.1	38.3
Fruits						
Any Fruit	47.8	39.2*	64.7	81.0**	58.5	74.6**
Baby Food Fruits	43.8	36.9	48.4	57.4*	3.8	6.5
Non-Baby Food Fruit	8.1	4.0	22.9	35.9**	56.4	70.9**
Fresh Fruit	5.4	3.8	14.3	24.3**	43.6	57.0**
Canned Fruit	3.4	0.5**	10.3	17.3**	22.3	25.3
Sample Size (unweighted)	265	597	351	808	205	791

* = P<0.05 non-participants significantly different from WIC participants.
** = P<0.01 non-participants significantly different from WIC participants.
WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Ponza et al. 2004.

Table 9-29. Average Portion Sizes per Eating Occasion of Fruits and Vegetables Commonly Consumed by Infants from the 2002 Feeding Infants and Toddlers Study

Food group	Reference unit	4 to 5 months (N=624)	6 to 8 months (N=708)	9 to 11 months (N=687)
		Mean± SEM		
Fruits and Juices				
All fruits	tablespoon	3.6±0.19	4.7±0.11	5.8±0.17
Baby food fruit	tablespoon	3.3±0.16	4.6±0.11	5.6±0.17
Baby food peaches	tablespoon	3.6±0.37	4.4±0.26	5.3±0.36
Baby food pears	tablespoon	3.5±0.46	4.5±0.21	6.0±0.40
Baby food bananas	tablespoon	3.4±0.23	5.0±0.21	5.9±0.35
Baby food applesauce	tablespoon	3.7±0.29	4.6±0.17	5.6±0.25
Canned fruit	tablespoon	-	4.5±0.59	4.8±0.25
Fresh fruit	tablespoon	-	5.3±0.52	6.4±0.37
100% juice	fluid ounce	2.5±0.17	2.8±0.11	3.1±0.09
Apple/apple blends	fluid ounce	2.7±0.22	2.9±0.13	3.2±0.11
Grape	fluid ounce	-	2.6±0.19	3.1±0.21
Pear	fluid ounce	-	2.6±0.29	3.1±0.28
Vegetables				
All vegetables	tablespoon	3.8±0.20	5.8±0.16	5.6±0.20
Baby food vegetables	tablespoon	4.0±0.20	5.9±0.16	6.6±0.21
Baby food green beans	tablespoon	3.5±0.33	5.1±0.28	6.1±0.50
Baby food squash	tablespoon	4.3±0.47	5.6±0.30	6.9±0.41
Baby food sweet	tablespoon	4.3±0.31	6.1±0.34	7.2±0.69
Baby food carrots	tablespoon	3.5±0.33	5.6±0.27	6.7±0.48
Cooked vegetables, excluding french fries	tablespoon	-	4.2±0.47	3.8±0.31
Deep yellow vegetables	tablespoon	-	3.2±0.59	3.2±0.39
Mashed potatoes	tablespoon	-	4.1±0.67	2.8±0.37
Green beans	tablespoon	-	3.2±0.62	5.0±0.61

- = Cell size was too small to generate a reliable estimate.
N = Number of respondents.
SEM = Standard error.

Source: Fox et al., 2006.

Table 9-30. Average Portion Sizes per Eating Occasion of Fruits and Vegetables Commonly Consumed by Toddlers from the 2002 Feeding Infants and Toddlers Study

Food group	Reference unit	12 to 14 months (N=371)	15 to 18 months (N=312)	19 to 24 months (N=320)
			Mean± SEM	
Fruits and Juices				
All fruits	cup	0.4±0.02	0.5±0.03	0.6±0.03
Canned fruit	cup	0.3±0.02	0.4±0.03	0.4±0.04
Fresh fruit	cup	0.4±0.02	0.5±0.03	0.6±0.03
Fresh apple	cup, slice	0.4±0.05	0.6±0.07	0.8+0.14
	1 medium	0.3±0.04	0.5±0.06	0.6±0.11
Fresh banana	cup, slice	0.4+0.02	0.5±0.03	0.5±0.03
	1 medium	0.6±0.03	0.7±0.03	0.7±0.04
Fresh grapes	cup	0.2±0.01	0.3±0.03	0.3±0.02
100% juice	fluid ounce	3.7±0.15	5.0±0.20	5.1±0.18
Orange/orange blends	fluid ounce	3.3+0.38	4.5±0.33	5.2±0.35
Apple/apple blends	fluid ounce	3.6±0.21	4.5±0.29	4.9±0.27
Grape	fluid ounce	3.6±0.38	5.6±0.43	4.7±0.31
Vegetables				
All vegetables	cup	0.4±0.02	0.4±0.03	0.4±0.02
Cooked vegetables, excluding french fries	cup	0.3±0.03	0.3±0.03	0.3±0.02
Deep yellow vegetables	cup	0.2±0.03	0.3±0.05	0.3±0.05
Corn	cup	0.2±0.03	0.2±0.03	0.2±0.03
Peas	cup	0.2±0.02	0.2±0.02	0.2±0.02
Green beans	cup	0.4±0.05	0.4±0.05	0.3±0.03
Mashed potatoes	cup	0.3±0.05	0.4±0.05	0.3±0.05
Baked, boiled potatoes	cup	0.3±0.05	0.4±0.06	-
French fries	cup	0.4±0.05	0.6±0.05	0.6±0.05

- Cell size too small to generate reliable estimate.
N = Number of respondents.
SEM = Standard error of the mean.

Source: Fox et al., 2006.

Table 9-31. Percentage of Hispanic and Non-Hispanic Infants and Toddlers Consuming Different Types of Fruits and Vegetables on A Given Day

	Age 4 to 5 months		Age 6 to 11 months		Age 12 to 24 months	
	Hispanic (n=84)	Non-Hispanic (n=538)	Hispanic (n=163)	Non-Hispanic (n=1,228)	Hispanic (n=124)	Non-Hispanic (n=871)
Fruits						
Any Fruit or 100% Fruit Juice	45.0	35.9	86.2	86.8	84.6	87.2
Any Fruit[a]	39.4	28.8	68.1	76.0	67.6	71.5
100% Fruit Juice	19.3	15.3	57.8	47.7	64.1	58.9
Fruit Preparation						
Baby Food Fruit	32.6	28.4	42.9*	58.1	5.6†	6.3
Non-Baby Food Fruit	9.1†	1.3†	35.8	27.4	64.2	68.0
Canned Fruit	2.3†	-	8.8	13.7	12.1**	26.2
Fresh Fruit	9.1*†	-	30.0**	17.7	59.3	53.1
Vegetables						
Any Vegetable or 100% Vegetable Juice[b]	30.0	27.3	66.2	70.3	76.0	80.5
Type of Preparation						
Baby Food Vegetables	25.7	25.4	34.4*	47.6	4.1†	4.9
Cooked Vegetables	4.2†	2.4†	33.2	29.4	71.4	72.9
Raw Vegetables	2.3†	-	8.3†	2.6	25.0	13.1
Types of Vegetables[b]						
Dark Green Vegetables[c]	-	-	3.3†	3.1	11.4†	7.5
Deep Yellow Vegetables[d]	21.0	18.2	32.2	25.9	20.0	15.4
Starchy Vegetable:						
White Potatoes	1.4†	2.3†	20.7	17.4	43.5	39.0
French Fries/Fried Potatoes	-	-	5.7†	5.3	23.4	20.3
Baked/Mashed	-	-	14.4†	10.7	19.8	17.7
Other Starchy Vegetables[e]	5.0†	4.0	6.7**	15.1	16.6	22.2
Other Non-starchy Vegetables[f]	8.1†	8.0	28.5	29.0	42.0	43.4

a Total includes all baby food and non-baby food fruits and excludes 100% fruit juices and juice drinks.
b Total includes commercial baby food, cooked vegetables, raw vegetables, and 100% vegetable juices.
c Reported dark green vegetables include broccoli, spinach, romaine lettuce and other greens such as kale.
d Reported yellow vegetables include carrots, pumpkin, sweet potatoes, and winter squash.
e Reported starchy vegetables include corn, green peas, immature lima beans, black-eyed peas (not dried), cassava, and rutabaga. Corn is also shown as a subcategory of other starchy vegetables.
f Reported non-starchy vegetables include asparagus, cauliflower, cabbage, onions, green beans, mixed vegetables, peppers, and tomatoes.
- = Less than 1 percent of the group consumed this food on a given day.
* = Significantly different from non-Hispanic at the *P*<0.05.
** = Significantly different from non-Hispanic at the *P*>0.01.
† = Statistic is potentially unreliable because of a high coefficient of variation.

Source: Mennella et al., 2006.

Table 9-32. Top Five Fruits and Vegetables Consumed by Hispanic and Non-Hispanic Infants and Toddlers Per Age Group [a]

Age	N	Ethnicity: Hispanic	Ethnicity: Non-Hispanic
		Top Fruits By Age Group	
4 to 5 months	84 Hispanic 538 non-Hispanic	Bananas (16.3%) Apples (14.7%) Peaches (10.9%) Melons (3.5%) Pears (2.5%)	Apples (12.5%) Bananas (10.0%) Pears (5.9%) Peaches (5.8%) Prunes (1.6%)
6 to 11 months	136 Hispanic 1,228 non-Hispanic	Bananas (35.9%) Apples (29.7%) Pears (15.2%) Peaches (11.7%) Melons (4.7%)	Apples (32.9%) Bananas (31.5%) Pears (17.5%) Peaches (13.9%) Apricots (3.7%)
12 to 24 months	124 Hispanic 871 non-Hispanic	Bananas (41.5%) Apples (25.7%) Berries (8.5%) Melons (7.6%) Pears (7.3%)	Bananas (30.9%) Apples (22.0%) Grapes (12.3%) Peaches (9.6%) Berries (8.7%)
		Top Vegetables By Age Group	
4 to 5 months	84 Hispanic 538 non-Hispanic	Carrots (9.9%) Sweet Potatoes (6.8%) Green Beans (5.8%) Peas (5.0%) Squash (4.3%)	Sweet Potatoes (7.5%) Carrots (6.6%) Green Beans (5.9%) Squash (5.4%) Peas (3.8%)
6 to 11 months	136 Hispanic 1,228 non-Hispanic	Potatoes (20.7%) Carrots (19.0%) Mixed Vegetables (11.1%) Green Beans (11.0%) Sweet Potatoes (8.7%)	Carrots (17.5%) Potatoes (16.4%) Green Beans (15.9%) Squash (11.8%) Sweet Potatoes (11.4%)
12 to 24 months	124 Hispanic 871 non-Hispanic	Potatoes (43.5%) Tomatoes (23.1%) Carrots (18.6%) Onions (11.8%) Corn (10.2%)	Potatoes (39.0%) Green Beans (19.6%) Peas (12.8%) Carrots (12.3%) Tomatoes (11.9%)

[a] Percentage consuming at least one in a day is in parentheses.

Source: Mennella, et al., 2006.

Table 9-33. Mean Moisture Content of Selected Food Groups Expressed as Percentages of Edible Portions

Food	Moisture Content		Comments
	Raw	Cooked	
Fruits			
Apples - dried	31.76	84.13*	sulfured; * without added sugar
Apples	85.56* 86.67**	- -	*with skin **without skin
Apples - juice	-	87.93	canned or bottled
Applesauce	-	88.35*	*unsweetened
Apricots	86.35	86.62*	*canned juice pack with skin
Apricots - dried	30.09	75.56*	sulfured; *without added sugar
Bananas	74.91	-	
Blackberries	88.15	-	
Blueberries	84.21	86.59*	*frozen unsweetened
Boysenberries	85.90	-	frozen unsweetened
Cantaloupes	90.15	-	
Casabas	91.85	-	
Cherries - sweet	82.25	84.95*	*canned, juice pack
Crabapples	78.94	-	
Cranberries	87.13	-	
Cranberries - juice cocktail	85.00	-	bottled
Currants (red and white)	83.95	-	
Elderberries	79.80	-	
Grapefruit (pink, red and white)	90.89	-	
Grapefruit - juice	90.00	90.10*	*canned unsweetened
Grapefruit - unspecified	90.89	-	pink, red, white
Grapes - fresh	81.30	-	American type (slip skin)
Grapes - juice	84.12	-	canned or bottled
Grapes - raisins	15.43	-	seedless
Honeydew melons	89.82	-	
Kiwi fruit	83.07	-	
Kumquats	80.85	-	
Lemons - juice	90.73	92.46*	*canned or bottled
Lemons - peel	81.60	-	
Lemons - pulp	88.98	-	
Limes	88.26	-	
Limes - juice	90.79	92.52*	*canned or bottled
Loganberries	84.61*	-	*frozen
Mulberries	87.68	-	
Nectarines	87.59	-	
Oranges - unspecified	86.75	-	all varieties
Peaches	88.87	87.49*	*canned juice pack
Pears - dried	26.69	64.44*	sulfured; *without added sugar
Pears - fresh	83.71	86.47*	*canned juice pack
Pineapple	86.00	83.51*	*canned juice pack
Pineapple - juice	-	86.37	canned
Plums - dried (prunes)	30.92	-	
Plums	87.23	84.02*	*canned juice pack
Quinces	83.80	-	
Raspberries	85.75	-	
Strawberries	90.95	89.97*	*frozen unsweetened
Tangerine - juice	88.90	87.00*	*canned sweetened
Tangerines	85.17	89.51*	*canned juice pack
Watermelon	91.45	-	

Table 9-33. Mean Moisture Content of Selected Food Groups Expressed as Percentages of Edible Portions (continued)			
Food	Moisture Content		Comments
	Raw	Cooked	
Vegetables			
Alfalfa seeds - sprouted	92.82		
Artichokes - globe & French	84.94	84.08	boiled, drained
Artichokes - Jerusalem	78.01	-	
Asparagus	93.22	92.63	boiled, drained
Bamboo shoots	91.00	95.92	boiled, drained
Beans - dry - blackeye peas (cowpeas)	77.20	75.48	boiled, drained
Beans - dry - hyacinth (mature seeds)	87.87	86.90	boiled, drained
Beans - dry - navy (mature seeds)	79.15	76.02	boiled, drained
Beans - dry - pinto (mature seeds)	81.30	93.39	boiled, drained
Beans - lima	70.24	67.17	boiled, drained
Beans - snap - green - yellow	90.27	89.22	boiled, drained
Beets	87.58	87.06	boiled, drained
Beets - tops (greens)	91.02	89.13	boiled, drained
Broccoli	90.69	89.25	boiled, drained
Brussel sprouts	86.00	88.90	boiled, drained
Cabbage - Chinese (pak-choi)	95.32	95.55	boiled, drained
Cabbage - red	90.39	90.84	boiled, drained
Cabbage - savoy	91.00	92.00	boiled, drained
Carrots	88.29	90.17	boiled, drained
Cassava (yucca blanca)	59.68	-	
Cauliflower	91.91	93.00	boiled, drained
Celeriac	88.00	92.30	boiled, drained
Celery	95.43	94.11	boiled, drained
Chives	90.65	-	
Cole slaw	81.50	-	
Collards	90.55	91.86	boiled, drained
Corn - sweet	75.96	69.57	boiled, drained
Cress - garden	89.40	92.50	boiled, drained
Cucumbers - peeled	96.73	-	
Dandelion - greens	85.60	89.80	boiled, drained
Eggplant	92.41	89.67	boiled, drained
Endive	93.79	-	
Garlic	58.58	-	
Kale	84.46	91.20	boiled, drained
Kohlrabi	91.00	90.30	boiled, drained
Lambsquarter	84.30	88.90	boiled, drained
Leeks - bulb and lower leaf-portion	83.00	90.80	boiled, drained
Lentils - sprouted	67.34	68.70	stir-fried
Lettuce - iceberg	95.64	-	
Lettuce - cos or romaine	94.61	-	
Mung beans - mature seeds (sprouted)	90.40	93.39	boiled, drained
Mushrooms - unspecified	-	91.08	boiled, drained
Mushrooms - oyster	88.80	-	
Mushrooms - Maitake	90.53	-	
Mushrooms - portabella	91.20	-	
Mustard greens	90.80	94.46	boiled, drained
Okra	90.17	92.57	boiled, drained
Onions	89.11	87.86	boiled, drained
Onions - dehydrated or dried	3.93	-	
Parsley	87.71	-	
Parsnips	79.53	80.24	boiled, drained
Peas - edible-podded	88.89	88.91	boiled, drained
Peppers - sweet - green	93.89	91.87	boiled, drained
Peppers - hot chili-green	87.74	92.50*	*canned solids & liquid

Table 9-33. Mean Moisture Content of Selected Food Groups Expressed as Percentages of Edible Portions (continued)

Food	Moisture Content		Comments
	Raw	Cooked	
Potatoes (white)	81.58	75.43	baked
Pumpkin	91.60	93.69	boiled, drained
Radishes	95.27	-	
Rutabagas - unspecified	89.66	88.88	boiled, drained
Salsify (vegetable oyster)	77.00	81.00	boiled, drained
Shallots	79.80	-	
Soybeans - mature seeds - sprouted	69.05	79.45	steamed
Spinach	91.40	91.21	boiled, drained
Squash - summer	94.64	93.70	all varieties; boiled, drained
Squash - winter	89.76	89.02	all varieties; baked
Sweet Potatoes	77.28	75.78	baked in skin
Swiss chard	92.66	92.65	boiled, drained
Taro - leaves	85.66	92.15	steamed
Taro	70.64	63.80	
Tomatoes - juice	-	93.90	canned
Tomatoes - paste	-	73.50	canned
Tomatoes - puree	-	87.88	canned
Tomatoes	93.95	-	
Towelgourd	93.85	84.29	boiled, drained
Turnips	91.87	93.60	boiled, drained
Turnips - greens	89.67	93.20	boiled, drained
Water chestnuts - Chinese	73.46	86.42*	*canned solids and liquids
Yambean - tuber	90.07	90.07	boiled, drained

\- Indicates data are not available for the fruit or vegetable under those conditions.

Source: USDA, 2007.

APPENDIX 9A

CODES AND DEFINITIONS USED TO DETERMINE THE VARIOUS FRUITS AND VEGETABLES USED IN THE U.S. EPA ANALYSIS OF CSFII DATA IN FCID

Table 9A-1. Food Codes and Definitions Used in Analysis of the 1994-96, 1998 USDA CSFII Data

Food Category	**EPA Food Commodity Codes**			
TOTAL FRUITS AND VEGETABLES				
Total Fruits	95000010	Acerola	95001930	Jackfruit
	11000090	Apple, dried	95001950	Kiwifruit
	11000091	Apple, dried-babyfood	10001970	Kumquat
	11000070	Apple, fruit with peel	10001990	Lemon
	11000080	Apple, peeled fruit	10002010	Lemon, peel
	11000081	Apple, peeled fruit-babyfood	10002060	Lime
	11000110	Apple, sauce	13012080	Loganberry
	11000111	Apple, sauce-babyfood	95002090	Longan
	12000120	Apricot	11002100	Loquat
	12000130	Apricot, dried	95002110	Lychee
	12000121	Apricot-babyfood	95002120	Lychee, dried
	95000200	Avocado	95002140	Mamey apple
	95000230	Banana	95002150	Mango
	95000240	Banana, dried	95002160	Mango, dried
	95000241	Banana, dried-babyfood	95002151	Mango-babyfood
	95000231	Banana-babyfood	95002270	Mulberry
	13010550	Blackberry	12002300	Nectarine
	13020570	Blueberry	10002400	Orange
	13020571	Blueberry-babyfood	10002420	Orange, peel
	13010580	Boysenberry	95002450	Papaya
	95000600	Breadfruit	95002460	Papaya, dried
	95000740	Canistel	95002451	Papaya-babyfood
	95000890	Cherimoya	95002520	Passionfruit
	12000900	Cherry	95002521	Passionfruit-babyfood
	12000901	Cherry-babyfood	95002540	Pawpaw
	10001060	Citrus citron	12002600	Peach
	10001070	Citrus hybrids	12002610	Peach, dried
	95001120	Coconut, dried	12002611	Peach, dried-babyfood
	95001110	Coconut, meat	12002601	Peach-babyfood
	95001111	Coconut, meat-babyfood	11002660	Pear
	95001130	Coconut, milk	11002670	Pear, dried
	11001290	Crabapple	11002661	Pear-babyfood
	95001300	Cranberry	95002770	Persimmon
	95001310	Cranberry, dried	95002790	Pineapple
	95001301	Cranberry-babyfood	95002800	Pineapple, dried
	13021360	Currant	95002791	Pineapple-babyfood
	13021370	Currant, dried	95002830	Plantain
	95001410	Date	95002840	Plantain, dried
	13011420	Dewberry	12002850	Plum
	08001480	Eggplant	12002870	Plum, prune, dried
	13021490	Elderberry	12002871	Plum, prune, dried-babyfood
	95001510	Feijoa	12002860	Plum, prune, fresh
	95001530	Fig	12002861	Plum, prune, fresh-babyfood
	95001540	Fig, dried	12002851	Plum-babyfood
	13021740	Gooseberry	95002890	Pomegranate
	95001750	Grape	10003070	Pummelo
	95001780	Grape, raisin	11003100	Quince
	10001800	Grapefruit	13013200	Raspberry
	95001830	Guava	13013201	Raspberry-babyfood
	95001831	Guava-babyfood	95003330	Sapote, Mamey
	13021910	Huckleberry	95003460	Soursop
	95001920	Jaboticaba	95003510	Spanish lime
	95003580	Starfruit	95003610	Sugar apple
	95003590	Strawberry	95003680	Tamarind
	95003591	Strawberry-babyfood	10003690	Tangerine

Table 9A-1. Food Codes and Definitions Used in Analysis of the 1994-96, 1998 USDA CSFII Data (continued)

Food Category	**EPA Food Commodity Codes**			
Total Vegetables	18000020	Alfalfa, seed	09020880	Chayote, fruit
	04010050	Amaranth, leafy	06030990	Chickpea, flour
	01030150	Arrowroot, flour	06030980	Chickpea, seed
	01030151	Arrowroot, flour-babyfood	06030981	Chickpea, seed-babyfood
	95000160	Artichoke, globe	01011000	Chicory, roots
	01030170	Artichoke, Jerusalem	02001010	Chicory, tops
	04010180	Arugula	09021020	Chinese waxgourd
	95000190	Asparagus	19011030	Chive
	09020210	Balsam pear	04011040	Chrysanthemum, garland
	95000220	Bamboo, shoots	19021050	Cinnamon
	19010290	Basil, dried leaves	19021051	Cinnamon-babyfood
	19010291	Basil, dried leaves-babyfood	19011180	Coriander, leaves
	19010280	Basil, fresh leaves	19011181	Coriander, leaves-babyfood
	19010281	Basil, fresh leaves-babyfood	19021190	Coriander, seed
	06020330	Bean, cowpea, succulent	19021191	Coriander, seed-babyfood
	06030360	Bean, kidney, seed	04011380	Dandelion, leaves
	06030380	Bean, lima, seed	01031390	Dasheen, corm
	06020370	Bean, lima, succulent	02001400	Dasheen, leaves
	06030390	Bean, mung, seed	19011440	Dill
	06030400	Bean, navy, seed	19021430	Dill, seed
	06030410	Bean, pink, seed	04021520	Fennel, Florence
	06030420	Bean, pinto, seed	03001640	Garlic
	06010430	Bean, snap, succulent	03001650	Garlic, dried
	06010431	Bean, snap, succulent-babyfood	03001651	Garlic, dried-babyfood
	01010500	Beet, garden, roots	01031660	Ginger
	01010501	Beet, garden, roots-babyfood	01031670	Ginger, dried
	02000510	Beet, garden, tops	01031661	Ginger-babyfood
	95000540	Belgium endive	01011680	Ginseng, dried
	05010610	Broccoli	95001770	Grape, leaves
	05020630	Broccoli raab	06031820	Guar, seed
	05010620	Broccoli, Chinese	06031821	Guar, seed-babyfood
	05010611	Broccoli-babyfood	19011840	Herbs, other
	05010640	Brussels sprouts	19011841	Herbs, other-babyfood
	05010690	Cabbage	05021940	Kale
	05020700	Cabbage, Chinese, bok choy	05011960	Kohlrabi
	05010720	Cabbage, Chinese, mustard	03001980	Leek
	05010710	Cabbage, Chinese, napa	19012020	Lemongrass
	95000730	Cactus	04012040	Lettuce, head
	09010750	Cantaloupe	04012050	Lettuce, leaf
	04020760	Cardoon	19012200	Marjoram
	01010780	Carrot	19012201	Marjoram-babyfood
	01010781	Carrot-babyfood	08002340	Okra
	09010800	Casaba	03002370	Onion, dry bulb
	01030820	Cassava	03002380	Onion, dry bulb, dried
	01030821	Cassava-babyfood	03002381	Onion, dry bulb, dried-babyfood
	05010830	Cauliflower	03002371	Onion, dry bulb-babyfood
	01010840	Celeriac	03002390	Onion, green
	04020850	Celery	95002430	Palm heart, leaves
	04020851	Celery-babyfood	19012490	Parsley, dried leaves
	04020870	Celtuce	19012491	Parsley, dried leaves-babyfood
	04012480	Parsley, leaves	01013270	Rutabaga
	01012500	Parsley, turnip rooted	01013310	Salsify, roots
	01012510	Parsnip	02003320	Salsify, tops
	01012511	Parsnip-babyfood	19013340	Savory 95003350Seaweed
	06032560	Pea, dry	95003351	Seaweed-babyfood
	06032561	Pea, dry-babyfood	03003380	Shallot
	06012570	Pea, edible podded, succulent	06003480	Soybean, flour
	06032580	Pea, pigeon, seed	06003481	Soybean, flour-babyfood
	06022590	Pea, pigeon, succulent	06003470	Soybean, seed
	06022550	Pea, succulent	19023540	Spices, other
	06022551	Pea, succulent-babyfood	19023541	Spices, other-babyfood
	08002700	Pepper, bell	09023560	Squash, summer
	08002710	Pepper, bell, dried	09023561	Squash, summer-babyfood

Table 9A-1. Food Codes and Definitions Used in Analysis of the 1994-96, 1998 USDA CSFII Data (continued)

Food Category	**EPA Food Commodity Codes**			
Total Vegetables (continued)	08002711	Pepper, bell, dried-babyfood	09023570	Squash, winter
	08002701	Pepper, bell-babyfood	09023571	Squash, winter-babyfood
	19022740	Pepper, black and white	01033660	Sweet potato
	19022741	Pepper, black and white-babyfood	01033661	Sweet potato-babyfood
	08002720	Pepper, nonbell	04023670	Swiss chard
	08002730	Pepper, nonbell, dried	01033710	Tanier, corm
	08002721	Pepper, nonbell-babyfood	08003740	Tomatillo
	95002750	Peppermint	08003750	Tomato
	01032960	Potato, chips	08003780	Tomato, dried
	01032970	Potato, dry (granules/ flakes)	08003781	Tomato, dried-babyfood
	01032971	Potato, dry (granules/ flakes)-babyfood	08003760	Tomato, paste
	01032980	Potato, flour	08003761	Tomato, paste-babyfood
	01032981	Potato, flour-babyfood	08003770	Tomato, puree
	01033000	Potato, tuber, w/o peel	08003771	Tomato, puree-babyfood
	01033001	Potato, tuber, w/o peel-babyfood	95003800	Tomato, Tree
	01032990	Potato, tuber, w/peel	08003751	Tomato-babyfood
	01032991	Potato, tuber, w/peel-babyfood	01033870	Turmeric
	09023080	Pumpkin	05023890	Turnip, greens
	04013130	Radicchio	01013880	Turnip, roots
	01013160	Radish, Oriental, roots	95003970	Water chestnut
	02003170	Radish, Oriental, tops	95003980	Watercress
	01013140	Radish, roots	09013990	Watermelon
	02003150	Radish, tops	01034070	Yam bean
	05023180	Rape greens	01034060	Yam, true
	04023220	Rhubarb		
INDIVIDUAL FRUIT CATEGORIES				
Apples	11000090	Apple, dried	11000080	Apple, peeled fruit
	11000091	Apple, dried-babyfood	11000081	Apple, peeled fruit-babyfood
	11000070	Apple, fruit with peel	11000110	Apple, sauce
	11000100	Apple, juice	11000111	Apple, sauce-babyfood
	11000101	Apple, juice-babyfood		
Bananas	95000230	Banana	95002830	Plantain
	95000240	Banana, dried	95002840	Plantain, dried
	95000241	Banana, dried-babyfood		
	95000231	Banana-babyfood		
Berries and Small Fruits	13010550	Blackberry	13021910	Huckleberry
	13010580	Boysenberry	95001300	Cranberry
	13011420	Dewberry	95001301	Cranberry-babyfood
	13012080	Loganberry	95001310	Cranberry, dried
	13013200	Raspberry	95001750	Grape
	13013201	Raspberry-babyfood	95001770	Grape, leaves
	13020570	Blueberry	95001780	Grape, raisin
	13020571	Blueberry-babyfood	95001950	Kiwifruit
	13021360	Currant	95002270	Mulberry
	13021370	Currant, dried	95003590	Strawberry
	13021490	Elderberry	95003591	Strawberry-babyfood
	13021740	Gooseberry		
Citrus Fruits	10001060	Citrus citron	10002060	Lime
	10001070	Citrus hybrids	10002400	Orange
	10001800	Grapefruit	10002420	Orange, peel
	10001970	Kumquat	10003070	Pummelo
	10001990	Lemon	10003690	Tangerine
	10002010	Lemon, peel		
Peaches	12002600	Peach		
	12002610	Peach, dried		
	12002611	Peach, dried-babyfood		
	12002601	Peach-babyfood		

Table 9A-1. Food Codes and Definitions Used in Analysis of the 1994-96, 1998 USDA CSFII Data (continued)

Food Category	EPA Food Commodity Codes			
Pears	11002660	Pear		
	11002670	Pear, dried		
	11002680	Pear, juice		
	11002681	Pear, juice-babyfood		
	11002661	Pear-babyfood		
Pome Fruits	11000070	Apple, fruit with peel	11001290	Crabapple
	11000080	Apple, peeled fruit	11002100	Loquat
	11000081	Apple, peeled fruit-babyfood	11002660	Pear
	11000090	Apple, dried	11002661	Pear-babyfood
	11000091	Apple, dried-babyfood	11002670	Pear, dried
	11000110	Apple, sauce	11003100	Quince
	11000111	Apple, sauce-babyfood		
Strawberries	95003590	Strawberry		
	95003591	Strawberry-babyfood		
Stone Fruits	12000120	Apricot	12002611	Peach, dried-babyfood
	12000121	Apricot-babyfood	12002850	Plum
	12000130	Apricot, dried	12002851	Plum-babyfood
	12000900	Cherry	12002860	Plum, prune, fresh
	12000901	Cherry-babyfood	12002861	Plum, prune, fresh-babyfood
	12002300	Nectarine	12002870	Plum, prune, dried
	12002600	Peach	12002871	Plum, prune, dried-babyfood
	12002601	Peach-babyfood		
	12002610	Peach, dried		
Tropical Fruits	95000010	Acerola	95002140	Mamey apple
	95000220	Avocado	95002150	Mango
	95000230	Banana	95002151	Mango-babyfood
	95000231	Banana-babyfood	95002160	Mango, dried
	95000240	Banana, dried	95002450	Papaya
	95000241	Banana, dried-babyfood	95002451	Papaya-babyfood
	95000600	Breadfruit	95002460	Papaya, dried
	95000740	Canistel	95002520	Passionfruit
	95000890	Cherimoya	95002521	Passionfruit-babyfood
	95001110	Coconut, meat	95002540	Pawpaw
	95001111	Coconut, meat-babyfood	95002790	Pineapple
	95001120	Coconut, dried	95002791	Pineapple-babyfood
	95001130	Coconut, milk	95002800	Pineapple, dried
	95001410	Date	95002830	Plantain
	95001510	Feijoa	95002840	Plantain, dried
	95001530	Fig	95002890	Pomegranate
	95001540	Fig, dried	95003330	Sapote, Mamey
	95001830	Guava	95003460	Soursop
	95001831	Guava-babyfood	95003510	Spanish lime
	95001930	Jackfruit	95003580	Starfruit
	95002090	Longan	95003610	Sugar apple
	95002110	Lychee	95003680	Tamarind
	95002120	Lychee, dried		

Table 9A-1. Food Codes and Definitions Used in Analysis of the 1994-96, 1998 USDA CSFII Data (continued)				
Food Category	**EPA Food Commodity Codes**			
INDIVIDUAL VEGETABLE CATEGORIES				
Asparagus	95000190	Asparagus		
Beans	06030350 06030300 06030320 06020310 06030340 06020330 06030360 06030380	Bean, great northern, seed Bean, black, seed Bean, broad, seed Bean, broad, succulent Bean, cowpea, seed Bean, cowpea, succulent Bean, kidney, seed Bean, lima, seed	06020370 06030390 06030400 06030410 06030420 06010430 06010431	Bean, lima, succulent Bean, mung, seed Bean, navy, seed Bean, pink, seed Bean, pinto, seed Bean, snap, succulent Bean, snap, succulent-babyfood
Beets	01010500 01010501 02000510	Beet, garden, roots Beet, garden, roots-babyfood Beet, garden, tops		
Broccoli	05010610 05010611	Broccoli Broccoli-babyfood		
Bulb Vegetables	03001640 03001650 03001651 03001980 03002370	Garlic Garlic, dried Garlic, dried-babyfood Leek Onion, dry bulb	03002371 03002380 03002381 03002390 03003380	Onion, dry bulb-babyfood Onion, dry bulb, dried Onion, dry bulb, dried-babyfood Onion, green Shallot
Cabbage	05010690Cabbage 05010720 Cabbage, Chinese, mustard 05010710 Cabbage, Chinese, napa			
Carrots	01010780	Carrot		
Corn	15001220 15001200 15001201 15001210 15001211 15001230	Corn, field, bran Corn, field, flour Corn, field, flour-babyfood Corn, field, meal Corn, field, meal-babyfood Corn, field, starch	15001231 15001260 15001270 15001271	Corn, field, starch-babyfood Corn, pop Corn, sweet Corn, sweet-babyfood
Cucumbers	09021350	Cucumber		
Cucurbit Vegetables	09010750 09010800 09011870 09013990 09020210 09020880 09021020	Cantaloupe Casaba Honeydew melon Watermelon Balsam pear Chayote, fruit Chinese waxgourd	09021350 09023080 09023090 09023560 09023561 09023570 09023571	Cucumber Pumpkin Pumpkin, seed Squash, summer Squash, summer-babyfood Squash, winter Squash, winter-babyfood
Fruiting Vegetables	08001480 08002340 08002700 08002701 08002710 08002711 08002720 08002721 08002730 08003740	Eggplant Okra Pepper, bell Pepper, bell-babyfood Pepper, bell, dried Pepper, bell, dried-babyfood Pepper, nonbell Pepper, nonbell-babyfood Pepper, nonbell, dried Tomatillo	08003750 08003751 08003760 08003761 08003770 08003771 08003780 08003781	Tomato Tomato-babyfood Tomato, paste Tomato, paste-babyfood Tomato, puree Tomato, puree-babyfood Tomato, dried Tomato, dried-babyfood

Table 9A-1. Food Codes and Definitions Used in Analysis of the 1994-96, 1998 USDA CSFII Data (continued)

Food Category	**EPA Food Commodity Codes**			
Leafy Vegetables (Brassica and Nonbrassica)	02000510	Beet, garden, tops	04021520	Fennel, Florence
	02001010	Chicory, tops	04023220	Rhubarb
	02001400	Dasheen, leaves	04023670	Swiss chard
	02003150	Radish, tops	05010610	Broccoli
	02003170	Radish, Oriental, tops	05010611	Broccoli-babyfood
	02003320	Salsify, tops	05010620	Broccoli, Chinese
	04010050	Amaranth, leafy	05010640	Brussels sprouts
	04010180	Arugula	05010690	Cabbage
	04011040	Chrysanthemum, garland	05010710	Cabbage, Chinese, napa
	04011330	Cress, garden	05010720	Cabbage, Chinese, mustard
	04011340	Cress, upland	05010830	Cauliflower
	04011380	Dandelion, leaves	05011960	Kohlrabi
	04011500	Endive	05020630	Broccoli raab
	04012040	Lettuce, head	05020700	Cabbage, Chinese, bok choy
	04012050	Lettuce, leaf	05021170	Collards
	04012480	Parsley, leaves	05021940	Kale
	04013130	Radicchio	05022290	Mustard greens
	04013550	Spinach	05023180	Rape greens
	04013551	Spinach-babyfood	05023890	Turnip, greens
	04020760	Cardoon	95000540	Belgium endive
	04020850	Celery	95003350	Seaweed
	04020851	Celery-babyfood	95003351	Seaweed - babyfood
	04020870	Celtuce	95003980	Watercress
Legume Vegetables	06003470	Soybean, seed	06030340	Bean, cowpea, seed
	06003480	Soybean, flour	06030350	Bean, great northern, seed
	06003481	Soybean, flour-babyfood	06030360	Bean, kidney, seed
	06003490	Soybean, soy milk	06030380	Bean, lima, seed
	06003491	Soybean, soy milk-babyfood or infant formula	06030390	Bean, mung, seed
			06030400	Bean, navy, seed
	06010430	Bean, snap, succulent	06030410	Bean, pink, seed
	06010431	Bean, snap, succulent-babyfood	06030420	Bean, pinto, seed
	06012570	Pea, edible podded, succulent	06030980	Chickpea, seed
	06020310	Bean, broad, succulent	06030981	Chickpea, seed-babyfood
	06020330	Bean, cowpea, succulent	06030990	Chickpea, flour
	06020370	Bean, lima, succulent	06031820	Guar, seed
	06022550	Pea, succulent	06031821	Guar, seed-babyfood
	06022551	Pea, succulent-babyfood	06032030	Lentil, seed
	06022590	Pea, pigeon, succulent	06032560	Pea, dry
	06030300	Bean, black, seed	06032561	Pea, dry-babyfood
	06030320	Bean, broad, seed	06032580	Pea, pigeon, seed
Lettuce	04012040	Lettuce, head		
	04012050	Lettuce, leaf		
Okra	08002340	Okra		
Onions	03002370	Onion, dry bulb		
	03002380	Onion, dry bulb, dried		
	03002381	Onion, dry bulb, dried-babyfood		
	03002371	Onion, dry bulb-babyfood		
	03002390	Onion, green		
Peas	06032560	Pea, dry	06022550	Pea, succulent
	06032561	Pea, dry-babyfood	06022551	Pea, succulent-babyfood
	06012570	Pea, edible podded, succulent		
	06032580	Pea, pigeon, seed		
	06022590	Pea, pigeon, succulent		
Peppers	08002700	Pepper, bell	08002730	Pepper, nonbell, dried
	08002710	Pepper, bell, dried	08002721	Pepper, nonbell-babyfood
	08002711	Pepper, bell, dried-babyfood		
	08002701	Pepper, bell-babyfood		
	08002720	Pepper, nonbell		

Table 9A-1. Food Codes and Definitions Used in Analysis of the 1994-96, 1998 USDA CSFII Data (continued)

Food Category	**EPA Food Commodity Codes**			
Pumpkin	09023080	Pumpkin		
	09023090	Pumpkin, seed		
Root and Tuber Vegetables	01030150	Arrowroot, flour	01012510	Parsnip
	01030151	Arrowroot, flour-babyfood	01012511	Parsnip-babyfood
	01030170	Artichoke, Jerusalem	01032960	Potato, chips
	01010500	Beet, garden, roots	01032970	Potato, dry (granules/ flakes)
	01010501	Beet, garden, roots-babyfood	01032971	Potato, dry (granules/ flakes)-babyfood
	02000510	Beet, garden, tops	01032980	Potato, flour
	01010520	Beet, sugar	01032981	Potato, flour-babyfood
	01010521	Beet, sugar-babyfood	01033000	Potato, tuber, w/o peel
	01010670	Burdock	01033001	Potato, tuber, w/o peel-babyfood
	01010780	Carrot	01032990	Potato, tuber, w/peel
	01010781	Carrot-babyfood	01032991	Potato, tuber, w/peel-babyfood
	01030820	Cassava	01013160	Radish, Oriental, roots
	01030821	Cassava-babyfood	01013140	Radish, roots
	01010840	Celeriac	01013270	Rutabaga
	01011000	Chicory, roots	01033660	Sweet potato
	01031390	Dasheen, corm	01033661	Sweet potato-babyfood
	01031660	Ginger	01033710	Tanier, corm
	01031670	Ginger, dried	01033870	Turmeric
	01031661	Ginger-babyfood	01013880	Turnip, roots
	01011680	Ginseng, dried	95003970	Water chestnut
	01011900	Horseradish	01034070	Yam bean
	01012500	Parsley, turnip rooted	01034060	Yam, true
Stalk and Stem Vegetable and Edible Fungi	95000160	Artichoke, globe		
	95000190	Asparagus		
	95000220	Bamboo, shoots		
	95002280	Mushroom		
	95002430	Palm heart, leaves		
Tomatoes	08003750	Tomato	08003770	Tomato, puree
	08003780	Tomato, dried	08003771	Tomato, puree-babyfood
	08003781	Tomato, dried-babyfood	08003751	Tomato-babyfood
	08003760	Tomato, paste		
	08003761	Tomato, paste-babyfood		
White Potatoes	01032960	Potato, chips	01033000	Potato, tuber, w/o peel
	01032970	Potato, dry (granules/ flakes)	01033001	Potato, tuber, w/o peel-babyfood
	01032971	Potato, dry (granules/ flakes)-babyfood	01032990	Potato, tuber, w/peel
	01032980	Potato, flour	01032991	Potato, tuber, w/peel-babyfood
	01032981	Potato, flour-babyfood		

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10 INTAKE OF FISH AND SHELLFISH

10.1 INTRODUCTION

Contaminated finfish and shellfish are potential sources of human exposure to toxic chemicals. Pollutants are carried in the surface waters, but also may be stored and accumulated in the sediments as a result of complex physical and chemical processes. Consequently, finfish and shellfish are exposed to these pollutants and may become sources of contaminated food.

Accurately estimating exposure to toxic chemicals in fish requires information about the nature of the exposed population (i.e., general population, recreational fishermen, subsistence fishers) and their intake rates. For example, general population intake rates may be appropriate for assessing contaminants that are widely distributed in commercially caught fish. However, these data may not be suitable to estimate exposure to contaminants in a particular water source among recreational or subsistence fishers. Since the catch of recreational and subsistence fishermen is not "diluted" by fish from other water bodies, these individuals and their families represent the population that is most vulnerable to exposure by intake of contaminated fish from a specific location.

This chapter focuses on intake rates of fish. Note that in this section the term fish refers to both finfish and shellfish. Intake rates for the general population, and recreational and Native American fishing populations are addressed, and data are presented for intake rates for both marine and freshwater fish, when available.

The U.S. EPA has prepared a review of and an evaluation of five different survey methods used for obtaining fish consumption data. They are:

- Recall-Telephone Survey;
- Recall-Mail Survey;
- Recall-Personal Interview;
- Diary; and
- Creel Census.

The reader is referred to U.S. EPA (1998) *Guidance for Conducting Fish and Wildlife Consumption Surveys* for more detail on these survey methods and their advantages and limitations. The type of survey used, its design, and any weighting factors used in estimating consumption should be considered when interpreting survey data for exposure assessment purposes. For surveys used in this handbook, respondents are typically adults who have reported on fish intake for themselves and for children living in their households.

Generally, surveys are either "creel" studies in which fishermen are interviewed while fishing, or broader population surveys using either mailed questionnaires or phone interviews. Both types of data can be useful for exposure assessment purposes, but somewhat different applications and interpretations are needed. In fact, results from creel studies have often been misinterpreted, due to inadequate knowledge of survey principles. Below, some basic facts about survey design are presented, followed by an analysis of the differences between creel and population based studies.

Typical surveys seek to draw inferences about a larger population from a smaller sample of that population. This larger population, from which the survey sample is taken and to which the results of the survey are generalized, is denoted the target population of the survey. In order to generalize from the sample to the target population, the probability of being sampled must be known for each member of the target population. This probability is reflected in weights assigned to survey respondents, with weights being inversely proportional to sampling probability. When all members of the target population have the same probability of being sampled, all weights can be set to one and essentially ignored. For example, in a mail or phone study of licensed anglers, the target population is generally all licensed anglers in a particular area, and in the studies presented, the sampling probability is essentially equal for all target population members.

In a creel study (i.e., a study in which fishermen are interviewed while fishing), the target population is anyone who fishes at the locations being studied; generally, in a creel study, the probability of being sampled is not the same for all members of the target population. For instance, if the survey is conducted for one day at a site, then it will include all persons who fish there daily, but only about 1/7 of the people who fish there weekly, 1/30th of the people who fish there monthly, etc. In this example, the probability of being sampled (or inverse weight) is seen to be proportional to the frequency of fishing. However, if the survey involves interviewers revisiting the same site on multiple days, and persons are only interviewed once for the survey, then the probability of being in the survey is not proportional to frequency; in fact, it increases less than proportionally with frequency. At the extreme of surveying the same site every day over the survey period with no re-interviewing, all members of the target population would have the same probability of being sampled regardless of fishing frequency, implying that the survey weights should all equal one. On the other hand, if the survey protocol calls for individuals to be interviewed each time an interviewer encounters them (i.e., without regard to whether they were previously interviewed), then the inverse weights will again be proportional to fishing frequency, no matter how many times interviewers revisit the same site. Note that when individuals can be interviewed multiple times, the results of each interview are included as separate records in the data base and the survey weights should be inversely proportional to the expected number of times that an individual's interviews are included in the data base.

In the published analyses of most creel studies, there is no mention of sampling weights; by default all weights are set to 1, implying equal probability of sampling. However, since the sampling probabilities in a creel study, even with repeated interviewing at a site, are highly dependent on fishing frequency, the fish intake distributions reported for these surveys are not reflective of the corresponding target populations. Instead, those individuals with high fishing frequencies are given too big a weight and the distribution is skewed to the right, i.e., it overestimates the target population distribution.

Price et al. (1994) explained this problem and set out to rectify it by adding weights to creel survey data; he used data from two creel studies (Puffer et al., 1981 and Pierce et al., 1981) as examples. Price et al. (1994) used inverse fishing frequency as survey weights and produced revised estimates of median and 95th percentile intake for the above two studies. These revised estimates were dramatically lower than the original estimates. The approach of Price et al. (1994) is discussed in more detail in Section 10.4 where the Puffer et al. (1981) and Pierce et al. (1981) studies are summarized.

When the correct weights are applied to survey data, the resulting percentiles reflect, on average, the distribution in the target population; thus, for example, an estimated 90 percent of the target population will have intake levels below the 90th percentile of the survey fish intake distribution. There is another way, however, of characterizing distributions in addition to the standard percentile approach; this approach is reflected in statements of the form "50 percent of the income is received by, for example, the top 10 percent of the population, which consists of individuals making more than $100,000", for example. Note that the 50th percentile (median) of the income distribution is well below $100,000. Here the $100,000 level can be thought of as, not the 50th percentile of the population income distribution, but as the 50th percentile of the "resource utilization distribution" (see Appendix 10A for technical discussion of this distribution). Other percentiles of the resource utilization distribution have similar interpretations; e.g., the 90th percentile of the resource utilization distribution (for income) would be that level of income such that 90 percent of total income is received by individuals with incomes below this level and 10 percent by individuals with income above this level. This alternative approach to characterizing distributions is of particular interest when a relatively small fraction of individuals consumes a relatively large fraction of a resource, which is the case with regards to recreational fish consumption. In the studies of recreational anglers, this alternative approach, based on resource utilization, will be presented, where possible, in addition to the primary approach of presenting the standard percentiles of the fish intake distribution.

The recommendations for fish and shellfish ingestion rates are provided in the next section, along with summaries of the confidence ratings for these recommendations. The recommended values for the general population and for other subsets of the population are based on the key studies identified by U.S. EPA for this factor. Following the recommendations, the studies on fish ingestion among the general population (Section 10.3), marine recreational angler populations (Section 10.4), freshwater recreational populations (Section 10.5), and Native American populations (Section 10.6) are summarized. Information is provided on the key studies that form the basis for the fish and shellfish intake rate recommendations. Relevant data on ingestion of fish and shellfish are also provided. These studies are presented to provide the reader with added perspective on the current state-of-knowledge pertaining to ingestion of fish and shellfish among children. Information on other population studies (Section 10.7), serving size (Section 10.8), and other factors to consider (Section 10.9) are also presented.

10.2 RECOMMENDATIONS

Considerable variation exists in the mean and upper percentile fish consumption rates obtained from the studies presented in this chapter. This can be attributed largely to the type of water body (i.e., marine, estuarine, freshwater) and the characteristics of the survey population (i.e., general population, recreational, Native American), but other factors such as study design, method of data collection, and geographic location also play a role. Based on these study variations, fish consumption studies were classified into the following categories:

- General Population (total, marine, freshwater/estuarine);
- Recreational Marine Intake;
- Recreational Freshwater Intake; and

- Native American Subsistence Populations

For exposure assessment purposes, the selection of intake rates for the appropriate category (or categories) will depend on the exposure scenario being evaluated.

10.2.1 Recommendations – General Population

Fish consumption rates are recommended for the general population, based on the key study presented in Section 10.3.1. The key study for estimating mean fish intake among the general population is the U.S. EPA (2002) analysis of data from the U.S. Department of Agriculture (USDA) Continuing Survey of Food Intake among Individuals (CSFII) 1994-1996, 1998.

For all fish (finfish and shellfish), the recommended per capita values for adults are 7.5 g/day for freshwater./estuarine fish, 12.4 g/day for marine fish, and 19.9 g/day for all fish (Table 10-1). Recommended values for children ages 3 to < 6, 6 to <11, 11 to < 16, and 16 to < 18 years, by habitat (i.e., marine, freshwater/estuarine, or total fish), are also shown in Table 10-1. It should be noted, however, that the key general population study presented in this chapter pre-dated the age groups recommended by U.S. EPA in *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). Thus, recommended values were not available for children less than 3 years old or 18 to < 21. The confidence ratings for the fish intake recommendations for the general population are presented in Table 10-2.

Note that the fish intake values presented in Table 10-1 are reported as uncooked fish weights. The CSFII 1994-1996, 1998 recipe files were used to convert, for each fish-containing food, the as-eaten fish weight consumed into an uncooked equivalent weight of fish. This is important because the concentrations of the contaminants in fish are generally measured in the uncooked samples. Assuming that cooking results in some reductions in weight (e.g., loss of moisture), and the mass of the contaminant in the fish tissue remains constant, then the contaminant concentration in the cooked fish tissue will increase.

In terms of calculating the dose, actual consumption may be overestimated when intake is expressed on an uncooked basis, but the actual concentration may be underestimated when it is based on the uncooked sample. The net effect on the dose would depend on the magnitude of the opposing effects on these two exposure factors. On the other hand, if the "as-prepared" (i.e., as-consumed) intake rate and the uncooked concentration are used in the dose equation, dose may be underestimated since the concentration in the cooked fish is likely to be higher, if the mass of the contaminant remains constant after cooking. Therefore, it is more conservative and appropriate to use uncooked fish intake rates. If concentration data can be adjusted to account for changes after cooking, then the "as-prepared" (i.e., as-consumed) intake rates are appropriate. However, data on the effects of cooking on contaminant concentrations are limited and assessors generally make the conservative assumption that cooking has no effect on the contaminant mass. Both "as-prepared" (i.e., as-consumed) and uncooked general population fish intake values are presented in this handbook so that the assessor can choose the intake data that best matches the concentration data that are being used.

The CSFII data on which the general population recommendations are based, are short-term survey data and could not be used to estimate the distribution over the long term. Also, it is important to note that a limitation associated with these data is that the total amount of fish reported by respondents included fish from all sources (e.g., fresh, frozen, canned, domestic, international origin). The CSFII surveys did not identify the source of the fish consumed. This type of information may be relevant for some assessments. It should also be noted that because these recommendations are based on 1994-1996, 1998 CSFII data, they may not reflect any recent changes that may have occurred in consumption patterns.

Recommended values should be selected that are relevant to the assessment, choosing the appropriate age groups and source of fish (i.e., freshwater/estuarine, marine, and total fish). In some cases a different study or studies may be particularly relevant to the needs of an assessment, in which case results from that specific study or studies may be used instead of the recommended values provided here. For example, it may be advantageous to use available regional or site-specific estimates if the assessment targets a particular region or site. In addition, seasonal, gender, and fish species variations should be considered when appropriate, if data are available. Also, relevant data on general population fish intake in this chapter and may be used if appropriate to the scenarios being assessed.

10.2.2 Recommendations – Recreational Marine Anglers

The recommended values for recreational marine anglers are presented in Table 10-3. These values are based on the surveys of the National

Marine Fisheries Service (NMFS, 1993). The values from NMFS (1993) are assumed to represent per capita intake of recreational marine fish among adult recreational fishers Age-specific values were not available from this source. However, recommendations for children have been estimated based on the age-specific ratios of general population children's marine fish intake to general population adult marine fish intake, multiplied by the adult marine recreational fish intake rates. Much of the other relevant data on recreational marine fish intake in this chapter are limited to certain geographic areas and cannot be generalized to the U.S. population as a whole. However, assessors may use the site-specific data from the relevant studies provided in this chapter if appropriate to the scenarios being assessed. The confidence ratings for recommended recreational marine fish intake rates are presented in Table 10-4.

10.2.3 Recommendations – Recreational Freshwater Anglers

Recommended values are not provided for recreational freshwater fish intake because the available data are limited to certain geographic areas and cannot be readily generalized to the U.S. population of freshwater recreational anglers as a whole. However, data from several relevant recreational freshwater studies are provided in this chapter. Data from these studies are summarized in Table 10-5. Assessors may use these data, if appropriate to the scenarios and locations being assessed.

10.2.4 Recommendations – Native American Subsistence Populations

Recommended values are also not provided for Native American subsistence fish intake because the available data are limited to certain geographic areas and/or tribes and cannot be readily generalized to Native American tribes as a whole. However, data from several Native American studies are provided in this chapter and are summarized in Table 10-6. Assessors may use these data, if appropriate to the scenarios and populations being assessed. These studies were performed at various study locations among various tribes.

Table 10-1. Recommended Values for General Population Fish Intake[a]

Age Group	Per Capita				Consumer Only				Multiple Percentiles	Source
	Mean		95th Percentile		Mean		95th Percentile			
	g/day	g/kg-day	g/day	g/kg-day	g/day	g/kg-day	g/day	g/kg-day		
Total Fish									See Tables 10-13, 10-14, 10-17, and 10-18	U.S. EPA (2002) (Rates are for uncooked weight)
3 to < 6 years	7.7	0.43	51.0	3.0	74	4.2	184	10		
6 to < 11 years	8.5	0.28	56.4	1.9	95	3.2	313*	8.7*		
11 to < 16 years	12.0	0.23	87.4	1.5	113	2.2	308*	6.2*		
16 to < 18 years	10.6	0.16	83.5	1.3	136*	2.1*	357*	6.6*		
>18 years	19.9	0.27	111.3	1.5	127	1.8	334	4.5		
Marine Fish										
3 to < 6 years	5.5	0.31	39.4	2.3	66	3.7	165	9.3*		
6 to < 11 years	5.6	0.20	38.4	1.5	78	2.8	202*	8.0*		
11 to < 16 years	7.6	0.15	56.5	1.3	102	2.0	262*	5.2*		
16 to < 18 years	6.1	0.10	29.5	0.5	126*	2.0*	353*	6.5*		
>18 years	12.4	0.17	80.7	1.1	108	1.5	270	3.7		
Freshwater/Estuarine Fish										
3 to < 6 years	2.2	0.12	12.2	0.7	40	2.3	129	7.2*		
6 to < 11 years	3.0	0.08	13.1	0.4	61	1.8	248*	6.2*		
11 to < 16 years	4.3	0.08	25.8	0.5	71	1.3	199*	4.4*		
16 to < 18 years	4.6	0.07	19.3	0.3	100*	1.4*	242*	3.3*		
>18 years	7.5	0.10	49.6	0.7	81	1.1	279	3.7		

[a] Analysis was conducted prior to Agency's issuance of *Guidance on Selecting Age groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA 2005). Thus, data were not presented for children less than 3 years old or for 18 to <21 years.

* The sample size does not meet the minimum reporting requirements, as described in the Third Report on Nutrition Monitoring in the United States (LSRO, 1995).

Table 10-2. Confidence in Recommendations for General Population Fish Intake		
General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	The survey methodology and the analysis of the survey data were adequate. Primary data were collected and used in a secondary analysis of the data. The sample size was large.	
Minimal (or Defined) Bias	The response rate was adequate. The survey data were based on recent recall. Data were collected over a short-duration (i.e., 2 days).	
Applicability and Utility		Medium
Exposure Factor of Interest	The key study focused on the exposure factor of interest.	
Representativeness	The survey was conducted nationwide and was representative of the general U.S. population.	
Currency	The most current CSFII 1994-96; 98 data were used.	
Data Collection Period	Data were collected for two non-consecutive days.	
Clarity and Completeness		High
Accessibility	The primary data are accessible through USDA.	
Reproducibility	The methodology was clearly presented; enough information was available to allow for reproduction of the results.	
Quality Assurance	Quality assurance of CSFII data was good; quality control of secondary analysis was good.	
Variability and Uncertainty		Medium
Variability in Population	Full distributions were provided by the key study.	
Uncertainty	The survey was not designed to capture long-term intake and was based on recall. Otherwise, the sources of uncertainty were minimal.	
Evaluation and Review		Medium
Peer Review	The primary data were reviewed by USDA; U.S. EPA review conducted a review of the secondary data analysis for fish intake.	
Number and Agreement of Studies	The number of studies is 1.	
Overall Rating		**Medium** (mean) **Low** (long-term upper percentiles)

Table 10-3. Recommended Values for Recreational Marine Fish Intake

Age Group	Per Capita[a]	
	Mean g/day	95th Percentile g/day
3 to <6 years[b]	2.5	8.2
6 to <11 years[b]	2.5	9.1
11 to <16 years[b]	3.4	14.1
16 to <18 years[b]	2.8	13.5
>18 years	5.6	18.0
3 to <6 years[b]	3.2	12.0
6 to <11 years[b]	3.3	13.2
11 to <16 years[b]	4.4	20.5
16 to <18 years[b]	3.5	19.6
>18 years	7.2	26.1
	Pacifi	
3 to <6 years[b]	0.9	3.1
6 to <11 years[b]	0.9	3.4
11 to <16 years[b]	1.2	5.3
16 to <18 years[b]	1.0	5.1
>18 years	2.0	6.8

[a] Represents per capita values for recreational fishing population only. Data from U.S. EPA analysis of NMFS (1993) assumed to represent adults >18 years. Per capita values represent both survey individuals who ate recreational fish during the survey period and those that did not, but may eat recreationally caught fish during other periods.

[B] Recommendations for children estimated based on proportion of children’s intake to adult intake for general population marine fish intake, applied to >18 years marine recreational fish intake rates.

Table 10-4. Confidence in Recommendations for Recreational Marine Fish Intake

General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	The survey methodology and the analysis of the survey data were adequate. Primary data were collected and used in a secondary analysis of the data. The sample size was large.	
Minimal (or Defined) Bias	The response rate was adequate. The survey data were based on recent recall.	
Applicability and Utility		Medium
Exposure Factor of Interest	The key study was not designed to estimate individual consumption of fish. U.S. EPA obtained the raw data and estimated intake distributions by employing assumptions derived from other data sources.	
Representativeness	The survey was conducted in coastal states in the Atlantic, Pacific, and Gulf regions and was representative of fishing populations in these regions of the U.S.	
Currency	The data are from a survey conducted in 1993.	
Data Collection Period	Data were collected in telephone interviews and direct interviews of fishermen in the field over a short time frame.	
Clarity and Completeness		Medium
Accessibility	The primary data are from NMFS.	
Reproducibility	The methodology was clearly presented; enough information was available to allow for reproduction of the results.	
Quality Assurance	Quality assurance of the primary data was not described. Quality assurance of the secondary analysis was good.	
Variability and Uncertainty		Low
Variability in Population	Mean and 95^{th} percentile values were provided.	
Uncertainty	The survey was specifically designed to estimate individual intake rates. U.S. EPA estimated intake based on an analysis of the raw data, using assumptions about the number of individuals consuming fish meals from the fish caught. Estimates for children are based on additional assumptions regarding the proportion of intake relative the amount eaten by adults.	
Evaluation and Review		Medium
Peer Review	Data from NMFS (1993) were reviewed by NMFS and U.S. EPA.	
Number and Agreement of Studies	The number of studies is 1.	
Overall Rating		**Low to Medium** (adults) **Low** (children)

Table 10-5. Summary of Relevant Studies on Freshwater Recreational Fish Intake

Location	Population Group	Mean	95th Percentile	Source
		g/day	g/day	
Alabama	Adults	44[a]	-	ADEM, 1994
Clinch River	Adults who eat fish from study area	38[b]	-	Campbell et al., 2002
	All Anglers	20[b]	-	
Connecticut	Sports Fishers	51	-	Balcom et al., 1999
Lake Ontario	Adults	4.9[c]	18	Connelly et al., 1996
Maine	All Anglers	5.0	21	Chemirisk, 1992; Ebert et al., 1993
	Consuming Anglers	6.4	26	
Michigan	1 to 5 years	5.6	-	West et al., 1989, 1993
	6 to 10 years	7.9	-	
	21 to 80 years	16[c]	-	
	All ages	14	39	
Indiana	Active Consumers	20	60.5	Williams et al., 2000a, 2000b
	Potential & Active Consumers	16		
Minnesota	0 to 14 years	1.2 (50th percentile)	15	Benson et al., 2001
	> 14 years (males)	4.5 (50th percentile)	38	
	15 to 44 (females)	2.1 (50th percentile)	25	
	> 44 (females)	3.6 (50th percentile)	32	
North Dakota	0 to 14 years	1.7 (50th percentile)	23	Benson et al., 2001
	> 14 years (males)	2.3 (50th percentile)	28	
	15 to 44 (females)	4.3 (50th percentile)	35	
	> 44 (females)	4.2 (50th percentile)	36	
Savannah Rive	Adult Whites	38[b]	-	Burger et al., 1999
	Adult Blacks	70[b]	-	
Wisconsin	Sports Anglers	7.4	25	Fiore et al., 1989

[a] Based on the average of 2 methods.
[b] Calculated as amount eaten per year divided by 365 days per year..
[c] Based on average of multiple adult age groups.

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Table 10-6. Summary of Relevant Studies on Native American Subsistence Fish Intake

Location/Tribe	Population Group	Mean [a]	95^{th} Percentile[a]	Source
94 Alaska Communities	Lowest of 94 Median of 94 Highest of 94	16 g/day 81 g/day 770 g/day	- - -	Wolfe and Walker, 1987
4 Columbia River Tribes	Adults Chilren ≤ 5 years	59 g/day 11 g/day (50^{th} percentile)	170 g/day 98 g/day	CRITFC, 1994
Chippewa Indians	Adults	19 g/day	-	Peterson et al., 1994
Florida	Consumers[b]	1.5 g/kg-day	5.7 g/kg-day	Westat, 2006
Maine – Native Americans	-	10 g/day	-	Chemirisk, 1992
Minnesota	Consumers[b]	2.8 g/kg-day	-	Westat, 2006
Mohawk	Women	8.8 g/day	-	Fitzgerald et al. 1995
North Dakota	Consumers[b]	0.4 g/kg-day	-	Westat, 2006
Tulalip Squaxin Island Tribe	Adult Adults	0.9 g/kg-day 0.9 g/kg-day	2.9 g/kg-day 3.0 g/kg-day	Toy et al., 1996
Suquamish Tribe	Adults	2.7 g/kg-day	10 g/kg-day	Duncan, 2000
Tulalip Tribe Squaxin Island Tribe	Adults	1.0 g/kg-day 1.0 g/kg-day	2.6 g/kg-day 3.4 g/kg-day	Polissar et al., 2006

[a] Results are reported in g/day or g/kg-day, depending upon which was provided in the source material.
[b] Based on uncooled fish weight.

10.3 GENERAL POPULATION STUDIES

10.3.1 Key General Population Study

10.3.1.1 *U.S. EPA, 2002 - Estimated Per Capita Fish Consumption in the United States*

U.S. EPA's Office of Water used data from the 1994-96 CSFII and its 1998 Children's Supplement (referred to collectively as CSFII 1994-96, 1998) to generate fish intake estimates (U.S. EPA, 2002). Participants in the CSFII 1994-96, 98 provided two non-consecutive days of dietary data. The Day 2 interview occurred three to ten days after the Day 1 interview, but not on the same day of the week. Data collection for the CSFII started in April of the given year and was completed in March of the following year. Respondents estimated the weight of each food that they consumed. Information on the consumption of food was classified using 11,345 different food codes, and stored in a database in units of grams consumed per day. A total of 831 of these food codes related to fish or shellfish; survey respondents reported consumption across 665 of these codes. The fish component (by weight) of the various foods was calculated using data from the recipe file for release 7 of USDA's Nutrient Data Base for Individual Food Intake Surveys.

The amount of fish consumed by each individual was then calculated by summing, over all fish containing foods, the product of the weight of food consumed and the fish component (i.e., the percentage fish by weight) of the food. The recipe file also contains cooking loss factors associated with each food. These were used to convert, for each fish-containing food, the as-eaten fish weight consumed into an uncooked equivalent weight of fish. Analyses of fish intake were performed on both an "as-prepared" (i.e., as-consumed) and uncooked basis.

Each fish-related food code was assigned, by U.S. EPA, to a habitat category. The habitat categories included freshwater/estuarine, or marine. Food codes were also designated as finfish or shellfish. Average daily individual consumption (g/day) was calculated, for a given fish type-by-habitat category (e.g., marine finfish), by summing the amount of fish consumed by the individual across the two reporting days for all fish-related food codes in the given fish-by-habitat category and then dividing by 2. Individual daily fish consumption (g/day) was calculated similarly except that total fish consumption was divided by the specific number of survey days the individual reported consuming fish; this was calculated for fish consumers only (i.e., those consuming fish on at least one of the two survey days). The reported body weight of the individual was used to convert consumption in g/day to consumption in g/kg-day.

There were a total of 20,607 respondents in the combined data set who had two-day dietary intake data. Survey weights were assigned to this data set to make it representative of the U.S. population with respect to various demographic characteristics related to food intake. Survey weights were also adjusted for nonresponse.

U.S. EPA (2002) reported means, medians, and estimates of the 90th, 95th, and 99th percentiles of fish intake. The 90-percent interval estimates are non-parametric estimates from bootstrap techniques. The bootstrap estimates result from the percentile method which calculates the lower and upper bounds for the interval estimate by the 100α percentile and 100 (1-α) percentile estimates from the non-parametric distribution of the given point estimate (U.S. EPA, 2002).

Analyses of fish intake were performed on an as-prepared as well as on an uncooked equivalent basis and on a g/day and mg/kg-day basis. Table 10-7 gives the mean and various percentiles of the distribution of per-capita finfish and shellfish intake rates (g/day), as prepared, by habitat and fish type, for the general population. Per-capita consumption estimates by species are shown in Table 10-8. Table 10-9 displays the mean and various percentiles of the distribution of per-capita finfish and shellfish intake rates (g/day) by habitat and fish type, on an uncooked equivalent basis. Per capita consumption estimates by species on an uncooked equivalent basis are shown in Table 10-10.

Tables 10-11 through 10-18 present data for daily average fish consumption. These data are presented by selected age groupings (14 and under, 15-44, 45 and older, all ages, children ages 3 to 17, and ages 18 and older) and gender. It should be noted the analysis predated the age groups recommended by U.S. EPA Guidelines on Selecting Age Groups for Monitoring and Assessing Childhood Exposure to Environmental Contaminants (U.S. EPA, 2005). Tables 10-11 through 10-14 present fish intake data (g/day and mg/kg-day; as prepared and uncooked) on for a per capita basis and Tables 10-15 through 10-18 provide data for consumers only.

The advantages of this study are its large size, its relative currency and its representativeness. The survey was also designed and conducted to support unbiased estimation of food consumption across the population. In addition, through use of the USDA recipe files, the analysis identified all fish-related food codes and estimated the percent fish content of each of these codes. By contrast, some analyses of the USDA National Food Consumption Surveys (NFCSs) which reported per capita fish intake rates (e.g., Pao et al., 1982; USDA, 1992a), excluded certain fish containing foods (e.g., fish mixtures, frozen plate meals) in their calculations.

The 1994-1996, 1998 CSFII data were preceded by 1989-91 CSFII data. Over 20,000 people nationwide participated in the combined 1994-1996, 1998 surveys, providing recalled food intake information for two separate days. In 1989-91, dietary data were collected on 3 consecutive days by using a 1-day dietary recall and a 2-day dietary record. The target population covered all 50 States in 1994-96, 1998 versus the 48 conterminous States in 1989-91. In both sets of surveys, the low-income population was oversampled.

Comparisons between the mean daily fish intake per individual in a day from the USDA survey data from years 1977-78, 1987-88, 1989-91, 1994, 1995, and 1996 indicate that fish intake has been relatively constant over time. The 1-day fish intake rates were 11 g/day, 11 g/day, 13 g/day, 9 g/day, 11 g/day, and 10 g/day for survey years 1977-78, 1987-88, 1989-91, 1994, and 1995, and 1996 respectively. The 1-day fish intake rate was 4 g/day for survey year 1998. This lower rate can be attributed to the fact that the sample selection for the 1998 data was made in the expectation that all datasets (1994-1996, 1998) would be combined to form one single set.

The 1998 set was meant to help correct bias from the previous sets. As such, bias can be found in the 1998 set (only households that included a child 10 years or younger were included in the data set). After accounting for the bias, the similarity in 1-day fish intake rates over a 20-year period listed above indicates that the 1994-1996, 1998 CSFII data presented in this handbook are probably adequate for assessing fish ingestion exposure for current populations.

10.3.2 Relevant General Population Studies

10.3.2.1 *Javitz, 1980; Tuna Research Foundation (TRF), 1975 – Seafood Consumption Study*

The Tuna Research Institute (TRI) funded a study of fish consumption which was performed by the National Purchase Diary (NPD) during the period of September, 1973 to August, 1974. The data tapes from this survey were obtained by the NMFS, which later, along with the FDA, USDA and TRI, conducted an intensive effort to identify and correct errors in the data base. Javitz (1980) summarized the TRI survey methodology and used the corrected tape to generate fish intake distributions for various sub-populations.

The TRI survey sample included 6,980 families who were currently participating in a syndicated national purchase diary panel, 2,400 additional families where the head of household was female and under 35 years old; and 210 additional black families (Javitz, 1980). Of the 9,590 families in the total sample, 7,662 families (25,162 individuals) completed the questionnaire, a response rate of 80 percent. The survey was weighted to represent the U.S. population based on a number of census-defined controls (i.e., census region, household size, income, presence of children, race and age). The calculations of means, percentiles, etc. were performed on a weighted basis with each person contributing in proportion to his/her assigned survey weight.

The survey population was divided into 12 different sample segments and, for each of the 12 survey months, data were collected from a different segment. Each survey household was given a diary in which they recorded, over a one month period, the date of any fish meals consumed and the following accompanying information: the species of fish consumed, whether the fish was commercially or recreationally caught, the way the fish was packaged (canned, frozen fresh, dried, smoked), the amount of fish prepared and consumed, and the number of servings consumed by household members and guests. Both meals eaten at home and away from home were recorded. The amount of fish prepared was determined as follows (Javitz, 1980): "For fresh fish, the weight was recorded in ounces and may have included the weight of the head and tail. For frozen fish, the weight was recorded in packaged ounces, and it was noted whether the fish was breaded or combined with other ingredients (e.g., TV dinners). For canned fish, the weight was recorded in packaged ounces and it was noted whether the fish was canned in water, oil, or with other ingredients (e.g., soups)."

Javitz (1980) reported that the corrected survey tapes contained data on 24,652 individuals who consumed fish in the survey month and that tabulations performed by NPD indicated that these fish consumers represented 94 percent of the U.S. population. For this population of "fish consumers", Javitz (1980) calculated means and percentiles of fish consumption by demographic variables (age, sex, race, census region and community type) and overall (Table 10-19). The overall mean fish intake rate among fish consumers was calculated at 14.3 g/day and the 95th percentile at 41.7 g/day.

As seen in Table 10-19, the mean and 95th percentile of fish consumption were higher for Asian-Americans as compared to the other racial groups. Other differences in intake rates are those between gender and age groups. While males (15.6 g/day) eat slightly more fish than females (13.2 g/day) and adults eat more fish than children, the corresponding differences in body weight would probably compensate for the different intake rates in exposure calculations (Javitz, 1980). There appeared to be no large differences in regional intake rates, although higher rates are shown in the New England and Middle Atlantic census regions.

Table 10-20 presents the distribution of fish consumption for females and males, by age; this table give the percentages of females/males in a given age bracket with intake rates within various ranges. Table 10-21 presents mean total fish consumption by fish species.

The TRI survey data were also utilized by Rupp et al. (1980) to generate fish intake distributions for three age groups (1 to 11, 12 to 18, and 18 to 98 years) within each of the 9 census regions and for the entire United States. Separate distributions were derived for freshwater finfish, saltwater finfish and shellfish; thus, a total of 90 (3*3*10) different distributions were derived, each corresponding to intake of a specific category of fish for a given age group within a given region. The analysis of Rupp et al. (1980) included only those respondents with known age. This amounted to 23,213 respondents.

Ruffle et al. (1994) used the percentiles data of Rupp et al. (1980) to estimate the best fitting lognormal parameters for each distribution. Three methods (non-linear optimization, first probability plot and second probability plot) were used to estimate optimal parameters. Ruffle et al. (1994) determined that, of the three methods, the non-linear optimization method (NLO) generally gave the best results. For some of the distributions fitted by the NLO method, however, it was determined that the lognormal model did not adequately fit the empirical fish intake distribution. Ruffle et al. (1994) used a criterion of minimum sum of squares (min SS) less than 30 to identify which distributions provided adequate fits. Of the 90 distributions studied, 77 were seen to have min SS < 30; for these, Ruffle et al. (1994) concluded that the NLO modeled lognormal distributions are "well suited for risk assessment". Of the remaining 13 distributions, 12 had min SS > 30; for these Ruffle et al. (1994) concluded that modeled lognormal distributions "may also be appropriate for use when exercised with due care and with sensitivity analyses". One distribution, that of freshwater finfish intake for children < 11 years of age in New England, could not be modeled due to the absence of any reported consumption.

Table 10-22 presents the optimal lognormal parameters, the mean (μ), standard deviation (s), and min SS. These parameters can be used to determine percentiles of the corresponding distribution of average daily fish consumption rates through the relation $DFC(p)=\exp[\mu+ z(p)s]$ where DFC(p) is the pth percentile of the distribution of average daily fish consumption rates and z(p) is the z-score associated with the pth percentile (e.g., z(50)=0). The mean average daily fish consumption rate is given by $\exp[\mu + 0.5s^2]$.

The analyses of Javitz (1980) and Ruffle et al. (1994) were based on consumers only, who are estimated to represent 94.0 percent of the U.S. population. U.S. EPA estimated the mean intake in the general population by multiplying the fraction consuming, 0.94, by the mean among consumers reported by Javitz (1980) of 14.3 g/day; the resulting estimate is 13.4 g/day. The 95th percentile estimate of Javitz (1980) of 41.7 g/day among consumers would be essentially unchanged when applied to the general population; 41.7 g/day would represent the 95.3 percentile (i.e., 100*[0.95*0.94+0.06]) among the general population.

The advantages of the TRI data survey are that it was a large, nationally representative survey with a high response rate (80 percent) and was conducted over an entire year. In addition, consumption was recorded in a daily diary over a one month period; this format should be more reliable than one based on one-month recall. The upper percentiles presented are derived from one month of data, and are likely to overestimate the corresponding upper percentiles of the long-term (i.e., one year or more) average daily fish intake distribution. Similarly, the standard deviation of the fitted lognormal distribution probably overestimates the standard deviation of the long-term distribution. However, the period of this survey (one month) is considerably longer than those of many other consumption studies, including the USDA National Food Consumption Surveys, which report consumption over a 2 day to one week period.

Another obvious limitation of this data base is that it is now over thirty years out of date. Ruffle et al. (1994) considered this shortcoming and suggested that one may wish to shift the distribution upward to account for the recent increase in fish consumption, though CSFII has shown little change in g/day fish consumption from 1978 to 1996. Adding ln(1+x/100) to the log mean μ will shift the distribution upward by x percent (e.g., adding 0.22 = ln(1.25) increases the distribution by 25 percent). Although the TRI survey distinguished between recreationally and commercially caught fish, Javitz (1980), Rupp et al. (1980), and Ruffle et al. (1994) (which was based on Rupp et al., 1980) did not present analyses by this variable.

10.3.2.2 *Pao et al., 1982 - Foods Commonly Eaten by Individuals: Amount Per Day and Per Eating Occasion*

The USDA 1977-78 Nationwide Food Consumption Survey (NFCS) consisted of a household and individual component. For the individual component, all members of surveyed households were asked to provide 3 consecutive days of dietary data. For the first day's data, participants supplied dietary recall information to an in-home interviewer. Second and third day dietary intakes were recorded by participants. A total of 15,000 households were included in the 1977-78 NFCS and about 38,000 individuals completed the 3-day diet records. Fish intake was estimated based on consumption of fish products identified in the NFCS data base according to NFCS-defined food codes. These products included fresh, breaded, floured, canned, raw and dried fish, but not fish mixtures or frozen plate meals.

Pao et al. (1982) used the data from this survey set to calculate per capita fish intake rates. However, because these data are now almost 30 years out of date, this analysis is not considered key with respect to assessing per capita intake (the average quantity of fish consumed per fish meal should be less subject to change over time than is per capita intake). In addition, fish mixtures and frozen plate meals were not included in the calculation of fish intake. The per capita fish intake rate reported by Pao et al. (1982) was 11.8 g/day. The 1977-1978 NFCS was a large and well designed survey and the data are representative of the U.S. population.

10.3.2.3 *USDA, 1992b – Food and nutrient intakes by individuals in the United States, 1 day, 1987-88: Nationwide Food Consumption Survey 1987-88*

The USDA 1987-88 Nationwide Food Consumption Survey (NFCS) is described in more detail in Chapter 13. Briefly, the survey consisted of a household and individual component. The household component asked about household food consumption over the past one week period. For the individual component, each member of a surveyed household was interviewed (in person) and asked to recall all foods eaten the previous day; the information from this interview made up the "one day data" for the survey. In addition, members were instructed to fill out a detailed dietary record for the day of the interview and the following day. The data for this entire 3-day period made up the "3-day diet records". A statistical sampling design was used to ensure that all seasons, geographic regions of the U.S., demographic, and socioeconomic groups were represented. Sampling weights were used to match the population distribution of 13 demographic characteristics related to food intake (USDA, 1992a).

Total fish intake was estimated based on consumption of fish products identified in the NFCS data base according to NFCS-defined food codes. These products included fresh, breaded, floured, canned, raw and dried fish, but not fish mixtures or frozen plate meals.

A total of 4,500 households participated in the 1987-88 survey; the household response rate was 38 percent. One day data were obtained for 10,172 (81 percent) of the 12,522 individuals in participating households; 8,468 (68 percent) individuals completed 3-day diet records.

USDA (1992b) used the one day data to derive per capita fish intake rate and intake rates for consumers of total fish. These rates, calculated by sex and age group, are shown in Table 10-23. Intake rates for consumers-only were calculated by dividing the per capita intake rates by the fractions of the population consuming fish in one day.

The 1987-1988 NFCS was also utilized to estimate consumption of home-produced fish (as well as home-produced fruits, vegetables, meats and dairy products) in the general U.S. population. The methodology for estimating home-produced intake rates was rather complex and involved combining the household and individual components of the NFCS; the methodology, as well as the estimated intake rates, are described in detail in Chapter 13. However, since much of the rest of this chapter is concerned with estimating consumption of recreationally caught, i.e., home-produced fish, the methods and results of Chapter 13, as they pertain to fish consumption, are summarized briefly here.

A total of 2.1 percent of the survey population reported home-produced fish consumption during the survey week. Among consumers, the mean intake rate was 2.07 g/kg-day and the 95th percentile was 7.83 g/kg-day; the per-capita intake rate was 0.04 g/kg-day. Note that intake rates for home-produced foods were indexed to the weight of the survey respondent and reported in g/kg-day.

It is possible to compare the estimates of home-produced fish consumption derived in this analysis with estimates derived from studies of recreational anglers (described in Sections 10.4-10.5); however, the intake rates must be put into a similar context. The home-produced intake rates described refer to average daily intake rates among individuals consuming home-produced fish in a week; results from recreational angler studies, however, usually report average daily rates for those eating home-produced fish (or for those who recreationally fish) at least some time during the year. Since many of these latter individuals eat home-produced fish at a frequency of less than once per week, the average daily intake in this group would be expected to be less than that reported.

The NFCS household component contains the question "Does anyone in your household fish?" For the population answering yes to this question (21 percent of households), the NFCS data show that 9 percent consumed home-produced fish in the week of the survey; the mean intake rate for these consumers from fishing households was 2.2 g/kg-day. (Note that 91 percent of individuals reporting home grown fish consumption for the week of the survey indicated that a household member fishes; the overall mean intake rate among home-produced fish consumers, regardless of fishing status, was the above reported 2.07 g/kg-day). The per capita intake rate among those living in a fishing household is then calculated as 0.2 g/kg-day (2.2 * 0.09). Using the estimated average weight of survey participants of 59 kg, this translates into 11.8 g/day. Among members of fishing households, home-produced fish consumption accounted for 32.5 percent of total fish consumption.

As discussed in Chapter 13 of this handbook, intake rates for home-produced foods, including fish, are based on the results of the household survey, and as such, reflect the weight of fish taken into the household. In most of the recreational fish surveys discussed later in this section, the weight of the fish catch (which generally corresponds to the weight taken into the household) is multiplied by an edible fraction to convert to an uncooked equivalent of the amount consumed. This fraction may be species specific, but some studies used an average value; these average values ranged from 0.3 to 0.5. Using a factor of 0.5 would convert the above 11.8 g/day rate to 5.9 g/day. This estimate, 5.9 g/day, of the per-capita fish intake rate among members of fishing households is within the range of the per-capita intake rates among recreational anglers addressed in sections to follow.

An advantage of analyses based on the 1987-1988 USDA NFCS is that the data set is a large, geographically and seasonally balanced survey of a representative sample of the U.S. population. The survey response rate, however, was low and an expert panel concluded that it was not possible to establish the presence or absence of non-response bias (USDA, 1992b). In addition, the data from this survey have been superseded by more recent surveys. Limitations of the home-produced analysis are given in Chapter 13 of this volume.

10.3.2.4 *Tsang and Klepeis, 1996 – National Human Activity Pattern Survey (NHAPS)*

The U.S. EPA collected information for the general population on the duration and frequency of time spent in selected activities and time spent in selected microenvironments via 24-hour diaries. Over 9,000 individuals from 48 contiguous states participated in NHAPS. Approximately 4,700 participants also provided information on seafood consumption. The survey was conducted between October 1992 and September 1994. Data were collected on (1) the number of people that ate seafood in the last month, (2) the number of servings of seafood consumed, and (3) whether the seafood consumed was caught or purchased (Tsang and Klepeis, 1996). The participant responses were weighted according to selected demographics such as age, gender, and race to ensure that results were representative of the U.S. population. Of those 4,700 respondents, 2,980 (59.6 percent) ate seafood (including shellfish, eels, or squid) in the last month (Table 10-24). The number of servings per month were categorized in ranges of 1-2, 3-5, 6-10, 11-19, and 20+ servings per month (Table 10-25). The highest percentage (35 percent) of the respondent population had an intake of 3-5 servings per month. Most (92 percent) of the respondents purchased the seafood they ate (Table 10-26).

Intake data were not provided in the survey. However, intake of fish can be estimated using the information on the number of servings of fish eaten from this study and serving size data from other studies. Smiciklas-Wright et al. (2002) estimated that the mean value for fish serving size for all age groups combined is 110 g/serving based on the 1994-1996 CSFII survey (See Section 10.8). The serving size CSFII data are based on all finfish, except canned, dried, and raw, whether reported separately or as part of a sandwich or other mixed food. Using this mean value for serving size and assuming that the average individual eats 3-5 servings per month, the amount of seafood eaten per month would range from 330 to 550 grams/month or 11.0 to 18.3 g/day for the highest percentage of the population. These values are within the range of per capita mean intake values for total fish (16.9 g/day, uncooked equivalent weight) calculated by U.S. EPA (2002) analysis of the USDA CSFII data. It should be noted that an all inclusive description for seafood was not presented in Tsang and Klepeis (1996). It is not known if processed or canned seafood and seafood mixtures are included in the seafood category.

The advantages of NHAPS are that the data were collected for a large number of individuals and are representative of the U.S. general population.

However, evaluation of seafood intake was not the primary purpose of the study and the data do not reflect the actual amount of seafood that was eaten. However, using the assumption described above, the estimated seafood intake from this study is comparable to that observed in the EPA CSFII analysis.

10.3.2.5 *Westat., 2006 - Fish Consumption in Connecticut, Florida, Minnesota, and North Dakota*

Westat (2006) analyzed the raw data from three fish consumption studies to derive fish consumption rates for various age, gender, and ethnic groups, and according to the source of fish consumed (i.e., bought or caught) and habitat (i.e., freshwater, estuarine, or marine). The studies represented data from four states: Connecticut, Florida, Minnesota and North Dakota.

The Connecticut data were collected in 1996/1997 by the University of Connecticut to obtain estimates of fish consumption for the general population, sport fishing households, commercial fishing households, minority and limited income households, women of child-bearing years, and children. Data were obtained from 810 households, representing 2,080 individuals, using a combination of a mail questionnaire that included a 10-day diary, and personal interviews. The response rate for this survey was low (i.e., 6 percent for the general population and 10 percent for anglers), but was considered to be adequate by the study authors (Balcom et al., 1999).

The Florida data were collected by telephone and in-person interviews by the University of Florida, and represented a random sample of 8,000 households (telephone interviews), and 500 food stamp recipients (in-person interviews). The purpose of the survey was to obtain information on the quantity of fish and shellfish eaten, as well as the cooking method used. Additional information of the Florida survey can be found in Degner et al. (1994).

The Minnesota and North Dakota data were collected by the University of North Dakota in 2000 and represented 1,572 households and 4,273 individuals. Data on purchased and caught fish were collected for the general population, anglers, new mothers, and Native American tribes. The survey also collected information of the species of fish eaten. Additional information on this study can be found in Benson et al. (2001).

The primary difference in survey procedures among the three studies was the manner in which the fish consumption data were collected. In Connecticut, the survey requested information on how often each type of seafood was eaten, without a recall period specified. In Minnesota and North Dakota, the survey requested information on the rate of fish or shellfish consumption during the previous 12 months. In Florida, the survey requested information on fish consumption during the last seven days prior to the telephone interview. In addition, for the Florida survey, information on away-from-home fish consumption was collected from a randomly selected adult from each participating household. Because this information was not collected from all household members, the study may tend to underestimate away-from-home consumption. The study notes that estimates of fish consumption using a shorter recall period will decrease the proportion of respondents that report eating fish or shellfish. This trend was observed in the Florida study (in which approximately half of respondents reported eating fish/shellfish), compared with Connecticut, Minnesota and North Dakota (in which approximately 90 percent of respondents reported eating fish or shellfish).

Tables 10-27 through 10-36 present key findings of the Westat (2006) consumption study. The tables show the fish and shellfish consumption rates for subgroups classified by demographic characteristics and by the source of the fish and shellfish consumed (i.e., freshwater versus marine, and bought versus self caught). Consumption rates are presented in grams per kilogram of bodyweight per day for the entire population (i.e., consumption per capita) and for just those that reported consuming fish and shellfish (consumption for consumers only).

10.3.2.6 *Moya et al., 2008 - Estimates of Fish Consumption Rates for Consumers of Bought and Self-caught fish in Connecticut, Florida, Minnesota, and North Dakota*

Moya et al. (2008) conducted an analysis based on the Westat (2006) study described in Section 10.3.2.5. Raw data from three fish consumption studies (representing data from four states) were analyzed to derive fish consumption rates . Moya et al. (2008) utilized the data to generate intake rates for three age groups of children (i.e., 1 to <6 years, 6 to <11 years, and 11 to <16 years) and three age groups of adults (16 to <30 years, 30 to <50 years, and >50 years), which are also listed by gender. These data represented the general population in the four states. Recreational fish intake rates were not provided for children, and data were not provided for children according to the source of intake (i.e., bought or caught) or habitat (i.e., freshwater, estuarine, or marine). Table 10-37 presents the intake rates for the general population who consumed fish and shellfish in g/kg-day, as-consumed. Table 10-37 also provides information on the fish intake among the sample populations from the four states, based on the source of the fish (i.e., caught or bought), and provides estimated fish intake rates among the general populations and angler populations from Connecticut, Minnesota, and North Dakota.

10.4 MARINE RECREATIONAL STUDIES

10.4.1 Key Marine Recreational Study

10.4.1.1 *National Marine Fisheries Service, 1986a, b, c; 1993*

The National Marine Fisheries Service (NMFS) conducts systematic surveys, on a continuing basis, of marine recreational fishing. These surveys are designed to estimate the size of the recreational marine finfish catch by location, species and fishing mode. In addition, the surveys provide estimates for the total number of participants in marine recreational finfishing and the total number of fishing trips.

The NMFS surveys involve two components, telephone surveys and direct interviewing of fishermen in the field. The telephone survey randomly samples residents of coastal regions, defined generally as counties within 25 miles of the nearest seacoast, and inquires about participation in marine recreational fishing in the resident's home state in the past year, and more specifically, in the past two months. This component of the survey is used to estimate, for each coastal state, the total number of coastal region residents who participate in marine recreational fishing (for finfish) within the state, as well as the total number of (within state) fishing trips these residents take. To estimate the total number of participants and fishing trips in the state, by coastal residents and others, a ratio approach, based on the field interview data, was used. Thus, if the field survey data found that there was a 4:1 ratio of fishing trips taken by coastal residents as compared to trips taken by non-coastal and out of state residents, then an additional 25 percent would be added to the number of trips taken by coastal residents to generate an estimate of the total number of within state trips.

The surveys are not designed to estimate individual consumption of fish from marine recreational sources, primarily because they do not attempt to estimate the number of individuals consuming the recreational catch. Intake rates for marine recreational anglers can be estimated, however, by employing assumptions derived from other data sources about the number of consumers.

The field intercept survey is essentially a creel type survey. The survey utilizes a national site register which details marine fishing locations in each state. Sites for field interviews are chosen in proportion to fishing frequency at the site. Anglers fishing on shore, private boat, and charter/party boat modes who had completed their fishing were interviewed. The field survey included questions about frequency of fishing, area of fishing, age, and place of residence. The fish catch was classified by the interviewer as either type A, type B1 or type B2 catch. The type A catch denoted fish that were taken whole from the fishing site and were available for inspection. The type B1 and B2 catch were not available for inspection; the former consisted of fish used as bait, filleted, or discarded dead while the latter was fish released alive. The type A catch was identified by species and weighed, with the weight reflecting total fish weight, including inedible parts. The type B1 catch was not weighed, but weights were estimated using the average weight derived from the type A catch for the given species, state, fishing mode and season of the year. For both the A and B1 catch, the intended disposition of the catch (e.g., plan to eat, plan to throw away, etc.) was ascertained.

U.S. EPA obtained the raw data tapes from NMFS in order to generate intake distributions and other specialized analyses. Fish intake distributions were generated using the field survey tapes. Weights proportional to the inverse of the angler's reported fishing frequency were employed to correct for the unequal probabilities of sampling; this was the same approach used by NMFS in deriving their estimates. Note that in the field survey, anglers were interviewed regardless of past interviewing experience; thus, the use of inverse fishing frequency as weights was justified (see Section 10.1).

For each angler interviewed in the field survey, the yearly amount of fish caught that was intended to be eaten by the angler and his/her family or friends was estimated by U.S. EPA as follows:

$$Y = [(wt\ of\ A\ catch) * I_A + (wt\ of\ B1\ catch) * I_B] * [Fishing\ frequency] \qquad \text{(Eqn. 10-1)}$$

where I_A (I_B) are indicator variables equal to 1 if the type A (B1) catch was intended to be eaten and equal to 0 otherwise. To convert Y to a daily fish intake rate by the angler, it was necessary to convert amount of fish caught to edible amount of fish, divide by the number of intended consumers, and convert from yearly to daily rate.

Although theoretically possible, U.S. EPA chose not to use species specific edible fractions to convert overall weight to edible fish weight since edible fraction estimates were not readily available for many marine species. Instead, an average value of 0.5 was employed. For the number of intended consumers, U.S. EPA used an average value of 2.5 which was an average derived from the results of several studies of recreational fish consumption (Chemrisk, 1992; Puffer et al., 1981; West et al., 1989). Thus, the average daily intake rate (ADI) for each angler was calculated as

$$ADI = Y * (0.5)/[2.5 * 365] \qquad \text{(Eqn. 10-2)}$$

Note that ADI will be 0 for those anglers who either did not intend to eat their catch or who did not catch any fish. The distribution of ADI among anglers was calculated by region and coastal status (i.e., coastal versus non-coastal counties).

The results presented in Tables 10-38 and 10-39 are based on the results of the 1993 survey. Samples sizes were 200,000 for the telephone survey and 120,000 for the field surveys. All coastal states in the continental U.S. were included in the survey except Texas and Washington.

Table 10-38 presents the estimated number of coastal, non-coastal, and out-of-state fishing participants by state and region of fishing. Florida had the greatest number of both Atlantic and Gulf participants. The total number of coastal residents who participated in marine finfishing in their home state was 8 million; an additional 750,000 non-coastal residents participated in marine finfishing in their home state.

Table 10-39 presents the estimated total weight of the A and B1 catch by region and time of year. For each region, the greatest catches were during the six-month period from May through October. This period accounted for about 90 percent of the North and Mid-Atlantic catch, about 80 percent of the Northern California and Oregon catch, about 70 percent of the Southern Atlantic and Southern California catch and 62 percent of the Gulf catch. Note that in the North and Mid-Atlantic regions, field surveys were not done in January and February due to very low fishing activity. For all regions, over half the catch occurred within 3 miles of the shore or in inland waterways.

Table 10-40 presents the mean and 95th percentile of average daily intake of recreationally caught marine finfish among anglers by region. The mean ADI among all anglers was 5.6, 7.2, and 2.0 g/day for the Atlantic, Gulf, and Pacific regions, respectively. Table 10-41 gives the distribution of the catch by species for the Atlantic and Gulf, and Pacific regions.

The NMFS surveys provide a large, geographically representative sample of marine angler activity in the U.S. The major limitation of this data base in terms of estimating fish intake is the lack of information regarding the intended number of consumers of each angler's catch. In this analysis, it was assumed that every angler's catch was consumed by the same number (2.5) of people; this number was derived from averaging the results of other studies. This assumption introduces a relatively low level of uncertainty in the estimated mean intake rates among anglers, but a somewhat higher level of uncertainty in the estimated intake distributions.

Under the above assumption, the distributions shown here pertain not only to the population of anglers, but also to the entire population of recreational fish consumers, which is 2.5 times the number of anglers. If the number of consumers was changed, to, for instance, 2.0, then the distribution would be increased by a factor of 1.25 (2.5/2.0), but the estimated population of recreational fish consumers to which the distribution would apply would decrease by a factor of 0.8 (2.0/2.5).

Another uncertainty involves the use of 0.5 as an (average) edible fraction. This figure is somewhat conservative (i.e., the true average edible fraction is probably lower); thus, the intake rates calculated here may be biased upward somewhat.

The recreational fish intake distributions given refer only to marine finfish. In addition, the intake rates calculated are based only on the catch of anglers in their home state. Marine fishing performed out-of-state would not be included in these distributions. Therefore, these distributions give an estimate of consumption of locally caught fish.

10.4.2 Relevant Marine Recreational Studies

10.4.2.1 *Pierce et al., 1981 - Commencement Bay Seafood Consumption Study*

Pierce et al. (1981) performed a local creel survey to examine seafood consumption patterns and demographics of sport fishermen in Commencement Bay, Washington. The objectives of this survey included determining (1) seafood consumption habits and demographics of non-commercial anglers catching seafood; (2) the extent to which resident fish were used as food; and (3) the method of preparation of the fish to be consumed. Salmon were excluded from the survey since it was believed that they had little potential for contamination. The first half of this survey was conducted from early July to mid-September, 1980 and the second half from mid-September through most of November. During the summer months, interviewers visited each of 4 sub-areas of Commencement Bay on five mornings and five evenings; in the fall the areas were sampled on 4 complete survey days. Interviews were conducted only with persons who had caught fish. The anglers were interviewed only once during the survey period. Data were recorded for species, wet weight, size of the living group (family), place of residence, fishing frequency, planned uses of the fish, age, sex, and race (Pierce et al., 1981). The analysis of Pierce et al. (1981) did not employ explicit sampling weights (i.e., all weights were set to 1).

There were 304 interviews in the summer and 204 in the fall. About 60 percent of anglers were white, 20 percent black, 19 percent Asian and the rest Hispanic or Native American. Table 10-42 gives the distribution of fishing frequency calculated by Pierce et al. (1981); for both the summer and fall, more than half of the fishermen caught and consumed fish weekly. The dominant (by weight) species caught were Pacific Hake and Walleye Pollock. Pierce et al. (1981) did not present a distribution of fish intake or a mean fish intake rate.

The U.S. EPA used the Pierce et al. (1981) fishing frequency distribution and an estimate of the average amount of fish consumed per angling trip to create an approximate intake distribution for the Pierce et al. (1981) survey. The estimate of the amount of fish consumed per angling trip (380 g/person-trip) was based on data on mean fish catch weight and mean number of consumers reported in Pierce et al. (1981) and on an edible fraction of 0.5. The median intake was estimated to be 23 g/day.

Price et al. (1994) obtained the raw data from this survey and performed a re-analysis using sampling weights proportional to inverse fishing frequency. The rationale for these weights is explained in Section 10.1 and in the discussion of the Puffer et al. (1981) study (Section 10.4.2.2). In the re-analysis, Pierce et al. (1994) calculated a median intake rate of 1.0 g/day and a 90th percentile rate of 13 g/day. The distribution of fishing frequency generated by Price et al. (1994) is shown in Table 10-43. Note that when equal weights were used, Price et al. (1994) found a median rate of 19 g/day, which was close to the approximate value calculated by the U.S. EPA of 23 g/day.

The same limitations apply to interpreting the results presented here to those presented in the discussion of Puffer et al. (1981) (Section 10.4.2.2). The median intake rate found by Price et al. (1994) (using inverse frequency weights) is more reflective of median intake in the target population than is the value of 19 g/day (or 23 g/day); the latter value reflects more the 50th percentile of the resource utilization distribution, (i.e., that anglers with intakes above 19 g/day consume 50 percent of the recreational fish catch). Similarly, the fishing frequency distribution generated by Price et al. (1994) is more reflective of the fishing frequency distribution in the target population than is the distribution presented in Pierce et al. (1981). Note the target population is those anglers who fished at Commencement Bay during the time period of the survey.

As with the Puffer et al. (1981) data described in the following section, these values (1.0 g/day and 19 g/day) are both probably underestimates since the sampling probabilities are less than proportional to fishing frequency; thus, the true target population median is probably somewhat above 1.0 g/day and the true 50th percentile of the resource utilization distribution is probably somewhat higher than 19 g/day. The data from this survey provide an indication of consumption patterns for the time period around 1980 in the Commencement Bay area. However, the data may not reflect current consumption patterns because fishing advisories were instituted due to local contamination. Another limitation of these data is that fish consumption rates were estimated indirectly from a series of assumptions.

10.4.2.2 *Puffer et al., 1981 - Intake Rates of Potentially Hazardous Marine Fish Caught in the Metropolitan Los Angeles Area*

Puffer et al. (1981) conducted a creel survey with sport fishermen in the Los Angeles area in 1980. The survey was conducted at 12 sites in the harbor and coastal areas to evaluate intake rates of potentially hazardous marine fish and shellfish by local, non-professional fishermen. It was conducted for the full 1980 calendar year, although inclement weather in January, February, and March limited the interview days. Each site was surveyed an average of three times per month, on different days, and at a different time of the day. The survey questionnaire was designed to collect information on demographic characteristics, fishing patterns, species, number of fish caught, and fish consumption patterns. Scales were used to obtain fish weights. Interviews were conducted only with anglers who had caught fish, and the anglers were interviewed only once during the entire survey period.

Puffer et al. (1981) estimated daily consumption rates (grams/day) for each angler using the following equation:

$$K \times N \times W \times F)/[E \times 365] \qquad \text{(Eqn. 10-3)}$$

where: K = edible fraction of fish (0.25 to 0.5 depending on species);

N = number of fish in catch;
W = average weight of (grams) fish in catch;
F = frequency of fishing/year; and
E = number of fish eaters in family/living group.

No explicit survey weights were used in analyzing this survey; thus, each respondent's data were given equal weight.

A total of 1,059 anglers were interviewed for the survey. The ethnic and age distribution of respondents is shown in Table 10-44; 88 percent of respondents were male. The median intake rate was higher for Asian/Samoan anglers (median 70.6 g/day) than for other ethnic groups and higher for those ages over 65 years (median 113.0 g/day) than for other age groups. Puffer et al. (1981) found similar median intake rates for seasons; 36.3 g/day for November through March and 37.7 g/day for April through October. Puffer et al. (1981) also evaluated fish preparation methods; these data are presented in Appendix 10B. The cumulative distribution of recreational fish (finfish and shellfish) consumption by survey respondents is presented in Table 10-45; this distribution was calculated only for those fishermen who indicated they eat the fish they catch. The median fish consumption rate was 37 g/day and the 90th percentile rate was 225 g/day (Puffer et al., 1981). A description of catch patterns for primary fish species kept is presented in Table 10-46.

As mentioned in the introduction to this Chapter, intake distributions derived from analyses of creel surveys which did not employ weights reflective of sampling probabilities will overestimate the target population intake distribution and will, in fact, be more reflective of the "resource utilization distribution." Therefore, the reported median level of 37.3 g/day does not reflect the fact that 50 percent of the target population has intake above this level; instead 50 percent of recreational fish consumption is by individuals consuming at or above 37.3 g/day. In order to generate an intake distribution reflective of that in the target population, weights inversely proportional to sampling probability need to be employed. Price et al. (1994) made this attempt with the Puffer et al. (1981) survey data, using inverse fishing frequencies as the sampling weights. Price et al. (1994) was unable to get the raw data for this survey, but through the use of frequency tables and the average level of fish consumption per fishing trip provided in Puffer et al. (1981), generated an approximate revised intake distribution. This distribution was dramatically lower than that obtained by Puffer et al. (1981); the median was estimated at 2.9 g/day (compared with 37.3 from Puffer et al., 1981) and the 90th percentile at 35 g/day (compared to 225 g/day from Puffer et al., 1981).

There are several limitations to the interpretation of the percentiles presented by both Puffer et al. (1981) and Price et al. (1994). As described in Appendix 10A, the interpretation of percentiles reported from creel surveys in terms of percentiles of the "resource utilization distribution" is approximate and depends on several assumptions. One of these assumptions is that sampling probability is proportional to inverse fishing frequency. In this survey, where interviewers revisited sites numerous times and anglers were not interviewed more than once, this assumption is not valid, though it is likely that the sampling probability is still highly dependant on fishing frequency so that the assumption does hold in an approximate sense. The validity of this assumption also impacts the interpretation of percentiles reported by Price et al. (1994) since inverse frequency was used as sampling weights. It is likely that the value (2.9 g/day) of Price et al. (1994) underestimates somewhat the median intake in the target population, but is much closer to the actual value than the Puffer et al. (1981) estimate of 37.3 g/day. Similar statements would apply about the 90th percentile. Similarly, the 37.3 g/day median value, if interpreted as the 50th percentile of the "resource utilization distribution", is also somewhat of an underestimate.

The fish intake distribution generated by Puffer et al. (1981) (and by Price et al., 1994) was based only on fishermen who caught fish and ate the fish they caught. If all anglers were included, intake estimates would be somewhat lower. In contrast, the survey assumed that the number of fish caught at the time of the interview was all that would be caught that day. If it were possible to interview fishermen at the conclusion of their fishing day, intake estimates could be potentially higher. An additional factor potentially affecting intake rates is that fishing quarantines were imposed in early spring due to heavy sewage overflow (Puffer et al., 1981). These data are also over 20 years old and may not reflect current behaviors.

10.4.2.3 *Burger. and Gochfeld, 1991 - Fishing a Superfund Site: Dissonance and Risk Perception of Environmental Hazards by Fishermen in Puerto Rico*

Burger and Gochfeld (1991) examined fishing behavior, consumption patterns, and risk perceptions of fishermen and crabbers engaged in recreational and subsistence fishing in the Humacao Lagoons located in eastern Puerto Rico. For a 20-day period in February and March 1988, all persons encountered fishing and crabbing at the Humacao lagoons and at control sites were interviewed on fishing patterns, consumption patterns, cooking patterns, fishing and crabbing techniques, and consumption warnings. The control interviews were conducted at sites that were ecologically similar to the Humacao lagoons and contained the same species of fish and crabs. A total of 45 groups of people (3 to 4 people per group) fishing at the Humacao Lagoons and 17 control groups (3 to 4 people per group) were interviewed.

Most people fished in the late afternoon or evenings, and on weekends. Eighty percent of the fishing groups from the lagoons were male. The breakdown according to age is as follows: 27 percent were younger than 20 years, 49 percent were 21-40 years old, 24 percent were 41-60 years old, and 2 percent were over 60. The age groups for fishing were generally lower than the groups for crabbing. Caught fish were primarily tilapia and some tarpon. All crabs caught were all blue crabs.

On average people at Humacao ate about 7 fish (N=25) or 13 crabs (N=20) each week, while people fishing at the control site ate about 2 fish (N=9) and 14 crabs (N=9) a week (Table 10-47). One hundred percent of the crabbers and 96 percent of the fisherman at the lagoons had heard of a contamination problem.

All the interviewees that knew of a contamination problem knew that the contaminant was mercury. Most fisherman and crabbers believed that the water was clean and the catch was safe (fisherman-96 percent and crabbers-100 percent), and all fisherman and crabbers ate their catch. Seventy-two percent of the fisherman and crabbers from the lagoons lived within 3 km, 18 percent lived 17-30 km away, and one group came from 66 km away. Since many of the people interviewed had cars, researchers concluded that they were not impoverished and did not need the fish as a protein substitute.

Burger and Gochfeld (1991) noted that fisherman and crabbers did not know of anyone who had gotten sick from eating catches from the lagoons and the potential of chronic health effects did not enter into their consideration. The study concluded that fisherman and crabbers experienced an incompatibility between their own experiences, and the risk driven by media reports of pollution and the lack of governmental prohibition of fishing.

One limitation of the study is that consumption rates were based on groups not individuals. In addition, rates were given in terms of fish per week and not mass consumed per time or body weight.

10.4.2.4 *Burger et al., 1992 – Exposure Assessment for Heavy Metal Ingestion from Sport Fish in Puerto Rico: Estimating Risk for Local Fishermen*

Burger wt al. (1992) conducted another study in conjunction with the Burger and Gochfeld (1991) study. The study interviewed 45 groups of fishermen at Humacao and 14 groups at Boqueron in Puerto Rico. The respondents were 80 percent male, 50 percent were 21 to 40 years old, most fished with pole or cast, and most fished for 1.5 hours. In Humacao 96 percent claimed that they ate the entire fish besides the head. The fish were either fried or boiled in stews or soups.

In February and March, 64 percent of the group caught only tilapia, but people stated that in June they caught mostly robalo and tarpon. Generally the fisherman stated that they ate 2.1 fish (maximum of 11 fish) form Boqueron and 6.8 fish (maximum of 23) from Humacao per week. The study reported that adults ate 374 grams of fish per day, while children ate 127 grams per day. In order to calculate the daily mass intake of fish, the study assumed that an adult ate 4.4 robalos each weighing 595 grams over a 7-day period and a child ate 1.5 robalos weighting 595 grams over a 7-day period. The study used a maximum consumption value of 200 g/day for fishermen to create various hazard indices.

One limitation of this study is that the consumption rates were based on groups not individuals. In addition, consumption rates were calculated using the average fish weight and the number of meals per week reported by the respondents.

10.4.2.5 *KCA Research Division, 1994 - Fish Consumption of Delaware Recreational Fishermen and Their Households*

In support of the Delaware Estuary Program, the State of Delaware's Department of Natural Resources and Environmental Control conducted a survey of marine recreational fishermen along the coastal areas of Delaware between July 1992 and June 1993 (KCA Research Division, 1994). There were two components of the study. One was a field survey of fishermen as they returned from their fishing trips and the second part was a telephone follow-up call.

The purpose of the first component was to obtain information on their fishing trips and on their household composition. This information included the method and location of fishing, number of fish caught and kept by species, and weight of each fish kept. Household information included race, age, gender, and number of persons in the household. Information was also recorded as to the location of the angler intercept (i.e., where the angler was interviewed) and the location of the household.

The purpose of the second component was to obtain information on the amount of fish caught and kept from the fishing trip and then eaten by the household. The methods used for preparing and cooking the fish were also documented.

The field portion of the study was designed to interview 2,000 anglers. Data were obtained from 1,901 anglers, representing 6,204 household members (KCA Research Division, 1994). While the primary goal of the study was to collect data on marine recreational fishing practices, the survey included some freshwater fishing and crabbing sites. Followup phone interviews typically occurred two weeks after the field interview and were used to gather information about consumption. Interviewers aided respondents in their estimation of fish intake by describing the weight of ordinary products, for the purpose of comparison to the quantity of fish eaten. Information on the number of fishing trips a respondent had taken during the month was used to estimate average annual consumption rates.

For all respondents, the average consumption was 17.5 grams per day. Males were found to have consumed more fish than women, and Caucasians consumed more fish per day than the other races surveyed (Table 10-48). More than half of the study respondents reported that they skinned the fish that they ate (i.e., 450 out of 807 who reported whether they skinned their catch); the majority ate filleted fish (i.e., 617 out of 794 who reported the preparation method used), and over half fried their fish (i.e., 506 out of 875 who reported the cooking method). Information on consumption relative to preparation method indicated a higher consumption level for skinned fish (0.627 ounces/day) than for un-skinned fish (0.517 ounces /day). Although most respondents fried their catch (0.553 ounces/day), baking and broiling were also common (0.484 and 0.541 ounces/day, respectively).

One limitation of this study is that information on fish consumption is based on anglers' recall of amount of fish eaten. While this study provides information on fish consumption of various ethnic groups, another limitation of this study is that the sample size for ethnic groups was very small. Also, the study was limited to one geographic area and may not be representative of the U.S. population.

10.4.2.6 *Santa Monica Bay Restoration Project, 1994 - Seafood Consumption Habits of Recreational Anglers in Santa Monica Bay, Los Angeles, CA*

The Santa Monica Bay Restoration Project (SMBRP) conducted a study on the seafood consumption habits of recreational anglers in Santa Monica Bay, California. The study was conducted between September 1991 and August 1992. Surveys were conducted at 11 piers and jetties, 3 private boat launches and hoists, 11 beach and intertidal sites, and 5 party boat landings. Information requested in the survey included fishing history, types of fish eaten, consumption habits, methods of preparing fish, and demographics. Consumption rates were calculated based on the anglers' estimates of meal size relative to a model fish fillet that represented a 150-gram meal. Interviewers identified 67 species of fish, 2 species of crustaceans, 2 species of mollusks, and one species of echinoderms that had been caught from the study area by recreational anglers during the study period. The most abundant species caught were chub mackerel, barred sand bass, kelp bass, white croaker, Pacific barracuda, and Pacific bonito.

A total of 2,376 anglers were censused during 113 separate surveys. Of those anglers, 1,243 were successfully interviewed and 554 provided sufficient information for calculation of consumption rates. The socio-demographics of the sample population were as follows: most anglers were male (93 percent), 21 to 40 years old (54%), white (43 percent), and had an annual household income of $25,000 to $50,000 (39 percent).

The results of the survey showed that the mean consumption rate was 50 g/day while the 90th percentile was over two times higher at 107 g/day (Table 10-49). Of the identified ethnic groups, Asians had the highest mean consumption rate (51 g/day) and the highest 90th percentile value for consumption rate (116 g/day). Anglers with annual household incomes greater than $50,000 had the highest mean consumption rate (59 g/day) and the highest 90th percentile consumption rate (129 g/day). Species of fish that were consumed in larger amounts than other species included barred sand bass, Pacific barracuda, kelp bass, rockfish species, Pacific bonito, and California halibut.

About 77 percent of all anglers were aware of health warnings about consumption of fish from Santa Monica Bay. Of these anglers, 50 percent had altered their seafood consumption habits as a result of the warnings (46 percent stopped consuming some species, 25 percent ate less of all species, 19 percent stopped consuming all fish, and 10 percent ate less of some species). Most anglers in the ethnic groups surveyed were aware of the health-risk warnings, but Asian and white anglers were more likely to alter their consumption behavior based on these warnings.

One limitation of this study is the low numbers of anglers younger than 21 years of age. In this study, if several anglers from the same household were fishing, only the head of the household was interviewed. Hence, young individuals were frequently not interviewed and therefore, are underrepresented in this study.

10.4.2.7 *Alcoa, 1998 - Draft Report for the Finfish/Shellfish Consumption Study Alcoa (Point Comfort)/Lavaca Bay Superfund Site*

The Texas Saltwater Angler Survey was conducted in 1996/97 to evaluate the quantity and species of finfish and shellfish consumed by individuals who fish at Lavaca Bay (Alcoa, 1998). The target population for this study was residents of three Texas counties: Calhoun, Victoria, and Jackson (over 70 percent of the anglers who fish Lavaca Bay are from these three counties). The random sample design specified that the population percentages for the counties should be as follows: 50 percent from Calhoun, 30 percent from Victoria, and 20 percent from Jackson.

Each individual in the sample population was sent an introductory note describing the study and then was contacted by telephone. People who agreed to participate and had taken fewer than six fishing trips to Lavaca Bay were interviewed by telephone. Persons who agreed to participate and had taken more than five fishing trips to Lavaca Bay were sent a mail survey with the same questions. A total of 1,979 anglers participated in this survey, representing a response rate greater than 68 percent. Data were collected from the households for men, women, and children.

The information collected as part of the survey included recreational fishing trip information for November 1996 (i.e., fishing site, site facilities, distance traveled, number and species caught), self-caught fish consumption (by the respondent, spouse and child, if applicable), opinions on different types of fishing experiences, and socio-demographics. Portion size for shellfish was determined by utilizing the number of shrimp, crabs, oysters, etc. that an individual consumed during a meal and the assumed tissue weight of the particular species of shellfish.

Table 10-50 presents the results of the study. Adult men consumed 25 grams of self-caught finfish per day while women consumed an average of 18 grams daily. Women of childbearing age consumed 19 grams per day, on average. Small children were found to consume 11 g/day and youths consumed 16 g/day, on average. Less shellfish was consumed by all individuals than finfish. Men consumed an average of 2 g/day, women and youths an average of 1 g/day, and small children consumed less than 1 g/day of shellfish.

The study results also showed the number of average meals and portion sizes for the respondents, (Table 10-51). On average, members of each cohort consumed slightly more than three meals per month of finfish, although small children and youths consumed slightly less than three meals per month of finfish and less than one meal per month of shellfish. For finfish, adult men consumed an average, per meal, portion size of 8 ounces, while women and youths consumed 7 ounces, and small children consumed less than 5 ounces per meal. The average number of shellfish meals consumed per month for all cohorts was less than one. Adult men consumed an average shellfish portion size of 4 ounces, women and youth 3 ounces, and small children consumed 2 ounces per meal.

The study also discussed the species composition of self-caught fish consumed by source. Four different sources of fish were included: fish consumed from the closure area, fish consumed from Lavaca Bay, fish consumed from all waters, and all self-caught finfish and shellfish consumed, including preserved (i.e., frozen or smoked) fish where the location of the catch is not known. Red drum comprised the bulk of total finfish grams consumed from any area while black drum represented the smallest amount of finfish grams consumed. Overall, almost 40 percent of all self-caught finfish consumed were red drum, followed by speckled sea trout, flounder, all other finfish (all species were not specifically examined in this study), and black drum. Out of all self-caught shellfish, oysters accounted for 37 percent, blue crabs for 35 percent, and shrimp for 29 percent of the total.

The study authors noted that since the survey relied on the anglers' recall of meal frequency and portion, fish consumption may have been overestimated. There was evidence of overestimation when the data were validated and approximately 10 percent of anglers reported consuming more fish than what they caught and kept. Also, the study was conducted at one geographic location and may not be representative of the U.S. population.

10.4.2.8 *Burger et al., 1998 - Fishing, Consumption, and Risk Perception in Fisherfolk along an East Coast Estuary*

Burger et al. (1998) examined fishing behavior, consumption patterns, and risk perceptions of 515 people that were fishing and crabbing in Barnegat Bay, New Jersey. This research also tested the null hypotheses that there are no gender differences in fishing behavior and consumption patterns and no gender differences in the perception of fish and crab safety.

The researchers interviewed 515 people who were fishing or crabbing on Barnegat Bay and Great Bay. Interviews were conducted from June 22 until September 27, 1996. Fifteen percent of the fishermen approached refused to be interviewed, usually because they did not have the time to participate. The questionnaire that researchers used to conduct the interviews contained questions about fishing behavior, consumption patterns, cooking patterns, warnings and safety associated with the seafood, environmental problems and changes in the bay, and personal demographics.

Eighty-four percent of those who were interviewed were men, 95 percent were White, and the rest were evenly divided between African American, Hispanic, and Asian. The age of interviewees ranged from 13 to 92 years. The subjects fished an average of 7 times per month and crabbed 3 times per month (Table 10-52). Bluefish (*pomatomus saltatrix*), fluke or summer flounder (*paralichthys dentatus*), and weakfish (*cynoscion regalis*) were the most frequently caught fish. The researchers found that the average consumption rate for people fishing along the Barnegat Bay was 5 fish meals per month (eating just under 10 ounces per meal) for an approximate total of 1,450 g of fish per month (48.3 g/day). Most of the subjects (80 percent) ate the fish they caught.

The study found that there were significant differences in fishing behavior and consumption as a function of gender. Women had more children with them when fishing and more women fished on foot along the Bay. The consumption by women included a significantly lower proportion of self-caught fish than of men. Men ate significantly larger portions of fish per meal than did women and men ate the whole fish more often. The study results showed that there were no gender differences with regard to the average number of fish caught or in fish size. Nearly 90 percent of the subjects believed the fish and crabs from Barnegat Bay were safe to eat, although approximately 40 percent of the subjects had heard warnings about their safety. The subjects generally did not have a clear understanding of the relationships between contaminants and fish size or trophic level. The researchers suggested that reducing the risk from contaminants does not necessarily involve a decrease in consumption rates, but rather a change in the fish species and sizes consumed.

While the study provides some useful information on gender difference in fishing behavior and consumption, the study is limited in that the majority of the people surveyed were white males. There were low numbers for women and ethnic groups.

10.4.2.9 *Chiang, A., 1998 - A Seafood Consumption Survey of the Laotian Community of West Contra Costa County, CA*

A survey of members of the Laotian community of West Contra Costa, CA, was conducted to obtain data on the fishing and fish consumption activities of this community. A questionnaire was developed and translated by the survey staff into the many ethnic languages spoken by the members of the Laotian community. The survey questions covered the following topics: demographics, fishing and fish consumption habits back home, current fishing and fish consumption habits, fish preparation methods, fish species commonly caught, fishing locations, and awareness of the health advisory for this area. A total of 229 people were surveyed.

Most respondents reported eating fish a few times per month and the most common portion size was about 3 ounces. The mean amount of fish eaten per day was reported as 18.3 g/day, with a maximum of 182.3 g/day (Table 10-53). “Fish consumers” were considered to be people who ate fish at least once a month and this group made up 86.9 percent of the people surveyed. The mean fish consumption rate for this group (“fish consumers”) averaged 21.4 g/day. Catfish was most often mentioned when respondents were asked to name the fish they caught, but striped bass was the species reported caught most often by respondents. Soups/stews were reported as the most common preparation method of fish (86.4 percent) followed by frying (78.4 percent), and baking (63.6 percent).

Of all survey respondents, 48.5 percent reported having heard of the health advisory about eating fish and shellfish from San Francisco Bay. Of those that had heard the advisory, 59.5 percent reported recalling its contents and 60.3 percent said that it had influenced their fishing and fish consumption patterns.

Some sectors of the Laotian community were not included in the survey such as the Lue, Hmong, and Lahu groups. However, it was noted that the groups excluded from the survey do not differ greatly from the sample population in terms of seafood consumption and fishing practices. The study authors also indicated that participants may have under-reported fishing and fish consumption practices due to recent publicity about contamination of the Bay, fear of losing disability benefits, and fear that the survey was linked to law enforcement actions about fishing from the Bay. Another limitation of the study involved the use of a 3-oz fish fillet model to estimate portion size of fish consumed. The use of this small model may have biased respondents to choose a smaller portion size than what they actually eat. In addition, the study authors noted that the fillet model may not have been appropriate for estimating fish portions eaten by those respondents who eat "family style" meals.

10.4.2.10 *San Francisco Estuary Institute (SFEI), 2000 - Technical Report: San Francisco Bay Seafood Consumption Report*

A comprehensive study of 1,331 anglers was conducted by the California Department of Health Services between July 1998 and June 1999 at various recreational fishing locations in the San Francisco Bay area (SFEI, 2000). The catching and consumption of 13 finned fish species and three shellfish species were investigated to determine the number of meals eaten from recreational and other sources such as restaurants and grocery stores. The method of fish preparation, including the parts of the fish eaten, was also documented. Information was gathered on the amount of fish consumed per meal, as well as respondents' ethnicity, age, income level, education, and the mode of fishing (e.g., pier, boat, and beach). Questions were also asked to ascertain the anglers' knowledge and response to local fish advisories. Respondents were asked to recall their fishing/consumption experiences within the previous four weeks. Anglers were not asked about the consumption habits of other members of their families.

About 15 percent of the anglers reported that they do not eat San Francisco Bay fish (whether self-caught or commercial). Of those who did consume Bay fish, 80 percent consumed about one fish meal per month or less; 10 percent ate about 2 fish meals per month; and 10 percent ate more than 2 fish meals per month, which is above the advisory level for fish. (The advisory level was 16 grams per day, or about two 8-ounce meals per four weeks.) Two thirds of those consuming fish at levels above the advisory limit consumed more than twice the advisory limit. Difference in income, education, or fishing mode did not markedly change anglers' likelihood of eating in excess of the advisory limit. African Americans and Filipino anglers reported higher consumption levels than Caucasians (Table 10-54). The overall mean consumption rate was 23 g/day.

More than 50 percent of the finned fish caught by anglers were striped bass, and about 25 percent were halibut. Approximately 15 percent of the anglers caught each of the following fish: jacksmelt, sturgeon, and white croaker. All other species were caught by less than 10 percent of the anglers. For white croaker fish consumption: (1) lower income anglers consumed statistically more fish than mid- and upper-level income anglers, (2) anglers who did not have a high school education consumed more than those anglers with higher educations, and (3) anglers of Asian descent consumed significantly more than anglers of other ethnic backgrounds. Asian anglers were more likely to eat fish skin, cooking juices, and raw fish than other anglers. These portions of the fish are believed to be more likely to contain higher levels of contamination. Likewise, skin consumption was higher for lower income and shore-based anglers. Anglers who had eaten Bay fish in the previous four weeks indicated, in general, that they were likely to have eaten one fish meal from another source in the same time period.

More than 60 percent of the anglers interviewed reported having knowledge of the health advisories. Of that 60 percent, only about one-third reported changing their fish-consumption behavior.

A limitation of this study is that the sample size for ethnic groups was very small.

10.5 FRESHWATER RECREATIONAL STUDIES

10.5.1 *Fiore et al., 1989 - Sport Fish Consumption and Body Burden Levels of Chlorinated Hydrocarbons: A Study of Wisconsin Anglers*

This survey, reported by Fiore et al. (1989), was conducted to assess sociodemographic factors and sport-fishing habits of anglers, to evaluate anglers' comprehension of and compliance with the Wisconsin Fish Consumption Advisory, to measure body burden levels of PCBs and DDE through analysis of blood serum samples and to examine the relationship between body burden levels and consumption of sport-caught fish. The survey targeted all Wisconsin residents who had purchased fishing or sporting licenses in 1984 in any of 10 pre-selected study counties. These counties were chosen in part based on their proximity to water bodies identified in Wisconsin fish advisories. A total of 1,600 anglers were sent survey questionnaires during the summer of 1985.

The survey questionnaire included questions about fishing history, locations fished, species targeted, kilograms caught for consumption, overall fish consumption (including commercially caught) and knowledge of fish advisories. The recall period was one year.

A total of 801 surveys were returned (50 percent response rate). Of these, 601 (75 percent) were from males and 200 from females; the mean age was 37 years. Fiore et al. (1989) reported that the mean number of fish meals for 1984 for all respondents was 18 for sport-caught meals and 24 for non-sport-caught meals. Fiore et al. (1989) assumed that each fish meal consisted of 8 ounces (227 grams) of fish to generate means and percentiles of fish intake. The reported per-capita intake rate of sport-caught fish was 11.2 g/day; among consumers, who comprised 91 percent of all respondents, the mean sport-caught fish intake rate was 12.3 g/day and the 95th percentile was 37.3 g/day. The mean daily fish intake from all sources (both sport-caught and commercial) was 26.1 g/day with a 95th percentile of 63.4 g/day. The 95th percentile of 37.3 g/day of sport caught fish represents 60 fish meals per year; 63.4 g/day (the 95th percentile of total fish intake) represents 102 fish meals per year.

Fiore et al. (1989) assumed a (constant) meal size of 8 ounces (227 grams) of fish which may over-estimate average meal size. Pao et al. (1982), using data from the 1977-78 USDA NFCS, reported an average fish meal size of slightly less than 150 grams for adult males. U.S. EPA obtained the raw data from this study and calculated the distribution of the number of sport-caught fish meals and the distribution of fish intake rates (using 150 grams/meal); these distributions are presented in Table 10-55. With this average meal size, the per-capita estimate is 7.4 g/day.

This study is limited in its ability to accurately estimate intake rates because of the absence of data on weight of fish consumed. Another limitation of this study is that the results are based on one year recall, which may tend to over-estimate the number of fishing trips (Ebert et al., 1993). In addition, the response rate was rather low (50 percent).

10.5.2 *West et al., 1989 - Michigan Sport Anglers Fish Consumption Survey*

The Michigan Sport Anglers Fish Consumption Survey (West et al., 1989) surveyed a stratified random sample of Michigan residents with fishing licenses. The sample was divided into 18 cohorts, with one cohort receiving a mail questionnaire each week between January and May 1989. The survey included both a short term recall component, and a usual frequency component. For the short-term recall component, respondents were asked to identify all household members and list all fish meals consumed by each household member during the past seven days. Information on the source of the fish for each meal was also requested (self-caught, gift, market, or restaurant). Respondents were asked to categorize serving size by comparison with pictures of 8 ounce fish portions; serving sizes could be designated as either “about the same size”, “less”, or “more” than the size pictured. Data on fish species, locations of self-caught fish and methods of preparation and cooking were also obtained.

The usual frequency component of the survey asked about the frequency of fish meals during each of the four seasons and requested respondents to give the overall percentage of household fish meals that came from recreational sources. A sample of 2,600 individuals was selected from state records to receive survey questionnaires. A total of 2,334 survey questionnaires were deliverable and 1,104 were completed and returned, giving a response rate of 47.3 percent..

In the analysis of the survey data by West et. al. (1989), the authors did not attempt to generate the distribution of recreationally caught fish intake in the survey population. U.S. EPA obtained the raw data of this survey for the purpose of generating fish intake distributions and other specialized analyses.

As described elsewhere in this handbook, percentiles of the distribution of average daily intake reflective of long-term consumption patterns cannot in general be estimated using short-term (e.g., one week) data. Such data can be used to adequately estimate mean average daily intake rates (reflective of short or long term consumption); in addition, short term data can serve to validate estimates of usual intake based on longer recall.

U.S. EPA first analyzed the short term data with the intent of estimating mean fish intake rates. In order to compare these results with those based on usual intake, only respondents with information on both short term and usual intake were included in this analysis. For the analysis of the short term data, U.S. EPA modified the serving size weights used by West et al. (1989), which were 5, 8 and 10 oz., respectively, for portions that were less, about the same, and more than the 8 oz. picture. U.S. EPA examined the percentiles of the distribution of fish meal sizes reported in Pao et al. (1982) derived from the 1977-1978 USDA National Food Consumption Survey and observed that a lognormal distribution provided a good visual fit to the percentile data. Using this lognormal distribution, the mean values for serving sizes greater than 8 oz. and for serving sizes at least 10 percent greater than 8 oz. were determined. In both cases a serving size of 12 oz. was consistent with the Pao et al. (1982) distribution. The weights used in the U.S. EPA analysis then were 5, 8, and 12 oz. for fish meals described as less, about the same, and more than the 8 oz. picture, respectively. The mean serving size from Pao et al. (1982) was about 5 oz., well below the value of 8 oz. most commonly reported by respondents in the West et al. (1989) survey.

Table 10-56 displays the mean number of total and recreational fish meals for each household member based on the seven day recall data. Also shown are mean fish intake rates derived by applying the weights described above to each fish meal. Intake was calculated on both a grams/day and grams/kg body weight/day basis. This analysis was restricted to individuals who eat fish and who reside in households reporting some recreational fish consumption during the previous year. About 75 percent of survey respondents (i.e., licensed anglers) and about 84 percent of respondents who fished in the prior year reported some household recreational fish consumption.

The U.S. EPA analysis next attempted to use the short term data to validate the usual intake data. West et al. (1989) asked the main respondent in each household to provide estimates of their usual frequency of fishing and eating fish, by season, during the previous year. The survey provides a series of frequency categories for each season and the respondent was asked to check the appropriate range. The ranges used for all questions were: almost daily, 2-4 times a week, once a week, 2-3 times a month, once a month, less often, none, and don't know. For quantitative analysis of the data it is necessary to convert this categorical information into numerical frequency values. As some of the ranges are relatively broad, the choice of conversion values can have some effect on intake estimates. In order to obtain optimal values, the usual fish eating frequency reported by respondents for the season during which the questionnaire was completed was compared to the number of fish meals reportedly consumed by respondents over the seven day short-term recall period.

The results of these comparisons are displayed in Table 10-57; it shows that, on average, there is general agreement between estimates made using one year recall and estimates based on seven day recall. The average number of meals (1.96/week) was at the bottom of the range for the most frequent consumption group with data (2-4 meals/week). In contrast, for the lower usual frequency categories, the average number of meals was at the top, or exceeded the top of category range. This suggests some tendency for relatively infrequent fish eaters to underestimate their usual frequency of fish consumption. The last column of the table shows the estimated fish eating frequency per week that was selected for use in making quantitative estimates of usual fish intake. These values were guided by the values in the second column, except that frequency values that were inconsistent with the ranges provided to respondents in the survey were avoided.

Using the four seasonal fish eating frequencies provided by respondents and the above conversions for reported intake frequency, U.S. EPA estimated the average number of fish meals per week for each respondent. This estimate, as well as the analysis above, pertain to the total number of fish meals eaten (in Michigan) regardless of the source of the fish. Respondents were not asked to provide a seasonal breakdown for eating frequency of recreationally caught fish; rather, they provided an overall estimate for the past year of the percent of fish they ate that was obtained from different sources. U.S. EPA estimated the annual frequency of recreationally caught fish meals by multiplying the estimated total number of fish meals by the reported percent of fish meals obtained from recreational sources; recreational sources were defined as either self caught or a gift from family or friends.

The usual intake component of the survey did not include questions about the usual portion size for fish meals. In order to estimate usual fish intake, a portion size of 8 oz. was applied (the majority of respondents reported this meal size in the 7 day recall data). Individual body weight data were used to estimate intake on a g/kg-day basis. The fish intake distribution estimated by U.S. EPA is displayed in Table 10-58.

The distribution shown in Table 10-58 is based on respondents who consumed recreational caught fish. As mentioned above, these represent 75 percent of all respondents and 84 percent of respondents who reported having fished in the prior year. Among this latter population, the mean recreational fish intake rate is 14.4*0.84=12.1 g/day; the value of 38.7 g/day (95th percentile among consumers) corresponds to the 95.8th percentile of the fish intake distribution in this (fishing) population.

The advantages of this data set and analysis are that the survey was relatively large and contained both short-term and usual intake data. The presence of short term data allowed validation of the usual intake data which was based on long term recall; thus, some of the problems associated with surveys relying on long term recall are mitigated here.

The response rate of this survey, 47 percent, was relatively low. In addition, the usual fish intake distribution generated here employed a constant fish meal size, 8 oz. Although use of this value as an average meal size was validated by the short-term recall results, the use of a constant meal size, even if correct on average, may seriously reduce the variation in the estimated fish intake distribution.

This study was conducted in the winter and spring months of 1988. This period does not include the summer months when peak fishing activity can be anticipated, leading to the possibility that intake results based on the 7 day recall data may understate individuals' usual (annual average) fish consumption. A second survey by West et al. (1993) gathered diary data on fish intake for respondents spaced over a full year. However, this later survey did not include questions about usual fish intake and has not been reanalyzed here. The mean recreational fish intake rates derived from the short term and usual components were quite similar, however, 14.0 versus 14.4 g/day.

10.5.3 *Chemrisk, 1992 - Consumption of Freshwater Fish by Maine Anglers*

Chemrisk conducted a study to characterize the rates of freshwater fish consumption among Maine residents (Chemrisk, 1992; Ebert et al., 1993). Since the only dietary source of local freshwater fish is recreational fish, the anglers in Maine were chosen as the survey population. The survey was designed to gather information on the consumption of fish caught by anglers from flowing (rivers and streams) and standing (lakes and ponds) water bodies. Respondents were asked to recall the frequency of fishing trips during the 1989-1990 ice-fishing season and the 1990 open water season, the number of fish species caught during both seasons, and estimate the number of fish consumed from 15 fish species. The respondents were also asked to describe the number, species, and average length of each sport-caught fish consumed that had been gifts from other members of their households or other household. The weight of fish consumed by anglers was calculated by first multiplying the estimated weight of the fish by the edible fraction, and then dividing this product by the number of intended consumers. Species specific regression equations were utilized to estimate weight from the reported fish length. The edible fractions used were 0.4 for salmon, 0.78 for Atlantic smelt, and 0.3 for all other species (Ebert et al., 1993).

A total of 2,500 prospective survey participants were randomly selected from a list of anglers licensed in Maine. The surveys were mailed in during October, 1990. Since this was before the end of the open fishing season, respondents were also asked to predict how many more open water fishing trips they would undertake in 1990.

Chemrisk (1992) and Ebert et al. (1993) calculated distributions of freshwater fish intake for two populations, "all anglers" and "consuming anglers". All anglers were defined as licensed anglers who fished during either the 1989-1990 ice-fishing season or the 1990 open-water season (consumers and non-consumers) and licensed anglers who did not fish but consumed freshwater fish caught in Maine during these seasons. "Consuming anglers" were defined as those anglers who consumed freshwater fish obtained from Maine sources during the 1989-1990 ice fishing or 1990 open water fishing season. In addition, the distribution of fish intake from rivers and streams was also calculated for two populations, those fishing on rivers and streams ("river anglers") and those consuming fish from rivers and streams ("consuming river anglers").

A total of 1,612 surveys were returned, giving a response rate of 64 percent; 1,369 (85 percent) of the 1,612 respondents were included in the "all angler" population and 1,053 (65 percent) were included in the "consuming angler" population. Freshwater fish intake distributions for these populations are presented in Table 10-59. The mean and 95th percentile was 5.0 g/day and 21.0 g/day, respectively, for "all anglers," and 6.4 g/day and 26.0 g/day, respectively, for "consuming anglers." Table 10-59 also presents intake distributions for fish caught from rivers and streams. Among "river anglers" the mean and 95th percentiles were 1.9 g/day and 6.2 g/day, respectively, while among "consuming river anglers" the mean was 3.7 g/day and the 95th percentile was 12.0 g/day. Table 10-60 presents fish intake distributions by ethnic group for consuming anglers. The highest mean intake rates reported are for Native Americans (10 g/day) and French Canadians (7.4 g/day). Because there was a low number of respondents for Hispanics, Asian/Pacific Islanders, and African Americans, intake rates within these subgroups were not calculated (Chemrisk, 1992).

The consumption, by species, of freshwater fish caught is presented in Table 10-61. The largest species consumption was salmon from ice fishing (~292,000 grams); white perch (380,000 grams) for lakes and ponds; and Brooktrout (420,000 grams) for rivers and streams (Chemrisk, 1992).

U.S. EPA obtained the raw data tapes from the marine anglers survey and performed some specialized analyses. One analysis involved examining the percentiles of the "resource utilization distribution" (this distribution was defined in Section

10.1). The 50th, or more generally the pth percentile of the resource utilization distribution, is defined as the consumption level such that p percent of the resource is consumed by individuals with consumptions below this level and 100-p percent by individuals with consumptions above this level. U.S. EPA found that 90 percent of recreational fish consumption was by individuals with intake rates above 3.1 g/day and 50 percent was by individuals with intakes above 20 g/day. Those above 3.1 g/day make up about 30 percent of the "all angler" population and those above 20 g/day make up about 5 percent of this population; thus, the top 5 percent of the angler population consumed 50 percent of the recreational fish catch.

U.S. EPA also performed an analysis of fish consumption among anglers and their families. This analysis was possible because the survey included questions on the number, sex, and age of each individual in the household and whether the individual consumed recreationally caught fish. The total population of licensed anglers in this survey and their household members was 4,872; the average household size for the 1,612 anglers in the survey was thus 3.0 persons. Fifty-six percent of the population was male and 30 percent was 18 or under.

A total of 55 percent of this population was reported to consume freshwater recreationally caught fish in the year of the survey. The sex and ethnic distribution of the consumers was similar to that of the overall population. The distribution of fish intake among the overall household population, or among consumers in the household, can be calculated under the assumption that recreationally caught fish was shared equally among all members of the household reporting consumption of such fish (note this assumption was used above to calculate intake rates for anglers). With this assumption, the mean intake rate among consumers was 5.9 g/day with a median of 1.8 g/day and a 95th percentile of 23.1 g/day; for the overall population the mean was 3.2 g/day and the 95th percentile was 14.1 g/day.

The results of this survey can be put into the context of the overall Maine population. The 1,612 anglers surveyed represent about 0.7 percent of the estimated 225,000 licensed anglers in Maine. It is reasonable to assume that licensed anglers and their families will have the highest exposure to recreationally caught freshwater fish. Thus, to estimate the number of persons in Maine with recreationally caught freshwater fish intake above, for instance, 6.5 g/day (the 80th percentile among household consumers in this survey), one can assume that virtually all persons came from the population of licensed anglers and their families. The number of persons above 6.5 g/day in the household survey population is calculated by taking 20 percent (i.e., 100 percent - 80 percent) of the consuming population in the survey; this number then is 0.2*(0.55*4872)=536. Dividing this number by the sampling fraction of 0.007 (0.7 percent), gives about 77,000 persons above 6.5 g/day of recreational freshwater fish consumption statewide. The 1990 census showed the population of Maine to be 1.2 million people; thus the 77,000 persons above 6.5 g/day represent about 6 percent of the state's population.

Chemrisk (1992) reported that the fish consumption estimates obtained from the survey were conservative because of assumptions made in the analysis. The assumptions included: a 40 percent estimate as the edible portion of landlocked and Atlantic salmon; inclusion of the intended number of future fishing trips and an assumption that the average success and consumption rates for the individual angler during the trips already taken would continue through future trips. The data collected for this study were based on recall and self-reporting which may have resulted in a biased estimate. The social desirability of the sport and frequency of fishing are also bias contributing factors; successful anglers are among the highest consumers of freshwater fish (Chemrisk, 1992). Over reporting appears to be correlated with skill level and the importance of the activity to the individual; it is likely that the higher consumption rates may be substantially overstated (Chemrisk, 1992). Additionally, fish advisories are in place in these areas and may affect the rate of fish consumption among anglers. The survey results showed that in 1990, 23 percent of all anglers consumed no freshwater fish, and 55 percent of the river anglers ate no freshwater fish. An advantage of this study is that it presents area-specific consumption patterns and the sample size is rather large.

10.5.4 *Connelly et al., 1992 - Effects of Health Advisory and Advisory Changes on Fishing Habits and Fish Consumption in New York Sport Fisheries*

Connelly et al. (1992) conducted a study to assess the awareness and knowledge of New York anglers about fishing advisories and contaminants found in fish and their fishing and fish consuming behaviors. The survey sample consisted of 2,000 anglers with New York State fishing licenses for the year beginning October 1, 1990 through September 30, 1991. A questionnaire was mailed to the survey sample in January, 1992. The questionnaire was designed to measure catch and consumption of fish, as well as methods of fish preparation and knowledge of and attitudes towards health advisories (Connelly et al., 1992). The survey adjusted response rate was 52.8 percent (1,030 questionnaires were completed and 51 were not deliverable).

The average and median number of fishing days per year were 27 and 15 days, respectively (Connelly et al., 1992). The mean number of sport-caught fish meals was 11. About 25 percent of anglers reported that they did not consume sport-caught fish.

Connelly et al. (1992) found that 80 percent of anglers statewide did not eat listed species or ate them within advisory limits and followed the 1 sport-caught fish meal per week recommended maximum. The other 20 percent of anglers exceeded the advisory recommendations in some way; 15 percent ate listed species above the limit and 5 percent ate more than one sport caught meal per week.

Connelly et al. (1992) found that respondents eating more than one sport-caught meal per week were just as likely as those eating less than one meal per week to know the recommended level of sport-caught fish consumption, although less than 1/3 in each group knew the level. An estimated 85 percent of anglers were aware of the health advisory. Over 50 percent of respondents said that they made changes in their fishing or fish consumption behaviors in response to health advisories.

The advisory included a section on methods that can be used to reduce contaminant exposure. Respondents were asked what methods they used for fish cleaning and cooking. Summary results on preparation and cooking methods are presented in Appendix 10B.

A limitation of this study with respect to estimating fish intake rates is that only the number of sport-caught meals was ascertained, not the weight of fish consumed. The fish meal data can be converted to an intake rate (g/day) by assuming a value for a fish meal such as that from Pao et al. (1982) (about 150 grams as the average amount of fish consumed per eating occasion for adult males - males comprised 88 percent of respondents in the current study). Using 150 grams/meal the mean intake rate among the angler population would be 4.5 g/day; note that about 25 percent of this population reported no sport-caught fish consumption.

The major focus of this study was not on consumption, per se, but on the knowledge of and impact of fish health advisories; Connelly et al. (1992) provides important information on these issues.

10.5.5 *Hudson River Sloop Clearwater, Inc., 1993 - Hudson River Angler Survey*

Hudson River Sloop Clearwater, Inc. (1993) conducted a survey of adherence to fish consumption health advisories among Hudson River anglers. All fishing has been banned on the upper Hudson River where high levels of PCB contamination are well documented; while voluntary recreational fish consumption advisories have been issued for areas south of the Troy Dam (Hudson River Sloop Clearwater, Inc., 1993).

The survey consisted of direct interviews with 336 shore-based anglers between the months of June and November 1991, and April and July 1992. Socio-demographic characteristics of the respondents are presented in Table 10-62. The survey sites were selected based on observations of use by anglers, and legal accessibility. The selected sites included upper-, mid-, and lower- Hudson River sites located in both rural and urban settings. The interviews were conducted on weekends and weekdays during morning, midday, and evening periods. The anglers were asked specific questions concerning: fishing and fish consumption habits; perceptions of presence of contaminants in fish; perceptions of risks associated with consumption of recreationally caught fish; and awareness of, attitude toward, and response to fish consumption advisories or fishing bans.

Approximately 92 percent of the survey respondents were male. The following statistics were provided by Hudson River Sloop Clearwater, Inc. (1993). The most common reason given for fishing was for recreation or enjoyment. Over 58 percent of those surveyed indicated that they eat their catch. Of those anglers who eat their catch, 48 percent reported being aware of advisories. Approximately 24 percent of those who said they currently do not eat their catch have done so in the past. Anglers were more likely to eat their catch from the lower Hudson areas where health advisories, rather than fishing bans, have been issued. Approximately 94 percent of Hispanic Americans were likely to eat their catch, while 77 percent of African Americans and 47 percent of Caucasian Americans intended to eat their catch. Of those who eat their catch, 87 percent were likely to share their meal with others (including women of childbearing age, and children under the age of fifteen).

For subsistence anglers, more low-income than upper income anglers eat their catch (Hudson River Sloop Clearwater, Inc., 1993). Approximately 10 percent of the respondents stated that food was their primary reason for fishing; this group is more likely to be in the lowest per capita income group (Hudson River Sloop Clearwater, Inc., 1993).

The average frequency of fish consumption reported was just under one (0.9) meal over the previous week, and three meals over the previous month. Approximately 35 percent of all anglers who eat their catch exceeded the amounts recommended by the New York State health advisories. Less than half (48 percent) of all the anglers interviewed were aware of the State health advisories or fishing bans. Only 42 percent of those anglers aware of the advisories have changed their fishing habits as a result.

The advantages of this study include: in-person interviews with 95 percent of all anglers approached; field-tested questions designed to minimize interviewer bias; and candid responses concerning consumption of fish from contaminated waters. The limitations of this study are that specific intake amounts are not indicated, and that only shore-based anglers were interviewed.

10.5.6 *West et al., 1993 - Michigan Sport Anglers Fish Consumption Study, 1991-1992*

West et al. (1993) conducted a survey financed by the Michigan Great Lakes Protection Fund, as a follow-up to the earlier 1989 Michigan survey described previously. The major purpose of 1991-1992survey was to provide short-term recall data of recreational fish consumption over a full year period; the 1989 survey, in contrast, was conducted over only a half year period (West et al., 1993).

This survey was similar in design to the 1989 Michigan survey. A sample of 7,000 persons with Michigan fishing licenses was drawn and surveys were mailed in 2-week cohorts over the period January, 1991 to January, 1992. Respondents were asked to report detailed fish consumption patterns during the preceding seven days, as well as demographic information; they were also asked if they currently eat fish. Enclosed with the survey were pictures of about a half pound of fish. Respondents were asked to indicate whether reported consumption at each meal was more, less or about the same as the picture. Based on responses to this question, respondents were assumed to have consumed 10, 5 or 8 ounces of fish, respectively.

A total of 2,681 surveys were returned. West et al. (1993) calculated a response rate for the survey of 46.8 percent; this was derived by removing from the sample those respondents who could not be located or who did not reside in Michigan for at least six months.

Of these 2,681 respondents, 2,475 (93 percent) reported that they currently eat fish; all subsequent analyses were restricted to the current fish eaters. The mean fish consumption rates were found to be 16.7 g/day for sport fish and 26.5 g/day for total fish (West et al., 1993). Table 10-63 shows mean sport-fish consumption rates by demographic categories. Rates were higher among minorities, people with low income, and people residing in smaller communities. Consumption rates in g/day were also higher in males than in females; however, this difference would likely disappear if rates were computed on a g/kg-day basis.

West et al. (1993) estimated the 80th percentile of the survey fish consumption distribution. More extensive percentile calculations were performed by U.S. EPA (1995) using the raw data from the West et al. (1993) survey and calculated 50th, 90th, and 95th percentiles. However, since this survey only measured fish consumption over a short (one week) interval, the resulting distribution will not be indicative of the long-term fish consumption distribution and the upper percentiles reported from the U.S. EPA analysis will likely considerably overestimate the corresponding long term percentiles. The overall 95th percentile calculated by U.S. EPA (1995) was 77.9; this is about double the 95th percentile estimated using year long consumption data from the 1989 Michigan survey.

The limitations of this survey are the relatively low response rate and the fact that only three categories were used to assign fish portion size. The main study strengths were its relatively large size and its reliance on short-term recall.

10.5.7 *Alabama Dept. of Environmental Management, 1994 - Estimation of Daily Per Capita Freshwater Fish Consumption of Alabama Anglers*

The Alabama Department of Environmental Management (1994) conducted a fish consumption survey of sport fishing Alabama anglers during the time period from August 1992 to August of 1993. The target population included all anglers who were Alabama residents. The survey design consisted of personal interviews given to sport fishermen at the end of their fishing trips at 23 sampling sites. Each sampling site was surveyed once during each season (summer, fall, winter, and spring). The survey was conducted for two consecutive days, either a Friday and Saturday or a Sunday and Monday. This approach minimized single-day-type bias and maximized surveying the largest number of anglers because a large amount of fishing occurs on weekends. Anglers were asked about consumption of fish caught at the sampling site as well as consumption of fish caught from other lakes and rivers in Alabama.

A total of 1,586 anglers were interviewed during the entire study period, of which 83 percent reported eating fish they caught from the sampling sites (1,313 anglers). The number of anglers interviewed during each season was as follows: 488 during the summer, 363 during the fall, 224 during the winter, and 511 during the spring. Fish consumption rates were estimated using two methods: the 4-oz Serving Method and the Harvest Method. The 4-oz Serving Method estimated consumption based on a typical 4-oz serving size. The Harvest Method used the actual harvest of fish and dressing method reported. All of the 1,313 anglers were used in the mean estimates of daily consumption based on the 4-oz Serving Method, while only the 563 anglers were utilized in the calculations of mean estimates of daily consumption, based on the Harvest Method.

Table 10-64 shows the results of the survey. Adults consumed an annual average of 32.6 g/day using the Harvest Method, calculated from study sites, and an annual average of 43.1 g/day using the Harvest Method, calculated from study sites plus other Alabama lakes and rivers. The survey also showed that adults consumed an annual average of 30.3 g/day using the 4-oz Serving Method, calculated from study sites, and an annual average of 45.8 g/day using the 4-oz Serving Method, calculated from study sites plus other Alabama lakes and rivers. When the entire sample was pooled, and a mean was taken over all respondents for the 4-oz Serving Method, the average annual consumption was 44.8 g/day.

The study also examined fish consumption in conjunction with socio-demographic factors. It was noted that fish consumption tended to increase with age. Anglers below the age of 20 years were not well represented in this study. However, based on estimates of consumption rates using the 4-oz Serving Method, the study found that anglers between 20 and 30 years of age consumed an average of 16 g/day, anglers between 30 and 50 years old consumed 39 g/day, and anglers over 50 years old consumed 76 g/day. Trends also emerged when ethnic groups and income levels were examined together. Using the 4-oz Serving Method, estimates of fish consumption for blacks dropped from 60 g/day for poverty level families to 15 g/day for upper income families. For whites, fish consumption rates dropped slightly from 41 g/day for poverty level families to 35 g/day for upper income families. Similar trends were observed with the Harvest Method estimates. Averaging the results from the two estimation methods, there was a tendency for upper income white anglers to eat roughly 30 percent less fish than poverty level white anglers, while upper income black anglers ate about 80 percent less fish as poverty level black anglers.

The analysis of seasonal intake showed that the highest consumption rates were consistently found to occur in the summer. It was also found the lowest fish consumption rate occurred in the spring.

10.5.8 *U.S. DHHS, 1995 - Health Study to Assess the Human Health Effects of Mercury Exposure to Fish Consumed from the Everglades*

A health study was conducted in two phases in the Everglades, Florida for the U.S. Department of Health and Human Services (U.S. DHHS, 1995). The objectives of the first phase were to: (a) describe the human populations at risk for mercury exposure through their consumption of fish and other contaminated animals from the Everglades and (b) evaluate the extent of mercury exposure in those persons consuming contaminated food and their compliance with the voluntary health advisory. The second phase of the study involved neurologic testing of all study participants who had total mercury levels in hair greater than 7.5 µg/g.

Study participants were identified by using special targeted screenings, mailings to residents, postings and multi-media advertisements of the study throughout the Everglades region, and direct discussions with people fishing along the canals and waterways in the contaminated areas. The contaminated areas were identified by the interviewers and long-term Everglade residents. Of a total of 1,794 individuals sampled, 405 individuals were eligible to participate in the study because they had consumed fish or wildlife from the Everglades at least once per month in the last 3 months of the study period. The majority of the eligible participants (> 93 percent) were either subsistence fishermen, Everglade residents, or both. Of the total eligible participants, 55 individuals refused to participate in the survey. Useable data were obtained from 330 respondents ranging in age from 10-81 years of age (mean age 39 years ± 18.8) (U.S. DHHS, 1995). Respondents were administered a three page questionnaire from which demographic information, fishing and eating habits, and other variables were obtained (U.S. DHHS, 1995).

Table 10-65 shows the ranges, means, and standard deviations of selected characteristics by subgroups of the survey population. Sixty-two percent of the respondents were male with a slight preponderance of black individuals (43 percent white, 46 percent black non-Hispanic, and 11 percent Hispanic). Most of the respondents reported earning an annual income of $15,000 or less per family before taxes (U.S. DHHS, 1995). The mean number of years fished along the canals by the respondents was 15.8 years with a standard deviation of 15.8. The mean number of times per week fish consumers reported eating fish over the last 6 months and last month of the survey period was 1.8 and 1.5 per week with a standard deviation of 2.5 and 1.4, respectively. Table 10-65 also indicates that 71 percent of the respondents reported knowing about the mercury health advisories. Of those who were aware, 26 percent reported that they had lowered their consumption of fish caught in the Everglades while the rest (74 percent) reported no change in consumption patterns (U.S. DHHS, 1995).

A limitation of this study is that fish intake rates (g/day) were not reported. Another limitation is that the survey was site limited, and, therefore, not representative of the U.S. population. An advantage of this study is that it is one of the few studies targeting subsistence fishermen.

10.5.9 *Connelly et al., 1996 – Sportfish Consumption Patterns of Lake Ontario Anglers and the Relationship to Health Advisories, 1992*

The objectives of the Connely et al. (1996) study were to provide accurate estimates of fish consumption (overall and sport caught) among Lake Ontario anglers and to evaluate the effect of Lake Ontario health advisory recommendations (Connelly et al., 1996). To target Lake Ontario anglers, a sample of 2,500 names was randomly drawn from 1990-1991 New York fishing license records for licenses purchased in six counties bordering Lake Ontario. Participation in the study was solicited by mail with potential participants encouraged to enroll in the study even if they fished infrequently or consumed little or no sport caught fish. The survey design involved three survey techniques including a mail questionnaire asking for 12 month recall of 1991 fishing trips and fish consumption, self-recording information in a diary for 1992 fishing trips and fish consumption, periodic telephone interviews to gather information recorded in the diary and a final telephone interview to determine awareness of health advisories (Connelly et al., 1996).

Participants were instructed to record in the diary the species of fish eaten, meal size, method by which fish was acquired (sport-caught or other), fish preparation and cooking techniques used and the number of household members eating the meal. Fish meals were defined as finfish only. Meal size was estimated by participants by comparing their meal size to pictures of 8 oz. fish steaks and fillets on dinner plates. An 8 oz. size was assumed unless participants noted their meal size was smaller than 8 oz., in which case a 4 oz. size was assumed, or they noted it was larger than 8 oz., in which case a 12 oz. size was assumed. Participants were also asked to record information on fishing trips to Lake Ontario and species and length of any fish caught.

From the initial sample of 2,500 license buyers, 1,993 (80 percent) were reachable by phone or mail and 1,410 of these were eligible for the study, in that they intended to fish Lake Ontario in 1992. A total of 1,202 of these 1,410, or 85 percent, agreed to participate in the study. Of the 1,202 participants, 853 either returned the diary or provided diary information by telephone. Due to changes in health advisories for Lake Ontario which resulted in less Lake Ontario fishing in 1992, only 43 percent, or 366 of these 853 persons indicated that they fished Lake Ontario during 1992. The study analyses summarized below concerning fish consumption and Lake Ontario fishing participation are based on these 366 persons.

Anglers who fished Lake Ontario reported an average of 30.3 (S.E. = 2.3) fish meals per person from all sources in 1992; of these meals 28 percent were sport caught (Connelly et al., 1996). Less than 1 percent ate no fish for the year and 16 percent ate no sport caught fish. The mean fish intake rate from all sources was 17.9 g/day and from sport caught sources was 4.9 g/day. Table 10-66 gives the distribution of fish intake rates from all sources and from sport caught fish. The median rates were 14.1 g/day for all sources and 2.2 g/day for sport caught; the 95th percentiles were 42.3 g/day and 17.9 g/day for all sources and sport caught, respectively. As seen in Table 10-67, statistically significant differences in intake rates were seen across age and residence groups, with residents of large cities and younger people having lower intake rates on average.

The main advantage of this study is the diary format. This format provides more accurate information on fishing participation and fish consumption, than studies based on 1 year recall (Ebert et al., 1993). However, a considerable portion of diary respondents participated in the study for only a portion of the year and some errors may have been generated in extrapolating these respondents' results to the entire year (Connelly et al., 1996). In addition, the response rate for this study was relatively low, 853 of 1,410 eligible respondents, or 60 percent, which may have engendered some non-response bias.

The presence of health advisories should be taken into account when evaluating the intake rates observed in this study. Nearly all respondents (>95 percent) were aware of the Lake Ontario health advisory. This advisory counseled to eat none of 9 fish species from Lake Ontario and to eat no more than one meal per month of another 4 species. In addition, New York State issues a general advisory to eat no more than 52 sport caught fish meals per year. Among participants who fished Lake Ontario in 1992, 32 percent said they would eat more fish if health advisories did not exist. A significant fraction of respondents did not totally adhere to the fish advisory; however, 36 percent of respondents, and 72 percent of respondents reporting Lake Ontario fish consumption, ate at least one species of fish over the advisory limit. Interestingly, 90 percent of those violating the advisory reported that they believed they were eating within advisory limits.

10.5.10 *Balcom et al., 1999 - Quantification of Seafood Consumption Rates for Connecticut*

Balcom et al. (1999) conducted a seafood consumption study utilizing a food frequency questionnaire along with portion size models. Follow-up telephone calls were made to encourage participation 7-10 days after mailing the questionnaires to improve response rates. Information requested in the survey included frequency of fish consumption, types of fish/seafood eaten, portion size, parts eaten and the source of the fish/seafood eaten. A diary was also given to the sample populations to record fish and seafood consumption over a ten day period, and to document where the fish/seafood was obtained and how it was prepared.

The sample population size for this study was 2,354 individuals (1,048 households). The study authors divided this overall population into various population groups including the general population (460 individuals/216 households), commercial fishing population (178 individuals/73 households), sport fishing and cultural/subsistence fishing population (514 individuals/348 households), minority population (860 individuals/245 households), Southeast Asian (329 individuals/89 households), Non-Southeast Asian (531 individuals/156 households), limited income population (937 individuals/276 households), women of childbearing age population (493 individuals/420 households), and children population (559 individuals/305 households).

It is important to note that the nine sub-populations used in this study are not mutually exclusive. Many individuals were included in more than one population. For this reason, the authors did not attempt to make any statistical comparisons between the sub-populations.

The survey showed that over 33 percent of the respondents ate 1-2 meals of fish or seafood per week, including 39 percent of the general population, 35 percent of the sport fishing population, 38 percent of the commercial and minority populations, and 39 percent of the limited income population. A total of 36.3 percent of the Southeast Asian population consumed 2-3 meals per week with 2.1 percent consuming 5 or more meals per week while 43 percent of non-Southeast Asians consume 1-2 meals of seafood per week. The general population consumed, on average, 4.2 ounces of fish per meal of purchased fish and 5.0 ounces per meal of caught fish. Individuals in the sport fishing population showed a marked difference, consuming 4.7 ounces per meal of bought fish and 7.3 ounces per meal of caught fish. Southeast Asians consumed smaller portions of fish per meal, and children consumed the smallest portions of fish per meal.

On average, the general population consumed 27.7 g/day of fish and seafood while the sport fishing population consumed 51.1 g/day (Table 10-68). The commercial fishing population had an average consumption rate of 47.4 g/day while the limited income population's rate was 43.1 g/day. The overall minority population consumption rate was 50.3 g/day, with Southeast Asians consuming an average of 59.2 g/day (the highest overall rate) and non-Southeast Asians consuming an average of 45.0 g/day. Child-bearing age women consumed an average of 45.0 g/day and children consumed an average of 18.3 g/day.

The study also examined fish preparations and cooking practices for each population group. It was found that the sport fishing population was most likely to perform risk-reducing preparation methods compared to the other populations, while the minority population was least likely to use the same risk-reducing methods. Cooking information by specie was only available for the Southeast Asian population, but the most common cooking methods were boiling, poaching-boiling-steaming, sauté/stir fry, and deep frying.

The authors noted that there were some limitations to this study. First, there was some interdependence within households in terms of the tendency to eat fish and seafood, but there was no dependence between individuals. Second, the study had a very low percent return rate for the general population mail survey and it is questionable whether or not the responses accurately reflect the total population's behavior.

10.5.11 *Burger et al., 1999 – Factors in Exposure Assessment: Ethnic and Socioeconomic Differences in Fishing and Consumption of Fish Caught along the Savannah River*

Burger et al. (1999) examined the differences in fishing rates and fish consumption of people fishing along the Savannah River as a function of age, education, ethnicity, employment history, and income. A total of 258 people who were fishing on the Savannah River were interviewed. The interviews were conducted both on land and by boat from April to November 1997. Anglers were asked about fishing behavior, consumption patterns, cooking patterns, knowledge of warnings and safety of fish, and personal demographics. The authors used multiple regression procedures to examine the relative contribution of ethnicity, income, age, and education to parameters such as years fished, serving size, meals/month, and total ounces of fish consumed per year.

Eighty-nine percent of people interviewed were men, 70 percent were White, 28 percent were African-American, and 2 percent were of other ethnicity not specified in the study. The age of the interviewees ranged from 16 to 82 years (mean = 43 ± 1 years). The study authors reported that the average fish intake for all survey respondents was 1.46 kg of fish per month (48.7 g/day). Although most of the respondents were men, they indicated that their wives and children consumed fish as often as they did, and children began to eat fish at 3 to 5 years of age.

There were significant differences in fishing behavior and consumption as a function of ethnicity (Table 10-69). African-Americans fished more often, consumed fish more frequently and ate larger portions of fish than did Whites. Given the higher level of consumption by African-Americans compared to consumption by Whites, the study authors suggested that the potential for exposure is higher for African-Americans than for Whites, although the risks depend on the levels of contaminants in the fish. Income and education also contributed to variations in fishing and consumption behavior. Anglers with low incomes (less than or equal to $20,000) ate fish more often that those with higher incomes. Anglers who had not graduated from high school consumed fish more frequently, eat more fish per month and per year, and deep fried fish more often than anglers with more education. At all levels of education, African-Americans consumed more fish than Whites.

The authors acknowledged that there may have been sampling bias in the study since they only interviewed people who were fishing on the river and were, therefore, limited to those people they found. To reduce the bias, the authors conducted the survey at all times of the day, on all days of the week, and along different sections of the river. Another limitation noted by the study authors is that the survey asked questions about consumption of fish from two general sources: self-caught and bought. The study authors indicated that it would have been useful to distinguish between fish obtained directly from the wild by the anglers, their friends or family, and store-bought or restaurant fish.

10.5.12 *Williams et al., 1999 - Consumption of Indiana Sport Caught Fish: Mail Survey of Resident License Holders*

In 1997, sport caught fish consumption among licensed anglers was assessed using a mail survey (Williams et al., 2000b). Anglers were asked about their consumption patterns during a three month recall, their fishing rates, species of fish consumed, awareness of advisory warnings, and associated behaviors.

Average meal size among respondents was 9.3 ounces per meal. Consumers indicated that on average they ate between one and two meals per month. The survey population was divided into active consumers (those who actively engage in consuming sport fish meals) and potential consumers (those who eat fish during other times of the year). The average consumption rate for active consumers was reported as 19.8 g/day. For both active and potential consumers, the rate was 16.4 g/day (Table 10-70).

The statewide mail survey of licensed Indiana anglers did not specifically address lower-income and minority anglers. The respondents to the mail survey were predominately white (94.5 percent). The recall period for this survey extended from the summer through the end of fall and early winter. No information was collected on consumption during spring or winter. Another limitation of the study was that only sport caught fish consumption was measured among anglers.

10.5.13 *Burger, 2000 - Gender Differences in Meal Patterns: Role of Self-caught Fish and Wild Game in Meat and Fish Diets*

Burger (2000) used the hypothesis that there are gender differences in consumption patterns of self-caught fish and wild game in a meat and fish diet. In the study, 457 people were interviewed while attending the Palmetto Sportsmen's Classic in Columbia, South Carolina (March 27-29, 1998). All subjects were selected randomly by walking transects through the exhibit halls and grounds to ensure that people were interviewed from all areas of the show.

The questionnaire requested information on two different categories: socio-demographics and number of meals consumed that included several types of fish and wild game. The demographics section contained questions dealing with ethnicity, gender, age, location of residence, occupation, and income. Questions dealing with consumption of wild game and fish included specific species such as: deer, wild-caught quail, restaurant quail, dove, duck, rabbit, squirrel, raccoon, wild turkey, beef, chicken, pork, self-caught fish, store-bought fish, and restaurant fish.

The study results showed that the mean age of the respondents was 40 years and ranged from 15 to 74. The study showed that there were no gender differences in the percentage of people who ate commercial protein sources, but there were significant gender differences for the consumption of most wild-caught game and fish. A higher proportion of men ate wild-caught species than women.

There were gender differences in mean monthly meals and mean serving size for all wild-caught foods except for raccoon and quail, which were eaten by few people. The study results indicated that men ate more meals of fish and meat overall, than woman, and men also ate larger portions than women. The study authors also found that individuals who consumed a large number of fish meals per month consumed a higher percentage of wild-caught fish meals than individuals who consumed a small number of fish meals per month.

This study is limited in that the subjects interviewed were people interested in fishing and hunting; therefore, their consumption rates may be higher than for the overall population. In addition, all subjects interviewed were white.

10.5.14 *Williams et al., 2000 - An Examination of Fish Consumption by Indiana Recreational Anglers: An Onsite Survey*

An on-site survey of Indiana anglers was conducted in the summer of 1998 (Williams et al., 2000). A total of 946 surveys were completed. Minority anglers accounted for 31.8 percent of those surveyed, with African American anglers accounting for the majority of this group (25.1 percent of all respondents). Respondents reporting household incomes below $25,000 comprised 30.9 percent of the respondents. Anglers were asked to report their Indiana sport caught fish consumption frequency for a three-month recall period. Using the meal frequency and portion size reported by the anglers, the amount of fish consumed was calculated into a daily amount called grams per day consumption. Consumption rates were weighted to correct for participation bias.

Consumption was reported as 27.2 g/day among minority consumers and 20.0 g/day among white consumers (Table 10-71). Of the anglers surveyed, 75.4 percent of white active consumers reported being aware of the fish consumption advisory, while 70.0 percent of the minority consumers reported awareness. The study authors also examined angler consumption rate based on the level of awareness of Indiana fish consumption advisories reported by the anglers. The consumption rate for those consumers who were very aware of the advisory was 35.2 g/day. For those with a general awareness of the advisory, the consumption rate was 14.1 g/day and for those who were not aware of the advisory, the consumption rate was 21.3 g/day. In terms of income, the study authors found that there was a significant difference in grams of Indiana sport caught fish consumed per day. Anglers reporting a household income below $25,000 had an average consumption rate of 18.9 g/day. Anglers with incomes between $25,000 and $34,999 averaged 18.8 g/day and anglers with incomes between $35,000 and $49,999 averaged 15.2 g/day. The highest income, those reporting an income $50,000 or above, consumed an average of 48.9 g/day.

The authors noted that this study was designed to determine the consumption rates of Indiana anglers, particularly those in minority and low income groups, during a portion of the year. Information was not collected for the period of September through January so calculation of year round consumption was not possible.

10.5.15 *Benson et al., 2001 - Fish Consumption Survey: Minnesota and North Dakota*

Benson et al. (2001) conducted a fish consumption survey among Minnesota and North Dakota residents. The target population included the general population, licensed anglers, and members of Native American tribes. The survey focused on obtaining the most recent year's fish intake from all sources, including locally caught fish. Survey questionnaires were mailed to potential respondent households. For the entire population, approximately 1,570 surveys were returned completed (out of 7,835 that were mailed out).

Groups of interest were selected and allotted a portion of the total number of surveys to be distributed to each group as follows: a group categorized as the general population and anglers received 37.5 percent of the surveys and new mothers and Native Americans each received 12.5 percent of the total surveys distributed. The survey distribution was split 60/40 between Minnesota and North

Dakota. For the entire survey population, a total of 1,565 surveys were returned completed (out of 7,835 that were mailed out), resulting in a total of 4,273 respondents. A target of 100 completed telephone interviews of non-respondents was set in order to characterize the non-respondent population; however, this target was not met.

The Minnesota survey showed a total fish mean and median consumption rate for the general population (2,312 respondents) of 12.3 and 2.8 g/day, respectively (Table 10-72). The total number of Minnesota Bois Forte Tribe respondents was 232 and total fish consumption in g/day was 2.8 and 22.4 for the 50th and 95th percentiles, respectively. For Minnesota residents with fishing licenses (2,020 respondents), total fish consumption in g/day was 13.2 and 64.5 for the 50th and 95th percentiles (lognormal distribution), respectively. For Minnesota respondents without fishing licenses, total fish consumption in g/day was 7.5 and 58.7 for the 50th and 95th percentiles (lognormal distribution), respectively. The survey results also show that total consumption rates were highest for men, followed by women over the age of 44 years, followed by women, ages 15 to 44 years. The lowest consumption was shown for children.

The North Dakota survey showed a total fish mean and median consumption rate for the general population (1,406 respondents) of 12.6 and 3.0 g/day, respectively (Table 10-72). The total number of North Dakota Spirit Lake Nation and Three Affiliated Tribes respondents was 105 and the total fish consumption in g/day was 1.4 and 27.3 for the mean and the 95th percentile, respectively. For North Dakota residents with fishing licenses (1,101 respondents), total fish consumption in g/day was 14.0 and 76.2 for the 50th and 95th percentiles (lognormal distribution), respectively. For North Dakota respondents without fishing licenses, total fish consumption in g/day was 7.2 and 54.1 for the 50th and 95th percentiles (lognormal distribution), respectively. The survey results also showed that the total consumption rates were highest for females ages 15 to 44 years, followed by men, followed by women over the age of 44 years. The lowest consumption was found for children.

The authors noted that 80 percent of respondents in Minnesota and 72 percent of respondents in North Dakota lived in a household that included a licensed angler. They stated that this was a result of a direct intent to oversample the angling population in both states by sending 37.5 percent of surveys distributed to persons who purchased a fishing license in either Minnesota or North Dakota. The data were adjusted to incorporate overall licensed angler rates in both states (47.3 percent of households in Minnesota and 40.0 percent of households in North Dakota).

An advantage of this study is its large overall sample size. A limitation of the study is the low numbers of Native Americans surveyed; thus, the survey may not be representative of overall Native American populations in Minnesota. In addition, the study did not include Asian Immigrants, African Americans, African immigrants, or Latino populations, and was limited to two states. Therefore, the results may not be representative of the U.S. population as a whole.

10.5.16 *Campbell et al., 2002 - Fishing along the Clinch River Arm of Watts Reservoir Adjacent to the Oak Ridge Reservation, Tennessee: Behavior, Knowledge and Risk Perception*

Campbell et al. (2002) examined consumption habits of anglers fishing along the Clinch River arm of Watts Bar Reservoir, adjacent to the U.S. Department of Energy's Oak Ridge Reservation (ORR) in East Tennessee. The study area included the Clinch River arm of Watts Bar Reservoir from Melton Hill Dam to the confluence with Poplar Creek, and Poplar Creek from the confluence with Clinch River to the intersection with Poplar Creek Road. A total of 202 anglers were interviewed on 65 sampling days, which included 48 weekdays and 17 weekend days. Eighty-six percent of fishermen interviewed were fishing from the shore while 14 percent were fishing from a boat. The questionnaire utilized in the study included questions on demographics, fishing behavior, perceptions, cooking patterns, consumption patterns, and consumption warnings. Interviews were conducted by two people who were local to the area in order to promote participation in the study.

Out of all anglers interviewed, approximately 35 percent did not eat fish. Of the 65 percent who ate fish, only 38 percent ate fish from the study area. This 38 percent (77 people) was considered useful to the study and thus, were the main focus of the data analysis. These anglers averaged two meals of fish per month with an average consumption rate of 37 grams per day or 13.7 kilograms per year (Table 10-73). They caught almost 90 percent of the fish they ate, had a mean age of 42 years, and a mean income of $28,800. The species of fish most often mentioned by anglers who caught and ate fish from the study area were crappie, striped bass, white bass, sauger, and catfish.

A limitation of this study is that the small size of the population does not allow for statistically significant analysis of the data.

10.6 NATIVE AMERICAN STUDIES

10.6.1 *Wolfe and Walker (1987) - Subsistence Economies in Alaska: Productivity, Geography, and Development Impacts*

Wolfe and Walker (1987) analyzed a dataset from 98 communities for harvests of fish, land mammals, marine mammals, and other wild resources. The analysis was performed to evaluate the distribution and productivity of subsistence harvests in Alaska during the 1980s. Harvest levels were used as a measure of productivity. Wolfe and Walker (1987) defined harvest to represent a single year's production from a complete seasonal round. The harvest levels were derived primarily from a compilation of data from subsistence studies conducted between 1980 and 1985 by various researchers in the Alaska Department of Fish and Game, Division of Subsistence.

Of the 98 communities studied, four were large urban population centers and 94 were small communities. The harvests for these latter 94 communities were documented through detailed retrospective interviews with harvesters from a sample of households (Wolfe and Walker, 1987). Harvesters were asked to estimate the quantities of a particular species that were harvested and used by members of that household during the previous 12-month period. Wolfe and Walker (1987) converted harvests to a common unit for comparison, pounds dressed weight per capita per year, by multiplying the harvests of households within each community by standard factors converting total pounds to dressed weight, summing across households, and then dividing by the total number of household members in the household sample. Dressed weight varied by species and community but in general was 70 to 75 percent of total fish weight; dressed weight for fish represents that portion brought into the kitchen for use (Wolfe and Walker, 1987).

Harvests for the four urban populations were developed from a statewide data set gathered by the Alaska Department of Fish and Game Divisions of Game and Sports Fish. Urban sport-fish harvest estimates were derived from a survey that was mailed to a randomly selected statewide sample of anglers (Wolfe and Walker, 1987). Sport-fish harvests were disaggregated by urban residency and the dataset was analyzed by converting the harvests into pounds and dividing by the 1983 urban population.

For the overall analysis, each of the 98 communities was treated as a single unit of analysis and the entire group of communities was assumed to be a sample of all communities in Alaska (Wolfe and Walker, 1987). Each community was given equal weight, regardless of population size. Annual per capita harvests were calculated for each community. For the four urban centers, fish harvests ranged from 5 to 21 pounds per capita per year (6.2 g/day to 26.2 g/day).

The range for the 94 small communities was 25 to 1,239 pounds per capita per year (31 g/day to 1,541 g/day). For these 94 communities, the median per capita fish harvest was 130 pounds per year (162 g/day). In most (68 percent) of the 98 communities analyzed, resource harvests for fish were greater than the harvests of the other wildlife categories (land mammal, marine mammal, and other) combined.

The communities in this study were not made up entirely of Alaska Natives. For roughly half the communities, Alaska Natives comprised 80 percent or more of the population, but for about 40 percent of the communities they comprised less than 50 percent of the population. Wolfe and Walker (1987) performed a regression analysis which showed that the per capita harvest of a community tended to increase as a function of the percentage of Alaska Natives in the community. Although this analysis was done for total harvest (i.e., fish, land mammal, marine mammal and others) the same result should hold for fish harvest since fish harvest is highly correlated with total harvest.

A limitation of this report is that it presents per-capita harvest rates as opposed to individual intake rates. Wolfe and Walker (1987) compared the per capita harvest rates reported to the results for the household component of the 1977-1978 USDA National Food Consumption Survey (NFCS). The NFCS showed that about 222 pounds of meat, fish, and poultry were purchased and brought into the household kitchen for each person each year in the western region of the United States. This contrasts with a median total resource harvest of 260 lbs/yr in the 94 communities studied. This comparison, and the fact that Wolfe and Walker (1987) state that "harvests represent that portion brought into the kitchen for use," suggest that the same factors used to convert household consumption rates in the NFCS to individual intake rates can be used to convert per capita harvest rates to individual intake rates. In Section 10.3, a factor of 0.5 was used to convert fish consumption from household to individual intake rates. Applying this factor, the median per capita individual fish intake in the 94 communities would be 81 g/day and the range 15.5 to 770 g/day.

A limitation of this study is that the data were based on 1-year recall from a mailed survey. An advantage of the study is that it is one of the few studies that present fish harvest patterns for subsistence populations.

10.6.2 *Chemrisk, 1992 - Consumption of Freshwater Fish by Maine Anglers*

As addressed in Section 10.5.3, Chemrisk (1992) conducted a study of 1,612 randomly selected Maine licensed anglers in 1990 to characterize the rates of freshwater fish consumption among residents. Freshwater fish intake distributions for these populations are presented in Table 10-60. The mean and 95th percentile was 5.0 g/day and 21.0 g/day, respectively, for all anglers, but the highest mean intake rate was 10 g/day for Native Americans (Chemrisk, 1992).

10.6.3 *Columbia River Inter-Tribal Fish Commission (CRITFC), 1994 - A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin*

The Columbia River Inter-Tribal Fish Commission (CRITFC) (1994) conducted a fish consumption survey among four Columbia River Basin Native American tribes during the fall and winter of 1991-1992. The target population included all adult tribal members who lived on or near the Yakama, Warm Springs, Umatilla or Nez Perce reservations. The survey was based on a stratified random sampling design where respondents were selected from patient registration files at the Indian Health Service. Interviews were performed in person at a central location on the member's reservation.

The overall response rate was 69 percent yielding a sample size of 513 tribal members, 18 years old and above. Of these, 58 percent were female and 59 percent were under 40 years old. Each participating adult was asked if there were any children 5 years old or younger in his or her household. Those responding affirmatively were asked a set of survey questions about the fish consumption patterns of the youngest child in the household (CRITFC, 1994). Information for 204 children, 5 years old and younger, was provided by participating adult respondents. Consumption data were available for 194 of these children.

Participants were asked to describe and quantify all food and drink consumed during the previous day. They were then asked to identify the months in which they ate the most and the least fish, and the number of fish meals consumed per week during each of those periods and an average value for the whole year. The typical portion size (in ounces) was determined with the aid of food models provided by the questioner. The next set of questions identified specific species of fish and addressed the number of times per month each was eaten, as well as what parts (e.g., fillet, skin, head, eggs, bones, other) were eaten. Respondents were then asked to identify the frequency with which they used various preparation methods, expressed as a percentage. Respondents sharing a household with a child, aged 5 years or less, were asked to repeat the serving size, eating frequency, and species questions for the child's consumption behavior. All respondents were asked about the geographic origin of any fish they personally caught and consumed, and to identify the major sources of fish in their diet (e.g., self-caught, grocery store, tribe, etc.). Fish intake rates were calculated by multiplying the annual frequency of fish meals by the average serving size per fish meal.

The population sizes of the four tribes were highly unequal, ranging from 818 to 3,872 individuals (CRITFC, 1994). In order to ensure an adequate sample size from each tribe, the study was designed to give nearly equal sample sizes for each tribe. Weighting factors were applied to the pooled data (in proportion to tribal population size) so that the survey results would be representative of the overall population of the four tribes for adults only. Because the sample size for children was considered small, only an unweighted analysis was performed for this population. Based on a desired sample size of approximately 500 and an expected response rate of 70 percent, 744 individuals were selected at random from lists of eligible patients; the numbers from each tribe were approximately equal.

The results of the survey showed that adults consumed an average of 1.71 fish meals/week and had an average intake of 58.7 grams/day (CRITFC, 1994). Table 10-74 shows the adult fish intake distribution; the median was between 29 and 32 g/day and the 95th percentile about 170 g/day. A small percentage (7 percent) of respondents indicated that they were not fish consumers. Table 10-75 shows that mean intake was slightly higher in males than females (63 g/d versus 56 g/d) and was higher in the over 60 years age group (74.4 g/d) than in the 18-39 years (57.6 g/d) or 40-59 years (55.8 g/d) age groups. Intake also tended to be higher among those living on the reservation. The mean intake for nursing mothers, 59.1 g/d, was similar to the overall mean intake. Intake rates were calculated for children for which both the number of fish meals per week and serving size information were available.

A total of 49 percent of respondents of the total survey population reported that they caught fish from the Columbia River basin and its tributaries for personal use or for tribal ceremonies and distributions to other tribe members and 88 percent reported that they obtained fish from either self-harvesting, family or friends, at tribal ceremonies or from tribal distributions. Of all fish consumed, 41 percent came from self or family harvesting, 11 percent from the harvest of friends, 35 percent from tribal ceremonies or distribution, 9 percent from stores and 4 percent from other sources (CRITFC, 1994).

Of the 204 children, the total number of respondents used in the analysis varied from 167 to 202, depending on the topic (amount and species consumed, fish meals consumed /week, age consumption began, serving size, consumption of fish parts) of the analysis. The unweighted mean for the age when children begin eating fish was 13.1 months of age (N = 167). The unweighted mean number of fish meals consumed per week by children was 1.2 meals per week (N = 195) and the unweighted mean serving size of fish for children aged five years old and less was 95 grams (i.e., 3.36 ounces) (N = 201). The unweighted percent of fish consumed by children by species was 82.7 percent for salmon, followed by 46.5 percent (N = 202) for trout.

The analysis of seasonal intake showed that May and June tended to be high-consumption months and December and January low consumption months. The mean adult intake rate for May and June was 108 g/d while the mean intake rate for December and January was 30.7 g/d. Salmon was the species eaten by the highest number of respondents (92 percent) followed by trout (70 percent), lamprey (54 percent), and smelt (52 percent). Table 10-76 gives the fish intake distribution for children under 5 years of age. The mean intake rate was 19.6 g/day and the 95th percentile was approximately 70 g/day. These mean intake rates include both consumers and non-consumers. These values are based on survey questions involving estimated behavior throughout the year, which survey participants answered in terms of meals per week or per month and typical serving size per meal. Table 10-77 presents consumption rates for children who were reported to consume particular species of fish.

The authors noted that some non-response bias may have occurred in the survey since respondents were more likely to be female and live near the reservation than non-respondents. In addition, they hypothesized that non-consumers may have been more likely to be non-respondents than fish consumers since non-consumers may have thought their contribution to the survey would be meaningless; if such were the case, this study would overestimate the mean per capita intake rate. It was also noted that the timing of the survey, which was conducted during low fish consumption months, may have led to underestimation of actual fish consumption; the authors conjectured that an individual may have reported higher annual consumption if interviewed during a relatively high consumption month and lower annual consumption if interviewed during a relatively low consumption month. Finally, with respect to children's intake, it was observed that some of the respondents provided the same information for their children as for themselves; thereby, the reliability of some of these data is questioned (CRITFC, 1994). The combination of four different tribes' survey responses into a single pooled data set is somewhat problematic. The data presented in are unweighted and therefore contain a bias toward the smaller tribes, who were oversampled compared to the larger tribes.

The limitations of this study, particularly with regard to the estimates of children's consumption, result in a high degree of uncertainty in the estimated rates of consumption. Although the authors have noted these limitations, this study does present information on fish consumption patterns and habits for a Native American subpopulation. It should be noted that the number of surveys that address subsistence subpopulations is very limited.

10.6.4 *Peterson et al., 1994 - Fish Consumption Patterns and Blood Mercury Levels in Wisconsin Chippewa Indians*

Peterson et al. (1994) investigated the extent of exposure to methylmercury by Chippewa Indians living on a Northern Wisconsin reservation who consume fish caught in Northern Wisconsin lakes. Chippewa have a reputation for high fish consumption (Peterson et al., 1994). The Chippewa Indians fish by the traditional method of spearfishing. Spearfishing (for walleye) occurs for about two weeks each spring after the ice breaks, and although only a small number of tribal members participate in it, the spearfishing harvest is distributed widely within the tribe by an informal distribution network of family and friends and through traditional tribal feasts (Peterson et al., 1994).

Potential survey participants, 465 adults, 18 years of age and older, were randomly selected from the tribal registries (Peterson et al., 1994). Participants were asked to complete a questionnaire describing their routine fish consumption and, more extensively, their fish consumption during the two previous months. The survey was carried out in May 1990. A follow-up survey was conducted for a random sample of 75 non-respondents (80 percent were reachable), and their demographic and fish consumption patterns were obtained. Peterson et al. (1994) reported that the non-respondents' socioeconomic and fish consumption were similar to the respondents.

A total of 175 of the original random sample (38 percent) participated in the study. In addition, 152 non-randomly selected participants were surveyed and included in the data analysis; these participants were reported by Peterson et al. (1994) to have fish consumption rates similar to those of the randomly selected participants. Results from the survey showed that fish consumption varied seasonally, with 50 percent of the respondents reporting April and May (spearfishing season) as the highest fish consumption months (Peterson et al., 1994). Table 10-78 shows the number of fish meals consumed per week during the last 2 months (recent consumption) before the survey was conducted and during the respondents' peak consumption months grouped by gender, age, education, and employment level. During peak consumption months, males consumed more fish (1.9 meals per week) than females (1.5 meals per week), respondents under 35 years of age consumed more fish (1.8 meals per week) than respondents 35 years of age and over (1.6 meals per week), and the unemployed consumed more fish (1.9 meals per week) than the employed (1.6 meals per week). During the highest fish consumption season (April and May), 50 percent of respondents reported eating one or less fish meals per week and only 2 percent reported daily fish consumption. A total of 72 percent of respondents reported Walleye consumption in the previous two months. Peterson et al. (1994) also reported that the mean number of fish meals usually consumed per week by the respondents was 1.2.

The mean fish consumption rate reported (1.2 fish meals per week, or 62.4 meals per year) in this survey was compared with the rate reported in a previous survey of Wisconsin anglers (Fiore et al., 1989) of 42 fish meals per year. These results indicate that the Chippewa Indians do not consume much more fish than the general Wisconsin angler population (Peterson et al., 1994). The differences in the two values may be attributed to differences in study methodology (Peterson et al., 1994). Note that this number (1.2 fish meals per week) includes fish from all sources. Peterson et al. (1994) noted that subsistence fishing, defined as fishing as a major food source, appears rare among the Chippewa. Using the recommended rate in this handbook of 110 g/meal as the average weight of fish consumed per fish meal in the general population, the rate reported here of 1.2 fish meals per week translates into a mean fish intake rate of 19 g/day in this population.

10.6.5 *Fitzgerald et al., 1995 - Fish PCB Concentrations and Consumption Patterns Among Mohawk Women at Akwesasne –*

Akwesasne is a Native American community of ten thousand plus persons located along the St. Lawrence River (Fitzgerald et al., 1995. Fitzgerald et al. (1995) conducted a recall study from 1986 to 1992 to determine the fish consumption patterns among nursing Mohawk women residing near three industrial sites. The study sample consisted of 97 Mohawk women and 154 nursing Caucasian controls. The Mohawk mothers were significantly younger (mean age 24.9) than the controls (mean age 26.4) and had significantly more years of education (mean 13.1 for Mohawks versus 12.4 for controls). A total of 97 out of 119 Mohawk nursing women responded, a response rate of 78 percent; 154 out of 287 control nursing Caucasian women responded, a response rate of 54 percent.

Potential participants were identified prior to, or shortly after, delivery. The interviews were conducted at home within one month postpartum and were structured to collect information for sociodemographics, vital statistics, use of medications, occupational and residential histories, behavioral patterns (cigarette smoking and alcohol consumption), drinking water source, diet, and fish preparation methods (Fitzgerald et al., 1995). The dietary data collected were based on recall for food intake during the index pregnancy, the year before the pregnancy, and more than one year before the pregnancy.

The dietary assessment involved the report by each participant on the consumption of various foods with emphasis on local species of fish and game (Fitzgerald et al., 1995). This method combined food frequency and dietary histories to estimate usual intake. Food frequency was evaluated with a checklist of foods for indicating the amount of consumption of a participant per week, month or year. Information gathered for the dietary history included duration of consumption, changes in the diet, and food preparation method.

Table 10-79 presents the number of local fish meals per year for both the Mohawk and control participants. The highest percentage of participants reported consuming between 1 and 9 local fish meals per year. Table 10-79 indicates that Mohawk respondents consumed statistically significantly more local fish than did control respondents during the two time periods prior to pregnancy; for the time period during pregnancy there was no significant difference in fish consumption between the two groups. Table 10-80 presents the mean number of local fish meals consumed per year by time period for all respondents and for those ever consuming (consumers only). A total of 82 (85 percent) Mohawk mothers and 72 (47 percent) control mothers reported ever consuming local fish. The mean number of local fish meals consumed per year by Mohawk respondents declined over time, from 23.4 (over one year before pregnancy) to 9.2 (less than one year before pregnancy) to 3.9 (during pregnancy); a similar decline was seen among consuming Mohawks only. There was also a decreasing trend over time in consumption among controls, though it was much less pronounced.

Table 10-81 presents the mean number of fish meals consumed per year for all participants by time period and selected characteristics (age, education, cigarette smoking, and alcohol consumption). Pairwise contrasts indicated that control participants over 34 years of age had the highest fish consumption of local fish meals (22.1) (Table 10-81). However, neither the overall nor pairwise differences by age among the Mohawk women over 34 years old were statistically significant, which may be due to the small sample size (N=6) (Fitzgerald et al., 1995). The most common fish consumed by Mohawk mothers was yellow perch; for controls the most common fish consumed was trout.

An advantage of this study is that it presents data for fish consumption patterns for Native Americans as compared to a demographically similar group of Caucasians. Although the data are based on nursing mothers as participants, the study also captures consumption patterns prior to pregnancy (up to one year before and more than one year before). Fitzgerald et al. (1995) noted that dietary recall for a period more than one year before pregnancy may be inaccurate, but these data were the best available measure of the more distant past. They also noted that the observed decrease in fish consumption among Mohawks from one year before pregnancy to the period of pregnancy is due to a secular trend of declining fish consumption over time in Mohawks. This decrease, which was more pronounced than that seen in controls, may be due to health advisories promulgated by tribal, as well as state, officials. The authors note that this decreasing secular trend in Mohawks is consistent with a survey from 1979-1980 that found an overall mean of 40 fish meals per year among male and female Mohawk adults.

The data are presented as number of fish meals per year; the authors did not assign an average weight to fish meals. If assessors wanted to estimate the weight of fish consumed, some average value of weight per fish meal would have to be assumed. Smiciklas-Wright et al. (2002) reported 117 grams as the average weight of fish consumed per eating occasion for females 20-39 years old. Using this value, the rate reported of 27.6 fish meals per year for consumers only (over one year before pregnancy) translates into a mean fish intake rate of 8.8 g/day.

10.6.6 *Toy et al., 1996 - A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region*

Toy et al. (1996) conducted a study to determine fish and shellfish consumption rates of the Tulalip and Squaxin Island tribes living in the Puget Sound region. These two Indian tribes were selected on the basis of judgment that they would be representative of the expected range of fishing and fish consumption activities of the fourteen tribes in the region. Commercial fishing is a major source of income for members of both tribes; some members the Squaxin Island tribe also participate in commercial shellfishing. Both tribes participate in subsistence fishing and shellfishing.

A survey was conducted to describe fish consumption for Puget Sound tribal members over the age of 18, and their dependents ages five and under, in terms of their consumption rate of anadromous, pelagic, bottom fish, and shellfish in grams per kilogram body weight per day. The survey focused on the frequency of fish and shellfish consumption (number of fish meals eaten per day, per week, per month, or per year) over a one-year period and the portion size of each meal. Data were also collected on fish parts consumed, preparation methods, patterns of acquisition for all fish and shellfish consumption (including seasonal variations in consumption), and children's consumption rates. Interviews were conducted between February 25 and May 15, 1994. A total of 190 tribal members, ages 18 years old and older, and 69 children between the ages birth and 5 years old, were surveyed on consumption of 52 species. The response rate was 77 percent for the Squaxin Island tribe and 76 percent for the Tulalip tribes.

The appropriate sample size was calculated based on the enrolled population of each tribe and a desired confidence interval of ±20 percent from the mean, with an additional 25 percent added to the total to allow for non-response or unusable data. The target population, derived from lists of enrolled tribal members provided by the tribes, consisted of enrolled tribal members aged 18 years and older and children aged five years and younger living in the same household as an enrolled member. Only members living on or within 50 miles of the reservation were considered for the survey. Each eligible enrolled tribal member was assigned a number, and computer-generated random numbers were used to identify the survey participants. Children were not sampled directly, but through adult members of their household; if one adult had more than one eligible child in his or her household, one of the children was selected at random. This indirect sampling method was necessitated by the available tribal records, but may have introduced sampling bias to the process of selecting children for the study. A total of 190 adult tribal members (ages 18 years old and older) and 69 children between ages birth and 5 years old (i.e., 0 to <6 years) were surveyed about their consumption of 52 fish species in six categories: anadromous, pelagic, bottom, shellfish, canned tuna, and miscellaneous.

Respondents described their consumption behavior for the past year in terms of frequency of fish meals eaten per week or per month, including seasonal variations in consumption rates. Portion sizes (in ounces) were estimated with the aid of model portions provided by the questioner. Data were also collected on fish parts consumed, preparation methods, patterns of acquisition for all fish and shellfish consumption, and children's consumption rates.

The adult mean and median consumption rates for all forms of fish combined were 0.89 and 0.55 g/kg/day for the Tulalip tribes and 0.89 and 0.52 g/kg/day for the Squaxin Island tribe, respectively (Table 10-82). As shown in Table 10-83, consumption per body weight varied by gender (males consumed more as indicated by mean and median consumption). The median rates for the Tulalip Tribes were 53 g/day for males and 34 g/day for females, while the rates were 66 g/day for males and 25 g/day for females for the Squaxin Island tribe (Table 10-84). Among adults consumption generally followed a curvilinear pattern, with greater median consumption in the age range of 35-64 years old and lower consumption in the age range of 18-34 years old and 65 years old and over (Table 10-85). No consistent pattern of consumption by income was found for either tribe (Table 10-86).

The mean and median consumption rates for children five years and younger for both tribes combined, were 0.53 and 0.17 g/kg-day, respectively. These values were significantly lower than those of adults, even when the consumption rate was adjusted for body weight (Table 10-87). Squaxin Island children tended to consume more fish than Tulalip children (mean 0.825 g/kg/day vs. 0.239 g/kg/day). The data were insufficient to allow re-analysis to fit the data to the standard U.S. EPA age categories used elsewhere in this handbook. A minority of consumers ate fish parts that are considered to have a higher concentration of toxins: skin, head, bones, eggs, and organs, and for the majority of consumers, fish were prepared (baking, boiling, broiling, roasting, and poaching) and eaten in a manner that tends to reduce intake of contaminants. Most anadromous fish and shellfish were obtained by harvesting in the Puget Sound area rather than by purchasing, though sources of harvesting varied between the tribes (See Appendix 10B).

The advantage of this study is that the data can be used to improve how exposure assessments are conducted for populations that are high consumers of fish and shellfish and to identify cultural characteristics that may place tribal members at disproportionate risk to chemical contamination. For males of both tribes, the median consumption rate was eight to ten times higher than the recommended national default value.

One limitation associated with this study is that although data from the Tulalip and Squaxin Island tribes may be representative of consumption rates of these specific tribes, fish consumption rates, habits, and patterns can vary among tribes and other sub-populations. As a result, the consumption rates of these two tribes may not be useful as a surrogate for consumption rates of other Native American tribes. There might also be a possible bias due to the time the survey was conducted; many species in the survey are seasonal, and although the survey was designed to solicit annual consumption rates, respondents may have weighed their responses toward the interview period. For example, because of the timing of the survey, respondents may have overestimated their annual consumption of shellfish and underestimated their annual consumption of salmon. Furthermore, there were differences in consumption patterns between the two tribes included in this study; the study provided data for each tribe and for the pooled data from both tribes, but the latter may not be a statistically valid measure for tribes in the region.

10.6.7 *Duncan, 2000 - Fish Consumption Survey of the Suquamish Indian Tribe of the Port Madison Indian Reservation, Puget Sound Region*

The Suquamish Tribal Council conducted a study of the Suquamish tribal members living on and near the Port Madison Indian Reservation in the Puget Sound region (Duncan, 2000). The study was funded by the Agency for Toxic Substances and Disease Registry (ATSDR) through a grant to the Washington State Department of Health. The purpose of the study was to determine seafood consumption rates, patterns, and habits of the members of the Suquamish Tribe. The second objective was to identify cultural practices and attributes that affect consumption rates, patterns and habits of members of the Suquamish Tribe.

A systematic random sample of adults, defined as individuals age 16 years and older, were selected from a sorted Tribal enrollment roster. The study had a participation rate of 64.8 percent, which was calculated on the basis of 92 respondents out of a total of 142 potentially eligible adults on the list of those selected into the sample. Consumption data for children under six years of age were gathered through adult respondents who had children in this age group living in the household at the time of the survey. Data were collected for 31 children under six years old.

A survey questionnaire was administered by personal interview. The survey included four parts: (1) 24-hour dietary recall; (2) identification, portions, frequency of consumption, preparation, harvest location of fish; (3) shellfish consumption, preparation, harvest location; and (4) changes in consumption over time, cultural information, physical information, and socioeconomic information. A display booklet was used to assist respondents in providing consumption data and identifying harvest locations of seafood consumed. Physical models of finfish and shellfish were constructed to assist respondents in determining typical food portions. Finfish and shellfish were grouped into categories based on similarities in life history as well as practices of Tribal members who fish for subsistence, ceremonial, and commercial purposes.

Adult respondents reported a mean consumption rate of all finfish and all shellfish of 2.71 g/kg/day (Table 10-88). Tables 10-89, 10-90, and 10-91 provide consumption rates for adults by species, gender, and age, respectively. For children under six years of age, the mean consumption rate of all finfish and shellfish was 1.48 g/kg/day (Tables 10-92 and 10-93). The Suquamish Tribe's seafood consumption rates for adults and children under six years of age represent the highest seafood consumption rates reported in studies conducted among the CRITFC, Tulalip Tribes, Squaxin Island Tribe, and the Asian Pacific Island population of King County (Duncan, 2000). This disparity illustrates the high degree of variability found between tribes even within a small geographic region (Puget Sound) and indicates that exposure and risk assessors should exercise care when imputing fish consumption rates to a population of interest using data from tribal studies.

An important attribute of this survey is that it provides consumption rates by individual type of fish and shellfish. It is important to note that the report indicates that increased levels of development as well as pollutants from residential, industrial, and commercial uses have resulted in degraded habitats and harvesting restrictions. Despite degraded water quality and habitat, tribal members continue to rely on fish and shellfish as a significant part of their diet. A limitation of this study is that the sample size for children was fairly small (31 children).

10.6.8 *Polissar et al., 2006 - A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region– Consumption Rates for Fish-consumers Only*

Using fish consumption data from the Toy et al. (1996) survey of the Tulalip and Squaxin Island tribes of Puget Sound, Polissar et al. (2006) calculated consumption rates for various fish species groups, considering only the consumers of fish within each group. Weight-adjusted consumption rates were calculated by tribe, age, gender, and species groups. Species groups (anadromous, bottom, pelagic, and shellfish) were defined by life history and distribution in the water column. Data were available for 69 children, birth to <6 years of age; 18 of these children had no reported fish consumption and were excluded from the analysis. Thus, estimated fish consumption rates are based on data for 51 children; 15 from the Tulalip tribe and 36 from the Squaxin Island tribe. Both median and mean fish consumption rates for adults and children within each tribe were calculated in terms of grams per kilogram of body weight per day (g/kg-day). Anadromous fish and shellfish were the groups of fish most frequently consumed by both tribes and genders. Consumption per body weight varied by gender (males consumed more) and age (35-64 years consumed more than those younger and older). The consumption rates for groups of fish differed between the tribes. The distribution of consumption rates was skewed toward large values. In the Tulalip Tribes, the estimated adult mean consumption rate for all forms of fish combined was 1.0 g/kg-day, and in the Squaxin Island tribe, the estimated mean rate was also 1.0 g/kg-day (Table 10-94). Table 10-95 presents consumption rates for adults by species and gender. Tables 10-96 and 10-97 show consumption rates for adults by species and age for the Squaxin Island and Tulalip tribes, respectively. The mean consumption rate for the Tulalip children was 0.45 g/kg-day and 2.9 g/kg-/day for the Squaxin Island children (Table 10-98). Table 10-99 presents consumption rates for children by species and gender.

Because this study used the data originally generated by Toy et al. (1996) the advantages and limitations associated with the Toy et al. (1996) study, as described in Section 10.6.6, also apply to this study. However, an advantage of this study is that the consumption rates are based only on individuals who consumed fish within the selected categories.

10.7 OTHER POPULATION STUDIES

10.7.1 *U.S. EPA, 1999 - Asian & Pacific Islander seafood consumption study in King County, WA*

This study was conducted to obtain seafood consumption rates, species, and seafood parts consumed, and cooking methods used for the Asian and Pacific Islander (API) community. Participants were seafood consumers who were first or second generation members of the API ethnic group, 18 years of age or older, and lived in King County, Washington. API's represent one of the most diverse and rapidly growing immigrant populations in the United States. In 1997 API's (166,000) accounted for 10 percent of King County's population, an increase from 8 percent in 1990. Between 1990 and 1997, the total population of King Country increased by 9 percent while the population of API's increased by 43 percent (State of Washington Population Trends, 1998).

This study was conducted in three phases. Phase I focused on identifying target ethnic groups and developing appropriate questionnaires in the language required for each ethnic group. Phase II focused on characterizing seafood consumption patterns for 10 API ethnic groups (Cambodian, Chinese, Filipino, Hmong, Japanese, Korean, Laotian, Mien, Samoan, and Vietnamese) within the study area. Phase III focused on developing culturally appropriate health messages on risks related to seafood consumption and disseminating this information for the API community. The majority of the 202 respondents (89 percent) were first generation (i.e., born outside the U.S.). There were slightly more women (53 percent) than men (47 percent) and 35 percent lived under the 1997 Federal Poverty Level (FPL).

In general, it was found that API members consumed seafood at a very high rate. As shown in Table 10-100, the mean overall consumption rate for all seafood combined was 1.9 grams/per kilogram body weight/day (g/kg/day), with a median consumption rate of 1.4 g/kg/day. The predominant seafood consumed was shellfish (46 percent of all seafood). The API community consumed more shellfish (average consumption rate of 0.87 g/kg/day) than all finfish combined (an average rate of 0.82 g/kg/day). Within the category of finfish, pelagic fish were consumed most by the API members, mean of 0.38 g/kg/day (median 0.22 g/kg/day), followed by anadromous fish with a mean consumption rate of 0.20 g/kg/day (median 0.09 g/kg/day). The mean consumption for freshwater fish was 0.11 g/kg/day (median 0.04 g/kg/day), and bottom fish was 0.13 g/kg/day (median 0.05 g/kg/day). Individuals in the lowest income level (under the FPL) consumed more seafood than those in higher income levels (1-2, 2-3, and >3 times the FPL), but the difference was not statistically significant.

In an effort to capture the participants consuming large quantities of seafood, the survey participants were classified as higher (n=44) or lower (n=158) consumers of shellfish or finfish based on their consumption rates being ≥75th (higher) or ≤75th (lower) percentile. Table 10-101 shows that people in the >55 years old category had the greatest percentage for high consumers of finfish; they had approximately the same percentage as other age groups for shellfish. The Japanese had a greater percentage (52 percent) for higher finfish consumers and Vietnamese (50 percent) were in the higher shellfish consumer category.

Table 10-102 presents seafood consumption rates by ethnicity. In general, members of the Vietnamese and Japanese communities had the highest overall consumption rate, averaging 2.6 g/kg/day (median 2.4 g/kg/day) and 2.2 g/kg/day (median 1.8 g/kg/day), respectively.

Table 10-103 presents consumption rates by gender. The mean consumption rate for all seafood for women was 1.8 g/kg/day (median 1.4 g/kg/day) and 1.7 g/kg/day (median 1.3 g/kg/day) for men.

Salmon and tuna were the most frequently consumed finfish. More than 75 percent of the respondents consumed shrimp, crab, and squid. These data are presented in Table 10-104. For all survey participants, the head, bones, eggs, and other organs were consumed 20 percent of the time. Fillet without skin was consumed 45 percent of the time and fillet with skin, 55 percent of the time. Consumption patterns of shellfish parts varied depending on the type of shellfish (See Appendix 10B).

Preparation methods were also surveyed in the API community. The survey covered two categories of preparation methods: (1) baked, broiled, roasted, or poached and (2) canned, fried, raw, smoked, or dried. The respondents most frequently prepared their finfish and shellfish using the bake, boiled, broiled, roasted, or poached method, averaging 65 percent and 78 percent, respectively, for these preparation methods (See Appendix 10B).

The benefit of this research is that it can be used to improve API specific risk assessments. API community members consume greater amounts of seafood than the general population and these consumption patterns may pose a health risk if the consumed seafood is contaminated with toxic chemicals. Because the survey was based on recall, the authors selected 20 respondents for a follow-up re-interview. Its purpose was to assess the reliability of the responses. The results of the re-interview suggest that, based on the difference in means between the original and re-interview responses, the estimated consumption rates form this study are reliable.

One limitation associated with this study is that it is based on a relatively small number of respondents within each ethnic group. Therefore, extrapolation of data to other ethnic groups should be used with caution. Further study of the consumption patterns and preparation methods for the Hmong, Laotian, Mien, and Vietnamese communities is also needed because of potential health risks from contaminated seafood.

10.8 SERVING SIZE STUDIES

10.8.1 Pao *et al., 1982 - Foods Commonly Eaten in the United States: Amount Per Day and Per Eating Occasion*

Pao et al. (1982) used the 1977-78 NFCS to examine the quantity of fish consumed per eating occasion. For each individual consuming fish in the 3 day survey period, the quantity of fish consumed per eating occasion was derived by dividing the total reported fish intake over the 3 day period by the number of occasions the individual reported eating fish. The distributions, by age and sex, for the quantity of fish consumed per eating occasion are displayed in Table 10-105 (Pao et al., 1982). For the general population, the average quantity of fish consumed per fish meal was 117 g, with a 95th percentile of 284 g. Males in the age groups 19-34, 35-64 and 65-74 years had the highest average and 95th percentile quantities among the age-sex groups presented. It should be noted that the serving size data from this analysis has been superceded by the analysis of the 1994-96 USDA CSFII data conducted by Smiciklas-Wright et al. (2002).

10.8.2 *Smiciklas-Wright et al., 2002 - Foods Commonly Eaten in the United States: Quantities Consumed per Eating Occasion and in a Day,1994-1996*

Using data gathered in the 1994-96 USDA CSFII, Smiciklas-Wright et al. (2002) calculated distributions for the quantities of canned tuna and other finfish consumed per eating occasion by members of the U.S. population (i.e., serving sizes), over a 2-day period. The estimates of serving size are based on data obtained from 14,262 respondents, ages 2 years and above, who provided 2 days of dietary intake information. Only dietary intake data from users of the specified food were used in the analysis (i.e., consumers only data).

Table 10-106 and Table 10-107 present serving size data for canned tuna and other finfish, respectively. These data are presented on an as-consumed basis (grams), and represent the quantity of fish consumed per eating occasion. These estimates may be useful for assessing acute exposures to contaminants in specific foods, or other assessments where the amount consumed per eating occasion is necessary.

The advantages of using these data are that they were derived from the USDA CSFII and are representative of the U.S. population. The analysis conducted by Smiciklas-Wright et al. (2002) accounted for individual foods consumed as ingredients of mixed foods. Mixed foods were disaggregated via recipe files so that the individual ingredients could be grouped together with similar foods that were reported separately. Thus, weights of foods consumed as ingredients were combined with weights of foods reported separately to provide a more thorough representation of consumption. However, it should be noted that since the recipes for the mixed foods consumed by respondents were not provided by the respondents, standard recipes were used. As a result, the estimates of the quantity of some food types are based on assumptions about the types and quantities of ingredients consumed as part of mixed foods.

10.9 OTHER FACTORS TO CONSIDER FOR FISH CONSUMPTION

Other factors to consider when using the available survey data include location, climate, season, and ethnicity of the angler or consumer population, as well as the parts of fish consumed and the methods of preparation. Some contaminants (for example, persistent, bioaccumulative, and toxic contaminants such as dioxins and polychlorinated biphenyls) have the affinity to accumulate more in certain tissues, such as the fatty tissue, as well as in certain internal organs. The effects of cooking methods for various food products on the levels of dioxin-like compounds have been addressed by evaluating a number of studies in U.S. EPA (2003). These studies showed various results for contamination losses based on the methodology of the study and the method of food preparation. The reader is referred to U.S. EPA (2003) for a detailed review of these studies.

In addition, some studies suggest that there is a significant decrease of contaminants in cooked fish when compared with raw fish (San Diego County, 1990). Several studies cited in this section have addressed fish preparation methods and parts of fish consumed. Table 10-108 provides summary results from these studies on fish preparation methods; further details on preparation methods, as well as results from some studies on parts of fish consumed, are presented in Appendix 10B.

Users of the data presented in this chapter should ensure that consistent units are used for intake rate and concentration of contaminants in fish. The following sections provide information on converting between wet weight and dry weight, and between wet weight and lipid weight.

10.9.1 Conversion Between Wet and Dry Weight

The intake data presented in this chapter is reported in units of wet weight (i.e., as-consumed or uncooked weight of fish consumed per day or per eating occasion). However, data on the concentration of contaminants in fish may be reported in units of either wet or dry weight (e.g., mg contaminant per gram-dry-weight of fish). It is essential that exposure assessors be aware of this difference so that they may ensure consistency between the units used for intake rates and those used for concentration data (i.e., if the contaminant concentration is measured in dry weight of fish, then the dry weight units should be used for fish intake values).

If necessary, wet weight (e.g., as-consumed) intake rates may be converted to dry weight intake rates using the moisture content percentages presented in Table 10-109 and the following equation:

$$IR_{dw} = IR_{ww}\left[\frac{100-W}{100}\right] \qquad \text{(Eqn. 10-4)}$$

where:

IR_{dw} = dry weight intake rate;
IR_{ww} = wet weight intake rate; and
W = percent water content.

Alternately, dry weight residue levels in fish may be converted to wet weight residue levels for use with wet weight (e.g., as-consumed) intake rates, as follows:

$$C_{ww} = C_{dw}\left[\frac{100-W}{100}\right] \qquad \text{(Eqn. 10-5)}$$

where:

C_{ww} = wet weight intake rate;
C_{dw} = dry weight intake rate; and
W = percent water content.

The moisture content data presented in Table 10-110are for selected fish taken from USDA, 2007. The moisture content is based on the percent of water present.

10.9.2 Conversion Between Wet Weight and Lipid Weight Intake Rates

The total fat content (percent) measured and/or calculated in various fish forms (i.e., raw, cooked, smoked, etc.) for selected fish species are presented in Table 10-109, based on data from USDA (2007). The total percent fat content is based on the sum of saturated, monounsaturated, and polyunsaturated fat. The moisture content is based on the percent of water present.

In some cases, the residue levels of contaminants in fish are reported as the concentration of contaminant per gram of fat. This may be particularly true for lipophilic compounds. When using these residue levels, the assessor should ensure consistency in the exposure assessment calculations by using consumption rates that are based on the amount of fat consumed for the fish product of interest.

If necessary, wet weight (e.g., as-consumed) intake rates may be converted to lipid weight intake rates using the fat content percentages presented in Table 10-109 and the following equation:

$$IR_{lw} = IR_{ww}\left[\frac{L}{100}\right] \qquad \text{(Eqn. 10-6)}$$

where:

IR_{lw} = lipid weight intake rate;
IR_{ww} = wet weight intake rate; and
L = percent lipid (fat) content.

Alternately, wet weight residue levels in fish may be estimated by multiplying the levels based on fat by the fraction of fat per product as follows:

$$C_{ww} = C_{lw}\left[\frac{L}{100}\right] \qquad \text{(Eqn. 10-7)}$$

where:

C_{ww} = wet weight intake rate;
C_{lw} = lipid weight intake rate; and
L = percent lipid (fat) content.

The resulting residue levels may then be used in conjunction with wet weight (e.g., as-consumed) consumption rates. The total fat content data presented in Table 10-109 are for selected fish taken from USDA, 2007.

10.10 REFERENCES FOR CHAPTER 10

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Table 10-7. Per Capita Distribution of Fish Intake (g/day) by Habitat and Fish Type for the U.S. Population (As Prepared)

Habitat	Statistic	Estimate (90% Interval) Finfish	Shellfish
Fresh/Estuarine	Mean	2.6 (2.3 – 2.8)	2.0 (1.8 - 2.3)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)
	90th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.2)
	95th%	6.7 (5.3 – 9.3)	9.6 (7.9 – 10.6)
	99th%	67.2 (63.5 - 75.5)	59.3 (51.5 – 64.0)
Marine	Mean	6.6 (6.1 – 7.0)	1.7 (1.3 – 2.0)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)
	90th%	26.3 (24.3 – 27.4)	0.0 (0.0 - 0.0)
	95th%	46.1 (43.1 – 47.5)	0.0 (0.0 – 0.0)
	99th%	94.7 (89.8 – 100.4)	67.9 (51.6 – 84.5)
All Fish	Mean	9.1 (8.6 – 9.7)	3.7 (3.2 – 4.2)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)
	90th%	34.8 (31.4 – 36.6)	0.0 (0.0 – 0.0)
	95th%	59.8 (57.5 – 61.6)	22.6 (17.2 – 26.3)
	99th%	126.3 (120.6 – 130.1)	90.6 (82.9 – 95.7)

Note: Percentile confidence intervals estimated using the bootstrap method with 1,000 replications. Estimates are projected from a sample of 20,607 individuals to the U.S. population of 261,897,236 using 4-year combined survey weights.

Source: U.S. EPA, 2002.

Table 10-8. Daily Average Per Capita Estimates of Fish Consumption U.S. Population - Mean Consumption by Species Within Habitat - As Prepared Fish

Habitat	Species	Estimated Mean Grams/Person/Day	Habitat	Species	Estimated Mean Grams/Person/Day	Habitat	Species	Estimated Mean Grams/Person/Day
Estuarine	Shrimp	1.63012	Marine (Cont)	Lobster	0.15725	All Species	Perch (Freshwater)	0.12882
	Flounder	0.45769		Scallop (Marine)	0.14813	(Cont)	Squid	0.12121
	Catfish (Estuarine)	0.34065		Squid	0.12121		Oyster	0.11615
	Flatfish (Estuarine)	0.27860		Ocean Perch	0.11135		Ocean Perch	0.11135
	Crab (Estuarine)	0.17971		Sea Bass	0.09766		Sea Bass	0.09766
	Perch (Estuarine)	0.12882		Mackerel	0.08780		Carp	0.09584
	Oyster	0.11615		Swordfish	0.07790		Herring	0.09409
	Herring	0.09409		Sardine	0.07642		Croaker	0.08798
	Croaker	0.08798		Pompano	0.07134		Mackerel	0.08780
	Trout, mixes sp.	0.08582		Flatfish (Marine)	0.05216		Trout (Estuarine)	0.08582
	Salmon (Estuarine)	0.05059		Mussels	0.05177		Trout (Freshwater)	0.08582
	Rockfish	0.03437		Octopus	0.04978		Swordfish	0.07790
	Anchovy	0.02976		Halibut	0.02649		Sardine	0.07642
	Clam (Estuarine)	0.02692		Snapper	0.02405		Pompano	0.07134
	Mullet	0.02483		Whitefish (Marine)	0.00988		Flatfish (Marine)	0.05216
	Smelts (Estuarine)	0.00415		Smelts (Marine)	0.00415		Mussels	0.05177
	Eel	0.00255		Shark	0.00335		Salmon (Estuarine)	0.05059
	Scallop (Estuarine)	0.00100		Snails (Marine)	0.00198		Octopus	0.04978
	Smelts, Rainbow	0.00037		Conch	0.00155		Rockfish	0.03437
	Sturgeon (Estuarine)	0.00013		Roe	0.00081		Anchovy	0.02976
			Unknown				Pike	0.02958
Freshwater	Catfish (Freshwater)	0.34065		Fish	0.23047		Clam (Estuarine)	0.02692
	Trout	0.15832		Seafood	0.00203		Halibut	0.02649
	Perch (Freshwater)	0.12882	All Species				Mullet	0.02483
	Carp	0.09584		Tuna	2.62988		Snapper	0.02405
	Trout, mixed sp.	0.08582		Shrimp	1.63012		Whitefish (Freshwater)	0.00988
	Pike	0.02958		Cod	1.12504		Whitefish (Marine)	0.00988
	Whitefish (Freshwater)	0.00988		Salmon (Marine)	1.01842		Crayfish	0.00575
	Crayfish	0.00575		Clam (Marine)	1.00458		Smelts (Estuarine)	0.00415
	Snails (Freshwater)	0.00198		Flounder	0.45769		Smelts (Marine)	0.00415
	Cisco	0.00160		Catfish (Estuarine)	0.34065		Shark	0.00335
	Salmon (Freshwater)	0.00053		Catfish (Freshwater)	0.34065		Eel	0.00255
	Smelts, Rainbow	0.00037		Flatfish (Estuarine)	0.27860		Seafood	0.00203
	Sturgeon (Freshwater)	0.00013		Pollock	0.27685		Snails (Freshwater)	0.00198
				Porgy	0.27346		Snails (Marine)	0.00198
Marine	Tuna	2.62988		Haddock	0.25358		Cisco	0.00160
	Cod	1.12504		Fish	0.23047		Conch	0.00155
	Salmon (Marine)	1.01842		Crab (Marine)	0.20404		Scallop (Estuarine)	0.00100
	Clam (Marine)	1.00458		Whiting	0.20120		Roe	0.00081
	Pollock	0.27685		Crab (Estuarine)	0.17971		Salmon (Freshwater)	0.00053
	Porgy	0.27346		Trout	0.15832		Smelts, Rainbow (Est.)	0.00037
	Haddock	0.25358		Lobster	0.15725		Smelts, Rainbow	0.00037
	Crab (Marine)	0.20404		Scallop (Marine)	0.14813		Sturgeon (Estuarine)	0.00013
	Whiting	0.20120		Perch (Estuarine)	0.12882		Sturgeon (Freshwater)	0.00013

Notes: Estimates are projected from a sample of 20,607 individuals to the U.S. population of 261,897,236 using 4-year combined survey weights.
Source of individual consumption data: USDA Combined 1994-1996,1998 Continuing Survey of Food Intakes by Individuals (CSFII).
The fish component of foods containing fish was calculated using data from the recipe file of the USDA's Nutrient Data Base for Individual Food Intake Surveys.

Source: U.S. EPA, 2002.

Table 10-9. Per Capita Distribution of Fish Intake (g/day) by Habitat and Fish Type for the U.S. Population (Uncooked Fish Weight)

		Estimate (90% Interval)	
Habitat	Statistic	Finfish	Shellfish
Fresh/Estuarine	Mean	3.6 (3.2 - 4.0)	2.7 (2.4 – 3.1)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)
	90th%	0.0 (0.00 - 0.7)	0.0 (0.0 - 0.0)
	95th%	14.1 (10.0 – 16.8)	12.8 (10.5 - 13.8)
	99th%	95.3 (80.7 – 100.8)	77.0 (69.7 – 84.1)
Marine	Mean	9.0 (8.4 – 9.6)	1.6 (1.2 – 2.0)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)
	90th%	37.5 (35.7 – 37.6)	0.0 (0.0 - 0.0)
	95th%	62.9 (61.3 – 65.5)	0.0 (0.0 – 0.0)
	99th%	128.4 (119.3 – 135.8)	54.8 (33.1 – 80.6)
All Fish	Mean	12.6 (11.9 – 13.3)	4.3 (3.7 - 4.9)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)
	90th%	48.7 (45.3 – 50.4)	0.0 (0.0 – 0.0)
	95th%	81.8 (79.5 – 85.0)	23.2 (18.3 – 28.3)
	99th%	173.6 (168.0 – 183.4)	110.5 (93.1 – 112.9)

Note: Percentile confidence intervals estimated using the bootstrap method with 1,000 replications. Estimates are projected from a sample of 20,607 individuals to the U.S. population of 261,897,236 using 4-year combined survey weights.

Source: U.S. EPA, 2002.

Table 10-10. Daily Average Per Capita Estimates of Fish Consumption U.S. Population - Mean Consumption by Species Within Habitat - Uncooked Fish

Habitat	Species	Estimated Mean Grams/Person/Day	Habitat	Species	Estimated Mean Grams/Person/Day	Habitat	Species	Estimated Mean Grams/Person/Day
Estuarine	Shrimp	2.20926	Marine (Cont)	Lobster	0.21290	All Species	Perch (Freshwater)	0.18148
	Flounder	0.58273		Scallop (Marine)	0.18951	(Cont)	Squid	0.15438
	Catfish (Estuarine)	0.48928		Squid	0.15438		Ocean Perch	0.14074
	Flatfish (Estuarine)	0.33365		Ocean Perch	0.14074		Oyster	0.13963
	Crab (Estuarine)	0.25382		Sea Bass	0.12907		Croaker	0.13730
	Perch (Estuarine)	0.18148		Mackerel	0.11468		Carp	0.13406
	Oyster	0.13963		Sardine	0.10565		Herring	0.13298
	Croaker	0.13730		Swordfish	0.10193		Sea Bass	0.12907
	Herring	0.13298		Pompano	0.09905		Trout (Estuarine)	0.11908
	Trout, mixes sp.	0.11908		Mussels	0.07432		Trout (Freshwater)	0.11908
	Salmon (Estuarine)	0.06898		Octopus	0.06430		Mackerel	0.11468
	Rockfish	0.04448		Flatfish (Marine)	0.06247		Sardine	0.10565
	Anchovy	0.04334		Halibut	0.03226		Swordfish	0.10193
	Mullet	0.03617		Snapper	0.02739		Pompano	0.09905
	Clam (Estuarine)	0.01799		Whitefish (Marine)	0.00995		Mussels	0.07432
	Smelts (Estuarine)	0.00611		Smelts (Marine)	0.00611		Salmon (Estuarine)	0.06898
	Eel	0.00324		Shark	0.00424		Octopus	0.06430
	Scallop (Estuarine)	0.00128		Snails (Marine)	0.00249		Flatfish (Marine)	0.06247
	Smelts, Rainbow	0.00052		Conch	0.00207		Rockfish	0.04448
	Sturgeon (Estuarine)	0.00013		Roe	0.00102		Anchovy	0.04334
			Unknown				Mullet	0.03617
Freshwater	Catfish (Freshwater)	0.48928		Fish	0.60608		Pike	0.03260
	Trout	0.19917		Seafood	0.00326		Halibut	0.03226
	Perch (Freshwater)	0.18148	All Species				Snapper	0.02739
	Carp	0.13406		Tuna	3.61778		Clam (Estuarine)	0.01799
	Trout, mixed sp.	0.11908		Shrimp	2.20926		Whitefish (Freshwater)	0.00995
	Pike	0.03260		Cod	1.47734		Whitefish (Marine)	0.00995
	Whitefish (Freshwater)	0.00995		Salmon (Marine)	1.38873		Crayfish	0.00746
	Crayfish	0.00746		Clam (Marine)	0.67135		Smelts (Estuarine)	0.00611
	Snails (Freshwater)	0.00249		Flounder	0.60608		Smelts (Marine)	0.00611
	Cisco	0.00234		Catfish (Estuarine)	0.58273		Shark	0.00424
	Salmon (Freshwater)	0.00073		Catfish (Freshwater)	0.48928		Seafood	0.00326
	Smelts, Rainbow	0.00052		Porgy	0.48928		Eel	0.00324
	Sturgeon (Freshwater)	0.00013		Flatfish (Estuarine)	0.40148		Snails (Freshwater)	0.00249
				Pollock	0.33365		Snails (Marine)	0.00249
Marine	Tuna	3.61778		Haddock	0.32878		Cisco	0.00234
	Cod	1.47734		Fish	0.32461		Conch	0.00207
	Salmon (Marine)	1.38873		Crab (Marine)	0.28818		Scallop (Estuarine)	0.00128
	Clam (Marine)	0.67135		Whiting	0.25725		Roe	0.00102
	Porgy	0.40148		Crab (Estuarine)	0.25382		Salmon (Freshwater)	0.00073
	Pollock	0.32878		Trout	0.21290		Smelts, Rainbow (Est.)	0.00052
	Haddock	0.32461		Lobster	0.19917		Smelts, Rainbow	0.00052
	Crab (Marine)	0.28818		Scallop (Marine)	0.18951		Sturgeon (Estuarine)	0.00013
	Whiting	0.25725		Perch (Estuarine)	0.18148		Sturgeon (Freshwater)	0.00013

Notes: Estimates are projected from a sample of 20,607 individuals to the U.S. population of 261,897,236 using 4-year combined survey weights.
Source of individual consumption data: USDA Combined 1994-1996,1998 Continuing Survey of Food Intakes by Individuals (CSFII).
Amount of consumed fish recorded by survey respondents was converted to uncooked fish quantities using data from the recipe file of USDA's Nutrient Data Base for Individual Food Intake Surveys. The fish component of foods containing fish was calculated using data from the recipe file of the USDA's Nutrient Data Base for Individual Food Intake Surveys.
Source: U.S. EPA, 2002.

Table 10-11. Per Capita Distributions of Fish (Finfish and Shellfish) Intake (g/day) - As Prepared[a]					
Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
Freshwater and Estuarine					
Females					
14 and under	5,182	1.6 (1.2-1.9)	0.0 (0.0-0.5)	5.8 (4.4-10.2)	40.0 (33.7-52.0)
15 to 44	2,332	4.3 (3.4-5.1)	5.1 (2.8-7.9)	23.9 (21.8-28.6)	82.9 (75.2-111.2)
45 and older	2,654	4.8 (4.0-5.6)	11.8 (5.7-16.8)	32.7 (26.7-40.1)	79.4 (74.2-87.0)
All ages	10,168	3.9 (3.3-4.4)	4.9 (2.6-6.3)	23.8 (22.1-27.5)	77.1 (74.3-85.2)
Males					
14 and under	5,277	2.1 (1.6-2.6)	0.0 (0.0-0.6)	6.6 (4.4-10.4)	60.8 (42.7-74.2)
15 to 44	2,382	5.7 (4.8-6.6)	10.4 (9.2-12.4)	38.6 (33.7-49.0)	112.7 (91.5-125.1)
45 and older	2,780	7.4 (6.3-8.5)	23.6 (19.7-28.1)	56.6 (52.3-57.2)	112.3 (107.5-130.1)
All ages	10,439	5.3 (4.7-6.0)	9.3 (7.1-10.9)	37.1 (32.1-40.3)	107.1 (97.1-125.1)
Both Sexes					
3 to 5	4,391	1.5 (1.2-1.8)	0.1 (0.00-1.0)	5.1 (4.1-6.2)	38.7 (32.9-43.6)
6 to 10	1,670	2.1 (1.4-2.9)	0.0 (0.0-0.6)	5.9 (3.2-12.7)	60.9* (51.0-86.0)
11 to 15	1,005	3.0 (2.2-3.8)	1.4 (0.5-5.5)	18.2 (14.8-21.1)	69.5* (56.0-75.1)
16 to 17	363	3.4 (1.6-5.3)	0.0 (0.0-1.5)	31.1* (5.2-29.2)	81.2* (42.0-117.0)
18 and older	9,596	5.5 (4.9-6.0)	11.7 (9.9-14.7)	38.0 (34.7-43.0)	105.1 (91.5-113.5)
14 and under	10,459	1.8 (1.5-2.1)	0.0 (0.0-0.0)	6.0 (5.5-9.5)	51.7 (39.4-61.2)
15 to 44	4,714	5.0 (4.4-5.6)	8.6 (5.3-10.4)	31.7 (28.6-36.8)	98.9 (85.5-125.1)
45 and older	5,434	6.0 (5.2-6.7)	17.4 (13.9-22.1)	42.7 (37.1-52.8)	104.2 (91.0-112.0)
All ages	20,607	4.6 (4.2-5.0)	6.6 (5.3-8.5)	29.7 (28.1-31.6)	91.0 (82.6-100.1)
Marine					
Females					
14 and under	5,182	3.6 (3.0-4.2)	10.8 (8.1-13.5)	28.1 (24.3-31.0)	61.3 (51.2-70.5)
15 to 44	2,332	7.0 (6.1-7.9)	27.9 (24.3-28.2)	48.1 (42.6-53.7)	97.0 (86.6-137.6)
45 and older	2,654	10.9 (9.6-12.1)	42.0 (38.4-42.5)	63.3 (57.8-66.3)	128.5 (120.5-138.3)
All ages	10,168	7.6 (6.9-8.3)	28.1 (27.9-29.2)	49.6 (46.6-52.4)	106.6 (95.2-119.2)
Males					
14 and under	5,277	4.3 (3.6-5.1)	11.8 (8.4-14.0)	29.1 (26.7-31.4)	84.4 (77.0-113.3)
15 to 44	2,382	9.4 (8.2-10.6)	36.6 (28.0-43.1)	72.8 (58.8-82.8)	127.4 (116.3-153.6)
45 and older	2,780	11.9 (10.5-13.2)	47.1 (42.2-54.5)	71.4 (64.4-81.3)	140.1 (114.9-149.6)
All ages	10,439	8.9 (8.1-9.8)	34.2 (28.2-38.5)	63.3 (59.0-73.2)	122.8 (109.4-139.6)
Both Sexes					
3 to 5	4,391	3.7 (3.2-4.3)	11.1 (10.4-12.6)	27.9 (24.4-29.1)	59.8 (52.4-71.3)
6 to 10	1,670	4.2 (3.5-4.9)	13.1 (9.7-17.0)	28.7 (27.6-33.8)	78.6* (49.2-84.4)
11 to 15	1,005	5.5 (4.2-6.7)	13.9 (9.8-20.6)	38.5 (30.8-50.3)	102.3* (84.4-113.6)
16 to 17	363	4.7 (2.9-6.4)	0.0 (0.0-6.9)	24.2* (7.8-71.5)	107.8* (68.4-118.9)
18 and older	9,596	9.8 (9.0-10.6)	38.6 (36.6-41.5)	63.8 (58.8-68.8)	126.3 (117.3-140.1)
14 and under	10,459	4.0 (3.5-4.5)	10.8 (10.1-13.5)	28.2 (27.9-29.8)	79.0 (63.0-98.8)
15 to 44	4,714	8.2 (7.4-9.1)	28.2 (27.9-34.3)	56.6 (54.5-68.9)	115.7 (98.5-143.8)
45 and older	5,434	11.3 (10.3-12.3)	42.7 (42.0-45.7)	65.1 (63.9-68.0)	136.9 (125.6-140.3)
All ages	20,607	8.3 (7.6-8.9)	29.2 (28.2-32.1)	55.8 (54.7-56.9)	114.6 (108.9-120.8)

Table 10-11. Per Capita Distributions of Fish (Finfish and Shellfish) Intake (g/day) - As Prepared[a] (continued)					
Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
		All Fish			
Females					
14 and under	5,182	5.2 (4.4-5.9)	18.9 (15.3-21.1)	37.5 (30.0-41.7)	80.2 (72.6-83.0)
15 to 44	2,332	11.3 (10.0-12.7)	41.2 (36.6-46.2)	66.3 (61.0-73.0)	143.4 (128.0-148.4)
45 and older	2,654	15.6 (14.0-17.3)	56.2 (52.7-60.6)	82.9 (75.6-88.0)	158.9 (141.6-170.6)
All ages	10,168	11.4 (10.5-12.4)	42.2 (39.0-45.7)	66.8 (63.2-71.4)	140.8 (128.5-148.4)
Males					
14 and under	5,277	6.4 (5.5-7.3)	21.1 (15.7-24.9)	42.2 (34.0-52.5)	114.3 (98.4-130.6)
15 to 44	2,382	15.1 (13.6-16.6)	58.4 (51.0-70.3)	89.1 (85.6-97.5)	177.2 (163.0-185.3)
45 and older	2,780	19.2 (17.6-20.9)	67.7 (65.0-72.2)	98.6 (92.7-105.1)	167.5 (157.0-193.3)
All ages	10,439	14.3 (13.4-15.2)	55.9 (51.0-59.4)	86.1 (84.3-89.7)	162.6 (155.8-178.7)
Both Sexes					
3 to 5	4,391	5.2 (4.6-5.8)	18.9 (15.3-21.3)	35.3 (31.1-39.5)	72.2 (66.7-81.4)
6 to 10	1,670	6.3 (5.3-7.3)	23.9 (21.1-27.0)	39.6 (34.3-51.5)	107.8* (91.6-130.6)
11 to 15	1,005	8.5 (6.9-10.0)	28.1 (24.9-31.4)	60.3 (53.4-74.2)	122.2* (106.8-131.9)
16 to 17	363	8.1 (5.4-10.8)	18.6 (7.0-40.9)	73.8* (29.2-89.8)	142.3* (107.9-200.4)
18 and older	9,596	15.3 (14.3-16.2)	56.2 (55.4-58.3)	86.1 (84.3-87.5)	162.6 (155.8-171.0)
14 and under	10,459	5.8 (5.2-6.5)	19.4 (17.2-21.2)	38.2 (36.6-42.1)	96.5 (83.0-114.3)
15 to 44	4,714	13.2 (12.2-14.2)	50.0 (45.3-56.2)	82.9 (76.2-86.1)	162.6 (147.2-176.2)
45 and older	5,434	17.3 (16.0-18.6)	61.1 (56.6-64.2)	90.5 (86.5-93.2)	162.7 (158.4-170.6)
All ages	20,607	12.8 (12.1-13.6)	48.2 (46.2-49.9)	79.0 (74.6-83.3)	153.2 (145.9-160.9)

[a] Estimates were projected from sample size to the U.S. population using 4-year combined survey weights.
N = Sample size.
CI = Confidence interval.
BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
* The sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States" (LSRO, 1995).

Note: Source: U.S. EPA, 2002.

Table 10-12. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) - As Prepared[a]

Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
Freshwater and Estuarine					
Females					
14 and under	4,879	56 (46-66)	0.0 (0.0-3.4)	208 (162-268)	1,516 (1,305-1,801)
15 to 44	2,275	67 (53-81)	75 (40-107)	380 (306-435)	1,329 (1,238-2,021)
45 and older	2,569	72 (58-85)	184 (75-247)	491 (369.3-606.2)	1,339 (1,133-1,462)
All ages	9,723	66 (58-75)	80 (44-104)	398 (364-435)	1,352 (1,222-1,528)
Males					
14 and under	4,994	65 (52-78)	0.0 (0.0-17)	279 (179-384)	1,767 (1,470-1,888)
15 to 44	2,369	72 (60-83)	131 (101-170)	481 (425-574)	1,350 (1,228-1,729)
45 and older	2,764	88 (75-101)	272 (212-321)	666 (540-712)	1,378 (1,260-1,508)
All ages	10,127	75 (67-84)	131 (107-181)	504 (455-560)	1,470 (1,378-1,568)
Both Sexes					
3 to 5	4,112	82.9 (67-99)	0.0 (0.0-56)	284 (240-353)	2,317 (1,736-2,463)
6 to 10	1,553	59.3 (39-79)	0.0 (0.0-5.3)	178 (88-402)	1,662* (1,433-2,335)
11 to 15	975	53.3 (42-64)	0.0 (0.0-78)	312 (253-390)	1,237* (950-1,521)
16 to 17	360	49.5 (23-76)	0.0 (0.0-33)	213* (106-390)	1,186* (600-2,096)
18 and older	9,432	74 (67-82)	158 (125-198)	502 (452-567)	1,353 (1,238-1,511)
14 and under	9,873	61 (52-70)	0.0 (0.0-0.0)	230 (187-283)	1,689 (1,470-1,805)
15 to 44	4,644	69 (61-78)	104 (72-139)	431 (390-476)	1,335 (1,238-1,684)
45 and older	5,333	79 (69-90)	236 (188-284)	557 (493.7-666)	1,351 (1,260-1,462)
All ages	19,850	71 (65-77)	106 (87-128)	451 (424-484)	1,432 (1,325-1,521)
Marine					
Females					
14 and under	4,879	147 (125-168)	381 (324-506)	1,028 (908-1,149)	2,819 (2,481-2,908)
15 to 44	2,275	114 (98-129)	423 (365-485)	768 (650-881)	1,648 (1,428-2,177)
45 and older	2,569	166 (147-185)	620 (567-658)	950 (900-1,042)	2,022 (1,899-2,683)
All ages	9,723	139 (127-150)	501 (465-534)	892 (847-923)	2,151 (1,858-2,484)
Males					
14 and under	4,994	154 (132-176)	426 (357-494)	1,081 (975-1,293)	2,678 (2383-3,073)
15 to 44	2,369	118 (104-132)	444 (368-547)	880 (760-954)	1,643 (1454-1,819)
45 and older	2764	149 (133-166)	568 (504-673)	889 (831-990)	1,859 (1725-2,011)
All ages	10,127	136 (125-147)	494 (445-543)	908 (868-954)	1,965 (1817-2,247)
Both Sexes					
3 to 5	4,112	209 (181-237)	614 (525-696)	1,537 (1,340-1,670)	3,447 (3,274-3,716)
6 to 10	1,553	150 (123-177)	416 (326-546)	1,055 (969-1,275)	2,800* (2,021-3,298)
11 to 15	975	109 (84-133)	338 (179-413)	821 (629-1,034)	1,902* (1,537-2,366)
16 to 17	360	75 (46-103)	0.0 (0.0-124)	381* (132-951)	1,785* (1,226-2,342)
18 and older	9,432	137 (126-147)	527 (501-575)	881 (840-945)	1,798 (1,708-1,971)
14 and under	9,873	150 (134-167)	413 (366-476)	1,037(1,002-1,163)	2,692 (2,481-2,823)
15 to 44	4,644	116 (104-128)	440 (389-488)	830 (750-920)	1,651.83 (1,487-1,793)
45 and older	5,333	158 (144-173)	601 (562-642)	921 (882-977)	1,975.67 (1,785-2,118)
All ages	19,850	137 (128-147)	497 (480-517)	903 (869-938)	2,014.52 (1,947-2,158)

Table 10-12. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) - As Prepared[a] (continued)

Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
			All Fish		
Females					
14 and under	4,879	203 (178-227)	693 (929-1408)	1,344 (1,224-1,489)	3,297 (2,823-3680)
15 to 44	2,275	181 (158-204)	641 (641-879)	1,040 (910-1,226)	2,292 (2,096-2494)
45 and older	2,569	238 (212-263)	812 (797-956)	1,265 (1,165-1,353)	2,696 (2,247-2974)
All ages	9,723	205 (188-221)	731 (797-912)	1,211 (1,128-1,256)	2,651 (2,358-2823)
Males					
14 and under	4,994	219 (252-356)	745 (583-881)	1,470 (1,282-1,775)	3,392 (2,893-3,954)
15 to 44	2,369	190 (219-263)	756 (689-851)	1,165 (1,060-1,239)	2,238 (2,045-2,492)
45 and older	2,764	237 (225-277)	849 (812-920)	1,253 (1,183-1,282)	2,310 (2,079-2,438)
All ages	10,127	211 (240-279)	792 (727-884)	1,239 (1,201-1,282)	2,537 (2,324-2,679)
Both Sexes					
3 to 5	4,112	292 (260-326)	1,057 (931-1,232)	1,988 (1,813-2,147)	4,089 (3,733-4,508)
6 to 10	1,553	209 (176-242)	780 (644-842)	1,357 (1,173-1,451)	3,350* (2,725-4,408)
11 to 15	975	162 (133-191)	570 (476-664)	1,051 (991-1,313)	2,305* (1,908-2,767)
16 to 17	360	124 (83-165)	261 (110-600)	1,029* (390-1,239)	2,359* (2,096-2,676)
18 and older	9,432	211 (197-225)	779 (743-816)	1,198 (1,165-1,238)	2,327 (2,198-2,438)
14 and under	9,873	211 (191-231)	713 (652-780)	1,429 (1,344-1,499)	3,354 (3,224-3,458)
15 to 44	4,644	185 (170-200)	714 (645-803)	1,139 (1,014-1,228)	2,290 (2,082-2,476)
45 and older	5,333	238 (219-256)	836 (767-883)	1,261 (1,185-1,314)	2,386 (2,158-2,672)
All ages	19,850	208 (196-220)	762 (737-790)	1,227 (1,198-1,251)	2,539 (2,476-2,679)

[a] Estimates were projected from sample size to the U.S. population using 4-year combined survey weights.
N = Sample size.
CI = Confidence interval.
BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
* The sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States" (LSRO, 1995).

Source: U.S. EPA, 2002.

Table 10-13. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) - Uncooked Fish Weight[a]

Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
			Freshwater and Estuarine		
Females					
14 and under	5,182	2.3 (1.8-2.8)	0.0 (0.0-0.2)	13.1 (9.9-16.4)	58.8 (45.8-86.4)
15 to 44	2,332	5.8 (4.6-6.9)	6.3 (4.7-11.4)	32.4 (27.7-38.0)	109.8 (100.4-154.5)
45 and older	2,654	6.4 (5.3-7.4)	17.7 (8.9-23.6)	44.9 (37.4-55.4)	108.8 (95.4-123.9)
All ages	10,168	5.2 (4.5-5.9)	7.3 (3.8-11.9)	31.9 (28.3-37.4)	102.1(95.5-114.0)
Males					
14 and under	5,277	3.0 (2.3-3.7)	¬ (0.0-0.2)	13.5 (10.2-17.0)	79.0 (55.2-97.9)
15 to 44	2,382	7.9 (6.7-9.1)	15.6 (13.2-19.8)	49.7 (45.7-66.4)	151.2 (126.4-183.4)
45 and older	2,780	10.2 (8.6-11.7)	32.5 (27.3-37.2)	73.5 (66.2-77.1)	165.9 (147.7-190.7)
All ages	10,439	7.4 (6.6-8.3)	14.6 (12.6-17.7)	49.3 (45.6-53.2)	147.8 (132.3-183.4)
Both Sexes					
3 to 5	4,391	2.2 (1.8-2.6)	0.1 (0.0-1.5)	12.2 (10.3-14.1)	52.5 (45.6-61.5)
6 to 10	1,670	3.0 (1.9-4.1)	0.0 (0.0-0.5)	13.1 (4.8-20.1)	78.5* (63.8-110.5)
11 to 15	1,005	4.3 (3.2-5.4)	2.3 (0.1-7.7)	25.8 (21.0-28.9)	94.8* (83.1-109.5)
16 to 17	363	4.6 (2.2-6.9)	0.0 (0.0-1.9)	19.3* (13.3-36.8)	109.2* (57.7-154.5)
18 and older	9,596	7.5 (6.8-8.3)	17.4 (14.3-21.6)	49.6 (46.9-55.4)	143.4 (125.3-156.8)
14 and under	10,459	2.6 (2.2-3.1)	- (0.0-0.0)	13.1 (11.9-14.8)	73.7 (51.5-86.4)
15 to 44	4,714	6.8 (6.0-7.6)	13.0 (8.6-15.6)	43.6 (37.8-47.4)	135.9 (1210-167.0)
45 and older	5,434	8.1 (7.1-9.2)	24.8 (18.8-28.6)	56.5 (48.9-69.7)	144.3 (121.7-156.8)
All ages	20,607	6.3 (5.7-6.9)	11.7 (8.4-13.7)	41.1 (37.9-43.7)	123.9 (114.0-138.8)
			Marine		
Females					
14 and under	5,182	5.2 (4.5-6.0)	18.8 (13.5-21.9)	40.1 (37.9-47.7)	81.3 (67.0-98.4)
15 to 44	2,332	9.0 (7.8-10.1)	37.5 (31.0-37.9)	61.7 (55.8-71.2)	120.6 (116.5-132.5)
45 and older	2,654	13.7 (12.0-15.4)	51.4 (49.0-55.4)	80.4 (76.9-82.6)	155.6 (148.7-179.2)
All ages	10,168	9.8 (8.9-10.6)	37.8 (37.3-40.2)	64.7 (59.2-67.7)	128.5 (119.4-142.9)
Males					
14 and under	5,277	6.0 (4.9-7.0)	17.0 (13.0-21.4)	39.7 (35.9-41.1)	113.3 (106.3-140.3)
15 to 44	2,382	12.0 (10.5-13.5)	41.7 (37.8-56.3)	90.2 (75.7-106.7)	151.5 (134.9-192.5)
45 and older	2,780	15.0 (13.3-16.7)	58.0 (53.5-68.3)	90.7 (85.4-97.3)	168.8 (157.1-186.9)
All ages	10,439	11.5 (10.4-12.5)	41.3 (37.8-49.7)	82.9 (75.7-96.8)	152.3 (136.6-166.9)
Both Sexes					
3 to 5	4,391	5.5 (4.8-6.2)	19.8 (16.6-23.1)	39.4 (37.7-41.4)	82.3 (73.0-95.4)
6 to 10	1,670	5.6 (4.6-6.5)	18.9 (14.2-24.3)	38.4 (37.9-41.6)	99.8* (62.8-111.4)
11 to 15	1,005	7.6 (5.9-9.4)	25.3 (16.4-34.5)	56.5 (45.3-67.1)	131.8* (110.3-148.7)
16 to 17	363	6.1 (3.7-8.4)	0.0 (0.0-9.3)	29.5* (11.6-90.7)	135.6* (92.0-177.1)
18 and older	9,596	12.4 (11.5-13.4)	48.9 (47.1-51.2)	80.7 (77.8-83.5)	150.8 (139.7-164.3)
14 and under	10,459	5.59 (4.9-6.3)	18.7 (16.1-19.7)	40.2 (39.6-40.4)	103.4 (82.6-123.5)
15 to 44	4,714	10.5 (9.4-11.6)	37.9 (37.5-41.3)	75.3 (67.3-83.5)	137.1 (122.0-151.0)
45 and older	5,434	14.3 (13.0-15.6)	55.7 (53.1-57.9)	83.4 (80.7-85.8)	166.0 (155.5-178.0)
All ages	20,607	10.6 (9.8-11.4)	38.4 (37.8-40.6)	74.9 (69.9-75.6)	139.2 (131.3-148.3)

Table 10-13. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) - Uncooked Fish Weight[a] (Continued)

Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
All Fish					
Females					
14 and under	5,182	7.5 (6.5-8.5)	28.5 (25.4-34.0)	55.2 (49.0-59.2)	103.9 (95.1-126.2)
15 to 44	2,332	14.7 (13.0-16.5)	53.6 (46.6-58.8)	85.2 (77.3-94.6)	189.9 (165.1-197.1)
45 and older	2,654	20.1 (17.9-22.2)	73.4 (67.7-77.3)	104.0 (96.7-112.1)	213.7 (190.1-221.6)
All ages	10,168	15.0 (13.7-16.2)	56.2 (51.0-59.2)	86.3 (81.2-93.2)	185.7 (162.6-187.2)
Males					
14 and under	5,277	9.0 (7.6-10.3)	31.5 (24.6-37.5)	56.5 (49.0-69.9)	165.2 (141.6-177.4)
15 to 44	2,382	19.9 (18.0-21.7)	77.0 (65.8-88.8)	118.6 (110.7-127.1)	242.7 (224.3-254.9)
45 and older	2,780	25.2 (23.0-27.3)	89.7 (86.5-94.2)	130.7 (125.8-135.5)	226.5 (207.3-278.3)
All ages	10,439	18.9 (17.7-20.1)	73.5 (66.6-80.5)	113.4 (110.7-118.6)	219.3 (204.8-236.5)
Both Sexes					
3 to 5	4,391	7.7 (6.9-8.6)	32.6 (27.6-34.0)	51.0 (46.3-56.7)	100.5 (89.1-111.4)
6 to 10	1,670	8.5 (7.1-10.0)	32.6 (27.0-37.9)	56.4 (49.6-69.8)	144.4* (117.4-183.4)
11 to 15	1,005	12.0 (9.7-14.2)	43.4 (36.7-50.8)	87.4 (69.6-102.6)	170.7* (147.9-176.8)
16 to 17	363	10.6 (7.0-14.2)	29.3 (9.4-48.7)	83.5* (42.3-114.5)	192.5* (120.5-266.0)
18 and older	9,596	19.9 (18.7-21.1)	74.8 (71.7-75.7)	111.4 (110.0-114.0)	215.7 (197.1-228.5)
14 and under	10,459	8.2 (7.3-9.2)	29.0 (27.6-32.6)	56.3 (52.2-56.7)	127.2 (118.2-149.5)
15 to 44	4,714	17.3 (15.9-18.7)	64.6 (57.0-73.5)	107.7 (99.2-113.6)	211.3 (197.1-242.3)
45 and older	5,434	22.4 (20.7-24.1)	80.6 (75.0-85.3)	115.3 (111.7-122.2)	215.7 (208.3-227.6)
All ages	20,607	16.9 (15.9-17.9)	63.5 (59.5-66.2)	102.3 (97.9-107.6)	198.2 (190.7-208.8)

[a] Estimates were projected from sample size to the U.S. population using 4-year combined survey weights.
N = Sample size.
CI = Confidence interval.
BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
* The sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States" (LSRO, 1995).

Source: U.S. EPA, 2002.

Table 10-14. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) - Uncooked Fish Weight[a]

Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
Freshwater and Estuarine					
Females					
14 and under	4,879	83 (69-96)	0.0 (0.0-1.6)	443 (269-572)	2,179 (1,866-2,345)
15 to 44	2,275	91 (71-110)	107 (57-145)	482 (403-538)	1,818 (1,633-2,767)
45 and older	2,569	96 (78-113)	250 (123-322)	655 (485-776)	1,822 (1,515-1,909)
All ages	9,723	91 (79-103)	117 (63-165)	535 (485-613)	1,871 (1,629-2,025)
Males					
14 and under	4,994	95 (76-113)	0.0 (0.0-1.7)	534 (371-605)	2,351 (1,920-2,501)
15 to 44	2,369	99 (84-115)	201 (151-254)	623 (558-810)	1,910 (1,760-2,221)
45 and older	2,764	121 (102-140)	378 (317-429)	891 (754-974)	1,963 (1,731-2,132)
All ages	10,127	106 (94-117)	208 (165-272)	697 (629-782)	2,034 (1,856-2,221)
Both Sexes					
3 to 5	4,112	124 (102-146)	0.0 (0.0-83)	712 (599-784)	3,091 (2,495-3,475)
6 to 10	1,553	84 (55-112)	0.0 (0.0-1.4)	354 (116-685)	2,322* (1,856-2,994)
11 to 15	975	77 (60-94)	20 (0.0-116)	477 (411-618)	1,610* (1,358-2,203)
16 to 17	360	65 (30-100)	0.0 (0.0-23)	285* (167-491)	1,542* (760-2,767)
18 and older	9,432	102 (92-112)	236 (183-277)	669 (597-749)	1,886 (1,700-2,049)
14 and under	9,873	89 (76-101)	0.0 (0.0-0.0)	485 (411-557)	2,246 (1,987-2,495)
15 to 44	4,644	95 (83-107)	150 (115-195)	558 (506-623)	1,893 (1,683-2,221)
45 and older	5,333	108 (94-122)	322 (250-379)	751 (653.97-870)	1,868 (1,709-1,941)
All ages	19,850	98 (90-107)	159 (131-198)	631 (590-675)	1,943 (1,816-2,086)
Marine					
Females					
14 and under	4,879	212 (183-242)	592 (508-785)	1,532 (1,418-1,703)	3,708 (3,276-4,295)
15 to 44	2,275	146 (126-166)	557 (463-632)	995 (874-1,078)	2,056 (1,848-2,330)
45 and older	2,569	209 (185-233)	802 (757-844)	1,184 (1,132-1,281)	2,464 (2,282-2,820)
All ages	9,723	181 (167-196)	657 (601-718)	1,158 (1,094-1,216)	2,716 (2,382-3,051)
Males					
14 and under	4,994	214 (183-244)	609 (480-808)	1,542 (1,380-1,887)	3,603 (3,212-4,131)
15 to 44	2,369	150 (132-168)	576 (461-675)	1,113 (963-1,226)	1,990 (1,782-2,317)
45 and older	2,764	187 (167-208)	713 (658-851)	1,138 (1,103-1,213)	2,275 (1,993-2,495)
All ages	10,127	175 (161-189)	649 (575-711)	1,205 (1,127-1,233)	2,545 (2,314-2,705)
Both Sexes					
3 to 5	4,112	309 (270-348)	1,108 (984-1,332)	2,314 (2,097-2,481)	4,608 (4,301-5,354)
6 to 10	1,553	198 (161-235)	600 (474-733)	1,481 (1,310-1549)	3,684* (2,458-4,353)
11 to 15	975	153 (117-189)	481 (361-609)	1,251 (808-1,390)	2381* (2,162-3,207)
16 to 17	360	98 (58-137)	0.0 (0.0-177)	460* (197-1,079)	2,148* (1,648-3,901)
18 and older	9,432	173 (160-186)	672 (651-732)	1,115 (1,078-1,182)	2,157 (2,024-2,412)
14 and under	9,873	213 (190-237)	606 (517-688)	1,543 (1,491-1,670)	3,694 (3,318-4,0656)
15 to 44	4,644	148 (132-163)	568 (502-630)	1,052 (973-1,184)	2,023 (1,925-2,197)
45 and older	5,333	199 (181-217)	767 (718-828)	1,156 (1,115-1,214)	2,389 (2,273-2,546)
All ages	19,850	178 (167-190)	651 (620-675)	1,178 (1,134-1,226)	2,587 (2,454-2,705)

Table 10-14. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) - Uncooked Fish Weight[a] (continued)

Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
All Fish					
Females					
14 and under	4,879	295 (261-330)	1,046 (885-1,262)	2,03,8 (1,853-2,251)	4,548 (4,117-4,977)
15 to 44	2,275	237 (206-267)	834.58 (771-981)	1,362 (1,181-1,556)	3,113 (2,767,-3,361)
45 and older	2,569	305 (272-338)	1,065.15 (98-1,200)	1,568 (1,472-1,671)	3,071 (2,716-3,941)
All ages	9,723	272 (251-294)	970.64 (906-1,040)	1,566 (1,511-1,633)	3,566 (3,270-3,782)
Males					
14 and under	4,994	308 (273-344)	1,122 (774-1,310)	2,136 (1,856-2,371)	4,518 (4,055-5,465)
15 to 44	2,369	249 (226-272)	982 (908-1,154)	1,533 (1,407-1,619)	3,011 (2,820-3,349)
45 and older	2,764	309 (282-335)	1,128 (1,078-1,206)	1,605 (1,534-1,731)	2,821 (2,587-3,204)
All ages	10,127	281 (264-297)	1,058 (962-1,201)	1,644 (1,559-1,731)	3,369 (3,204-3,680)
Both Sexes					
3 to 5	4,112	433 (385-482)	1,842 (1,555-1,957)	2,964 (2,790-3,194)	5,604 (5,231-6,135)
6 to 10	1,553	282 (235-328)	1,045 (744.58-1,219)	1,854 (1,638-2,175)	4,371* (3,433-5,814)
11 to 15	975	231 (186-275)	824 (657-952)	1,531 (1,362-1,850)	3,651* (2,745-3,795)
16 to 17	360	163 (107-219)	406 (145-756)	1,272* (558-1,500)	3,544* (2,767-3,946)
18 and older	9,432	275 (258-292)	1,017 (975-1,065)	1,549 (1,481-1,591)	3,060 (2,771-3,204)
14 and under	9,873	302 (274-330)	1,072 (961-1,162)	2,089 (1,987-2,207)	4,539 (4,391-5,108)
15 to 44	4,644	243 (223-262)	938 (878-1,019)	1,451 (1,342-1,602)	3,094 (2,788-3,349)
45 and older	5,333	307 (283-331)	1,112 (1,002-1,168)	1,591 (1,517-1,685)	3,014 (2,714-3,226)
All ages	19,850	276 (261-292)	1,013 (976-1,052)	1,613 (1,561-1,651)	3,457 (3,349-3,680)

[a] Estimates were projected from sample size to the U.S. population using 4-year combined survey weights.
N = Sample size.
CI = Confidence interval.
BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
* The sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States" (LSRO, 1995).

Source: U.S. EPA, 2002.

Table 10-15. Consumer Only Distribution of Fish (Finfish and Shellfish) Intake (g/day) - As Prepared[a]

Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
Freshwater and Estuarine					
Females					
14 and under	445	32.7 (26.8-36.6)	79.9 (77.1-103.9)	111.0 (103.0-163.5)	185.4 (163.5-384.3)
15 to 44	325	55.4 (45.9-64.8)	125.9 (117.0-157.8)	189.4 (154.2-259.9)	341.4 (260.2-853.4)
45 and older	449	49.0 (44.3-53.6)	122.8 (118.7-128.0)	158.3 (151.3-165.8)	284.7 (241.2-308.5)
All ages	1,219	49.4 (44.5-54.3)	122.7 (117.0-126.6)	163.2 (151.5-193.8)	320.6 (260.2-345.2)
Males					
14 and under	442	41.7 (34.9-48.4)	121.5 (85.3-148.4)	161.9 (138.6-229.2)	260.8 (260.2-292.5)
15 to 44	361	66.6 (59.7-73.6)	165.0 (158.8-171.0)	226.3 (194.2-250.2)	336.9 (327.0-402.9)
45 and older	553	65.8 (59.0-72.6)	154.3 (148.1-174.0)	214.4 (200.2-222.3)	400.2 (300.8-571.0)
All ages	1,356	62.9 (57.8-67.9)	158.2(148.4-165.8)	215.4 (202.4-226.5)	335.9 (316.5-437.1)
Both Sexes					
3 to 5	442	27.1 (23.2-31.1)	72.6 (65.0-79.0)	95.6 (87.2-109.6)	159.0* (136.1-260.2)
6 to 10	147	43.5 (31.8-55.2)	121.6* (82.5-187.3)	186.7* (114.8-260.2)	260.4* (172.1-261.3)
11 to 15	107	49.0 (39.4-58.5)	126.6* (103.9-148.4)	149.9* (134.6-192.7)	307.1* (192.7-384.3)
16 to 17	28	75.8* (58.9-92.7)	158.5* (151.1-171.0)	167.8* (158.8-484.4)	371.6* (171.0-484.4)
18 and older	1,633	59.2 (54.9-63.4)	150.2 (141.8-154.2)	201.0 (181.9-216.6)	338.2 (308.5-345.2)
14 and under	887	36.8 (32.5-41.1)	103.1 (75.5-120.7)	146.8 (114.8-167.4)	260.0 (250.2-292.5)
15 to 44	686	61.3 (56.4-66.2)	157.8 (150.3-163.5)	217.1 (181.8-253.2)	342.6 (321.1-484.4)
45 and older	1,002	57.3 (51.9-62.7)	141.1 (127.6-151.0)	182.5 (170.5-200.1)	306.9 (261.8-345.5)
All ages	2,575	56.3 (52.5-60.0)	145.3 (138.6-151.3)	188.8 (178.5-211.9)	332.9 (308.5-361.3)
Marine					
Females					
14 and under	670	48.7 (43.7-53.7)	98.1 (93.3-112.6)	135.9 (112.6-162.2)	196.2 (162.2-238.4)
15 to 44	412	71.0 (66.2-75.7)	158.5 (128.0-170.8)	181.5 (167.4-202.8)	286.7 (234.6-293.2)
45 and older	588	82.3 (75.9-88.6)	153.3 (140.1-166.1)	203.5 (181.2-252.5)	362.3 (275.4-485.4)
All ages	1,670	72.2 (68.6-75.8)	146.3 (140.3-158.7)	181.6 (169.0-201.6)	286.6 (269.5-293.2)
Males					
14 and under	677	59.5 (51.3-67.7)	144.6 (113.3-168.7)	168.8 (167.0-227.2)	265.1 (170.0-291.6)
15 to 44	412	99.1 (91.3-106.9)	186.1 (174.7-199.5)	232.5 (214.0-254.4)	403.8 (321.5-407.2)
45 and older	623	90.0 (84.9-95.1)	179.8 (167.3-200.1)	224.4 (207.2-280.1)	306.3 (292.5-380.9)
All ages	1,712	88.7 (83.7-93.7)	178.2 (170.0-181.2)	226.1 (214.4-232.7)	354.2 (315.3-403.6)
Both Sexes					
3 to 5	682	44.5 (40.6-48.5)	90.6 (84.3-104.8)	119.1 (102.0-142.8)	227.6* (168.7-292.5)
6 to 10	217	59.4 (52.6-66.1)	128.7 (111.6-158.4)	159.2* (134.9-219.05)	242.5* (219.0-291.6)
11 to 15	122	72.4 (59.9-84.9)	165.3* (157.6-202.8)	203.6* (168.8-227.2)	245.6* (213.6-268.6)
16 to 17	37	96.9* (65.3-128.5)	218.9* (179.6-237.8)	237.5* (179.6-292.5)	365.3* (229.8-428.0)
18 and older	1.978	85.1 (81.3-88.9)	168.9 (168.9-174.6)	214.1 (195.9-227.2)	337.2 (306.4-380.9)
14 and under	1,347	54.1 (48.4-59.9)	119.1 (112.3-144.8)	162.3 (141.9-168.7)	238.2 (219.0-269.4)
15 to 44	824	85.0 (79.5-90.4)	172.0 (168.8-179.6)	213.7 (194.3-229.7)	343.7 (304.9-404.2)
45 and older	1,211	85.8 (81.5-90.2)	168.4 (158.7-181.2)	218.7 (207.3-229.8)	320.1 (299.2-485.4)
All ages	3,382	80.2 (76.6-83.8)	168.9 (165.6-169.0)	207.6 (197.0-214.4)	310.2 (299.2-383.5)

Table 10-15. Consumer Only Distribution of Fish (Finfish and Shellfish) Intake (g/day) - As Prepared[a] (continued)					
Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
All Fish					
Females					
14 and under	836	54.2 (49.3-59.0)	112.5 (97.2-136.9)	155.4 (128.5-162.2)	237.5 (197.9-285.6)
15 to 44	554	82.5 (74.8-90.2)	170.8 (151.0-184.7)	221.7 (197.9-260.2)	336.5 (294.3-345.2)
45 and older	751	90.5 (85.3-95.7)	170.5 (158.7-181.7)	219.8 (197.0-242.5)	326.0 (308.5-612.9)
All ages	2,141	81.5 (77.3-85.7)	163.6 (151.3-171.0)	208.2 (193.8-238.4)	327.0 (285.6-359.6)
Males					
14 and under	836	69.1 (61.9-76.3)	157.0 (136.1-168.8)	227.5 (168.7-260.2)	276.0 (269.4-292.5)
15 to 44	565	111.9 (106.0-117.9)	210.6 (195.0-242.5)	296.1 (249.7-316.5)	427.9 (403.6-465.6)
45 and older	849	106.5 (101.5-111.5)	210.3 (193.3-229.8)	271.1 (241.4-292.5)	392.5 (330.6-535.5)
All ages	2,250	102.9 (99.0-106.8)	206.0 (192.7-219.0)	262.0 (251.3-285.8)	404.1 (380.9-428.4)
Both Sexes					
3 to 5	834	50.2 (46.3-54.0)	103.1 (94.5-124.9)	133.9 (120.7-151.8)	260.0* (195.3-293.3)
6 to 10	270	70.6 (63.8-77.4)	154.7 (130.0-183.2)	218.2* (197.9-261.3)	280.9* (260.2-291.6)
11 to 15	172	79.6 (70.4-88.7)	167.1* (154.0-192.7)	208.8* (205.9-257.0	285.2* (263.8-327.0)
16 to 17	52	104.1* (75.0-133.1)	200.5* (167.4-242.5)	241.9* (215.7-484.4)	451.0* (292.5-484.4)
18 and older	2,634	97.56 (93.7-101.4)	191.8 (184.7-197.9)	253.2 (243.6-261.8)	399.5 (359.1-407.2)
14 and under	1,672	61.7 (56.6-66.8)	138.4 (125.1-150.1)	168.7 (162.4-232.8)	271.4 (260.2-291.6)
15 to 44	1,119	97.2 (92.1-102.4)	195.1 (183.2-206.0)	256.0 (240.2-283.9)	404.0 (352.4-450.4)
45 and older	1,600	98.1 (93.6-102.6)	187.0 (184.1-198.0)	248.5 (238.00-260.2)	381.4 (300.6-413.0)
All ages	4,391	92.0 (88.5-95.5)	184.5 (179.6-195.0)	249.3 (234.3-259.8)	379.0 (340.2-413.0)

[a] Estimates were projected from sample size to the U.S. population using 4-year combined survey weights; consumers only are those individuals who consumed fish at least once during the 2-day reporting period.
N = Sample size.
CI = Confidence interval.
BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
* The sample size does not meet minimum reporting requirements as described in the “Third Report on Nutrition Monitoring in the United States” (LSRO, 1995).

Source: U.S. EPA, 2002.

Table 10-16. Consumer Only Distributions of Fish (Finfish and Shellfish) Intake (mg/kg/day) - As Prepared[a]

Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
			Freshwater and Estuarine		
Females					
14 and under	410	1,198 (1,029-1,367)	3,167 (2,626-3,601)	4,921 (3,601-6,563)	9,106 (6,875-10,967)
15 to 44	315	872 (7,13-1,032)	2,702 (1,777-2,484)	3,153 (2,484-4,067)	5,738 (4,584-15,930)
45 and older	432	736 (658-813)	1,943 (1,803-2,128)	2,487 (2,249-2,706)	3,169 (3,027-7,078)
All ages	1,157	859 (776-943)	2,151 (1,941-2,476)	3,004 (2,602-3,368)	6,102 (5,475-7,078)
Males					
14 and under	419	1,299 (1,106-1,492)	3,556 (3,068-3830)	4,495 (3,830-4,982)	8,714 (6,266-11,276)
15 to 44	358	841 (751-931)	2,182 (2,057-2,318)	2,819 (2,539-3,241)	4,379 (4,057-4,931)
45 and older	548	782 (701-862)	1,804 (1,696-1,903)	2,511 (2,175-2,652)	4,812 (4,036-6,987)
All ages	1,325	882 (814-950)	2,148 (2,045-2,318)	3,021 (2,867-3,241)	5,333 (4,548-6,775)
Both Sexes					
3 to 5	416	1,532 (1320-1743)	4,307 (3,472-4,624)	5,257 (4,926-5,746)	10,644* (9,083-12,735)
6 to 10	132	1,296 (1004-1,588)	3,453* (2,626-4,671)	4,675* (3,459-8,816)	8,314* (4,684-9,172)
11 to 15	101	869 (724.60-1,013)	2,030* (1,628-2,104)	3,162* (2,104-3,601)	4,665* (3,597-7,361)
16 to 17	28	1,063* (781-1,346)	2,293* (2,096-2,577)	2,505* (2,096-6,466)	5,067* (2,295-6,466)
18 and older	1,599	805 (748-861)	2,025 (1,888-2,072)	2,679 (2,539-2,947)	4,930 (4,285-5,849)
14 and under	829	1,251 (1,135-1,367)	3,456 (3,136-3,597)	4,681 (4,084-5,247)	8,792 (7,361-10,967)
15 to 44	673	855 (778-933)	2,136 (2,057-2,371)	3,071 (2,675-3,478)	5,795 (4,066-6,096)
45 and older	980	759 (694-824)	1,896 (1,739-1,983)	2,512 (2,262-2,706)	4,261 (3,117-6,419)
All ages	2,482	871 (816-926)	2,152 (2,063-2,295)	3,019 (2,924-3,101)	5,839 (4,926-7,078)
			Marine		
Females					
14 and under	629	1,988 (1,827-2,148)	4,378 (,3927-4,962)	5,767 (5,041-6,519)	8,185 (6,907-8,842)
15 to 44	403	1,147 (1,061-1,234)	2,404 (2,014-2660)	3,151 (2,621-3,325)	4,774 (4,523-5,510)
45 and older	568	1,259 (1,159-1,360)	2,430 (2,258-2,627)	3,274 (2,699-4,029)	5,798 (5,365-9,297)
All ages	1,600	1,323 (1,260-1,385)	2,680 (2,477-2,977)	3,644 (3,381-4,305)	5,895 (5,750-6,956)
Males					
14 and under	643	2,084 (1,842-2,326)	4,734 (3,911-5,307)	5,490 (4,944-6,628)	9,004 (7,432-10,962)
15 to 44	409	1,242 (1,151-1,333)	2,448 (2,349-2,773)	2,985 (2,870-3,265)	4,674 (3,637-5,926)
45 and older	621	1,129 (1,063-1,195)	2,294 (2,106-2,452)	2,942 (2,809-3,526)	4,622 (4,094-4,936)
All ages	1,673	1,337 (1,267-1,408)	2,745 (2,513-2,858)	3,636 (3,450-3,922)	5,908 (5,359-6,366)
Both Sexes					
3 to 5	640	2,492 (2,275-2,709)	5,303 (4,873-5,930)	6,762 (6,097-7,168)	11,457* (7,432-14,391)
6 to 10	203	2,120 (1,880-2,361)	4,950 (4,043-5,384)	5,817* (5,333-6,596)	8,092* (6,146-9,184)
11 to 15	120	1,427 (1,203-1,651)	2,971* (2,858-3,741)	4,278* (3,026-4,766)	5,214* (4,647-5,646)
16 to 17	37	1,534* (1,063-2,004)	3,602* (2,974-4,649)	4,475* (3,068-4,685)	4,982* (3,467-5,238)
18 and older	1,944	1,187 (1,137-1,238)	2,386 (2,265-2,450)	2,998 (2,907-3,191)	4,961 (4,523-5,510)
14 and under	1,272	2,037 (1,880-2,195)	4,646 (4,213-4,892)	5,664 (5,384-6,093)	8,611 (7,755-9,184)
15 to 44	812	1,195 (1,127-1,263)	2,442 (2,349-2,660)	3,046 (2,856-3,309)	4,817 (3,932-5,238)
45 and older	1,189	1,198 (1,135-1,261)	2,394 (2,205-2,534)	3,100 (2,933-3,500)	5,436 (4,655-7,504)
All ages	3,273	1,330 (1,278-1,382)	2,710 (2,618-2,870)	3,637 (3,544-3,927)	5,910 (5,646-6,711)

Table 10-16. Consumer Only Distributions of Fish (Finfish and Shellfish) Intake (mg/kg/day) - As Prepared[a] (continued)

Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
All Fish					
Females					
14 and under	779	2,183 (2,021-2,344)	4,786 (4,422-5,138)	6,218 (5,766-6,738)	10,395 (8,680-10,967)
15 to 44	541	1,317 (1,184-1,451)	2,636 (2,385-3,051)	3,611 (3,225-4,584)	5,712 (4,952-5,849)
45 and older	725	1,380 (1,299-1,460)	2,639 (2,406-2,950)	3,560 (3,008-3,967)	5,929 (5,452-9,905)
All ages	2,045	1,469 (1,400-1,539)	3,008 (2,752-3,169)	4,088 (3,649-4,544)	7,074 (6,519-8,761)
Males					
14 and under	788	2,355 (2,164-2,545)	5,097 (4,680-5,535)	6,712 (6,146-7,432)	9,182 (8,816-11,276)
15 to 44	561	1,409 (1,339-1,478)	2,770 (2,570-3,241)	3,490 (3,092-3,725)	5,612 (5,163-5,926)
45 and older	842	1,311 (1,250-1,373	2,564 (2,501-2,801)	3,133 (3,050-3,584)	4,935 (4,548-6,987)
All ages	2,191	1,518 (1,461-1,575)	3,043 (2,867-3,159)	4,029 (3,779-4,477)	6,736 (6,096-7,117)
Both Sexes					
3 to 5	779	2,828 (2,608-3,049)	5,734 (5,268-6,706)	7,422 (6,907-8,393)	13,829* (11,349-14,391)
6 to 10	250	2,375 (2,199-2,551)	5,135 (4,684-5,816)	6,561* (5,404-8,816)	9,179* (8,130-10,485)
11 to 15	164	1,533 (1,384-1,682)	3,207* (2,945-3,485)	3,924.64* (3,485-4,764)	5,624* (4,764-6,929)
16 to 17	52	1,578* (1,187-1,969)	3,468* (2,676-4,752)	4,504.25* (3,709-6,466)	5,738* (4,752-6,466)
18 and older	2,585	1,349 (1,297-1,401)	2,641 (2,539-2,773)	3,493 (3,258-3,628)	5,708 (5,085-5,926)
14 and under	1,567	2,271 (2,130-2,412)	4,959 (4,647-5,450)	6,531 (5,887-6,929)	10,389 (8,982-10,967)
15 to 44	1,102	1,363 (1,292-1,435)	2,728 (2,570-2,974)	3,583 (3,275-3,999)	5,694 (4,987-5,849)
45 and older	1,567	1,347 (1,288-1,406)	2,619 (2,546-2,752)	3,265 (3,115-3,569)	5,807 (5,073-6,9877)
All ages	4,236	1,494 (1,440-1,548)	3,021 (2,941-3,082)	4,055 (3,816-4,218)	6,920 (6,466-7,527)

[a] Estimates were projected from sample size to the U.S. population using 4-year combined survey weights; consumers only are those individuals who consumed fish at least once during the 2-day reporting period..

N = Sample size.

CI = Confidence interval.

BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

* The sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States" (LSRO, 1995).

Note: Source: U.S. EPA, 2002.

Table 10-17. Consumer Only Distributions of Fish (Finfish and Shellfish) Intake (g/day) – Uncooked Fish Weight[a]					
Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
Freshwater and Estuarine					
Females					
14 and under	445	47 (40-54)	117 (104-142)	172 (150-204)	243 (220-514)
15 to 44	325	75 (62-88)	173 (155-204)	274 (204-331)	503 (381-1,144)
45 and older	449	66 (59-72)	163 (153-168)	204 (192-226)	394 (303-431)
All ages	1,219	67 (60-74)	163 (154-170)	219 (199-267)	461 (381-508)
Males					
14 and under	442	60 (50-70)	158 (110-196)	199 (189-296)	381 (381-401)
15 to 44	361	93 (82.33-103)	236 (226-246)	305 (272-367)	495 (444-643)
45 and older	553	91 (81.11-100)	221 (204-236)	295 (264-332)	562 (402-764)
All ages	1,356	87 (80-95)	220 (200-232)	296 (289-333)	490 (444-595)
Both Sexes					
3 to 5	442	40 (35-46)	95 (86-102)	129 (120-142)	205* (200-381)
6 to 10	147	61 (44-79)	157* (117-250)	248* (150-381)	386* (221-401)
11 to 15	107	71 (58-83)	173* (166-196)	199* (173-296)	392* (296-514)
16 to 17	28	100* (80-121)	203* (197-248)	242* (206-643)	501* (241-643)
18 and older	1,633	81 (75-87)	200 (190-206)	279 (253-301)	506 (444-508)
14 and under	887	53 (47-59)	144 (101-173)	196 (173-220)	381 (367-401)
15 to 44	686	84 (77-91)	205 (197-226)	295 (253-345)	504 (438-818)
45 and older	1,002	78 (70-86)	191 (170-202)	245 (230-264)	413 (382-505)
All ages	2,575	78 (72-83)	196 (189-202)	258 (243-289)	468 (431-531)
Marine					
Females					
14 and under	670	71 (65-77)	134 (124-155)	183 (151-205)	240 (209-379)
15 to 44	412	91 (85-96)	188 (163-210)	241 (227-265)	376 (347-391)
45 and older	588	104 (94-113)	189 (170-213)	239 (222-283)	441 (359-647)
All ages	1,670	93 (88-98)	183 (174-192)	232 (227-250)	385 (354-397)
Males					
14 and under	677	81 (69-93)	198 (162-227)	231 (225-307)	353 (244-392)
15 to 44	412	127 (116-137)	240 (227-258)	279 (271-370)	568 (488-647)
45 and older	623	113 (107-120)	223 (205-252)	285 (250-324)	384 (359-480)
All ages	1,712	114 (107-120)	227 (223-236)	277 (270-297)	483 (390-501)
Both Sexes					
3 to 5	682	66 (60-71)	125 (114-150)	165 (139-190)	316* (227-390)
6 to 10	217	78 (67-89)	150 (129-201)	202* (165-317)	350* (223-392)
11 to 15	122	102 (85-118)	220* (205-265)	262* (227-307)	320* (277-379)
16 to 17	37	126* (80-171)	281* (241-354)	353* (241-390)	530* (291-650)
18 and older	1,978	108 (103-113)	217 (213-223)	270 (251-283)	464 (391-487)
14 and under	1,347	76 (68-85)	161 (149-201)	220 (183-227)	335 (307-379)
15 to 44	824	109 (101-116)	225 (213-233)	270 (247-279)	483 (390-634)
45 and older	1,211	108 (102-114)	206 (195-224)	272 (250-293)	407 (374-647)
All ages	3,382	103 (98-108)	215 (207-217)	258 (247-270)	395 (390-487)

Table 10-17. Consumer Only Distributions of Fish (Finfish and Shellfish) Intake (g/day) – Uncooked Fish Weight[a] (continued)

Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
			All Fish		
Females					
14 and under	836	79 (73-85)	158 (142-198)	205 (180-218)	372 (254-381)
15 to 44	554	108 (97-118)	221 (197-236)	315 (246-378)	495 (394-508)
45 and older	751	117 (109-124)	215 (200-228)	270 (236-286)	444 (428-817)
All ages	2,141	107 (101-113)	207 (196-227)	275 (246-3000)	453 (394-508)
Males					
14 and under	836	96 (85-107)	225 (195-254)	336 (286-353)	390 (381-401)
15 to 44	565	148 (139-156)	272 (253-334)	381 (323-431)	636 (595-647)
45 and older	849	139 (132-146)	274 (285-304)	348 (320-374)	505 (439-693)
All ages	2,250	136 (130-142)	266 (248-289)	354 (315-379)	595 (505-643)
Both Sexes					
3 to 5	834	74 (69-79)	149 (136-165)	184 (172-223)	363* (310-391)
6 to 10	270	95 (85-106)	200 (177-235)	313* (254-381)	387* (381-401)
11 to 15	172	113 (99-127)	227* (205-296)	308* (271-348)	380* (353-409)
16 to 17	52	136* (97-174)	242* (206-358)	357* (266-643)	645* (390-650)
18 and older	2,634	127 (122-133)	248 (236-264)	334 (321-349)	519 (508-634)
14 and under	1,672	88 (80-95)	191 (173-201)	249 (214-330)	381 (367-392)
15 to 44	1,119	128 (121-135)	255 (241-271)	358 (330-381)	609 (508-647)
45 and older	1,600	127 (120-134)	244 (230-258)	317 (304-330)	476 (439-593)
All ages	4,391	121 (116-126)	241 (233-255)	329 (314-343)	507 (486-593)

[a] Estimates were projected from sample size to the U.S. population using 4-year combined survey weights; consumers only are those individuals who consumed fish at least once during the 2-day reporting period..

N = Sample size.

CI = Confidence interval.

BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

* The sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States" (LSRO, 1995).

Note: Source: U.S. EPA, 2002.

Table 10-18. Consumer Only Distributions of Fish (Finfish and Shellfish) Intake (mg/kg/day) – Uncooked Fish Weight[a]

Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
Freshwater and Estuarine					
Females					
14 and under	410	1,776 (1,543-2,009)	4,397 (3,635-4,535)	6,855 (4,881-9,166)	11,544 (9,166-16,108)
15 to 44	315	1,185 (962-1,408)	2,922 (2,294-3,314)	4,260 (3,266-5,973)	8,154 (6,721-20,620)
45 and older	432	986 (880-1,093)	2,655 (2,313-2,875)	3,263 (2,944-3,716)	4,630 (4,037-9,900)
All ages	1,157	1,185 (1,071-1,299)	2,875 (2,654-3,266)	4,033 (3,516-4,406)	8,608 (7,087-9,900)
Males					
14 and under	419	1,895 (1,618-2,172)	4,707 (3,992-4,990)	5,905 (5,522-6,103)	12,628 (8,111-15,495)
15 to 44	358	1,167 (1,034-1,299)	2,998 (2,724-3,349)	4,015 (3,712-4,635)	6,534 (5,511-8,577)
45 and older	548	1,076 (963-1,190)	2,467 (2,378-2,597)	3,447 (3,093-3,849)	6,574 (5,557-9,351)
All ages	1,325	1,238 (1,140-1,336)	3,052 (2,735-3,221)	4,257 (4,039-4,473)	7,998 (6,539-9,351)
Both Sexes					
3 to 5	416	2,292 (2,012-2,572)	5,852 (4,703-6,068)	7,160 (6,950-7,442)	15,600* (11,877-18,670)
6 to 10	132	1,830 (1,416-2,245)	4,688* (3,673-5,987)	6,207* (4,767-12,926)	12,365* (6,763-12,926)
11 to 15	101	1,273 (1,082-1,464)	2,777* (2,091-3,026)	4,419* (3,026-5,522)	5,717* (5,457-9,852)
16 to 17	28	1,401* (10,588-1,744)	2,971* (2,743-3,692)	3,279* (2,767-8,577)	6,819* (3,221-8,577)
18 and older	1,599	1,102 (1,023-1,181)	2,693 (2,507-2,820)	3,744 (3,520-4,037)	7,140 (6,388-8,604)
14 and under	829	1,834 (1,680-1,987)	4,512 (4,045-4,780)	5,986 (5,531-6,867)	12,389.(9,852-15,495)
15 to 44	673	1,175 (1,067-1,282)	2,978 (2,739-3,221)	4,125 (3,815-4,841)	8,580(5,973-9,477)
45 and older	980	1,032 (941-1,123)	2,508 (2,383-2,797)	3,319 (3,034-3,716)	6,122 (4,422-8,254)
All ages	2,482	1,213 (1,136-1,291)	2,947 (2,808-3,118)	4,135 (4,037-4,287)	8,587 (6,950-9,900)
Marine					
Females					
14 and under	629	2,893 (2,679-3,107)	6,279 (5,286-6,554)	7,899 (7,033-8,478)	10,514 (9,322-11,981)
15 to 44	403	1,475 (1,366-1,584)	3,102 (2,580-3,378)	3,927 (3,440-4,929)	6,491 (5,931-7,802)
45 and older	568	1,579 (1,439-1,719)	3,028 (2,676-3,239)	3,917 (3,584-4,560)	7,416 (6,021-12,395)
All ages	1,600	1,732 (1,649-1,815)	3,558 (3,335-3,880)	4,878 (4,560-5,640)	8,618 (7,802-9,322)
Males					
14 and under	643	2,885 (2,540-3,230)	6,244 (5,390-6,931)	8,068 (6,577-8,707)	11,871 (10,365-14,194)
15 to 44	409	1,579 (1,458-1,701)	3,063 (2,855-3,481)	3,736 (3,554-4,048)	7,103 (4,634-7,701)
45 and older	621	1,412 (1,328-1,496)	2,812 (2,589-3,072)	3,724 (3,386-3,987)	5,504 (5,134-6,321)
All ages					
Both Sexes					
3 to 5	640	3,689 (3,395-3,982)	7,253 (6,777-8,504)	9,270 (8,415-9,991)	16,100* (11,980-17,989)
6 to 10	203	2,787 (2,417-3,157)	5,910 (4,813-7,365)	8,001* (6,375-8,707)	10,754* (8,707-12,055)
11 to 15	120	2,020 (1,741-2,327)	4,224* (3,744-4,781)	5,195* (3,859-6,448)	6,839* (6,076-8,970)
16 to 17	37	2,007* (1,302-2,712)	4,468* (3,880-7,802)	6,537* (3,991-7,802)	7,886* (4,661-7,958)
18 and older	1,944	1,501 (1,440-1,562)	2,971 (2,740-3,098)	3,749-3,579-3,962	6,345 (5,653-7,224)
14 and under	1,272	2,892 (2,674-3,111)	6,290 (5,748-6,448)	8,047 (7,365-8,564)	11,507 (10,124-12,054)
15 to 44	812	1,527 (1,441-1,614)	3,093 (2,855-3,318)	3,872 (3,564-4,131)	6,898 (5,287-7,701)
45 and older	1,189	1,501 (1,416-1,586)	2,948 (2,664-3,232)	3,889 (3,494-4,030)	6,229 (5,409-9,759)
All ages					

Table 10-18. Consumer Only Distributions of Fish (Finfish and Shellfish) Intake (mg/kg/day) – Uncooked Fish Weight[a] (continued)

Age (years)	N	Mean (90% CI)	90th % (90% BI)	95th % (90% BI)	99th % (90% BI)
All Fish					
Females					
14 and under	779	3,202 (2,983-3,421)	6,854 (6,596-7,365)	8,808 (8,451-9,408)	13,907 (11,461-16,108)
15 to 44	541	1,728 (1,547-1,909)	3,437 (3,153-3,925)	5,045 (4,221-6,122)	8,011 (6,721-8,604)
45 and older	725	1,774 (1,657-1,890)	3,422 (3,098-3,767)	4,098 (3,870-4,853)	7,996 (6,121-15,117)
All ages	2,045	1,962 (1,864-2,061)	4,005 (3,831-4,278)	5,792 (5,097-6,059)	9,878 (8,970-12,235)
Males					
14 and under	788	3,314 (3,022-3,607)	7,402 (6,241-7,626)	8,720 (8,323-10,591)	13,025 (12,278-16,803)
15 to 44	561	1,851 (1,754-1,947)	3,599 (3,232-4,197)	4,461 (3,991-5,063)	7,621 (7,361-8,473)
45 and older	842	1,703 (1,616-1,791)	3,395 (3,118-3,638)	4,253 (3,912-4,685)	6,376 (5,514-9,351)
All ages	-	-	-	-	-
Both Sexes					
3 to 5	779	4,198 (3,894-4,502)	8,061 (7,366-9,223)	10,444 (9,475-12,261)	17,874* (15,290-18,670)
6 to 10	250	3,188 (2,923-3,452)	6,544 (6,013-8,707)	8,654* (7,086-11,756)	12,785* (10,930-13,979)
11 to 15	164	2,199 (1,950-2,449)	4,387* (3,785-5,522)	6,234* (4,420-7,589)	8,345* (6,076-8,970)
16 to 17	52	2,066* (1,529-2,603)	3,902* (3,536-7,892)	6,594* (4,661-8,577)	8,210* (7,892-8,577)
18 and older	2,585	1,758 (1,687-1,829)	3,438 (3,303-3,584)	4,492 (4,271-4,810)	7,510 (6,679-8,604)
14 and under	1,567	3,260 (3,062-3,457)	7,120 (6,533-7,859)	8,758 (8,487-9,362)	13,955 (12,926-15,495)
15 to 44	1,102	1,790 (1,696-1,884)	3,549 (3,318-3,833)	4,806 (4,214-5,422)	7,839 (7,361-8,604)
45 and older	1,567	1,740 (1,650-1,830)	3,416 (3,227-3,572)	4,261 (4,017-4,497)	6,704 (6,195-9,351)
All ages	-	-	-	-	-

[a] Estimates were projected from sample size to the U.S. population using 4-year combined survey weights; consumers only are those individuals who consumed fish at least once during the 2-day reporting period..

N = Sample size.

CI = Confidence interval.

BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

* The sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States" (LSRO, 1995).

Note: Source: U.S. EPA, 2002.

Table 10-19. Total Fish Consumption, Consumers Only by Demographic Variables[a]

Demographic Category	Intake (g/person/day)	
	Mean	95th Percentile
Overall (all fish consumers)	14.3	41.7
Race		
Caucasian	14.2	41.2
Black	16.0	45.2
Asian	21.0	67.3
Other	13.2	29.4
Sex		
Female	13.2	38.4
Male	15.6	44.8
Age (years)		
0 to 9	6.2	16.5
10 to 19	10.1	26.8
20 to 29	14.5	38.3
30 to 39	15.8	42.9
40 to 49	17.4	48.1
50 to 59	20.9	53.4
60 to 69	21.7	55.4
≥ 70	13.3	39.8
Sex and Age (years)		
Female		
0 to 9	6.1	17.3
10 to 19	9.0	25.0
20 to 29	13.4	34.5
30 to 39	14.9	41.8
40 to 49	16.7	49.6
50 to 59	19.5	50.1
60 to 69	19.0	46.3
≥ 70	10.7	31.7
Male		
0 to 9	6.3	15.8
10 to 19	11.2	29.1
20 to 29	16.1	43.7
30 to 39	17.0	45.6
40 to 49	18.2	47.7
50 to 59	22.8	57.5
60 to 69	24.4	61.1
≥ 70	15.8	45.7
Census Region		
New England	16.3	46.5
Middle Atlantic	16.2	47.8
East North Central	12.9	36.9
West North Central	12.0	35.2
South Atlantic	15.2	44.1
East South Central	13.0	38.4
West South Central	14.4	43.6
Mountain	12.1	32.1
Pacific	14.2	39.6

Table 10-19. Total Fish Consumption by Demographic Variables[a] (continued)		
	Intake (g/person/day)	
Demographic Category	Mean	Mean
Community Type		
Rural, non-SMSA	13.0	38.3
Central city, 2M or more	19.0	55.6
Outside central city, 2M or more	15.9	47.3
Central city, 1M - 2M	15.4	41.7
Outside central city, 1M - 2M	14.5	41.5
Central city, 500K - 1M	14.2	41.0
Outside central city, 500K - 1M	14.0	39.7
Outside central city, 250K - 500K	12.2	32.1
Central city, 250K - 500K	14.1	40.5
Central city, 50K - 250K	13.8	43.4
Outside central city, 50K - 250K	11.3	31.7
Other urban	13.5	39.2

[a] The calculations in this table are based on respondents who consumed fish during the survey month. These respondents are estimated to represent 94 percent of the U.S. population.

Source: Javitz, 1980.

Table 10-20. Percent Distribution of Total Fish Consumption for Females and Males by Age[a]

	Consumption Category (g/day)										
Age (yrs)	0.0-5.0	5.1-10.0	10.1-15.0	15.1-20.0	20.1-25.0	25.1-30.0	30.1-37.5	37.6-47.5	47.6-60.0	60.1-122.5	over 122.5
Females											
0 to 9	55.5	26.8	11.0	3.7	1.0	1.1	0.7	0.3	0.0	0.0	0.0
10 to 19	17.8	31.4	15.4	6.9	3.5	2.4	1.2	0.7	0.2	0.4	0.0
20 to 29	28.1	26.1	20.4	11.8	6.7	3.5	4.4	2.2	0.9	0.9	0.0
30 to 39	22.4	23.6	18.0	12.7	8.3	4.8	3.8	2.8	1.9	1.7	0.1
40 to 49	17.5	21.9	20.7	13.2	9.3	4.5	4.6	2.8	3.4	2.1	0.2
50 to 59	17.0	17.4	16.8	15.5	10.5	8.5	6.8	5.2	4.2	2.0	0.2
60 to 69	11.5	16.9	20.6	15.9	9.1	9.2	6.0	6.1	2.4	2.1	0.2
≥ 70	41.9	22.1	12.3	9.7	5.2	2.9	2.6	1.2	0.8	1.2	0.1
Overall	28.9	24.0	16.8	10.7	6.4	4.3	3.5	2.4	1.6	1.2	0.1
Males											
0 to 9	52.1	30.1	11.9	3.1	1.2	0.6	0.7	0.1	0.2	0.1	0.0
10 to 19	27.8	29.3	19.0	10.4	6.0	3.2	1.7	1.7	0.4	0.5	0.0
20 to 29	16.7	22.9	19.6	14.5	8.8	6.2	4.4	3.1	1.9	1.9	0.1
30 to 39	16.6	21.2	19.2	13.2	9.5	7.3	5.2	3.2	1.3	2.2	0.0
40 to 49	11.9	22.3	18.6	14.7	8.4	8.5	5.3	5.2	3.3	1.7	0.1
50 to 59	9.9	15.2	15.4	14.4	10.4	9.7	8.7	7.6	4.3	4.1	0.2
60 to 69	7.4	15.0	15.6	12.8	11.4	8.5	9.9	8.3	5.5	5.5	0.1
≥ 70	24.5	21.7	15.7	9.9	9.8	5.3	5.4	3.1	1.7	2.8	0.1
Overall	22.6	23.1	17.0	11.3	7.7	5.7	4.6	3.6	2.2	2.1	0.1

[a] The percentage of females in an age bracket whose average daily fish consumption is within the specified range. The calculations in this table are based upon the respondents who consumed fish during the month of the survey. These respondents are estimated to represent 94% of the U.S. population.

Source: Javitz, 1980.

Table 10-21. Mean Total Fish Consumption by Species[a]

Species	Mean consumption (g/day)	Species	Mean consumption (g/day)
Not reported	1.173	Mullet[b]	0.029
Abalone	0.014	Oysters[b]	0.291
Anchovies	0.010	Perch (Freshwater)[b]	0.062
Bass[b]	0.258	Perch (Marine)	0.773
Bluefish	0.070	Pike (Marine)[b]	0.154
Bluegills[b]	0.089	Pollock	0.266
Bonito[b]	0.035	Pompano	0.004
Buffalofish	0.022	Rockfish	0.027
Butterfish	0.010	Sablefish	0.002
Carp[b]	0.016	Salmon[b]	0.533
Catfish (Freshwater)[b]	0.292	Scallops[b]	0.127
Catfish (Marine)[b]	0.014	Scup[b]	0.014
Clams[b]	0.442	Sharks	0.001
Cod	0.407	Shrimp[b]	1.464
Crab, King	0.030	Smelt[b]	0.057
Crab, other than King[b]	0.254	Snapper	0.146
Crappie[b]	0.076	Snook[b]	0.005
Croaker[b]	0.028	Spot[b]	0.046
Dolphin[b]	0.012	Squid and Octopi	0.016
Drums	0.019	Sunfish	0.020
Flounders[b]	1.179	Swordfish	0.012
Groupers	0.026	Tilefish	0.003
Haddock	0.399	Trout (Freshwater)[b]	0.294
Hake	0.117	Trout (Marine)[b]	0.070
Halibut[b]	0.170	Tuna, light	3.491
Herring	0.224	Tuna, White Albacore	0.008
Kingfish	0.009	Whitefish[b]	0.141
Lobster (Northern)[b]	0.162	Other finfish[b]	0.403
Lobster (Spiny)	0.074	Other shellfish[b]	0.013
Mackerel, Jack	0.002		
Mackerel, other than Jack	0.172		

[a] The calculations in this table are based upon respondents who consumed fish during the month of the survey. These respondents are estimated to represent 94% percent of the U.S. population.

[b] Designated as freshwater or estuarine species by Stephan (1980).

Source: Javitz, 1980.

Table 10-22. Best Fits of Lognormal Distributions Using the NonLinear Optimization (NLO) Method			
	Adults	Teenagers	Children
Shellfish			
Φ	1.370	-0.183	0.854
Φ	0.858	1.092	0.730
(min SS)	27.57	1.19	16.06
Finfish (freshwater)			
Φ	0.334	0.578	-0.559
Φ	1.183	0.822	1.141
(min SS)	6.45	23.51	2.19
Finfish (saltwater)			
Φ	2.311	1.691	0.881
Φ	0.72	0.830	0.970
(min SS)	30.13	0.33	4.31

The following equations may be used with the appropriate Φ and Φ values to obtain an average Daily Consumption Rate (DCR), in grams, and percentiles of the DCR distribution.

$DCR50 = \exp(\Phi)$

$DCR90 = \exp[\Phi + z(0.90) \cong \Phi]$

$DCR99 = \exp[\Phi + z(0.99) \cong \Phi]$

$DCR_{avg} = \exp[\Phi + 0.5 \cong \Phi^2]$

Source: Ruffle et al., 1994.

Table 10-23. Mean Fish Intake in a Day, by Sex and Age[a]

Sex Age (years)	Per capita intake (g/day)	Percent of population consuming fish in 1 day	Mean intake (g/day) for consumers only[b]
Males or Females			
5 and under	4	6.0	67
Males			
6 to 11	3	3.7	79
12 to 19	3	2.2	136
20 and over	15	10.9	138
Females			
6 to 11	7	7.1	99
12 to 19	9	9.0	100
20 and over	12	10.9	110
All individuals	11	9.4	117

[a] Based on USDA Nationwide Food Consumption Survey 1987-88 data for one day.
[b] Intake for users only was calculated by dividing the per capita consumption rate by the fraction of the population consuming fish in one day.

Source: USDA, 1992b.

Table 10-24. Percent of Respondents That Responded Yes, No, or Don't Know to Eating Seafood in 1 Month (including shellfish, eels, or squid)

		Response					
		No		Yes		DK	
Population Group	Total N	N	%	N	%	N	%
Overall	4663	1811	38.8	2780	59.6	72	1.5
Gender							
*	2	1	50.0	1	50.0	*	*
Male	2163	821	38.0	1311	60.6	31	1.4
Female	2498	989	39.6	1468	58.8	41	1.6
Age (years)							
*	84	25	29.8	42	50.0	17	20.2
1-4	263	160	60.8	102	38.8	1	0.4
5-11	348	177	50.9	166	47.7	5	1.4
12-17	326	179	54.9	137	42.0	10	3.1
18-64	2972	997	33.5	1946	65.5	29	1.0
>64	670	273	40.7	387	57.8	10	1.5
Race							
*	60	20	33.3	22	36.7	18	30.0
White	3774	1475	39.1	2249	59.6	50	1.3
Black	463	156	33.7	304	65.7	3	0.6
Asian	77	21	27.3	56	72.7	*	*
Some Others	96	39	40.6	56	58.3	1	1.0
Hispanic	193	100	51.8	93	48.2	*	*
Hispanic							
*	46	10	21.7	412	43.0	28	41.3
No	4243	1625	31.2	1366	67.7	21	1.2
Yes	348	165	35.4	236	62.3	9	*
DK	26	11	40.4	766	58.5	14	*
Employment							
*	958	518	54.1	412	43.0	28	2.9
Full Time	2017	630	31.2	1366	67.7	21	1.0
Part Time	379	134	35.4	236	62.3	9	2.4
Not Employed	1309	529	40.4	766	58.5	14	1.1
Education							
*	1021	550	53.9	434	42.5	37	3.6
< High School	399	196	49.1	198	49.6	45	1.3
High School Graduate	1253	501	40.0	739	59.0	13	1.0
< College	895	304	34.0	584	65.3	7	0.8
College Graduate	650	159	24.5	484	74.5	7	1.1
Post Graduate	445	101	22.7	341	76.6	3	0.7
Census Region							
Northeast	1048	370	35.3	655	62.5	23	2.2
Midwest	1036	449	43.3	575	55.5	12	1.2
South	1601	590	36.9	989	61.8	22	1.4
West	978	402	41.1	561	57.4	15	1.5
Day of Week							
Weekday	3156	1254	39.7	1848	58.6	54	1.7
Weekend	1507	557	37.0	932	61.8	18	1.2
Season							
Winter	1264	462	36.6	780	61.7	22	1.7
Spring	1181	469	39.7	691	58.5	21	1.8
Summer	1275	506	39.7	745	58.4	24	1.9
Fall	943	374	39.7	564	59.8	5	0.5

Table 10-24. Percent of Respondents That Responded Yes, No, or Don't Know to Eating Seafood in 1 Month (including shellfish, eels, or squid) (continued)

		Response					
		No		Yes		DK	
Population Group	Total N	N	%	N	%	N	%
Asthma							
No	4287	1674	39.0	2563	59.8	50	1.2
Yes	341	131	38.4	207	60.7	3	0.9
DK	35	6	17.7	10	28.6	19	54.3
Angina							
No	4500	1750	38.9	2698	60.0	52	1.2
Yes	125	56	44.8	68	54.4	1	0.8
DK	38	50	13.2	14	36.8	19	50.0
Bronchitis/Emphysema							
No	4424	1726	9.0	2648	59.6	50	1.1
Yes	203	80	39.4	121	59.6	2	1.0
DK	36	5	13.9	11	30.6	20	55.6

* = Missing data.
DK = Don't know
% = Row percentage.
N = Sample size.

Source: Tsang and Klepeis, 1996.

Table 10-25. Number of Respondents Reporting Consumption of a Specified Number of Servings of Seafood in 1 Month

		Number of Servings in a Month					
Population Group	Total N	1-2	3-5	6-10	11-19	20+	DK
Overall	2780	918	990	519	191	98	64
Gender							
*	1311	405	458	261	101	57	29
Male	1468	512	532	258	90	41	35
Female	1	1	*	*	*	*	*
Age (years)							
*	42	13	16	5	4	1	3
1-4	102	55	29	12	2	*	4
5-11	166	72	57	21	6	4	6
12-17	137	68	54	9	2	1	3
18-64	1946	603	679	408	145	79	32
>64	387	107	155	64	32	13	16
Race							
*	2249	731	818	428	155	76	41
White	304	105	103	56	16	10	14
Black	56	15	17	11	5	5	3
Asian	56	22	18	6	5	3	2
Some Others	93	41	25	14	9	2	2
Hispanic	22	4	9	4	1	2	2
Hispanic							
*	2566	844	922	480	175	88	57
No	182	68	52	34	15	8	5
Yes	15	5	8	2	*	*	*
DK	17	1	8	3	1	2	2
Employment							
*	399	190	140	40	11	5	13
Full Time	1366	407	466	307	107	57	22
Part Time	236	70	95	46	14	8	3
Not Employed	766	249	285	124	57	26	25
Refused	13	2	4	2	2	2	1
Education							
*	434	205	149	47	12	7	14
< High School	198	88	62	20	6	10	12
High School Graduate	739	267	266	119	46	21	20
< College	584	161	219	122	48	26	8
College Graduate	484	115	183	121	43	17	5
Post Graduate	341	82	111	90	36	17	5
Census Region							
Northeast	655	191	241	137	62	12	12
Midwest	575	199	221	102	17	22	14
South	989	336	339	175	70	41	28
West	561	192	189	105	42	23	10
Day of Week							
Weekday	1848	602	661	346	129	70	40
Weekend	932	316	329	173	62	28	24
Season							
Winter	780	262	284	131	60	28	15
Spring	691	240	244	123	45	25	14
Summer	745	220	249	160	59	31	26
Fall	564	196	213	105	27	14	9
Asthma							
No	2563	846	917	475	180	88	57
Yes	207	69	71	42	11	9	5
DK	10	3	2	2	*	1	2

Table 10-25. Number of Respondents Reporting Consumption of a Specified Number of Servings of Seafood in 1 Month (continued)

		Number of Servings in a Month					
Population Group	Total N	1-2	3-5	6-10	11-19	20+	DK
Angina							
No	2698	896	960	509	183	95	55
Yes	68	19	27	8	7	1	6
DK	14	3	3	2	1	2	3
Bronchitis/Emphysema							
No	2648	877	940	495	185	91	60
Yes	121	37	47	23	6	6	2
DK	11	4	3	1	*	1	2

* = Missing data.
DK = Don't know.
% = Row percentage.
N = Sample size.
Refused = Respondent refused to answer.

Source: Tsang and Klepeis, 1996.

Table 10-26. Number of Respondents Reporting Monthly Consumption of Seafood That Was Purchased or Caught by Someone They Knew

Population Group	Total N	*	Mostly Purchased	Mostly Caught	DK
Overall	2780	3	2584	154	39
Gender					
*	1311	1	1206	85	19
Male	1468	2	1377	69	20
Female	1	*	1	*	*
Age (years)					
*	42	*	39	3	*
1 to 4	102	*	94	8	*
5 to 11	166	*	153	9	4
12 to 17	137	*	129	6	2
18 to 64	1946	3	1810	106	27
>64	387	*	359	22	6
Race					
*	2249	1	2092	124	32
White	304	1	280	19	4
Black	56	*	50	4	2
Asian	56	*	55	*	1
Some Others	93	*	86	7	*
Hispanic	22	1	21	*	*
Hispanic					
*	2566	2	2387	140	37
No	182	*	169	13	*
Yes	15	*	12	1	2
DK	17	1	16	*	*
Employment					
*	399	*	368	25	6
Full Time	1366	2	1285	64	15
Part Time	236	1	217	15	3
Not Employed	766	*	701	50	15
Refused	13	*	13	*	*
Education					
*	434	*	401	26	7
< High School	198	*	174	20	4
High School Graduate	739	*	680	48	11
< College	584	2	547	28	7
College Graduate	484	*	460	19	5
Post Graduate	341	1	322	13	5
Census Region					
Northeast	655	2	627	21	5
Midwest	575	*	547	20	8
South	989	1	897	73	18
West	561	*	513	40	8
Day of Week					
Weekday	1848	2	1724	100	22
Weekend	932	1	860	54	17
Season					
Winter	780	*	741	35	4
Spring	691	*	655	27	9
Summer	745	2	674	54	15
Fall	564	1	514	38	11
Asthma					
No	2563	2	2384	142	35
Yes	207	1	190	12	4
DK	10	*	10	*	*

Table 10-26. Number of Respondents Reporting Monthly Consumption of Seafood
That Was Purchased or Caught by Someone They Knew (continued)

Population Group	Total N	*	Mostly Purchased	Mostly Caught	DK
Angina					37
No	2698	3	2507	151	2
Yes	68	*	63	3	*
DK	14	*	14	*	
Bronchitis/Emphysema					
No	2648	3	2457	149	39
Yes	121	*	116	5	*
DK	11	*	11	*	*

* = Missing data.
DK = Don't know.
N = Sample size.
Refused = Respondent refused to answer.

Source: Tsang and Klepeis, 1996.

Table 10-27. Fish Consumption per Kg Bodyweight, all Respondents, by Selected Demographic Characteristics, As-consumed g/kg/day

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Connecticut								
All		420	0.41	85.1	0.00	0.25	1.00	1.32
Gender								
	Male	201	0.39	86.2	0.00	0.24	1.05	1.34
	Female	219	0.43	84.0	0.00	0.28	0.95	1.30
Age-Gender Category								
	Child 1-5	26	0.32	51.7	0.00	0.05	0.95	1.47
	Child 6-10	26	0.51	86.7	0.00	0.35	1.13	1.29
	Child 11-15	21	0.27	85.6	0.00	0.19	0.52	0.89
	Female 16-29	17	0.67	79.9	0.00	0.31	1.06	4.02
	Female 30-49	85	0.46	86.7	0.00	0.28	1.00	1.36
	Female 50+	77	0.43	90.6	0.01	0.33	0.96	1.33
	Male 16-29	14	0.16	70.5	0.00	0.14	0.41	0.53
	Male 30-49	80	0.47	92.8	0.03	0.29	1.13	1.44
	Male 50+	63	0.35	90.5	0.02	0.22	0.86	1.11
	Unknown	11	0.09	76.1	0.00	0.02	0.37	0.45
Race/Ethnicity								
	White, Non-Hispanic	370	0.41	88.7	0.00	0.27	0.98	1.27
	Black, Non-Hispanic	9	0.05	33.5	0.00	0.00	0.17	*
	Hispanic	20	0.48	70.9	0.00	0.21	1.53	2.29
	Asian	19	0.61	59.2	0.00	0.14	1.33	3.80
	Unknown	2	0.01	43.4	0.00	0.00	*	*
Respondent Education								
	0-11	13	0.33	100.0	0.05	0.15	1.04	1.39
	High School	87	0.38	85.3	0.00	0.22	1.00	1.14
	Some College	62	0.41	88.7	0.00	0.30	0.80	1.41
	College grad	258	0.43	83.4	0.00	0.25	1.03	1.32
Household Income ($)								
	0-20000	40	0.39	86.4	0.00	0.26	0.96	1.45
	20000-50000	150	0.47	87.4	0.00	0.28	1.04	1.43
	50000-	214	0.38	84.1	0.00	0.24	0.99	1.27
	Unknown	16	0.32	73.4	0.00	0.30	0.75	1.00
Florida								
All		15367	0.47	50.5	0.00	0.06	1.27	1.91
Gender								
	Male	7911	0.44	49.2	0.00	0.00	1.22	1.84
	Female	7426	0.50	51.9	0.00	0.10	1.32	1.98
	Unknown	30	0.41	48.0	0.00	0.00	1.41	2.38

Table 10-27. Fish Consumption per Kg Bodyweight, all Respondents, by Selected Demographic Characteristics, As-consumed g/kg/day (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Florida (continued)								
Age-Gender Category								
	Child 1-5	1102	0.89	37.8	0.00	0.00	2.75	3.97
	Child 6-10	938	0.44	39.4	0.00	0.00	1.37	2.03
	Child 11-15	864	0.37	42.9	0.00	0.00	1.02	1.44
	Female 16-29	1537	0.44	49.1	0.00	0.00	1.10	1.75
	Female 30-49	2264	0.53	56.6	0.00	0.20	1.38	1.98
	Female 50+	2080	0.41	56.5	0.00	0.20	1.14	1.62
	Male 16-29	1638	0.44	46.1	0.00	0.00	1.11	1.72
	Male 30-49	2540	0.43	53.0	0.00	0.11	1.17	1.77
	Male 50+	2206	0.38	54.5	0.00	0.15	0.98	1.46
	Unknown	198	0.35	54.7	0.00	0.20	0.88	1.22
Race/Ethnicity								
	White, Non-Hispanic	11607	0.46	51.6	0.00	0.09	1.24	1.84
	Black, Non-Hispanic	1603	0.54	48.3	0.00	0.00	1.49	2.24
	Hispanic	1556	0.46	45.9	0.00	0.00	1.20	1.96
	Asian	223	0.58	49.5	0.00	0.00	1.33	1.78
	American Indian	104	0.63	53.4	0.00	0.15	1.95	3.61
	Unknown	274	0.43	45.9	0.00	0.00	1.17	1.71
Respondent Education								
	0-11	1481	0.40	41.5	0.00	0.00	1.16	1.69
	High School	4992	0.46	48.5	0.00	0.00	1.26	1.96
	Some College	4791	0.49	52.3	0.00	0.11	1.30	1.98
	College grad	4012	0.47	54.2	0.00	0.15	1.30	1.85
	Unknown	91	0.46	41.2	0.00	0.00	1.57	2.61
Household Income ($)								
	0-20000	3314	0.47	45.9	0.00	0.00	1.21	2.11
	20000-50000	6678	0.48	50.4	0.00	0.06	1.28	1.92
	50000-	3136	0.51	57.5	0.00	0.21	1.38	1.99
	Unknown	2239	0.35	47.6	0.00	0.00	1.09	1.57
Minnesota								
All		837	0.31	94.4	0.02	0.18	0.62	1.07
Gender								
	Male	419	0.26	95.3	0.02	0.16	0.58	1.06
	Female	418	0.36	93.4	0.02	0.21	0.65	1.10
Age-Gender Category								
	Child 1-5	47	0.57	97.4	0.05	0.45	1.09	1.74
	Child 6-10	46	0.33	88.4	0.00	0.21	0.82	1.34
	Child 11-15	68	0.22	92.8	0.02	0.19	0.54	0.59
	Female 16-29	47	0.67	96.0	0.02	0.15	0.61	4.48
	Female 30-49	132	0.24	95.0	0.02	0.22	0.50	0.58
	Female 50+	162	0.34	94.9	0.03	0.21	0.90	1.35
	Male 16-29	55	0.10	92.3	0.01	0.07	0.26	0.33
	Male 30-49	120	0.24	96.0	0.04	0.16	0.42	0.64
	Male 50+	155	0.24	99.8	0.05	0.19	0.53	0.68
	Unknown	5	0.00	1.6	0.00	0.00	0.00	0.00

Table 10-27. Fish Consumption per Kg Bodyweight, all Respondents, by Selected Demographic Characteristics, As-consumed g/kg/day (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Minnesota (continued)								
Race/Ethnicity								
	White, Non-Hispanic	775	0.27	93.8	0.02	0.17	0.59	0.90
	Black, Non-Hispanic	1	0.00	*	*	*	*	*
	Hispanic	3	0.65	100.0	*	0.27	*	*
	Asian	7	0.53	100.0	0.13	0.47	*	*
	American Indian	12	2.08	100.0	0.09	0.16	*	*
	Unknown	39	0.32	100.0	0.10	0.24	0.79	1.02
Respondent Education								
	0-11	46	0.34	86.2	0.00	0.19	1.23	1.56
	High School	234	0.29	92.9	0.02	0.17	0.65	1.11
	Some College	259	0.41	95.3	0.03	0.20	0.65	0.95
	College grad	255	0.26	95.0	0.02	0.17	0.57	1.05
	Unknown	43	0.24	99.7	0.09	0.23	0.41	0.51
Household Income ($)								
	0-20000	87	0.40	91.0	0.03	0.20	1.20	1.61
	20000-50000	326	0.34	91.3	0.01	0.17	0.62	0.90
	50000-	327	0.29	97.9	0.03	0.18	0.62	1.09
	Unknown	97	0.24	92.9	0.03	0.21	0.56	0.68
North Dakota								
All		575	0.32	95.2	0.03	0.18	0.71	1.18
Gender								
	Male	276	0.32	96.2	0.04	0.19	0.68	1.20
	Female	299	0.32	94.2	0.03	0.17	0.73	1.16
Age-Gender Category								
	Child 1-5	30	0.67	94.4	0.04	0.22	1.56	3.83
	Child 6-10	44	0.51	92.0	0.07	0.29	1.14	1.49
	Child 11-15	55	0.40	97.1	0.06	0.21	1.01	1.24
	Female 16-29	42	0.18	89.9	0.00	0.11	0.39	0.63
	Female 30-49	95	0.28	98.3	0.04	0.18	0.55	0.86
	Female 50+	99	0.38	93.4	0.02	0.16	0.99	1.47
	Male 16-29	36	0.22	100.0	0.04	0.13	0.45	0.56
	Male 30-49	90	0.22	97.8	0.04	0.18	0.45	0.54
	Male 50+	81	0.29	94.0	0.01	0.18	0.67	1.16
	Unknown	3	0.11	31.5	0.00	0.00	*	*
Race/Ethnicity								
	White, Non-Hispanic	528	0.33	95.1	0.03	0.18	0.72	1.21
	Black, Non-Hispanic	2	0.25	100.0	*	0.25	*	*
	Asian	4	0.20	100.0	*	0.18	*	*
	American Indian	9	0.30	100.0	0.08	0.25	0.69	*
	Unknown	32	0.30	93.5	0.05	0.13	0.71	0.94

Table 10-27. Fish Consumption per Kg Bodyweight, all Respondents, by Selected Demographic Characteristics, As-consumed g/kg/day (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
North Dakota (continued)								
Respondent Education								
	0-11	29	0.23	86.6	0.00	0.11	0.65	0.86
	High School	138	0.42	97.3	0.04	0.20	0.89	1.56
	Some College	183	0.28	95.2	0.03	0.18	0.63	0.99
	College Grad	188	0.31	96.7	0.04	0.18	0.69	1.26
	Unknown	37	0.35	87.2	0.00	0.10	0.73	1.32
Household Income ($)								
	0-20000	51	0.52	93.7	0.02	0.17	1.79	2.55
	20000-50000	235	0.27	94.2	0.02	0.14	0.70	1.13
	50000-	233	0.31	97.1	0.05	0.22	0.63	1.02
	Unknown	56	0.42	92.7	0.04	0.18	0.79	1.21

FL Consumption is based on a 7-day recall, CT, MN, ND consumption is based on rate of consumption

FL Consumption excludes away-from-home consumption by children < 18.

Statistics are weighted to represent the general population in the states.

Source: Westat, 2006.

Table 10-28. Fish Consumption per Kg Bodyweight, Consumers only, by Selected Demographic Characteristics, As-consumed g/kg/day

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Connecticut								
All		362	0.48	100	0.07	0.32	1.09	1.37
Gender								
	Male	175	0.45	100	0.08	0.29	1.11	1.40
	Female	187	0.52	100	0.05	0.34	1.03	1.35
Age-Gender Category								
	Child 1-5	14	0.61	100	0.16	0.55	1.42	1.56
	Child 6-10	22	0.59	100	0.14	0.47	1.15	1.30
	Child 11-15	18	0.32	100	0.07	0.19	0.52	0.84
	Female 16-29	14	0.84	100	0.11	0.35	1.12	3.10
	Female 30-49	74	0.53	100	0.05	0.34	1.12	1.48
	Female 50+	70	0.48	100	0.05	0.37	1.03	1.36
	Male 16-29	10	0.23	100	0.08	0.21	0.47	0.56
	Male 30-49	74	0.51	100	0.11	0.35	1.15	1.46
	Male 50+	57	0.38	100	0.10	0.26	0.93	1.12
	Unknown	9	0.12	100	0.01	0.04	0.39	*
Race/Ethnicity								
	White, Non-Hispanic	331	0.46	100	0.07	0.32	1.05	1.31
	Black, Non-Hispanic	3	0.15	100	*	0.15	*	*
	Hispanic	15	0.68	100	0.12	0.30	1.86	2.47
	Asian	12	1.03	100	0.09	0.48	1.95	4.78
	Unknown	1	0.01	100	*	*	*	*
Respondent Education								
	0-11 years	13	0.32	100	0.05	0.15	0.97	1.37
	High School	76	0.44	100	0.05	0.27	1.04	1.15
	Some College	56	0.46	100	0.10	0.34	0.85	1.43
	College grad	217	0.51	100	0.08	0.33	1.12	1.39
Household Income ($)								
	0-20000	35	0.45	100	0.08	0.32	1.13	1.47
	20000-50000	133	0.54	100	0.07	0.33	1.12	1.45
	50000-	182	0.45	100	0.07	0.30	1.06	1.31
	Unknown	12	0.44	100	0.10	0.41	0.84	1.03
Florida								
All		7757	0.93	100	0.19	0.58	1.89	2.73
Gender								
	Male	3880	0.90	100	0.18	0.55	1.85	2.65
	Female	3861	0.95	100	0.19	0.62	1.94	2.78
	Unknown	16	0.85	100	0.12	0.69	2.37	2.61

Table 10-28. Fish Consumption per Kg Bodyweight, Consumers only, by Selected Demographic Characteristics, As-consumed g/kg/day (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Florida (continued)								
Age-Gender Category								
	Child 1-5	420	2.34	100	0.50	1.74	4.67	6.80
	Child 6-10	375	1.10	100	0.28	0.81	2.23	2.97
	Child 11-15	365	0.85	100	0.20	0.63	1.62	2.16
	Female 16-29	753	0.89	100	0.16	0.55	1.77	2.42
	Female 30-49	1287	0.94	100	0.18	0.63	1.86	2.68
	Female 50+	1171	0.73	100	0.19	0.52	1.52	2.05
	Male 16-29	754	0.96	100	0.16	0.52	1.77	2.65
	Male 30-49	1334	0.81	100	0.17	0.53	1.69	2.44
	Male 50+	1192	0.70	100	0.17	0.50	1.41	1.93
	Unknown	106	0.64	100	0.21	0.49	1.15	1.55
Race/Ethnicity								
	White, Non-Hispanic	5957	0.88	100	0.18	0.56	1.82	2.61
	Black, Non-Hispanic	785	1.11	100	0.23	0.73	2.27	3.21
	Hispanic	721	1.01	100	0.17	0.60	2.08	2.81
	Asian	110	1.16	100	0.27	0.67	1.78	3.29
	American Indian	57	1.17	100	0.21	0.69	3.13	4.70
	Unknown	127	0.94	100	0.19	0.67	1.73	2.43
Respondent Education								
	0-11 years	613	0.96	100	0.22	0.60	1.86	2.81
	High School	2405	0.96	100	0.18	0.58	1.98	2.83
	Some College	2511	0.93	100	0.18	0.58	1.91	2.70
	College grad	2190	0.87	100	0.19	0.57	1.79	2.47
	Unknown	38	1.13	100	0.25	0.85	2.69	2.74
Household Income ($)								
	0-20000	1534	1.03	100	0.19	0.61	2.22	2.99
	20000-50000	3370	0.95	100	0.19	0.60	1.91	2.78
	50000-	1806	0.89	100	0.17	0.56	1.87	2.73
	Unknown	1047	0.74	100	0.17	0.51	1.61	2.09
Minnesota								
All		793	0.33	100	0.04	0.2	0.65	1.08
Gender								
	Male	401	0.28	100	0.04	0.17	0.62	1.07
	Female	392	0.38	100	0.05	0.22	0.7	1.22
Age-Gender Category								
	Child 1-5	46	0.58	100	0.07	0.46	1.1	1.75
	Child 6-10	42	0.38	100	0.05	0.25	1.01	1.36
	Child 11-15	63	0.24	100	0.03	0.21	0.55	0.59
	Female 16-29	44	0.69	100	0.02	0.16	0.66	2.95
	Female 30-49	127	0.25	100	0.04	0.23	0.51	0.58
	Female 50+	150	0.36	100	0.05	0.22	0.93	1.37
	Male 16-29	52	0.11	100	0.02	0.08	0.27	0.33
	Male 30-49	115	0.25	100	0.07	0.17	0.42	0.64
	Male 50+	153	0.24	100	0.05	0.19	0.53	0.68
	Unknown	1	0.18	100	*	*	*	*

Table 10-28. Fish Consumption per Kg Bodyweight, Consumers only, by Selected Demographic Characteristics, As-consumed g/kg/day (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Minnesota (continued)								
Race/Ethnicity								
	White, Non-Hispanic	732	0.29	100	0.04	0.19	0.60	0.98
	Black, Non-Hispanic	*	*	100	*	*	*	*
	Hispanic	3	0.65	100	*	0.27	*	*
	Asian	7	0.53	100	0.13	0.46	*	*
	American Indian	12	2.08	100	0.09	0.15	*	*
	Unknown	39	0.32	100	0.10	0.24	0.79	1.01
Respondent Education								
	0-11 years	41	0.39	100	0.07	0.20	1.37	1.56
	High School	219	0.31	100	0.04	0.18	0.68	1.13
	Some College	249	0.43	100	0.04	0.22	0.65	0.98
	College grad	242	0.27	100	0.04	0.19	0.58	1.05
	Unknown	42	0.24	100	0.09	0.23	0.41	0.50
Household Income ($)								
	0-20000	77	0.44	100	0.09	0.20	1.30	1.63
	20000-50000	301	0.37	100	0.05	0.18	0.65	0.96
	50000-	321	0.29	100	0.03	0.19	0.62	1.10
	Unknown	94	0.26	100	0.05	0.23	0.57	0.69
North Dakota								
All		546	0.34	100	0.05	0.19	0.74	1.21
Gender								
	Male	265	0.33	100	0.04	0.20	0.74	1.22
	Female	281	0.34	100	0.05	0.18	0.74	1.20
Age-Gender Category								
	Child 1-5	28	0.70	100	0.05	0.23	1.58	3.82
	Child 6-10	41	0.56	100	0.11	0.30	1.17	1.51
	Child 11-15	53	0.41	100	0.06	0.22	1.04	1.26
	Female 16-29	38	0.20	100	0.04	0.15	0.41	0.67
	Female 30-49	93	0.29	100	0.05	0.18	0.56	0.87
	Female 50+	92	0.40	100	0.06	0.17	1.14	1.52
	Male 16-29	36	0.22	100	0.04	0.13	0.45	0.56
	Male 30-49	88	0.22	100	0.05	0.18	0.45	0.54
	Male 50+	76	0.31	100	0.04	0.19	0.74	1.20
	Unknown	1	0.34	100	*	*	*	*
Race/Ethnicity								
	White, Non-Hispanic	501	0.34	100	0.05	0.19	0.74	1.23
	Black, Non-Hispanic	2	0.25	100	*	0.25	*	*
	Asian	4	0.20	100	*	0.14	*	*
	American Indian	9	0.30	100	0.08	0.25	0.61	*
	Unknown	30	0.32	100	0.05	0.16	0.73	0.95
Respondent Education								
	0-11 years	25	0.26	100	0.07	0.12	0.73	0.90
	High School	134	0.43	100	0.05	0.20	0.98	1.62
	Some College	174	0.29	100	0.05	0.20	0.65	1.02
	College grad	181	0.32	100	0.05	0.19	0.72	1.30
	Unknown	32	0.40	100	0.04	0.13	0.84	1.43

Table 10-28. Fish Consumption per Kg Bodyweight, Consumers only, by Selected Demographic Characteristics, As-consumed g/kg/day (continued)								
					Percentiles			
State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	10th	50th	90th	95th
North Dakota (continued)								
Household Income ($)								
	0-20000	48	0.55	100	0.07	0.19	1.80	2.62
	20000-50000	221	0.29	100	0.04	0.15	0.73	1.17
	50000-	225	0.32	100	0.06	0.23	0.64	1.04
	Unknown	52	0.45	100	0.05	0.20	0.82	1.28

FL Consumption is based on a 7-day recall, CT, MN, ND consumption is based on rate of consumption

FL Consumption excludes away-from-home consumption by children < 18.

Statistics are weighted to represent the general population in the states.

Source: Westat, 2006.

Table 10-29. Fish Consumption per Kg Bodyweight, all Respondents by State, Acquisition MethodAs-consumed g/kg/day

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Connecticut								
All		420	0.41	85.1	0.00	0.25	1.00	1.32
Acquisition Method								
	Bought	420	0.40	84.8	0.00	0.25	0.96	1.30
	Caught	420	0.01	16.3	0.00	0.00	0.01	0.03
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	40	0.38	86.4	0.00	0.26	0.96	1.45
	Bought; 20000-50000	150	0.46	86.6	0.00	0.27	0.93	1.42
	Bought; 50000-	214	0.38	84.1	0.00	0.24	0.99	1.27
	Bought; Unknown	16	0.32	73.4	0.00	0.30	0.75	1.00
	Caught; 0-20000	40	0.01	11.0	0.00	0.00	0.00	0.05
	Caught; 20000-50000	150	0.01	18.1	0.00	0.00	0.02	0.06
	Caught; 50000-	214	0.01	16.8	0.00	0.00	0.01	0.02
	Caught; Unknown	16	0.00	6.2	0.00	0.00	0.00	0.01
Habitat								
	Freshwater	420	0.01	36.4	0.00	0.00	0.03	0.07
	Estuarine	420	0.10	76.0	0.00	0.04	0.23	0.43
	Marine	420	0.29	84.8	0.00	0.17	0.67	0.97
Fish/Shellfish Type								
	Shellfish	420	0.13	74.6	0.00	0.06	0.30	0.55
	Finfish	420	0.27	82.7	0.00	0.14	0.69	0.95
Florida								
All		15367	0.47	50.5	0.00	0.06	1.27	1.91
Acquisition Method								
	Bought	15367	0.41	47.5	0.00	0.00	1.12	1.70
	Caught	15367	0.06	7.4	0.00	0.00	0.00	0.34
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	3314	0.41	42.5	0.00	0.00	1.10	1.84
	Bought; 20000-50000	6678	0.41	47.4	0.00	0.00	1.11	1.68
	Bought; 50000-	3136	0.45	54.2	0.00	0.14	1.27	1.79
	Bought; Unknown	2239	0.32	45.3	0.00	0.00	0.99	1.45
	Caught; 0-20000	3314	0.06	6.7	0.00	0.00	0.00	0.32
	Caught; 20000-50000	6678	0.07	7.8	0.00	0.00	0.00	0.38
	Caught; 50000-	3136	0.06	8.4	0.00	0.00	0.00	0.42
	Caught; Unknown	2239	0.03	5.5	0.00	0.00	0.00	0.16
Habitat								
	Freshwater	15367	0.04	9.1	0.00	0.00	0.00	0.26
	Estuarine	15367	0.10	26.5	0.00	0.00	0.32	0.54
	Marine	15367	0.33	40.3	0.00	0.00	0.90	1.43
Fish/Shellfish Type								
	Shellfish	15367	0.07	21.1	0.00	0.00	0.22	0.43
	Finfish	15367	0.39	41.9	0.00	0.00	1.10	1.67

Table 10-29. Fish Consumption per Kg Bodyweight, all Respondents by State, Acquisition MethodAs-consumed g/kg/day (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Minnesota								
All		837	0.31	94.4	0.02	0.18	0.62	1.07
Acquisition Method								
	Bought	837	0.20	89.9	0.00	0.10	0.51	0.76
	Caught	837	0.11	60.6	0.00	0.03	0.22	0.37
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	87	0.26	90.7	0.02	0.12	0.61	1.06
	Bought; 20000-50000	326	0.18	84.4	0.00	0.10	0.45	0.58
	Bought; 50000-	327	0.20	93.9	0.02	0.10	0.55	0.86
	Bought; Unknown	97	0.21	91.3	0.01	0.18	0.54	0.65
	Caught; 0-20000	87	0.14	70.4	0.00	0.03	0.28	1.00
	Caught; 20000-50000	326	0.15	66.0	0.00	0.04	0.25	0.36
	Caught; 50000-	327	0.09	55.5	0.00	0.02	0.24	0.39
	Caught; Unknown	97	0.04	56.7	0.00	0.02	0.12	0.14
Habitat								
	Freshwater	837	0.11	60.6	0.00	0.03	0.22	0.37
	Estuarine	837	0.02	67.5	0.00	0.01	0.05	0.09
	Marine	837	0.18	89.9	0.00	0.09	0.46	0.68
Fish/Shellfish Type								
	Shellfish	837	0.04	67.5	0.00	0.01	0.10	0.18
	Finfish	837	0.27	94.0	0.01	0.15	0.57	0.83
North Dakota								
All		575	0.32	95.2	0.03	0.18	0.71	1.18
Acquisition Method								
	Bought	575	0.23	89.9	0.00	0.10	0.52	0.93
	Caught	575	0.09	68.3	0.00	0.04	0.24	0.40
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	51	0.41	88.0	0.00	0.12	1.34	2.03
	Bought; 20000-50000	235	0.21	90.6	0.01	0.09	0.48	1.01
	Bought; 50000-	233	0.19	90.7	0.01	0.10	0.48	0.77
	Bought; Unknown	56	0.30	85.5	0.00	0.10	0.66	0.91
	Caught; 0-20000	51	0.10	53.9	0.00	0.01	0.23	0.45
	Caught; 20000-50000	235	0.07	59.4	0.00	0.02	0.18	0.30
	Caught; 50000-	233	0.12	76.2	0.00	0.06	0.34	0.46
	Caught; Unknown	56	0.11	85.7	0.00	0.05	0.22	0.23
Habitat								
	Freshwater	575	0.09	68.3	0.00	0.04	0.24	0.40
	Estuarine	575	0.02	71.3	0.00	0.01	0.05	0.08
	Marine	575	0.21	89.9	0.00	0.09	0.45	0.80

Table 10-29. Fish Consumption per Kg Bodyweight, all Respondents by State, Acquisition MethodAs-consumed g/kg/day (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
North Dakota (continued)								
Fish/Shellfish Type								
	Shellfish	575	0.04	71.3	0.00	0.02	0.09	0.15
	Finfish	575	0.28	94.3	0.02	0.14	0.63	1.01

FL Consumption is based on a 7-day recall, CT, MN, ND consumption is based on rate of consumption

FL Consumption excludes away-from-home consumption by children < 18.

Statistics are weighted to represent the general population in the states.

A respondent can be represented in more than one row.

Source: Westat, 2006.

Table 10-30. Fish Consumption per Kg Bodyweight, Consumers only, by State, Acquisition Method, As-consumed g/kg/day								
					Percentiles			
State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	10th	50th	90th	95th
Connecticut								
All		362	0.48	100	0.07	0.32	1.09	1.37
Acquisition Method								
	Bought	361	0.47	100	0.07	0.31	1.05	1.38
	Caught	71	0.05	100	0.00	0.02	0.13	0.18
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	35	0.44	100	0.08	0.30	1.13	1.47
	Bought; 20000-50000	132	0.53	100	0.07	0.32	1.03	1.46
	Bought; 50000-	182	0.45	100	0.06	0.30	1.04	1.29
	Bought; Unknown	12	0.44	100	0.10	0.41	0.84	1.03
	Caught; 0-20000	4	0.05	100	*	0.01	*	*
	Caught; 20000-50000	30	0.08	100	0.00	0.02	0.23	0.46
	Caught; 50000-	36	0.03	100	0.00	0.02	0.08	0.11
	Caught; Unknown	1	0.01	100	*	*	*	*
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	1	0.01	100	*	*	*	*
	Eats Caught&Bought	70	0.49	100	0.10	0.34	1.10	1.33
	Eats Bought Only	291	0.48	100	0.06	0.32	1.06	1.39
Habitat								
	Freshwater	157	0.04	100	0.00	0.02	0.07	0.15
	Estuarine	327	0.14	100	0.01	0.06	0.30	0.51
	Marine	361	0.34	100	0.04	0.23	0.78	1.09
Eats Freshwater/Estuarine Caught Fish								
	Sometimes	50	0.46	100	0.09	0.29	1.10	1.25
	Never	312	0.49	100	0.07	0.32	1.06	1.41
Fish/Shellfish Type								
	Shellfish	320	0.18	100	0.02	0.09	0.37	0.68
	Finfish	353	0.32	100	0.02	0.20	0.77	1.08
Florida								
All		7757	0.93	100	0.19	0.58	1.89	2.73
Acquisition Method								
	Bought	7246	0.86	100	0.17	0.54	1.77	2.55
	Caught	1212	0.83	100	0.15	0.52	1.74	2.36
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	1418	0.97	100	0.19	0.58	2.10	2.78
	Bought; 20000-50000	3141	0.87	100	0.18	0.56	1.74	2.50
	Bought; 50000-	1695	0.83	100	0.16	0.53	1.75	2.54
	Bought; Unknown	992	0.71	100	0.16	0.48	1.55	2.06
	Caught; 0-20000	246	0.89	100	0.19	0.60	1.94	2.77
	Caught; 20000-50000	563	0.90	100	0.15	0.53	1.79	2.38
	Caught; 50000-	274	0.76	100	0.11	0.49	1.63	2.42
	Caught; Unknown	129	0.58	100	0.16	0.41	1.07	1.52

Table 10-30. Fish Consumption per Kg Bodyweight, Consumers only, by State, Acquisition MethodAs-consumed g/kg/day (continued)								
					Percentiles			
State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	10th	50th	90th	95th
Florida (continued)								
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	511	0.76	100	0.15	0.50	1.67	2.34
	Eats Caught&Bought	701	1.81	100	0.50	1.15	3.35	5.09
	Eats Bought Only	6545	0.85	100	0.18	0.54	1.75	2.49
Habitat								
	Freshwater	1426	0.47	100	0.07	0.30	1.09	1.51
	Estuarine	4124	0.37	100	0.07	0.23	0.80	1.14
	Marine	6124	0.81	100	0.15	0.50	1.64	2.40
Eats Freshwater/Estuarine Caught Fish								
	Exclusively	235	0.71	100	0.10	0.42	1.60	2.16
	Sometimes	458	1.73	100	0.43	1.10	3.44	4.96
	Never	7064	0.88	100	0.18	0.56	1.81	2.60
Fish/Shellfish Type								
	Shellfish	3260	0.35	100	0.07	0.21	0.74	1.02
	Finfish	6428	0.94	100	0.24	0.60	1.85	2.72
Minnesota								
All		793	0.33	100	0.04	0.20	0.65	1.08
Acquisition Method								
	Bought	755	0.22	100	0.03	0.12	0.55	0.83
	Caught	593	0.18	100	0.02	0.07	0.30	0.57
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	76	0.29	100	0.04	0.13	0.64	1.08
	Bought; 20000-50000	284	0.22	100	0.03	0.13	0.47	0.74
	Bought; 50000-	312	0.21	100	0.03	0.11	0.57	0.97
	Bought; Unknown	83	0.23	100	0.02	0.2	0.54	0.65
	Caught; 0-20000	56	0.19	100	0.02	0.05	0.49	1.09
	Caught; 20000-50000	232	0.23	100	0.02	0.08	0.30	0.46
	Caught; 50000-	235	0.16	100	0.02	0.08	0.37	0.65
	Caught; Unknown	70	0.07	100	0.02	0.03	0.14	0.16
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	38	0.16	100	0.02	0.08	0.37	0.51
	Eats Caught&Bought	555	0.40	100	0.08	0.23	0.70	1.32
	Eats Bought Only	200	0.23	100	0.02	0.14	0.56	0.91
Habitat								
	Freshwater	593	0.18	100	0.02	0.07	0.30	0.57
	Estuarine	559	0.03	100	0.00	0.01	0.07	0.12
	Marine	755	0.20	100	0.02	0.10	0.50	0.73
Eats Freshwater/Estuarine Caught Fish								
	Exclusively	38	0.16	100	0.02	0.08	0.37	0.51
	Sometimes	555	0.40	100	0.08	0.23	0.70	1.32
	Never	200	0.23	100	0.02	0.14	0.56	0.91

Table 10-30. Fish Consumption per Kg Bodyweight, Consumers only, by State, Acquisition Method, As-consumed g/kg/day (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Minnesota (continued)								
Fish/Shellfish Type								
	Shellfish	559	0.06	100	0.01	0.02	0.14	0.24
	Finfish	791	0.28	100	0.03	0.16	0.57	0.86
North Dakota								
All		546	0.34	100	0.05	0.19	0.74	1.21
Acquisition Method								
	Bought	516	0.25	100	0.03	0.12	0.61	1.02
	Caught	389	0.14	100	0.02	0.07	0.34	0.46
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	45	0.47	100	0.05	0.14	1.54	2.22
	Bought; 20000-50000	213	0.23	100	0.03	0.11	0.52	1.03
	Bought; 50000-	210	0.21	100	0.03	0.11	0.48	0.79
	Bought; Unknown	48	0.35	100	0.03	0.14	0.70	1.08
	Caught; 0-20000	27	0.19	100	0.01	0.08	0.42	0.64
	Caught; 20000-50000	142	0.11	100	0.02	0.05	0.25	0.40
	Caught; 50000-	173	0.15	100	0.02	0.08	0.38	0.53
	Caught; Unknown	47	0.13	100	0.03	0.06	0.23	0.24
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	30	0.21	100	0.05	0.14	0.33	0.51
	Eats Caught&Bought	359	0.39	100	0.07	0.23	0.82	1.25
	Eats Bought Only	157	0.25	100	0.03	0.10	0.53	0.97
Habitat								
	Freshwater	389	0.14	100	0.02	0.07	0.34	0.46
	Estuarine	407	0.03	100	0.00	0.01	0.06	0.10
	Marine	516	0.23	100	0.02	0.10	0.54	0.86
Eats Freshwater/Estuarine Caught Fish								
	Exclusively	30	0.21	100	0.05	0.14	0.33	0.51
	Sometimes	359	0.39	100	0.07	0.23	0.82	1.25
	Never	157	0.25	100	0.03	0.10	0.53	0.97
Fish/Shellfish Type								
	Shellfish	407	0.05	100	0.01	0.02	0.13	0.21
	Finfish	541	0.30	100	0.04	0.16	0.67	1.08

FL Consumption is based on a 7-day recall, CT, MN, ND consumption is based on rate of consumption

FL Consumption excludes away-from-home consumption by children < 18.

Statistics are weighted to represent the general population in the states.

A respondent can be represented in more than one row.

Source: Westat, 2006.

Table 10-31. Fish Consumption per Kg Bodyweight, all Respondents, by Selected Demographic Characteristics, Uncooked g/kg/day

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Connecticut								
All		420	0.56	85.1	0.00	0.35	1.37	1.76
Gender								
	Male	201	0.53	86.2	0.00	0.34	1.48	1.78
	Female	219	0.59	84.0	0.00	0.39	1.29	1.73
Age-Gender Category								
	Child 1-5	26	0.43	51.7	0.00	0.07	1.25	1.95
	Child 6-10	26	0.71	86.7	0.00	0.48	1.55	1.74
	Child 11-15	21	0.37	85.6	0.00	0.25	0.71	1.20
	Female 16-29	17	0.88	79.9	0.00	0.43	1.41	5.25
	Female 30-49	85	0.64	86.7	0.00	0.39	1.39	1.80
	Female 50+	77	0.59	90.6	0.01	0.45	1.28	1.74
	Male 16-29	14	0.23	70.5	0.00	0.21	0.55	0.74
	Male 30-49	80	0.64	92.8	0.04	0.43	1.56	1.97
	Male 50+	63	0.47	90.5	0.03	0.36	1.15	1.55
	Unknown	11	0.12	76.1	0.00	0.03	0.52	0.62
Race/Ethnicity								
	White, Non-Hispanic	370	0.56	88.7	0.00	0.38	1.32	1.69
	Black, Non-Hispanic	9	0.07	33.5	0.00	0.00	0.23	*
	Hispanic	20	0.67	70.9	0.00	0.29	2.14	3.43
	Asian	19	0.81	59.2	0.00	0.18	1.74	4.96
	Unknown	2	0.01	43.4	0.00	0.00	*	*
Respondent Education								
	0-11	13	0.43	100.0	0.07	0.20	1.34	1.74
	High School	87	0.51	85.3	0.00	0.30	1.40	1.55
	Some College	62	0.56	88.7	0.00	0.41	1.09	1.87
	College grad	258	0.58	83.4	0.00	0.36	1.40	1.78
Household Income ($)								
	0-20000	40	0.52	86.4	0.00	0.34	1.28	1.86
	20000-50000	150	0.64	87.4	0.00	0.39	1.40	1.93
	50000-	214	0.52	84.1	0.00	0.34	1.37	1.69
	Unknown	16	0.45	73.4	0.00	0.42	1.02	1.36
Florida								
All		15367	0.59	50.5	0.00	0.08	1.59	2.39
Gender								
	Male	7911	0.55	49.2	0.00	0.00	1.51	2.32
	Female	7426	0.62	51.9	0.00	0.14	1.66	2.48
	Unknown	30	0.51	48.0	0.00	0.00	1.73	2.90

Table 10-31. Fish Consumption per Kg Bodyweight, all Respondents, by Selected Demographic Characteristics, Uncooked g/kg/day (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Florida (continued)								
Age-Gender Category								
	Child 1-5	1102	1.10	37.8	0.00	0.00	3.41	4.85
	Child 6-10	938	0.54	39.4	0.00	0.00	1.69	2.55
	Child 11-15	864	0.46	42.9	0.00	0.00	1.27	1.92
	Female 16-29	1537	0.55	49.1	0.00	0.00	1.42	2.20
	Female 30-49	2264	0.67	56.6	0.00	0.27	1.73	2.56
	Female 50+	2080	0.52	56.5	0.00	0.27	1.44	2.04
	Male 16-29	1638	0.55	46.1	0.00	0.00	1.41	2.20
	Male 30-49	2540	0.54	53.0	0.00	0.16	1.49	2.21
	Male 50+	2206	0.49	54.5	0.00	0.20	1.24	1.86
	Unknown	198	0.45	54.7	0.00	0.27	1.07	1.53
Race/Ethnicity								
	White, Non-Hispanic	11607	0.57	51.6	0.00	0.12	1.56	2.33
	Black, Non-Hispanic	1603	0.67	48.3	0.00	0.00	1.87	2.77
	Hispanic	1556	0.57	45.9	0.00	0.00	1.52	2.46
	Asian	223	0.72	49.5	0.00	0.00	1.65	2.34
	American Indian	104	0.78	53.4	0.00	0.20	2.46	4.52
	Unknown	274	0.53	45.9	0.00	0.00	1.45	2.14
Respondent Education								
	0-11	1481	0.50	41.5	0.00	0.00	1.45	2.16
	High School	4992	0.58	48.5	0.00	0.00	1.59	2.45
	Some College	4791	0.61	52.3	0.00	0.15	1.59	2.47
	College grad	4012	0.60	54.2	0.00	0.20	1.64	2.34
	Unknown	91	0.58	41.2	0.00	0.00	2.04	3.05
Household Income ($)								
	0-20000	3314	0.59	45.9	0.00	0.00	1.55	2.61
	20000-50000	6678	0.61	50.4	0.00	0.08	1.61	2.42
	50000-	3136	0.65	57.5	0.00	0.27	1.77	2.53
	Unknown	2239	0.45	47.6	0.00	0.00	1.36	1.99
Minnesota								
All		837	0.41	94.4	0.03	0.24	0.83	1.43
Gender								
	Male	419	0.35	95.3	0.03	0.22	0.77	1.41
	Female	418	0.48	93.4	0.02	0.27	0.87	1.46

Table 10-31. Fish Consumption per Kg Bodyweight, all Respondents, by Selected Demographic Characteristics, Uncooked g/kg/day (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Minnesota (continued)								
Age-Gender Category								
	Child 1-5	47	0.76	97.4	0.06	0.60	1.46	2.32
	Child 6-10	46	0.44	88.4	0.00	0.28	1.09	1.79
	Child 11-15	68	0.29	92.8	0.02	0.25	0.72	0.78
	Female 16-29	47	0.89	96.0	0.03	0.20	0.81	5.97
	Female 30-49	132	0.32	95.0	0.03	0.29	0.67	0.77
	Female 50+	162	0.46	94.9	0.04	0.28	1.19	1.80
	Male 16-29	55	0.13	92.3	0.01	0.09	0.35	0.44
	Male 30-49	120	0.32	96.0	0.06	0.22	0.56	0.85
	Male 50+	155	0.32	99.8	0.06	0.25	0.70	0.91
	Unknown	5	0.00	1.6	0.00	0.00	0.00	0.00
Race/Ethnicity								
	White, Non-Hispanic	775	0.36	93.8	0.02	0.23	0.79	1.19
	Black, Non-Hispanic	1	0.00	*	*	*	*	*
	Hispanic	3	0.86	100	*	0.36	*	*
	Asian	7	0.71	100	0.18	0.63	*	*
	American Indian	12	2.77	100	0.12	0.21	*	*
	Unknown	39	0.43	100	0.14	0.31	1.05	1.36
Respondent Education								
	0-11	46	0.45	86.2	0.00	0.25	1.64	2.08
	High School	234	0.39	92.9	0.02	0.22	0.86	1.48
	Some College	259	0.54	95.3	0.04	0.27	0.86	1.27
	College grad	255	0.34	95.0	0.03	0.23	0.76	1.40
	Unknown	43	0.32	99.7	0.12	0.30	0.55	0.68
Household Income ($)								
	0-20000	87	0.53	91.0	0.04	0.27	1.60	2.14
	20000-50000	326	0.45	91.3	0.02	0.23	0.83	1.20
	50000-	327	0.38	97.9	0.04	0.24	0.82	1.46
	Unknown	97	0.33	92.9	0.04	0.29	0.74	0.91
North Dakota								
All		575	0.43	95.2	0.05	0.24	0.95	1.58
Gender								
	Male	276	0.43	96.2	0.05	0.25	0.91	1.60
	Female	299	0.43	94.2	0.04	0.23	0.97	1.55

Table 10-31. Fish Consumption per Kg Bodyweight, all Respondents, by Selected Demographic Characteristics, Uncooked g/kg/day (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
North Dakota (continued)								
Age-Gender Category								
	Child 1-5	30	0.89	94.4	0.05	0.30	2.08	5.10
	Child 6-10	44	0.68	92.0	0.09	0.39	1.52	1.99
	Child 11-15	55	0.53	97.1	0.07	0.28	1.35	1.65
	Female 16-29	42	0.24	89.9	0.00	0.15	0.52	0.84
	Female 30-49	95	0.38	98.3	0.05	0.24	0.74	1.14
	Female 50+	99	0.50	93.4	0.03	0.21	1.32	1.95
	Male 16-29	36	0.29	100.0	0.05	0.17	0.61	0.75
	Male 30-49	90	0.29	97.8	0.05	0.23	0.59	0.71
	Male 50+	81	0.38	94.0	0.02	0.23	0.90	1.54
	Unknown	3	0.14	31.5	0.00	0.00	*	*
Race/Ethnicity								
	White, Non-Hispanic	528	0.43	95.1	0.04	0.24	0.96	1.62
	Black, Non-Hispanic	2	0.33	100.0	*	0.33	*	*
	Asian	4	0.26	100.0	*	0.24	*	*
	American Indian	9	0.40	100.0	0.11	0.33	0.92	*
	Unknown	32	0.40	93.5	0.06	0.18	0.95	1.25
Respondent Education								
	0-11	29	0.30	86.6	0.00	0.15	0.86	1.15
	High School	138	0.56	97.3	0.06	0.26	1.19	2.08
	Some College	183	0.37	95.2	0.04	0.25	0.84	1.32
	College Grad	188	0.41	96.7	0.05	0.25	0.92	1.69
	Unknown	37	0.46	87.2	0.00	0.13	0.98	1.76
Household Income ($)								
	0-20000	51	0.69	93.7	0.03	0.23	2.39	3.40
	20000-50000	235	0.36	94.2	0.03	0.18	0.93	1.51
	50000-	233	0.41	97.1	0.06	0.30	0.84	1.36
	Unknown	56	0.55	92.7	0.05	0.24	1.05	1.62

FL Consumption is based on a 7-day recall, CT, MN, ND consumption is based on rate of consumption

FL Consumption excludes away-from-home consumption by children < 18.

Statistics are weighted to represent the general population in the states.

Source: Westat, 2006.

Table 10-32. Fish Consumption per Kg Bodyweight, Consumers only, by Selected Demographic Characteristics, Uncooked g/kg/day

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Connecticut								
All		362	0.66	100	0.10	0.43	1.51	1.80
Gender								
	Male	175	0.61	100	0.11	0.41	1.54	1.85
	Female	187	0.70	100	0.09	0.47	1.40	1.77
Age-Gender Category								
	Child 1-5	14	0.83	100	0.21	0.74	1.88	2.07
	Child 6-10	22	0.81	100	0.21	0.74	1.57	1.76
	Child 11-15	18	0.43	100	0.12	0.30	0.72	1.14
	Female 16-29	14	1.10	100	0.15	0.47	1.50	4.07
	Female 30-49	74	0.73	100	0.08	0.47	1.60	1.97
	Female 50+	70	0.65	100	0.07	0.50	1.39	1.76
	Male 16-29	10	0.32	100	0.11	0.30	0.63	0.78
	Male 30-49	74	0.69	100	0.15	0.48	1.58	1.98
	Male 50+	57	0.52	100	0.14	0.38	1.25	1.55
	Unknown	9	0.16	100	0.01	0.05	0.54	*
Race/Ethnicity								
	White, Non-Hispanic	331	0.63	100	0.10	0.43	1.41	1.75
	Black, Non-Hispanic	3	0.20	100	*	0.20	*	*
	Hispanic	15	0.95	100	0.16	0.39	2.95	3.52
	Asian	12	1.36	100	0.12	0.69	2.57	6.24
	Unknown	1	0.03	100	*	*	*	*
Respondent Education								
	0-11	13	0.43	100	0.07	0.20	1.27	1.72
	High School	76	0.60	100	0.06	0.37	1.47	1.56
	Some College	56	0.63	100	0.16	0.46	1.16	1.89
	College grad	217	0.70	100	0.11	0.45	1.53	1.85
Household Income ($)								
	0-20000	35	0.60	100	0.10	0.43	1.53	1.90
	20000-50000	133	0.73	100	0.12	0.46	1.55	1.98
	50000-	182	0.62	100	0.09	0.41	1.49	1.75
	Unknown	12	0.61	100	0.13	0.57	1.14	1.41
Florida								
All		7757	1.16	100	0.24	0.73	2.39	3.37
Gender								
	Male	3880	1.12	100	0.23	0.69	2.33	3.32
	Female	3861	1.20	100	0.25	0.77	2.42	3.48
	Unknown	16	1.05	100	0.15	0.91	2.90	3.19

Table 10-32. Fish Consumption per Kg Bodyweight, Consumers only, by Selected Demographic Characteristics, Uncooked g/kg/day (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Florida (continued)								
Age-Gender Category								
	Child 1-5	420	2.92	100	0.63	2.16	5.73	8.37
	Child 6-10	375	1.37	100	0.38	1.01	2.72	3.45
	Child 11-15	365	1.06	100	0.28	0.79	2.02	2.78
	Female 16-29	753	1.12	100	0.23	0.71	2.22	3.10
	Female 30-49	1287	1.18	100	0.24	0.78	2.39	3.31
	Female 50+	1171	0.91	100	0.24	0.66	1.92	2.53
	Male 16-29	754	1.19	100	0.22	0.66	2.26	3.30
	Male 30-49	1334	1.02	100	0.22	0.67	2.18	3.05
	Male 50+	1192	0.89	100	0.22	0.62	1.75	2.51
	Unknown	106	0.81	100	0.27	0.61	1.50	2.02
Race/Ethnicity								
	White, Non-Hispanic	5957	1.11	100	0.24	0.71	2.30	3.28
	Black, Non-Hispanic	785	1.39	100	0.30	0.91	2.81	3.92
	Hispanic	721	1.25	100	0.23	0.75	2.53	3.57
	Asian	110	1.46	100	0.35	0.84	2.34	4.08
	American Indian	57	1.45	100	0.28	0.90	4.02	5.73
	Unknown	127	1.16	100	0.24	0.81	2.23	3.10
Respondent Education								
	0-11	613	1.20	100	0.27	0.74	2.38	3.53
	High School	2405	1.20	100	0.23	0.73	2.49	3.58
	Some College	2511	1.16	100	0.24	0.72	2.39	3.39
	College grad	2190	1.10	100	0.24	0.73	2.25	3.17
	Unknown	38	1.40	100	0.32	1.06	3.08	3.17
Household Income ($)								
	0-20000	1534	1.28	100	0.25	0.77	2.77	3.66
	20000-50000	3370	1.20	100	0.25	0.75	2.41	3.45
	50000-	1806	1.13	100	0.22	0.71	2.39	3.37
	Unknown	1047	0.93	100	0.23	0.64	2.06	2.52
Minnesota								
All		793	0.44	100	0.06	0.26	0.86	1.44
Gender								
	Male	401	0.37	100	0.05	0.23	0.82	1.43
	Female	392	0.51	100	0.06	0.29	0.93	1.62

Table 10-32. Fish Consumption per Kg Bodyweight, Consumers only, by Selected Demographic Characteristics, Uncooked g/kg/day (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Minnesota (continued)								
Age-Gender Category								
	Child 1-5	46	0.78	100	0.09	0.62	1.47	2.33
	Child 6-10	42	0.50	100	0.06	0.33	1.35	1.81
	Child 11-15	63	0.32	100	0.04	0.28	0.73	0.78
	Female 16-29	44	0.92	100	0.03	0.21	0.88	3.93
	Female 30-49	127	0.34	100	0.05	0.30	0.68	0.78
	Female 50+	150	0.48	100	0.07	0.29	1.24	1.82
	Male 16-29	52	0.14	100	0.02	0.11	0.36	0.44
	Male 30-49	115	0.33	100	0.09	0.23	0.56	0.86
	Male 50+	153	0.33	100	0.06	0.25	0.70	0.91
	Unknown	1	0.24	100	*	*	*	*
Race/Ethnicity								
	White, Non-Hispanic	732	0.38	100	0.05	0.25	0.81	1.31
	Black, Non-Hispanic	*	*	100	*	*	*	*
	Hispanic	3	0.86	100	*	0.36	*	*
	Asian	7	0.71	100	0.18	0.62	*	*
	American Indian	12	2.77	100	0.12	0.21	*	*
	Unknown	39	0.43	100	0.14	0.31	1.05	1.34
Respondent Education								
	0-11	41	0.53	100	0.10	0.26	1.83	2.08
	High School	219	0.42	100	0.06	0.24	0.90	1.51
	Some College	249	0.57	100	0.05	0.29	0.86	1.31
	College grad	242	0.36	100	0.05	0.25	0.78	1.41
	Unknown	42	0.32	100	0.12	0.31	0.55	0.67
Household Income ($)								
	0-20000	77	0.59	100	0.12	0.27	1.73	2.17
	20000-50000	301	0.49	100	0.07	0.24	0.86	1.28
	50000-	321	0.39	100	0.04	0.25	0.83	1.46
	Unknown	94	0.35	100	0.07	0.30	0.76	0.92
North Dakota								
All		546	0.45	100	0.07	0.25	0.99	1.62
Gender								
	Male	265	0.44	100	0.06	0.27	0.99	1.62
	Female	281	0.46	100	0.07	0.24	0.99	1.60

Table 10-32. Fish Consumption per Kg Bodyweight, Consumers only, by Selected Demographic Characteristics, Uncooked g/kg/day (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
North Dakota (continued)								
Age-Gender Category								
	Child 1-5	28	0.94	100	0.07	0.31	2.11	5.09
	Child 6-10	41	0.74	100	0.14	0.40	1.56	2.02
	Child 11-15	53	0.54	100	0.08	0.29	1.39	1.68
	Female 16-29	38	0.27	100	0.05	0.19	0.54	0.89
	Female 30-49	93	0.38	100	0.06	0.24	0.75	1.16
	Female 50+	92	0.54	100	0.08	0.23	1.53	2.02
	Male 16-29	36	0.29	100	0.05	0.17	0.60	0.75
	Male 30-49	88	0.29	100	0.06	0.25	0.60	0.72
	Male 50+	76	0.41	100	0.05	0.25	0.99	1.60
	Unknown	1	0.45	100	*	*	*	*
Race/Ethnicity								
	White, Non-Hispanic	501	0.45	100	0.06	0.25	0.99	1.64
	Black, Non-Hispanic	2	0.33	100	*	0.33	*	*
	Asian	4	0.26	100	*	0.18	*	*
	American Indian	9	0.40	100	0.11	0.33	0.82	*
	Unknown	30	0.42	100	0.07	0.21	0.98	1.27
Respondent Education								
	0-11	25	0.35	100	0.09	0.16	0.97	1.20
	High School	134	0.57	100	0.07	0.27	1.30	2.16
	Some College	174	0.38	100	0.06	0.26	0.87	1.36
	College Grad	181	0.43	100	0.07	0.25	0.95	1.73
	Unknown	32	0.53	100	0.05	0.17	1.12	1.91
Household Income ($)								
	0-20000	48	0.74	100	0.09	0.25	2.40	3.49
	20000-50000	221	0.39	100	0.05	0.20	0.97	1.55
	50000-	225	0.42	100	0.08	0.31	0.85	1.39
	Unknown	52	0.60	100	0.06	0.27	1.10	1.71

FL Consumption is based on a 7-day recall, CT, MN, ND consumption is based on rate of consumption

FL Consumption excludes away-from-home consumption by children < 18.

Statistics are weighted to represent the general population in the states.

Source: Westat, 2006.

Table 10-33. Fish Consumption per Kg Bodyweight, all Respondents, by State, Acquisition MethodUncooked g/kg/day

State	Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Connecticut								
All		420	0.56	85.1	0.00	0.35	1.37	1.76
Acquisition Method								
	Bought	420	0.55	84.8	0.00	0.34	1.30	1.76
	Caught	420	0.01	16.3	0.00	0.00	0.02	0.04
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	40	0.51	86.4	0.00	0.34	1.28	1.86
	Bought; 20000-50000	150	0.62	86.6	0.00	0.37	1.22	1.93
	Bought; 50000-	214	0.52	84.1	0.00	0.33	1.34	1.64
	Bought; Unknown	16	0.45	73.4	0.00	0.42	1.02	1.36
	Caught; 0-20000	40	0.01	11.0	0.00	0.00	0.00	0.06
	Caught; 20000-50000	150	0.02	18.1	0.00	0.00	0.03	0.08
	Caught; 50000-	214	0.01	16.8	0.00	0.00	0.01	0.03
	Caught; Unknown	16	0.00	6.2	0.00	0.00	0.00	0.01
Habitat								
	Freshwater	420	0.02	36.4	0.00	0.00	0.05	0.09
	Estuarine	420	0.15	76.0	0.00	0.06	0.36	0.59
	Marine	420	0.40	84.8	0.00	0.23	0.90	1.29
Fish/Shellfish Type								
	Shellfish	420	0.19	74.6	0.00	0.09	0.43	0.76
	Finfish	420	0.36	82.7	0.00	0.19	0.94	1.28
Florida								
All		15367	0.59	50.5	0.00	0.08	1.59	2.39
Acquisition Method								
	Bought	15367	0.51	47.5	0.00	0.00	1.41	2.16
	Caught	15367	0.08	7.40	0.00	0.00	0.00	0.45
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	3314	0.51	42.5	0.00	0.00	1.34	2.32
	Bought; 20000-50000	6678	0.52	47.4	0.00	0.00	1.40	2.12
	Bought; 50000-	3136	0.57	54.2	0.00	0.19	1.58	2.27
	Bought; Unknown	2239	0.40	45.3	0.00	0.00	1.21	1.82
	Caught; 0-20000	3314	0.08	6.7	0.00	0.00	0.00	0.42
	Caught; 20000-50000	6678	0.09	7.8	0.00	0.00	0.00	0.48
	Caught; 50000-	3136	0.08	8.4	0.00	0.00	0.00	0.53
	Caught; Unknown	2239	0.04	5.5	0.00	0.00	0.00	0.21
Habitat								
	Freshwater	15367	0.05	9.1	0.00	0.00	0.00	0.33
	Estuarine	15367	0.13	26.5	0.00	0.00	0.43	0.73
	Marine	15367	0.40	40.3	0.00	0.00	1.11	1.76
Fish/Shellfish Type								
	Shellfish	15367	0.11	21.1	0.00	0.00	0.32	0.61
	Finfish	15367	0.48	41.9	0.00	0.00	1.35	2.08

Table 10-33. Fish Consumption per Kg Bodyweight, all Respondents, by State, Acquisition MethodUncooked g/kg/day (continued)

State	Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Minnesota								
All		837	0.41	94.4	0.03	0.24	0.83	1.43
Acquisition Method								
	Bought	837	0.27	89.9	0.00	0.14	0.68	1.01
	Caught	837	0.15	60.6	0.00	0.03	0.30	0.49
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	87	0.35	90.7	0.02	0.15	0.82	1.42
	Bought; 20000-50000	326	0.25	84.4	0.00	0.13	0.60	0.77
	Bought; 50000-	327	0.27	93.9	0.02	0.14	0.74	1.15
	Bought; Unknown	97	0.28	91.3	0.02	0.23	0.72	0.86
	Caught; 0-20000	87	0.18	70.4	0.00	0.04	0.38	1.33
	Caught; 20000-50000	326	0.20	66.0	0.00	0.06	0.33	0.48
	Caught; 50000-	327	0.12	55.5	0.00	0.03	0.31	0.53
	Caught; Unknown	97	0.05	56.7	0.00	0.02	0.16	0.19
Habitat								
	Freshwater	837	0.15	60.6	0.00	0.03	0.30	0.49
	Estuarine	837	0.03	67.5	0.00	0.01	0.06	0.12
	Marine	837	0.24	89.9	0.00	0.12	0.61	0.91
Fish/Shellfish Type								
	Shellfish	837	0.06	67.5	0.00	0.02	0.13	0.24
	Finfish	837	0.36	94.0	0.02	0.19	0.76	1.11
North Dakota								
All		575	0.43	95.2	0.05	0.24	0.95	1.58
Acquisition Method								
	Bought	575	0.30	89.9	0.00	0.13	0.69	1.24
	Caught	575	0.13	68.3	0.00	0.05	0.31	0.53
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	51	0.55	88.0	0.00	0.15	1.79	2.71
	Bought; 20000-50000	235	0.28	90.6	0.01	0.13	0.65	1.35
	Bought; 50000-	233	0.26	90.7	0.01	0.13	0.64	1.02
	Bought; Unknown	56	0.41	85.5	0.00	0.14	0.88	1.21
	Caught; 0-20000	51	0.14	53.9	0.00	0.01	0.31	0.61
	Caught; 20000-50000	235	0.09	59.4	0.00	0.03	0.23	0.40
	Caught; 50000-	233	0.15	76.2	0.00	0.08	0.45	0.61
	Caught; Unknown	56	0.15	85.7	0.00	0.07	0.29	0.31
Habitat								
	Freshwater	575	0.13	68.3	0.00	0.05	0.31	0.53
	Estuarine	575	0.03	71.3	0.00	0.01	0.06	0.10
	Marine	575	0.28	89.9	0.00	0.11	0.60	1.07

Table 10-33. Fish Consumption per Kg Bodyweight, all Respondents, by State, Acquisition MethodUncooked g/kg/day (continued)

State	Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
North Dakota (continued)								
Fish/Shellfish Type								
	Shellfish	575	0.05	71.3	0.00	0.02	0.12	0.20
	Finfish	575	0.38	94.3	0.03	0.19	0.84	1.35

FL Consumption is based on a 7-day recall, CT, MN, ND consumption is based on rate of consumption

FL Consumption excludes away-from-home consumption by children < 18.

Statistics are weighted to represent the general population in the states.

A respondent can be represented in more than one row.

Source: Westat, 2006.

Table 10-34. Fish Consumption per Kg Bodyweight, Consumers only, by State, Acquisition MethodUncooked g/kg/day

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Connecticut								
All		362	0.66	100	0.10	0.43	1.51	1.80
Acquisition Method								
	Bought	361	0.65	100	0.10	0.43	1.43	1.80
	Caught	71	0.07	100	0.00	0.02	0.17	0.23
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	35	0.59	100	0.10	0.41	1.53	1.90
	Bought; 20000-50000	132	0.71	100	0.11	0.45	1.40	1.98
	Bought; 50000-	182	0.62	100	0.08	0.41	1.45	1.75
	Bought; Unknown	12	0.61	100	0.13	0.57	1.14	1.41
	Caught; 0-20000	4	0.07	100	*	0.02	*	*
	Caught; 20000-50000	30	0.11	100	0.01	0.03	0.30	0.62
	Caught; 50000-	36	0.04	100	0.00	0.02	0.11	3.15
	Caught; Unknown	1	0.01	100	*	*	*	*
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	1	0.03	100	*	*	*	*
	Eats Caught&Bought	70	0.67	100	0.13	0.46	1.54	1.71
	Eats Bought Only	291	0.66	100	0.09	0.43	1.50	1.82
Habitat								
	Freshwater	157	0.05	100	0.00	0.03	0.10	0.21
	Estuarine	327	0.19	100	0.01	0.09	0.40	0.69
	Marine	361	0.47	100	0.06	0.31	1.03	1.45
Eats Freshwater/Estuarine Caught Fish								
	Sometimes	50	0.64	100	0.12	0.39	1.53	1.68
	Never	312	0.66	100	0.10	0.44	1.50	1.83
Fish/Shellfish Type								
	Shellfish	320	0.26	100	0.03	0.14	0.56	0.91
	Finfish	353	0.43	100	0.03	0.26	1.03	1.45
Florida								
All		7757	1.16	100	0.24	0.73	2.39	3.37
Acquisition Method								
	Bought	7246	1.07	100	0.23	0.68	2.22	3.18
	Caught	1212	1.05	100	0.20	0.64	2.18	3.03
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	1418	1.20	100	0.24	0.72	2.54	3.44
	Bought; 20000-50000	3141	1.09	100	0.24	0.70	2.18	3.21
	Bought; 50000-	1695	1.05	100	0.22	0.67	2.18	3.17
	Bought; Unknown	992	0.89	100	0.22	0.60	1.96	2.50
	Caught; 0-20000	246	1.14	100	0.26	0.76	2.40	3.72
	Caught; 20000-50000	563	1.14	100	0.20	0.67	2.31	3.13
	Caught; 50000-	274	0.95	100	0.16	0.61	2.09	3.06
	Caught; Unknown	129	0.74	100	0.22	0.54	1.36	2.03

Table 10-34. Fish Consumption per Kg Bodyweight, Consumers only, by State, Acquisition MethodUncooked g/kg/day (continued)								
					Percentiles			
State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	10th	50th	90th	95th
Florida (continued)								
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	511	0.97	100	0.20	0.64	2.14	2.89
	Eats Caught&Bought	701	2.28	100	0.65	1.48	4.38	6.37
	Eats Bought Only	6545	1.06	100	0.23	0.68	2.20	3.08
Habitat								
	Freshwater	1426	0.59	100	0.09	0.37	1.36	1.89
	Estuarine	4124	0.50	100	0.10	0.31	1.05	1.46
	Marine	6124	0.99	100	0.20	0.62	2.01	2.94
Eats Freshwater/Estuarine Caught Fish								
	Exclusively	235	0.91	100	0.13	0.56	2.14	2.7
	Sometimes	458	2.21	100	0.56	1.40	4.54	6.17
	Never	7064	1.11	100	0.24	0.71	2.27	3.24
Fish/Shellfish Type								
	Shellfish	3260	0.50	100	0.10	0.30	1.07	1.42
	Finfish	6428	1.15	100	0.29	0.73	2.28	3.32
Minnesota								
All		793	0.44	100	0.06	0.26	0.86	1.44
Acquisition Method								
	Bought	755	0.30	100	0.04	0.16	0.73	1.10
	Caught	593	0.24	100	0.02	0.09	0.40	0.76
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	76	0.39	100	0.05	0.18	0.85	1.44
	Bought; 20000-50000	284	0.29	100	0.04	0.17	0.63	0.99
	Bought; 50000-	312	0.28	100	0.03	0.15	0.76	1.30
	Bought; Unknown	83	0.30	100	0.03	0.26	0.73	0.87
	Caught; 0-20000	56	0.26	100	0.02	0.07	0.65	1.45
	Caught; 20000-50000	232	0.31	100	0.03	0.10	0.41	0.61
	Caught; 50000-	235	0.21	100	0.03	0.11	0.5	0.86
	Caught; Unknown	70	0.09	100	0.02	0.04	0.19	0.21
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	38	0.21	100	0.02	0.11	0.49	0.68
	Eats Caught&Bought	555	0.53	100	0.11	0.31	0.93	1.76
	Eats Bought Only	200	0.31	100	0.03	0.18	0.75	1.21
Habitat								
	Freshwater	593	0.24	100	0.02	0.09	0.4	0.76
	Estuarine	559	0.04	100	0.00	0.02	0.09	0.16
	Marine	755	0.26	100	0.03	0.14	0.67	0.97
Eats Freshwater/Estuarine Caught Fish								
	Exclusively	38	0.21	100	0.02	0.11	0.49	0.68
	Sometimes	555	0.53	100	0.11	0.31	0.93	1.76
	Never	200	0.31	100	0.03	0.18	0.75	1.21

Table 10-34. Fish Consumption per Kg Bodyweight, Consumers only, by State, Acquisition MethodUncooked g/kg/day (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Minnesota (continued)								
Fish/Shellfish Type								
	Shellfish	559	0.08	100	0.01	0.03	0.19	0.32
	Finfish	791	0.38	100	0.04	0.21	0.77	1.15
North Dakota								
All		546	0.45	100	0.07	0.25	0.99	1.62
Acquisition Method								
	Bought	516	0.34	100	0.04	0.15	0.81	1.36
	Caught	389	0.18	100	0.02	0.09	0.46	0.61
Acquisition Method-Household Income ($) Group								
	Bought; 0-20000	45	0.63	100	0.06	0.19	2.06	2.97
	Bought; 20000-50000	213	0.30	100	0.04	0.15	0.69	1.37
	Bought; 50000-	210	0.28	100	0.04	0.15	0.64	1.05
	Bought; Unknown	48	0.47	100	0.04	0.19	0.93	1.44
	Caught; 0-20000	27	0.25	100	0.02	0.10	0.56	0.86
	Caught; 20000-50000	142	0.15	100	0.02	0.07	0.33	0.54
	Caught; 50000-	173	0.20	100	0.03	0.11	0.51	0.71
	Caught; Unknown	47	0.17	100	0.04	0.08	0.30	0.32
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	30	0.28	100	0.07	0.18	0.43	0.68
	Eats Caught&Bought	359	0.52	100	0.10	0.31	1.10	1.66
	Eats Bought Only	157	0.33	100	0.03	0.13	0.71	1.29
Habitat								
	Freshwater	389	0.18	100	0.02	0.09	0.46	0.61
	Estuarine	407	0.04	100	0.01	0.01	0.08	0.14
	Marine	516	0.31	100	0.03	0.13	0.72	1.15
Eats Freshwater/Estuarine Caught Fish								
	Exclusively	30	0.28	100	0.07	0.18	0.43	0.68
	Sometimes	359	0.52	100	0.10	0.31	1.10	1.66
	Never	157	0.33	100	0.03	0.13	0.71	1.29
Fish/Shellfish Type								
	Shellfish	407	0.07	100	0.01	0.03	0.17	0.27
	Finfish	541	0.40	100	0.05	0.21	0.89	1.44

FL Consumption is based on a 7-day recall, CT, MN, ND consumption is based on rate of consumption

FL Consumption excludes away-from-home consumption by children < 18.

Statistics are weighted to represent the general population in the states.

A respondent can be represented in more than one row.

Source: Westat, 2006.

Table 10-35. Fish Consumption per Kg Bodyweight, all Respondents, by State, Subpopulation, and Gender, As-consumed g/kg/day

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Connecticut								
Population for Sample Selection								
	Angler	250	0.64	97.6	0.08	0.40	1.51	2.07
	Aquaculture Students	25	0.22	76.0	0.00	0.07	0.65	0.89
	Asians	396	1.15	99.2	0.30	0.91	2.28	3.15
	Commercial Fisherman	173	0.65	96.0	0.05	0.44	1.51	1.63
	EFNEP Participants	67	1.00	86.6	0.00	0.31	2.46	3.50
	General	420	0.41	85.1	0.00	0.25	1.00	1.32
	WIC Participants	699	0.80	79.1	0.00	0.42	1.93	3.02
Population for Sample Selection and Gender Group								
	Angler; Male	197	0.68	97.5	0.08	0.41	1.68	2.16
	Angler; Female	53	0.49	98.1	0.10	0.30	1.06	1.45
	Aquaculture Students; Male	10	0.21	90.0	0.00	0.09	0.75	0.85
	Aquaculture Students; Female	15	0.24	66.7	0.00	0.03	0.62	0.91
	Asians; Male	188	1.06	99.5	0.27	0.88	1.99	2.44
	Asians; Female	208	1.24	99.0	0.36	0.92	2.85	3.33
	Commercial Fishermen; Male	94	0.67	92.6	0.05	0.46	1.54	1.62
	Commercial Fishermen; Female	79	0.63	100	0.06	0.42	1.40	1.93
	EFNEP Participants; Male	25	1.05	88.0	0.00	0.33	2.83	3.80
	EFNEP Participants; Female	42	0.96	85.7	0.00	0.26	2.02	3.95
	General; Male	201	0.39	86.2	0.00	0.24	1.05	1.34
	General; Female	219	0.43	84.0	0.00	0.28	0.95	1.30
	WIC Participants; Male	312	0.94	79.2	0.00	0.45	2.30	3.52
	WIC Participants; Female	387	0.69	79.1	0.00	0.40	1.64	2.43
Florida								
Population for Sample Selection								
	General	15367	0.47	50.5	0.00	0.06	1.27	1.91
Population for Sample Selection and Gender Group								
	General; Male	7911	0.44	49.2	0.00	0.00	1.22	1.84
	General; Female	7426	0.50	51.9	0.00	0.10	1.32	1.98
	Unknown	30	0.41	48.0	0.00	0.00	1.41	2.38
Minnesota								
Population for Sample Selection								
	American Indian	216	0.21	88.9	0.00	0.13	0.52	0.64
	Anglers	1152	0.31	96.3	0.04	0.17	0.66	0.97
	General	837	0.31	94.4	0.02	0.18	0.62	1.07
	New Mothers	401	0.33	85.0	0.00	0.15	0.80	1.21

Table 10-35. Fish Consumption per Kg Bodyweight, all Respondents, by State, Subpopulation, and Gender, As-consumed g/kg/day (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Minnesota (continued)								
Population for Sample Selection and Gender Group								
	American Indians; Male	108	0.19	89.8	0.00	0.14	0.46	0.55
	American Indians; Female	108	0.23	88.0	0.00	0.12	0.57	0.93
	Anglers; Male	606	0.30	96.9	0.04	0.18	0.63	0.93
	Anglers; Female	546	0.31	95.6	0.04	0.17	0.70	1.04
	General; Male	419	0.26	95.3	0.02	0.16	0.58	1.06
	General; Female	418	0.36	93.4	0.02	0.21	0.65	1.10
	New Mothers; Male	205	0.27	86.3	0.00	0.15	0.67	0.93
	New Mothers; Female	196	0.39	83.7	0.00	0.14	0.95	1.42
North Dakota								
Population for Sample Selection								
	American Indians	106	0.35	60.4	0.00	0.04	1.10	2.27
	Anglers	854	0.32	94.6	0.04	0.19	0.77	1.14
	General	575	0.32	95.2	0.03	0.18	0.71	1.18
Population for Sample Selection and Gender Group								
	American Indians; Male	50	0.35	58.0	0.00	0.04	0.76	1.39
	American Indians; Female	56	0.36	62.5	0.00	0.05	1.34	2.32
	Anglers; Male	467	0.32	95.3	0.04	0.19	0.77	1.14
	Anglers; Female	387	0.33	93.8	0.03	0.19	0.77	1.18
	General; Male	276	0.32	96.2	0.04	0.19	0.68	1.20
	General; Female	299	0.32	94.2	0.03	0.17	0.73	1.16

FL Consumption is based on a 7-day recall, CT, MN, ND consumption is based on rate of consumption.

FL Consumption excludes away-from-home consumption by children < 18.

Statistics are weighted to represent the general population in the states. Subpopulations statistics are unweighted

Source: Westat, 2006.

Table 10-36. Fish Consumption per Kg, Consumers Only, by State, Subpopulation, and Gender, As-consumed g/kg/day

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Connecticut								
Population for Sample Selection								
	Angler	244	0.66	100	0.10	0.40	1.55	2.07
	Aquaculture Students	19	0.30	100	0.02	0.14	0.75	0.91
	Asians	393	1.16	100	0.31	0.91	2.28	3.16
	Commercial Fisherman	166	0.68	100	0.09	0.46	1.53	1.65
	EFNEP Participants	58	1.15	100	0.11	0.39	2.69	4.51
	General	362	0.48	100	0.07	0.32	1.09	1.37
	WIC Participants	553	1.01	100	0.12	0.61	2.30	3.39
Population for Sample Selection and Gender Group								
	Angler; Male	192	0.70	100	0.10	0.42	1.69	2.17
	Angler; Female	52	0.50	100	0.11	0.33	1.07	1.45
	Aquaculture Students; Male	9	0.23	100	0.01	0.11	0.74	*
	Aquaculture Students; Female	10	0.36	100	0.03	0.31	0.75	1.00
	Asians; Male	187	1.06	100	0.28	0.88	1.99	2.44
	Asians; Female	206	1.25	100	0.37	0.93	2.86	3.34
	Commercial Fishermen; Male	87	0.72	100	0.12	0.54	1.57	1.63
	Commercial Fishermen; Female	79	0.63	100	0.06	0.42	1.40	1.91
	EFNEP Participants; Male	22	1.20	100	0.14	0.42	2.89	3.75
	EFNEP Participants; Female	36	1.12	100	0.07	0.39	2.38	4.50
	General; Male	175	0.45	100	0.08	0.29	1.11	1.40
	General; Female	187	0.52	100	0.05	0.34	1.03	1.35
	WIC Participants; Male	247	1.18	100	0.12	0.69	2.89	3.78
	WIC Participants; Female	306	0.87	100	0.12	0.59	1.87	2.73
Population for Sample Selection and Eats Freshwater/Estuarine Caught Fish Group								
	Angler; Exclusively	1	0.04	100	*	*	*	*
	Angler; Sometimes	190	0.74	100	0.14	0.44	1.69	2.18
	Angler; Never	53	0.38	100	0.05	0.27	0.89	1.00
	Aquaculture Students; Sometimes	2	0.34	100	*	0.21	*	*
	Aquaculture Students; Never	17	0.29	100	0.02	0.14	0.80	0.93
	Asians; Sometimes	199	1.23	100	0.30	0.93	2.94	3.50
	Asians; Never	194	1.09	100	0.34	0.87	2.03	2.39
	Commercial Fishermen; Sometimes	120	0.78	100	0.18	0.54	1.58	1.98
	Commercial Fishermen; Never	46	0.41	100	0.03	0.30	0.89	1.36
	EFNEP Participants; Sometimes	8	0.25	100	0.14	0.22	0.40	*
	EFNEP Participants; Never	50	1.29	100	0.09	0.52	2.82	6.09
	General; Sometimes	50	0.46	100	0.09	0.29	1.10	1.25
	General; Never	312	0.49	100	0.07	0.32	1.06	1.41
	WIC Participants; Sometimes	67	1.49	100	0.28	0.91	3.43	5.12
	WIC Participants; Never	486	0.95	100	0.10	0.60	2.02	3.12

Table 10-36. Fish Consumption and Fish Consumption per Kg, Consumers Only, by State, Subpopulation, and Gender, As-consumed g/kg/day (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Florida								
Population for Sample Selection								
	General	7757	0.93	100	0.19	0.58	1.89	2.73
Population for Sample Selection and Gender Group								
	General; Male	3880	0.90	100	0.18	0.55	1.85	2.65
	General; Female	3861	0.95	100	0.19	0.62	1.94	2.78
	Unknown	16	0.85	100	0.12	0.69	2.37	2.61
Population for Sample Selection and Eats Freshwater/Estuarine Caught Fish Group								
	General; Exclusively	235	0.71	100	0.10	0.42	1.60	2.16
	General; Sometimes	458	1.73	100	0.43	1.10	3.44	4.96
	General; Never	7064	0.88	100	0.18	0.56	1.81	2.60
Minnesota								
Population for Sample Selection								
	American Indian	192	0.24	100	0.02	0.15	0.53	0.70
	Anglers	1109	0.32	100	0.05	0.18	0.67	0.99
	General	793	0.33	100	0.04	0.20	0.65	1.08
	New Mothers	341	0.38	100	0.04	0.20	0.89	1.30
Population for Sample Selection and Gender Group								
	American Indians; Male	97	0.21	100	0.03	0.15	0.49	0.55
	American Indians; Female	95	0.26	100	0.02	0.16	0.59	0.95
	Anglers; Male	587	0.31	100	0.05	0.18	0.63	0.93
	Anglers; Female	522	0.33	100	0.05	0.18	0.72	1.05
	General; Male	401	0.28	100	0.04	0.17	0.62	1.07
	General; Female	392	0.38	100	0.05	0.22	0.70	1.22
	New Mothers; Male	177	0.31	100	0.04	0.19	0.75	1.06
	New Mothers; Female	164	0.46	100	0.05	0.21	1.04	1.83
Population for Sample Selection and Eats Freshwater/Estuarine Caught Fish Group								
	American Indians; Exclusively	31	0.18	100	0.01	0.07	0.42	0.55
	American Indians; Sometimes	136	0.28	100	0.05	0.18	0.57	0.92
	American Indians; Never	25	0.05	100	0.01	0.04	0.12	0.15
	Anglers; Exclusively	57	0.35	100	0.02	0.16	0.89	1.93
	Anglers; Sometimes	879	0.34	100	0.07	0.20	0.71	1.05
	Anglers; Never	173	0.20	100	0.03	0.10	0.46	0.66
	General; Exclusively	38	0.16	100	0.02	0.08	0.37	0.51
	General; Sometimes	555	0.40	100	0.08	0.23	0.70	1.32
	General; Never	200	0.23	100	0.02	0.14	0.56	0.91
	New Mothers; Exclusively	17	0.06	100	0.02	0.09	0.20	0.25
	New Mothers; Sometimes	189	0.47	100	0.07	0.27	1.00	1.32
	New Mothers; Never	135	0.30	100	0.03	0.12	0.74	1.35

Table 10-36. Fish Consumption and Fish Consumption per Kg, Consumers Only, by State, Subpopulation, and Gender, As-consumed g/kg/day (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
North Dakota								
Population for Sample Selection								
	American Indians	64	0.58	100	0.03	0.19	1.75	2.65
	Anglers	808	0.34	100	0.05	0.20	0.81	1.17
	General	546	0.34	100	0.05	0.19	0.74	1.21
Population for Sample Selection and Gender Group								
	American Indians; Male	29	0.60	100	0.03	0.18	1.31	3.67
	American Indians; Female	35	0.57	100	0.02	0.19	2.25	2.55
	Anglers; Male	445	0.33	100	0.05	0.20	0.78	1.14
	Anglers; Female	363	0.35	100	0.05	0.21	0.83	1.29
	General; Male	265	0.33	100	0.04	0.20	0.74	1.22
	General; Female	281	0.34	100	0.05	0.18	0.74	1.20
Population for Sample Selection and Eats Freshwater/Estuarine Caught Fish Group								
	American Indians; Exclusively	4	0.05	100	*	0.05	*	*
	American Indians; Sometimes	30	1.08	100	0.13	0.60	2.65	3.62
	American Indians; Never	30	0.16	100	0.02	0.07	0.36	0.66
	Anglers; Exclusively	47	0.19	100	0.01	0.07	0.61	1.02
	Anglers; Sometimes	660	0.38	100	0.07	0.23	0.84	1.29
	Anglers; Never	101	0.18	100	0.02	0.10	0.41	0.53
	General; Exclusively	30	0.21	100	0.05	0.14	0.33	0.51
	General; Sometimes	359	0.39	100	0.07	0.23	0.82	1.25
	General; Never	157	0.25	100	0.03	0.10	0.53	0.97

FL Consumption is based on a 7-day recall, CT, MN, ND consumption is based on rate of consumption.

FL Consumption excludes away-from-home consumption by children < 18.

Statistics are weighted to represent the general population in the states. Subpopulations statistics are unweighted

Source: Westat, 2006.

Table 10-37. Fish Consumption Among General Population Children in Four States, Consumers Only, g/kg-day As-Consumed										
	N	Mean	CI	Percentiles						Maximum
				10th	25th	50th	75th	90th	95th	
Connecticut										
1 to <6 years	14	0.61	0.42-0.81	0.16	0.26	0.55	0.83	1.4	1.6	1.6
6 to <11 years	22	0.59	0.040-0.77	0.14	0.23	0.47	0.96	1.2	1.3	1.5
11 to <16 years	18	0.32	0.17-0.46	0.07	0.14	0.19	0.38	0.52	0.84	1.3
16 to <30 years										
Females	14	0.84	0.10-1.58	0.11	0.30	0.35	0.87	1.1	3.1	7.0
Males	10	0.23	0.14-0.32	0.08	0.13	0.21	0.25	0.47	0.56	0.58
30 to <50 years										
Females	74	0.53	0.37-0.70	0.05	0.15	0.34	0.67	1.1	1.5	4.5
Males	74	0.51	0.40-0.61	0.11	0.18	0.35	0.70	1.2	1.5	2.2
>50 years										
Females	70	0.48	0.37-0.59	0.05	0.13	0.37	0.72	1.0	1.4	2.7
Males	57	0.38	0.30-0.46	0.10	0.17	0.26	0.50	0.93	1.1	1.4
Eats Caught Only	1	0.01	-	-	-	-	-	-	-	0.01
Eats Caught and Bought	70	0.49	0.36-0.61	0.10	0.17	0.34	0.75	1.1	1.3	2.2
Eats Bought Only	291	0.48	0.40-0.57	0.06	0.16	0.32	0.61	1.1	1.4	7.0
Anglers	244	0.66	-	0.10	0.20	0.40	0.80	1.6	2.1	3.5
General Population	362	0.48	-	0.07	0.16	0.32	0.63	1.1	1.4	2.4
Florida										
1 to <6 years	420	2.3	2.05-2.63	0.5	1.0	1.7	2.8	4.7	6.8	14.6
6 to <11 years	375	1.1	0.98-1.22	0.28	0.52	0.81	1.4	2.2	3.0	9.4
11 to <16 years	365	0.85	0.73-0.98	0.20	0.36	0.63	0.99	1.6	2.2	11.0
16 to <30 years										
Females	753	0.89	0.74-1.04	0.16	0.31	0.55	0.95	1.8	2.4	25
Males	754	0.96	0.80-1.12	0.16	0.28	0.52	0.99	1.8	2.7	34
30 to <50 years										
Females	1287	0.94	0.87-1.00	0.18	0.33	0.63	1.0	1.9	2.7	20
Males	1334	0.81	0.74-0.88	0.17	0.28	0.53	0.95	1.7	2.4	23
>50 years										
Females	1171	0.73	0.69-0.77	0.19	0.31	0.52	0.94	1.5	2.1	7.4
Males	1192	0.70	0.66-0.75	0.17	0.27	0.50	0.84	1.4	1.9	14
Eats Caught Only	511	0.76	0.66-0.86	0.15	0.30	0.50	0.90	1.7	2.3	7.4
Eats Caught and Bought	701	1.8	1.6-2.1	0.50	0.76	1.2	2.0	3.4	5.1	34
Eats Bought Only	6545	0.85	0.81-0.89	0.18	0.30	0.54	0.98	1.8	2.5	24

Table 10-37. Fish Consumption Among General Population Children in Four States, Consumers Only, g/kg-day As-Consumed (continued)

	N	Mean	CI	Percentiles						Maximum
				10th	25th	50th	75th	90th	95th	
Minnesota										
1 to <6 years	46	0.58	0.32-0.85	0.07	0.15	0.46	0.73	1.1	1.8	8.0
6 to <11 years	42	0.38	0.21-0.54	0.05	0.07	0.25	0.47	1.0	1.4	5.3
11 to <16 years	63	0.24	0.16-0.31	0.03	0.06	0.21	0.32	0.55	0.59	1.4
16 to <30 years										
Females	44	0.69	-0.21-1.59	0.02	0.08	0.16	0.29	0.66	3.0	9.2
Males	52	0.11	0.07-0.15	0.02	0.02	0.08	0.14	0.27	0.33	0.74
30 to <50 years										
Females	127	0.25	0.21-0.30	0.04	0.10	0.23	0.32	0.51	0.58	1.3
Males	115	0.25	0.17-0.32	0.07	0.11	0.17	0.30	0.42	0.64	1.9
>50 years										
Females	150	0.36	0.26-0.46	0.05	0.11	0.22	0.38	0.93	1.4	1.9
Males	153	0.24	0.20-0.29	0.05	0.11	0.19	0.28	0.53	0.68	1.3
Eats Caught Only	38	0.16	0.05-0.26	0.02	0.03	0.08	0.25	0.37	0.51	0.57
Eats Caught and Bought	555	0.40	0.27-0.52	0.08	0.11	0.23	0.49	0.70	1.3	9.2
Eats Bought Only	200	0.23	0.18-0.28	0.02	0.05	0.14	0.26	0.56	0.91	8.0
Anglers	1,109	0.32	-	0.05	0.10	0.18	0.34	0.67	0.99	2.2
General Population	793	0.33	-	0.04	0.10	0.20	0.34	0.65	1.1	1.8
North Dakota										
1 to <6 years	28	0.70	0.24-1.17	0.05	0.12	0.23	0.68	1.6	3.8	6.8
6 to <11 years	41	0.56	0.31-0.81	0.11	0.21	0.30	0.66	1.2	1.5	4.3
11 to <16 years	53	0.41	0.23-0.59	0.06	0.12	0.22	0.54	1.0	1.3	2.3
16 to <30 years										
Females	38	0.20	0.14-0.26	0.04	0.06	0.15	0.26	0.41	0.67	0.80
Males	36	0.22	0.13-0.31	0.04	0.07	0.13	0.23	0.45	0.56	1.9
30 to <50 years										
Females	93	0.29	0.22-0.36	0.05	0.10	0.18	0.36	0.56	0.87	2.6
Males	88	0.22	0.17-0.27	0.05	0.08	0.18	0.26	0.45	0.54	1.3
>50 years										
Females	92	0.40	0.27-0.54	0.06	0.10	0.17	0.52	1.1	1.5	4.2
Males	76	0.31	0.20-0.41	0.04	0.08	0.19	0.33	0.74	1.2	1.8
Eats Caught Only	30	0.21	0.09-0.32	0.05	0.09	0.14	0.22	0.33	0.51	1.8
Eats Caught and Bought	359	0.39	0.29-0.49	0.07	0.13	0.23	0.43	0.82	1.3	4.3
Eats Bought Only	157	0.25	0.13-0.36	0.03	0.05	0.10	0.24	0.53	0.97	6.8
Anglers	808	0.34	-	0.05	0.10	0.20	0.39	0.81	1.2	2.0
General Population	546	0.34	-	0.05	0.09	0.19	0.35	0.74	1.2	2.2

N = Sample size.
CI = Confidence interval.

Source: Moya et al, 2008.

Table 10-38. Estimated Number of Participants in Marine Recreational Fishing by State and Subregion

Subregion	State	Coastal Participants	Non Coastal Participants	Out of State [a]	Total Participants[a]
Pacific	Southern California	902	8	159	910
	Northern California	534	99	63	633
	Oregon	265	19	78	284
	TOTAL	1,701	126		
North Atlantic	Connecticut	186	*[b]	47	186
	Maine	93	9	100	102
	Massachusetts	377	69	273	446
	New Hampshire	34	10	32	44
	Rhode Island	97	*	157	97
	TOTAL	787	88		
Mid-Atlantic	Delaware	90	*	159	90
	Maryland	540	32	268	572
	New Jersey	583	9	433	592
	New York	539	13	70	552
	Virginia	294	29	131	323
	TOTAL	1,046	83		
South Atlantic	Florida	1,201	*	741	1,201
	Georgia	89	61	29	150
	North Carolina	398	224	745	622
	South Carolina	131	77	304	208
	TOTAL	1,819	362		
Gulf of Mexico	Alabama	95	9	101	104
	Florida	1,053	*	1,349	1,053
	Louisiana	394	48	63	442
	Mississippi	157	42	51	200
	TOTAL	1,699	99		
	GRAND TOTAL	8,053	760		

[a] Not additive across states. One person can be counted as "OUT OF STATE" for more than one state.
[b] An asterisk (*) denotes no non-coastal counties in state.

Source: NMFS, 1993.

Table 10-39. Estimated Weight of Fish Caught (Catch Type A and B1) by Marine Recreational Fishermen, by Wave and Subregion				
	Atlantic and Gulf		Pacific	
	Region	Weight (1,000 kg)	Region	Weight (1,000 kg)
Jan/Feb	South Atlantic	1,060	So. California	418
	Gulf	3,683	N. California	101
	TOTAL	4,743	Oregon	165
			TOTAL	684
Mar/Apr	North Atlantic	310	So. California	590
	Mid Atlantic	1,030	N. California	346
	South Atlantic	1,913	Oregon	144
	Gulf	3,703	TOTAL	1,080
	TOTAL	6,956		
May/Jun	North Atlantic	3,272	So. California	1,195
	Mid Atlantic	4,815	N. California	563
	South Atlantic	4,234	Oregon	581
	Gulf	5,936	TOTAL	2,339
	TOTAL	18,257		
Jul/Aug	North Atlantic	4,003	So. California	1,566
	Mid Atlantic	9,693	N. California	1,101
	South Atlantic	4,032	Oregon	39
	Gulf	5,964	TOTAL	2,706
	TOTAL	23,692		
Sep/Oct	North Atlantic	2,980	So. California	859
	Mid Atlantic	7,798	N. California	1,032
	South Atlantic	3,296	Oregon	724
	Gulf	7,516	TOTAL	2,615
	TOTAL	21,590		
Nov/Dec	North Atlantic	456	So. California	447
	Mid Atlantic	1,649	N. California	417
	South Atlantic	2,404	Oregon	65
	Gulf	4,278	TOTAL	929
	TOTAL	8,787		
	GRAND TOTAL	84,025	GRAND TOTAL	10,353

Source: NMFS, 1993.

Table 10-40. Average Daily Intake (g/day) of Marine Finfish, by Region and Coastal Status

	Intake Among Anglers	
Region[a]	Mean	95th Percentile
North Atlantic	6.2	20.1
Mid-Atlantic	6.3	18.9
South Atlantic	4.7	15.9
All Atlantic	5.6	18.0
Gulf	7.2	26.1
South California	2.0	5.5
North California	2.0	5.7
Oregon	2.2	8.9
All Pacific	2.0	6.8

[a] North Atlantic - ME, NH, MA, RI, and CT; Mid-Atlantic - NY, NJ, MD, DE, and VA; South Atlantic - NC, SC, GA, ar (Atlantic Coast); Gulf - AL, MS, LA, and FL (Gulf Coast).

Source: NMFS, 1993.

Table 10-41. Estimated Weight of Fish Caught (Catch Type A and B1)[a] by Marine Recreational Fishermen by Species Group and Subregion

	North Atlantic (1,000 kg)	Mid Atlantic (1,000 kg)	South Atlantic (1,000 kg)	Gulf (1,000 kg)	All Atlantic and Gulf (1,000 kg)
Cartilaginous fishes	66	1,673	162	318	2,219
Eels	14	9	*[b]	0[c]	23
Herrings	118	69	1	89	177
Catfishes	0	306	138	535	979
Toadfishes	0	7	0	*	7
Cods and Hakes	2,404	988	4	0	1,396
Searobins	2	68	*	*	70
Sculpins	1	*	0	0	1
Temperate Basses	837	2,166	22	4	2,229
Sea Basses	22	2,166	644	2,477	5,309
Bluefish	4,177	3,962	1,065	158	5,362
Jacks	0	138	760	2,477	3,375
Dolphins	65	809	2,435	1,599	4,908
Snappers	0	*	508	3,219	3,727
Grunts	0	9	239	816	1,064
Porgies	132	417	1,082	2,629	4,160
Drums	3	2,458	2,953	9,866	15,280
Mullets	1	43	382	658	1,084
Barracudas	0	*	356	244	600
Wrasses	783	1,953	46	113	2,895
Mackerels and Tunas	878	3,348	4,738	4,036	13,000
Flounders	512	4,259	532	377	5,680
Triggerfishes/Filefishes	0	48	109	544	701
Puffers	*	16	56	4	76
Other fishes	105	72	709	915	1,801

Species Group	Southern California (1,000 kg)	Northern California (1,000 kg)	Oregon (1,000 kg)	All Pacific
Cartilaginous fish	35	162	1	198
Sturgeons	0[b]	89	13	102
Herrings	10	15	40	65
Anchovies	*[c]	7	0	7
Smelts	0	71	0	71
Cods and Hakes	0	0	0	0
Silversides	58	148	0	206
Striped Bass	0	51	0	51
Sea Basses	1,319	17	0	1,336
Jacks	469	17	1	487
Croakers	141	136	0	277
Sea Chubs	53	1	0	54
Surfperches	74	221	47	342
Pacific Barracuda	866	10	0	876
Wrasses	73	5	0	78
Tunas and Mackerels	1,260	36	1	1,297
Rockfishes	409	1,713	890	3,012
California Scorpionfish	86	0	0	86
Sablefishes	0	0	5	5
Greenlings	22	492	363	877
Sculpins	6	81	44	131
Flatfishes	106	251	5	362
Other fishes	89	36	307	432

[a] For Catch Type A and B1, the fish were not thrown back.
[b] An asterisk (*) denotes data not reported.
[c] Zero (0) = < 1000 kg.

Source: NMFS, 1993.

Table 10-42. Percent of Fishing Frequency During the Summer and Fall Seasons in Commencement Bay, Washington			
Fishing Frequency	Frequency Percent in the Summer[a]	Frequency Percent in the Fall[b]	Frequency Percent in the Fall[c]
Daily	10.4	8.3	5.8
Weekly	50.3	52.3	51.0
Monthly	20.1	15.9	21.1
Bimonthly	6.7	3.8	4.2
Biyearly	4.4	6.1	6.3
Yearly	8.1	13.6	11.6

[a] Summer - July through September, includes 5 survey days and 4 survey areas (i.e., area #1, #2, #3 and #4)

[b] Fall - September through November, includes 4 survey days and 4 survey areas (i.e., area #1, #2, #3 and #4)

[c] Fall - September through November, includes 4 survey days described in footnote [b] plus an additional survey area (5 survey areas) (i.e., area #1, #2, #3, #4 and #5)

Source: Pierce et al., 1981.

Table 10-43. Selected Percentile Consumption Estimates (g/day) for the Survey and Total Angler Populations Based on the Reanalysis of the Puffer et al. (1981) and Pierce et al. (1981) Data		
	50th Percentile	90th Percentile
Survey Population		
Puffer et al. (1981)	37	225
Pierce et al. (1981)	19	155
Average	28	190
Total Angler Population		
Puffer et al. (1981)	2.9[a]	35[b]
Pierce et al. (1981)	1.0	13
Average	2.0	24

[a] Estimated based on the average intake for the 0 - 90th percentile anglers.

[b] Estimated based on the average intake for the 91st - 96th percentile anglers.

Source: Price et al., 1994.

Table 10-44. Median Intake Rates Based on Demographic Data of Sport Fishermen and Their Family/Living Group

	Percent of total interviewed	Median intake rates (g/person-day)
Ethnic Group		
Caucasian	42	46.0
Black	24	24.2
Mexican-American	16	33.0
Asian/Samoan	13	70.6
Other	5	-[a]
Age (years)		
< 17	11	27.2
18 to 40	52	32.5
41 to 65	28	39.0
> 65	9	113.0

[a] Not reported.

Source: Puffer et al., 1981.

Table 10-45. Cumulative Distribution of Total Fish/Shellfish Consumption by Surveyed Sport Fishermen in the Metropolitan Los Angeles Area

Percentile	Intake rate (g/person-day)
5	2.3
10	4.0
20	8.3
30	15.5
40	23.9
50	36.9
60	53.2
70	79.8
80	120.8
90	224.8
95	338.8

Source: Puffer et al., 1981.

Table 10-46. Catch Information for Primary Fish Species Kept by Sport Fishermen (n = 1059)

Species	Average Weight (Grams)	Percent of Fishermen who Caught
White Croaker	153	34
Pacific Mackerel	334	25
Pacific Bonito	717	18
Queenfish	143	17
Jacksmelt	223	13
Walleye Perch	115	10
Shiner Perch	54	7
Opaleye	307	6
Black Perch	196	5
Kelp Bass	440	5
California Halibut	1752	4
Shellfish[a]	421	3

[a] Crab, mussels, lobster, abalone.

Source: Modified from Puffer et al., 1981.

Table 10-47. Fishing and Crabbing Behavior of Fishermen at Humacao, Puerto Rico.

	Mean ± Standard Error
Crabbing	
Number. of interviews	20
Number of people in group	3.5 ± 0.4
Number of adults (> 21 years)	2.3 ± 0.3
Visits to site/month	3.8 ± 0.7
No. crabs caught per season	21.4 ± 4.7
Crabs/hr	21.6 ± 4.9
Crabs eaten/week	13.3 ± 2.3
Range in no. eaten/week	0 - 25
Fishing	
Number of interviews	25
Number of people in group	2.9 ± 0.3
Number of adults (> 21 years)	2.3 ± 0.2
Visits to site/month	2.8 ± 0.4
No. fish caught per season	16.9 ± 3.5
Fish/hr	11.3 ± 2.5
Fish eaten/week	6.8 ± 0.7
Range in no. eaten/week	3 - 30

Source: Burger et al., 1991.

Table 10-48. Fish Consumption of Delaware Recreational Fishermen and Their Households			
	N	Mean consumption (g/day)	Standard Error (%)
All respondents	867	17.5	5.3
Gender			
Males	496	18.6	6.6
Females	369	15.9	8.7
Age (years)			
0 to 9	73	6.0	13.4
10 to 19	102	11.4	16.8
20 to 29	95	11.7	10.9
30 to 39	148	18.1	13.9
40 to 49	144	12.6	8.5
50 to 59	149	28.6	11.1
60 to 69	124	23.0	12.4
70 to 79	28	21.8	33.4
80 to 89	4	53.9	68.3
Race			
African American	81	14.9	27.1
Asian	12	5.6	31.2
Hispanic	12	3.0	35.2
Caucasian	748	18.2	5.3

Source: KCA Research Division, 1994.

Table 10-49. Seafood Consumption Rates of All Fish by Ethnic and Income Groups of Santa Monica Bay Consumption Rates of Recreational Marine fish and Shellfish at Specific Locations

Category	N	Consumption (g/day) Mean	95% C.I.	50th	90th
All respondents	555	49.6	9.3	21.4	107.1
Ethnicity					
White	217	58.1	19.1	21.4	112.5
Hispanic	137	28.2	5.9	16.1	64.3
Black	57	48.6	18.9	24.1	85.7
Asian	122	51.1	18.7	21.4	115.7
Other	14	137.3	92.2	85.7	173.6
Income					
< $5,000	20	42.1	18.0	32.1	64.3
$5,000 - $10,000	27	40.5	29.1	21.4	48.2
$10,000- $25,000	90	40.4	9.3	21.4	80.4
$25,000-$50,000	149	46.9	10.5	21.4	113.0
> $50,000	130	58.9	20.6	21.4	128.6

Source: Santa Monica Bay Restoration Project, 1994.

Table 10-50. Grams Per Day of Self-Caught Fish Consumed by Recreational Anglers – Alcoa/Lavaca Bay

Cohort	Mean	95% Upper Confidence Limit on Mean	90th or 95th Percentile of Distribution[a]
Finfish			
Adult men	24.8	27.7	68.1
Adult women	17.9	19.7	47.8
Women of childbearing age	18.8	22.1	45.4
Small children	11.4	14.2	30.3
Youths	15.6	17.8	45.4
Shellfish			
Adult men	1.2	1.6	5.1
Adult women	0.8	1.1	2.4
Women of childbearing age	0.9	1.2	4.0
Small children	0.4	0.6	2.0
Youths	0.7	1.0	4.5

[a] For shellfish, the 95th percentile value is provided because less than 90 percent of the individuals consumed shellfish, resulting in a 90th percentile of zero.

Source: Alcoa, 1998.

Table 10-51 Number of Meals and Portion Sizes of Self-Caught Fish Consumed by Recreational Anglers
Lavaca Bay, Texas

Age Group	Number of Meals		Portion Size (ounces)[a]	
	Mean	95% Upper Confidence Limit on Mean	Mean	95% Upper Confidence Limit on Mean
Finfish				
Adult Men	3.2	3.5	8.0	8.2
Adult Women	2.6	3.0	6.8	7.1
Women of Childbearing Age	2.8	3.2	6.8	7.3
Small children (<6 years)	2.6	3.1	4.5	4.7
Youths (6 to 19 years)	2.4	2.7	6.6	6.9
Shellfish				
Adult Men	0.3	0.4	3.7	4.3
Adult Women	0.3	0.4	2.9	3.4
Women of Childbearing Age	0.3	0.5	3.3	4.3
Small children (<6 years)	0.3	0.5	2.0	2.4
Youths (6 to 19 years)	0.3	0.4	2.5	2.9

[a] Converted from ounces; 1 ounce = 28.35 grams.

Source: Alcoa, 1998.

Table 10-52. Consumption Patterns of People Fishing and Crabbing in Barnegat Bay, New Jersey

	Males	Females
N	434	81
% Eat fish	84.1	78.05
% Give away fish	55.0	41.2
% Eat crabs	87.9	94.7
% Give away crabs	48.2	53.1
Number of times fish eaten/month	5.21 ± 0.33	5.21 ± 0.33
% Eaten that are self-caught	48.7 ± 2.15	48.7 ± 2.15
Number of times crabs eaten/month	2.14 ± 0.32	2.14 ± 0.32
Average serving size (oz)	10.12 ± 0.32	10.12 ± 0.32
Average consumption (males and females) (g/day)	48.3	

N = Sample size.

Source: Burger et al., 1998

Table 10-53. Fish Intake Rates of Members of the Laotian Community of West Contra Costa County, California

Group	Sample Size	Consumption (g/day)					
		Mean	Percentile			Max	Min
			50th	90th	95th		
All respondents	229	18.3	9.1	42.5	85.1	182.3	--
Fish consumers[a]	199	21.4	9.1	42.5	85.1	--	1.5

[a] "Fish consumers" were those who reported consumption of fish at least once a month.
Max = Maximum.
Min = Minimum.

Source: Chiang, 1998.

Table 10-54. Consumption Rates (grams/day) among Recent Consumers[a] by Demographic Factor

				Percentiles			
	N	Mean	SD	10th	50th	90th	95th
Overall	465	23.0	32.1	4.0	16.0	48.0	80.0
Gender							
Male	410	22.7	32.3	4.0	16.0	48.0	72.0
Female	35	22.3	26.8	6.0	16.0	53.2	84.0
Age (years)							
18 to 45	256	24.2	32.2	5.3	12.0	48.0	84.0
46 to 65	148	21.0	32.9	4.0	16.0	32.0	64.0
65 and older	43	21.8	24.4	4.0	16.0	64.0	72.0
Ethnicity							
African American	41	26.7	38.3	8.0	16.0	48.0	6.04
Asian-Chinese	26	27.8	34.8	4.0	12.0	80.0	128.0
Asian-Filipino	70	32.7	48.8	5.3	16.0	72.0	176.0
Asian-Other	31	22.0	27.6	4.0	8.0	72.0	72.0
Asian-Pacific Islander	12	38.0	44.2	4.0	24.0	96.0	184.0
Asian –Vietnamese	51	21.8	20.7	4.0	16.0	48.0	72.0
Hispanic	52	22.0	29.5	4.0	16.0	48.0	84.0
Caucasian	158	18.9	27.0	4.0	10.7	36.0	56.0
Education							
< 12th Grade	73	24.2	28.7	4.0	16.0	48.0	64.0
HS/GED	142	21.5	28.0	4.0	12.0	48.0	72.0
Some college	126	22.7	29.0	5.3	16.0	45.0	84.0
> 4 years college	94	25.0	42.1	4.0	12.0	53.2	96.0
Annual income							
< $20,000	101	21.9	27.8	4.0	8.0	48.0	72.0
$20,000 - $45,000	119	21.7	32.9	4.0	8.0	40.0	56.0
> $45,000	180	25.3	35.3	5.3	8.0	56.0	108.0
Season							
Winter	70	19.4	28.2	4.0	8.0	48.0	80.0
Spring	76	22.1	37.6	4.0	8.0	40.0	144.0
Summer	189	23.9	30.6	7.9	16.0	48.0	72.0
Fall	130	24.4	32.1	5.4	16.0	64.0	96.0

[a] Recent consumers are defined in the study as anglers who report consuming fish caught from San Francisco Bay in the four weeks prior to the date they were interviewed. Recent consumers are a subset of the overall consumer group.

N = Sample size.

SD = Standard deviation.

Source: SFEI, 2000.

Table 10-55. Percentile and Mean Intake Rates for Wisconsin Sport Anglers

Percentile	Annual Number of Sport Caught Meals	Intake Rate of Sport-Caught Meals (g/day)
25th	4	1.7
50th	10	4.1
75th	25	10.2
90th	50	20.6
95th	60	24.6
98th	100	41.1
100th	365	150
Mean	18	7.4

Source: Raw data on sport-caught meals from Fiore et al., 1989. U.S. EPA calculated intake rates using a value of 150 grams per fish meal; this value is dervied from Pao et al., 1982.

Table 10-56. Mean Fish Intake Among Individuals Who Eat Fish and Reside in Households With Recreational Fish Consumption

Group	All Fish meals/week	Recreational Fish meals/week	N	Total Fish grams/day	Recreational Fish grams/day	Total Fish grams/kg/ day	Recreational Fish grams/ kg/day
All household members	0.686	0.332	2,196	21.9	11.0	0.356	0.178
Respondents (i.e., licensed anglers)	0.873	0.398	748	29.4	14.0	0.364	0.168
Age Groups (years)							
1 to 5	0.463	0.223	121	11.4	5.63	0.737	0.369
6 to 10	0.49	0.278	151	13.6	7.94	0.481	0.276
1 to 20	0.407	0.229	349	12.3	7.27	0.219	0.123
21 to 40	0.651	0.291	793	22	10.2	0.306	0.139
40 to 60	0.923	0.42	547	29.3	14.2	0.387	0.186
60 to 70	0.856	0.431	160	28.2	14.5	0.377	0.193
71 to 80	1.0	0.622	45	32.3	20.1	0.441	0.271
80+	0.8	0.6	10	26.5	20	0.437	0.345

N = Sample size.

Source: U.S. EPA analysis using data from West et al., 1989.

Table 10-57. Comparison of Seven-Day Recall and Estimated Seasonal Frequency for Fish Consumption

Usual Fish Consumption Frequency Category	Mean Fish Meals/Week 7-day Recall Data	Usual frequency Value Selected for Data Analysis (times/week)
Almost daily	no data	4 [if needed]
2-4 times a week	1.96	2
Once a week	1.19	1.2
2-3 times a month	0.840 (3.6 times/month)	0.7 (3 times/month)
Once a month	0.459 (1.9 times/month)	0.4 (1.7 times/month)
Less often	0.306 (1.3 times/month)	0.2 (0.9 times/month)

Source: U.S. EPA analysis using data from West et al., 1989.

Table 10-58. Distribution of Usual Fish Intake Among Survey Main Respondents Who Fished and Consumed Recreationally Caught Fish

	All Fish Meals/Week	Recreational Fish Meals/Week	All Fish Intake grams/day	Recreational Fish Intake grams/day	All Fish Intake grams/kg/day	Recreational Fish Intake grams/kg/day
N	738	738	738	738	726	726
Mean	0.859	0.447	27.74	14.42	0.353	0.1806
10%	0.300	0.040	9.69	1.29	0.119	0.0159
25%	0.475	0.125	15.34	4.04	0.187	0.0504
50%	0.750	0.338	24.21	10.90	0.315	0.1357
75%	1.200	0.672	38.74	21.71	0.478	0.2676
90%	1.400	1.050	45.20	33.90	0.634	0.4146
95%	1.800	1.200	58.11	38.74	0.747	0.4920

N = Sample size.

Source: U.S. EPA analysis using data from West et al., 1989.

Table 10-59. Estimates of Fish Intake Rates of Licensed Sport Anglers in Maine During the 1989-1990 Ice Fishing or 1990 Open-Water Seasons[a]

Intake Rates (grams/day)

	All Waters[b]		Rivers and Streams	
Percentile Rankings	All Anglers[c] (N = 1,369)	Consuming Anglers[d] (N = 1,053)	River Anglers[e] (N = 741)	Consuming Anglers[d] (N = 464)
50th (median)	1.1	2.0	0.19	0.99
66th	2.6	4.0	0.71	1.8
75th	4.2	5.8	1.3	2.5
90th	11.0	13.0	3.7	6.1
95th	21.0	26.0	6.2	12.0
Arithmetic Mean[f]	5.0 [79]	6.4 [77]	1.9 [82]	3.7 [81]

a Estimates are based on rank except for those of arithmetic mean.
b All waters based on fish obtained from all lakes, ponds, streams and rivers in Maine, from other household sources and from other non-household sources.
c Licensed anglers who fished during the seasons studied and did or did not consume freshwater fish, and licensed anglers who did not fish but ate freshwater fish caught in Maine during those seasons.
d Licensed anglers who consumed freshwater fish caught in Maine during the seasons studied.
e Those of the "all anglers" who fished on rivers or streams (consumers and nonconsumers).
f Values in brackets [ ] are percentiles at the mean consumption rates.

Source: Chemrisk, 1992; Ebert et al., 1993.

Table 10-60. Analysis of Fish Consumption by Ethnic Groups for "All Waters" (g/day)[a]

	Consuming Anglers[b]					
	French Canadian Heritage	Irish Heritage	Italian Heritage	Native American Heritage	Other White Non-Hispanic Heritage	Scandinavian Heritage
N of Cases	201	138	27	96	533	37
Median (50th percentile)[c,d]	2.3	2.4	1.8	2.3	1.9	1.3
66th percentile[c,d]	4.1	4.4	2.6	4.7	3.8	2.6
75th percentile[c,d]	6.2	6.0	5.0	6.2	5.7	4.9
Arithmetic Mean[c]	7.4	5.2	4.5	10	6.0	5.3
Percentile at the Mean[d]	80	70	74	83	76	78
90th percentile[c,d]	15	12	12	16	13	9.4
95th percentile[c,d]	27	20	21	51	24	25
Percentile at 6.5 g/day[d,e]	77	75	81	77	77	84

[a] "All Waters" based on fish obtained from all lakes, ponds, streams and rivers in Maine, from other household sources and from other non-household sources.
[b] "Consuming Anglers" refers to only those anglers who consumed freshwater fish obtained from Maine sources during the 1989-1990 ice fishing or 1990 open water fishing season.
[c] The average consumption per day by freshwater fish consumers in the household.
[d] Calculated by rank without any assumption of statistical distribution.
[e] Fish consumption rate recommended by U.S. EPA (1984) for use in establishing ambient water quality standards.

Source: Chemrisk, 1992.

Table 10-61. Total Consumption of Freshwater Fish Caught by All Survey Respondents During the 1990 Season

	Ice Fishing		Lakes and Ponds		Rivers and Streams	
Species	Quantity Consumed (#)	Grams ($x10^3$) Consumed	Quantity Consumed (#)	Grams ($x10^3$) Consumed	Quantity Consumed (#)	Grams ($x10^3$) Consumed
Landlocked salmon	832	290	928	340	305	120
Atlantic salmon	3	1.1	33	9.9	17	11
Togue (Lake trout)	483	200	459	160	33	2.7
Brook trout	1,309	100	3,294	210	10,185	420
Brown trout	275	54	375	56	338	23
Yellow perch	235	9.1	1,649	52	188	7.4
White perch	2,544	160	6,540	380	3,013	180
Bass (smallmouth and largemouth)	474	120	73	5.9	787	130
Pickerel	1,091	180	553	91	303	45
Lake whitefish	111	20	558	13	55	2.7
Hornpout (Catfish and bullheads)	47	8.2	1,291	100	180	7.8
Bottom fish (Suckers, carp and sturgeon)	50	81	62	22	100	6.7
Chub	0	0	252	35	219	130
Smelt	7,808	150	428	4.9	4,269	37
Other	201	210	90	110	54	45
TOTALS	**15,463**	**1,583.4**	**16,587**	**1,590**	**20,046**	**1,168**

Source: Chemrisk, 1992.

Table 10-62. Sociodemographic Characteristics of Respondents

Category	Subcategory	Percent of Total[a]
Geographic Distribution	Upper Hudson	18 %
	Mid Hudson	35 %
	Lower Hudson	48 %
Age Distribution (years)	< 14	3 %
	15 - 29	26 %
	30 - 44	35 %
	45 - 59	23 %
	> 60	12 %
Annual Household Income	< $10,000	16 %
	$10 - 29,999	41 %
	$30 - 49,999	29 %
	$50 - 69,999	10 %
	$70 - 89,999	2 %
	> $90,000	3 %
Ethnic Background	Caucasian American	67 %
	African American	21 %
	Hispanic American	10 %
	Asian American	1 %
	Native American	1 %

[a] A total of 336 shore-based anglers were interviewed.

Source: Hudson River Sloop Clearwater, Inc., 1993.

Table 10-63. Mean Sport-Fish Consumption by Demographic Variables, Michigan Sport Anglers Fish Consumption Study, 1991-1992

	N	Mean (g/day)	95% C.I.
Income[a]			
<$15,000	290	21.0	16.3 - 25.8
$15,000 - $24,999	369	20.6	15.5 - 25.7
$25,000 - $39,999	662	17.5	15.0 - 20.1
>$40,000	871	14.7	12.8 - 16.7
Education			
Some High School	299	16.5	12.9 - 20.1
High School Degree	1,074	17.0	14.9 - 19.1
Some College-College Degree	825	17.6	14.9 - 20.2
Post Graduate	231	14.5	10.5 - 18.6
Residence Size[b]			
Large City/Suburb (>100,000)	487	14.6	11.8 - 17.3
Small City (20,000-100,000)	464	12.9	10.7 - 15.0
Town (2,000-20,000)	475	19.4	15.5 - 23.3
Small Town (100-2,000)	272	22.8	16.8 - 28.8
Rural, Non Farm	598	17.7	15.1 - 20.3
Farm	140	15.1	10.3 - 20.0
Age (years)			
16-29	266	18.9	13.9 - 23.9
30-39	583	16.6	13.5 - 19.7
40-49	556	16.5	13.4 - 19.6
50-59	419	16.5	13.6 - 19.4
60+	596	16.2	13.8 - 18.6
Sex[a]			
Male	299	17.5	15.8 - 19.1
Female	1,074	13.7	11.2 - 16.3
Race/Ethnicity[b]			
Minority	160	23.2	13.4 - 33.1
White	2,289	16.3	14.9 - 17.6

[a] $P < .01$, F test
[b] $P < .05$, F test

Source: West et al., 1993.

Table 10-64. Mean Per Capita Freshwater Fish Intake of Alabama Anglers

	Mean Consumption (g/day)					
	Harvest Method[a]			4-oz Serving Method[b]		
	N	Site meals	All meals	N	Site Meals	All Meals
All respondents	563	32.6	43.1	1303	30.3	45.8
All respondents; all meals; 4 oz serving method						44.8
Age (years)						
20 to 30						16
31 to 50						39
51 and over						76
Race/Ethnicity						
African American	113	35.4	49.6	232	33.4	50.7
Native American	0	0	0	2	22.7	22.7
Asian	2	74.7	74.7	3	44.1	44.1
Hispanic	2	0	0	2	0	0
Caucasian	413	33.9	48.6	925	29.4	49.7

[a] The Harvest Method used the actual harvest of fish and dressing method reported to calculate consumption rates.
[b] The 4-oz Serving Method estimated consumption based on a typical 4-oz serving size.

Source: Alabama Department of Environmental Management (ADEM), 1994.

Table 10-65. Means and Standard Deviations of Selected Characteristics by Subpopulation Groups in Everglades, Florida

Variables (N[a]=330)	Mean ± SD.[b]	Range
Age (years)	38.6 ± 18.8	2 - 81
Sex		
Female	38%	-
Male	62%	-
Race/ethnicity		
Black	46%	-
White	43%	-
Hispanic	11%	-
Number of Years Fished	15.8 ± 15.8	0 - 70
Number Per Week Fished in Past 6 Months of Survey Period	1.8 ± 2.5	0 - 20
Number Per Week Fished in Last Month of Survey Period	1.5 ± 1.4	0 - 12
Aware of Health Advisories	71%	-

[a] N = Number of respondents who reported consuming fish.
[b] SD = Standard deviation.

Source: U.S. DHHS, 1995.

Table 10-66. Distribution of Fish Intake Rates
(from all sources and from sport-caught sources) For 1992 Lake Ontario Anglers

Percentile of Lake Ontario Anglers	Fish from All Sources (g/day)	Sport-Caught Fish (g/day)
25%	8.8	0.6
50%	14.1	2.2
75%	23.2	6.6
90%	34.2	13.2
95%	42.3	17.9
99%	56.6	39.8

Source. Connelly et al., 1996.

Table 10-67. Mean Annual Fish Consumption (g/day)
for Lake Ontario Anglers, 1992, by Sociodemographic Characteristics

	Mean Consumption	
Demographic Group	Fish from all Sources	Sport-Caught Fish
Overall	17.9	4.9
Residence		
Rural	17.6	5.1
Small City	20.8	6.3
City (25-100,000)	19.8	5.8
City (> 100,000)	13.1	2.2
Income		
< $20,000	20.5	4.9
$21,000-34,000	17.5	4.7
$34,000-50,000	16.5	4.8
>$50,000	20.7	6.1
Age (years)		
<30	13.0	4.1
30-39	16.6	4.3
40-49	18.6	5.1
50+	21.9	6.4
Education		
< High School	17.3	7.1
High School Graduate	17.8	4.7
Some College	18.8	5.5
College Graduate	17.4	4.2
Some Post Grad.	20.5	5.9

Note - Scheffe’s test showed statistically significant differences between residence types (for all sources and sport caught) and age groups (all sources).

Source: Connelly et al., 1996.

Table 10-68. Seafood Consumption Rates of Nine Connecticut Population Groups. (Cooked, Edible Meat, g/day)					
	N	Mean	Standard Deviation	Minimum	Maximum
General population	437	27.7	42.7	0	494.8
Sport-fishing households	502	51.1	66.1	0	586.0
Commercial fishing households	178	47.4	58.5	0	504.3
Minority	861	50.3	57.5	0	430.0
South East Asians	329	59.2	49.3	0.13	245.6
Non Asians	532	44.8	61.5	0	430.0
Limited income households	937	43.1	60.4	0	571.9
Women age15-45 years	497	46.5	57.4	0	494.8
Children ≤15 years old	559	18.3	29.8	0	324.8

N = Sample size.

Source: Balcom et al., 1999.

Table 10-69. Fishing Patterns and Consumption Rates of People Fishing Along the Savannah River (Mean ± SE)									
	N	Age	Years fished	Years fished Savannah River	Distance traveled (km)	How often eat fish/month	Serving size (g)	Fish/month (kg)	Fish/year (Kg)
Ethnicity									
White	180	42 ± 1	31 ± 1	24 ± 1	42 ± 9	2.88 ± 0.30	370 ± 6.60	1.17 ± 0.14	14.0 ± 1.70
Black	72	47 ± 2	34 ± 2	24 ± 2	15 ± 1	5.37 ± 0.57	387 ± 10.2	2.13 ± 0.24	25.6 ± 2.92
Income									
≤ $20,000	138	43 ± 1	32± 2	24 ± 2	31 ± 4	3.39 ± 0.52	379 ± 7.27	1.44 ± 0.24	17.3 ± 2.82
> $20,000	99	42 ± 1	30± 1	22 ± 2	32 ± 9	3.97 ± 0.36	375 ± 8.10	1.58 ± 0.16	18.9 ± 1.88
Education									
Not high school graduate	45	49 ± 2	36 ± 2	23 ± 3	24 ± 4	5.93 ± 0.85	383 ± 13.3	2.61 ± 0.44	31.3 ± 5.26
High school graduate	154	43 ± 1	31 ± 1	26 ± 1	36 ± 9	3.02 ± 0.27	366 ± 6.81	1.15 ± 0.11	13.8 ± 1.36
College or technical training	59	41 ± 2	28 ± 2	17 ± 2	54 ± 24	3.36 ± 0.67	398 ± 11.8	1.52 ± 0.31	18.2 ± 3.66
Overall mean (all respondents)									48.7 g/day

N = Sample size.

Source: Burger et al., 1999.

Table 10-70. Fish Consumption Rates for Indiana Anglers - Mail Survey, g/day						
			Percentile			
	N	Mean	50th	80th	90th	95th
Active Consumers	1045	19.8	9.5	28.4	37.8	60.5
Potential and Active Consumers	1261	16.4	7.6	23.6	37.8	60.5

Source: Williams et al., 1999.

Table 10-71. Fish Consumption Rates for Indiana Anglers - On-site Survey, g/day						
			Percentile			
	N	Mean	50^{th}	80^{th}	90^{th}	95^{th}
Active Consumers						
White	177	20.0	7.6	23.6	37.8	113.4
Minority	143	27.2	7.6	30.2	90.7	136.1
Income						
< $25,000	101	18.9	7.5	18.9	37.8	136.1
$25,000 - $34,999	62	18.8	7.6	23.6	60.5	90.7
$35,000 - $49,999	55	15.2	5.7	23.6	23.6	45.4
>$50,000	60	48.9	11.3	113.4	181.4	181.4
Potential and Active Consumers						
White	361	6.8	0	5.7	15.1	37.8
Minority	217	15.3	3.8	13.2	37.8	90.7
Income	180	10.2	3.8	9.5	23.6	37.8
< $25,000	117	7.4	0	7.6	15.1	37.8
$25,000 - $34,999	91	6.8	0	5.7	22.7	23.6
$35,000 - $49,999	126	13.6	0	7.6	37.8	113.4
>$50,000						
Source: Williams et al., 2000.						

Table 10-72. Consumption of Sport-Caught and Purchased Fish by Minnesota and North Dakota Residents, g/day

	N	Mean	Percentile			
			50th	75th	90th	95th
Minnesota						
All respondents	2,312	12.3	2.8	7.5	18.1.7	30.7
Sport-caught fish only						
Age/Gender						
0-14	582	-	1.2	3.3	8.3	14.6
14 and over (males)	996	-	4.5	10.8	23.7	37.8
15-44 (females)	505	-	2.1	5.8	14.6	25.3
44 and over (females)	460	-	3.6	8.8	19.9	32.3
Purchased fish only						
Age/Gender						
0-14	582	-	3.6	8.7	19.2	30.9
14 and over (males)	996	-	7.4	15.5	30.0	44.6
15-44 (females)	505	-	6.1	13.7	28.6	44.4
44 and over (females)	460	-	7.1	14.6	27.9	41.1
Fishing License						
Yes	2020	-	3.9	9.2	20.1	32.1
No	490	-	0.0	1.98	4.93	8.50
North Dakota						
All respondents	1,406	12.6	3.0	7.8	18.1	29.9
Sport-caught fish only						
Age/Gender						
0-14	343	-	1.7	5.1	13.1	23.3
14 and over (males)	579	-	2.3	6.4	16.0	27.6
15-44 (females)	311	-	4.3	10.2	22.3	35.4
44 and over (females)	278	-	4.2	10.1	22.2	35.7
Purchased fish only						
Age/Gender						
0-14	343	-	4.7	11.6	26.3	42.8
14 and over (males)	579	-	6.8	15.2	31.5	48.6
15-44 (females)	311	-	7.1	15.4	30.8	46.7
44 and over (females)	278	-	6.1	14.0	29.7	46.5
Fishing License						
Yes	1101	-	4.5	10.3	21.7	33.9
No	391	-	1.17	1.54	4.10	7.37

\- Indicates data are not available.

Source: Benson et al., 2001.

Table 10-73. Fishing Patterns and Consumption Rates of Anglers along the Clinch River Arm of Watts Bar Reservoir (Mean ± SE)

	N	Age (years)	Years fished	Years fished Clinch River	Distance traveled (km)	How often eat fish/month	Serving size (g)	Fish/month (kg)	Fish/year (Kg)
All Anglers	202	39.2± 1	31 ± 1	11 ± 1	61 ± 5	1.28 ± 0.12	283 ± 20.9	0.62 ± 0.08	7.40 ± 1.01
Anglers who catch and eat fish from study area	77	41.8 ± 2	34 ± 2	12 ± 2	57 ± 6	2.06 ± 0.22	486 ± 32.7	1.14 ± 0.19	13.7 ± 2.17
Ethnicity									
White	71	42 ± 2	34 ± 2	12 ± 2	59 ± 6	2.14 ± 0.23	501 ± 33.6	1.21 ± 0.20	14.5 ± 2.36
Black	6	43 ± 6	33 ± 7	20 ± 5	44 ± 20	0.94 ± 0.78	307 ± 116	0.34 ± 0.68	4.14 ± 8.11
Income									
≤ $20,000	22	42 ± 3	33 ± 4	16 ± 3	49 ± 10	1.37 ±0.40	392 ± 41.7	0.52 ± 0.29	6.29 ± 3.58
$20,000 - $29,000	19	35 ± 3	29 ± 4	8.8 ± 3	37 ± 12	1.84 ± 0.44	548 ± 44.9	1.19 ± 0.32	14.3 ± 3.85
$30,000 - $39,000	18	43 ± 3	37 ± 4	8.9 ± 3	69 ± 11	2.13 ± 0.45	482 ± 46.1	1.11 ± 0.33	13.3 ± 3.95
> $40,000	15	47 ± 4	38 ± 4	13.9 ± 3	81 ± 12	3.01 ± 0.49	452 ± 50.5	1.56 ± 0.36	18.8 ± 4.33
Education									
Not high school graduate	18	44 ± 4	35 ± 4	13 ± 3	57 ± 12	1.67 ± 0.46	439 ± 67.7	0.83 ± 0.39	9.99 ± 4.77
High school graduate	28	40 ± 3	32 ± 3	14 ± 3	55 ± 10	2.12 ± 0.37	551 ± 54.2	1.45 ± 0.32	17.4 ± 3.82
Some college, associates, trade school	20	40 ± 3	35 ± 4	9.0 ± 3	61 ± 11	2.05 ± 0.44	486 ± 64.2	1.11 ± 0.38	13.4 ± 4.52
College, at least a bachelors degree	10	42 ± 5	36 ± 5	10 ± 4	59 ± 16	2.33 ± 0.62	414 ± 90.8	0.92 ± 0.53	11.0 ± 6.39

Source: Campbell et al., 2002.

Table 10-74. Number of Grams Per Day of Fish Consumed by All Adult Respondents (Consumers and Non-consumers Combined) - Throughout the Year

Number of Grams/Day	Cumulative Percent	Number of Grams/Day	Cumulative Percent
0.00	8.9%	64.8	80.6%
1.6	9.0%	72.9	81.2%
3.2	10.4%	77.0	81.4%
4.0	10.8%	81.0	83.3%
4.9	10.9%	97.2	89.3%
6.5	12.8%	130	92.2%
7.3	12.9%	146	93.7%
8.1	13.7%	162	94.4%
9.7	14.4%	170	94.8%
12.2	14.9%	194	97.2%
13.0	16.3%	243	97.3%
16.2	22.8%	259	97.4%
19.4	24.0%	292	97.6%
20.2	24.1%	324	98.3%
24.3	27.9%	340	98.7%
29.2	28.1%	389	99.0%
32.4	52.5%	486	99.6%
38.9	52.9%	648	99.7%
40.5	56.5%	778	99.9%
48.6	67.6%	972	100%

N = 500
Weighted Mean = 58.7 grams/day (g/d)
Weighted SE = 3.64
90th Percentile 97.2 g/d < (90th) < 130 g/d
95th Percentile = 170 g/d
99th Percentile = 389 g/d

Source: CRITFC, 1994.

Table 10-75. Fish Intake Throughout the Year by Sex, Age, and Location by All Adult Respondents

	N	Weighted Mean (grams/day)	Weighted SE
Sex			
Female	278	55.8	4.78
Male	222	62.6	5.60
Total	500	58.7	3.64
Age (years)			
18 to 39	287	57.6	4.87
40 to 59	155	55.8	4.88
60 & Older	58	74.4	15.3
Total	500	58.7	3.64
Location			
On Reservation	440	60.2	3.98
Off Reservation	60	47.9	8.25
Total	500	58.7	3.64

Source: CRITFC, 1994.

Table 10-76. Fish Consumption Rates among Native American Children (age 5 years and under)[a]	
Grams/Day	Unweighted Cumulative Percent
0.0	21.1
0.4	21.6
0.8	22.2
1.6	24.7
2.4	25.3
3.2	28.4
4.1	32.0
4.9	33.5
6.5	35.6
8.1	47.4
9.7	48.5
12.2	51.0
13.0	51.5
16.2	72.7
19.4	73.2
20.3	74.2
24.3	76.3
32.4	87.1
48.6	91.2
64.8	94.3
72.9	96.4
81.0	97.4
97.2	98.5
162.0	100

[a] Sample size = 194; unweighted mean = 19.6 grams/day; unweighted standard error = 1.94.

Note: Data are compiled from the Umatilla, Nez Perce, Yakama, and Warm Springs tribes of the Columbia River Basin.

Source: CRITFC, 1994.

Table 10-77. Number of Fish Meal Eaten per Month and Fish Intake Among Native American Children who Consume Particular Species

Species	N	Fish Meals/Month		Intake (g/day)	
		Unweighted Mean	Unweighted SE	Unweighted Mean	Unweighted SE
Salmon	164	2.3	0.16	19	1.5
Lamprey	37	0.89	0.27	8.1	2.8
Trout	89	0.96	0.12	8.8	1.4
Smelt	39	0.40	0.09	3.8	0.99
Whitefish	21	3.5	2.83	21	16
Sturgeon	21	0.43	0.12	4.0	1.3
Walleye	5	0.22	0.20	2.0	1.5
Squawfish	2	0.00	-	0.0	-
Sucker	4	0.35	0.22	2.6	1.7
Shad	3	0.10	0.06	1.1	0.57

- Not applicable.

SE = Standard error.

Source: CRITFC, 1994.

Table 10-78. Sociodemographic Factors and Recent Fish Consumption

	Peak Consumption[a]		Recent Consumption[b]			
	Average[c]	3[d] (%)	Walleye	N. Pike	Muskellunge	Bass
All participants (N-323)	1.7	20	4.2	0.3	0.3	0.5
Gender						
Male (N-148)	1.9	26	5.1	0.5[a]	0.5	0.7[a]
Female (N-175)	1.5	15	3.4	0.2	0.1	0.3
Age (y)						
<35 (N-150)	1.8	23	5.3[a]	0.3	0.2	0.7
35 (N-173)	1.6	17	3.2	0.4	0.3	0.3
High School Graduate						
No (N-105)	1.6	18	3.6	0.2	0.4	0.7
Yes (N-218)	1.7	21	4.4	0.4	0.2	0.4
Unemployed						
Yes (N-78)	1.9	27	4.8	0.6	0.6	1.1
No (n-245)	1.6	18	4.0	0.3	0.2	0.3

[a] Highest number of fish meals consumed/week.
[b] Number of meals of each species in the previous 2 months.
[c] Average peak fish consumption.
[d] Percentage of population reporting peak fish consumption of 3 fish meals/week.

Source: Peterson et al., 1994.

Table 10-79. Number of Local Fish Meals Consumed Per Year by Time Period for All Respondents

Number of Local Fish Meals Consumed Per Year	Time Period											
	During Pregnancy				≤1 Yr. Before Pregnancy[a]				>1 Yr. Before Pregnancy[b]			
	Mohawk		Control		Mohawk		Control		Mohawk		Control	
	N[c]	%	N[c]	%	N[c]	%	N[c]	%	N[c]	%	N[c]	%
None	63	64.9	109	70.8	42	43.3	99	64.3	20	20.6	93	60.4
1 to 9	24	24.7	24	15.6	40	41.2	31	20.1	42	43.3	35	22.7
10 to 19	5	5.2	7	4.5	4	4.1	6	3.9	6	6.2	8	5.2
20 to 29	1	1.0	5	3.3	3	3.1	3	1.9	9	9.3	5	3.3
30 to 39	0	0.0	2	1.3	0	0.0	3	1.9	1	1.0	1	0.6
40 to 49	0	0.0	1	0.6	1	1.0	1	0.6	1	1.0	1	0.6
50+	4	4.1	6	3.9	7	7.2	11	7.1	18	18.6	11	7.1
Total	97	100.0	154	100.0	97	100.0	154	100.0	97	100.0	154	100.0

[a] $p < 0.05$ for Mohawk vs. Control.
[b] $p < 0.001$ for Mohawk vs. Control.
[c] N = number of respondents.

Source: Fitzgerald et al., 1995.

Table 10-80. Mean Number of Local Fish Meals Consumed Per Year by Time Period for All Respondents and Consumers Only

	All Respondents (N=97 Mohawks and 154 Controls)			Consumers Only (N=82 Mohawks and 72 Controls)		
	During Pregnancy	<1 Yr. Before Pregnancy	>1 Yr. Before Pregnancy	During Pregnancy	<1 Yr. Before Pregnancy	>1 Yr. Before Pregnancy
Mohawk	3.9 (1.2)	9.2 (2.3)	23.4 (4.3)[a]	4.6 (1.3)	10.9 (2.7)	27.6 (4.9)
Control	7.3 (2.1)	10.7 (2.6)	10.9 (2.7)	15.5 (4.2)[a]	23.0 (5.1)[b]	23.0 (5.5)

[a] p <0.001 for Mohawk vs. Control..
[b] p<0.05 for Mohawk vs. Control.
( ) = Standard error..
Test for linear trend:
p<0.001 for Mohawk (All participants and consumers only);
p=0.07 for Controls (All participants and consumers only).

Source: Fitzgerald et al., 1995.

Table 10-81. Mean Number of Local Fish Meals Consumed Per Year by Time Period and Selected Characteristics for All Respondents (Mohawk, N=97; Control, N=154)

	Time Period					
	During Pregnancy		≤1 Year Before Pregnancy		>1 Year Before Pregnancy	
Variable	Mohawk	Control	Mohawk	Control	Mohawk	Control
Age (Yrs)						
<20	7.7	0.8	13.5	13.9	27.4	10.4
20 - 24	1.3	5.9	5.7	14.5	20.4	15.9
25 - 29	3.9	9.9	15.5	6.2	25.1	5.4
30 - 34	12.0	7.6	9.5	2.9	12.0	5.6
>34	1.8	11.2	1.8	26.2	52.3	22.1[a]
Education (Yrs)						
<12	6.3	7.9	14.8	12.4	24.7	8.6
12	7.3	5.4	8.1	8.4	15.3	11.4
13 - 15	1.7	10.1	8.0	15.4	29.2	13.3
>15	0.9	6.8	10.7	0.8	18.7	2.1
Cigarette Smoking						
Yes	3.8	8.8	10.4	13.0	31.6	10.9
No	3.9	6.4	8.4	8.3	18.1	10.8
Alcohol Consumption						
Yes	4.2	9.9	6.8	13.8	18.0	14.8
No	3.8	6.3[b]	12.1	4.7[c]	29.8	2.9[d]

[a] $F(4,149) = 2.66$, $p=0.035$ for Age Among Controls.
[b] $F(1,152) = 3.77$, $p=0.054$ for Alcohol Among Controls.
[c] $F(1,152) = 5.20$, $p=0.024$ for Alcohol Among Controls.
[d] $F(1,152) = 6.42$, $p=0.012$ for Alcohol Among Controls.

Source: Fitzgerald et al., 1995.

Table 10-82. Percentiles and Mean of Adult Tribal Member Consumption Rates (g/kg/day)

	5%	50%	90%	95%	SE	Mean	95% CI
Tulalip Tribes (N = 73)							
Anadromous fish	0.006	0.190	1.429	2.114	0.068	0.426	(0.297, 0.555)
Pelagic fish	0.000	0.004	0.156	0.234	0.008	0.036	(0.021, 0.051)
Bottom fish**	0.000	0.008	0.111	0.186	0.007	0.033	(0.020, 0.046)
Shellfish**	0.000	0.153	1.241	1.5296	0.059	0.362	(0.250, 0.474)
Total finfish	0.010	0.284	1.779	2.149	0.072	0.495	(0.359, 0.631)
Other fish:+*	0.000	0.000	0.113	0.264	0.008	0.031	(0.016, 0.046)
Total fish	0.046	0.552	2.466	2.876	0.111	0.889	(0.679, 1.099)
Squaxin Island Tribe (N = 117)							
Anadromous fish	0.016	0.308	1.639	2.182	0.069	0.590	(0.485, 0.695)
Pelagic fish	0.000	0.003	0.106	0.248	0.009	0.043	(0.029, 0.057)
Bottom fish**	0.000	0.026	0.176	0.345	0.010	0.063	(0.048, 0.078)
Shellfish**	0.000	0.065	0.579	0.849	0.027	0.181	(0.140, 0.222)
Total finfish	0.027	0.383	1.828	2.538	0.075	0.697	(0.583, 0.811)
Other fish:+*	0.000	0.000	0.037	0.123	0.003	0.014	(0.009, 0.019)
Total fish	0.045	0.524	2.348	3.016	0.088	0.891	(0.757, 1.025)
Both Tribes Combined (weighted)							
Anadromous fish	0.010	0.239	1.433	2.085	0.042	0.508	(0.425, 0.591)
Pelagic fish	0.000	0.004	0.112	0.226	0.005	0.040	(0.029, 0.050)
Bottom fish**	0.000	0.015	0.118	0.118	0.005	0.048	(0.038, 0.058)
Shellfish**	0.000	0.115	0.840	1.308	0.030	0.272	(0.212, 0.331)
Total finfish	0.017	0.317	1.751	2.188	0.045	0.596	(0.507, 0.685)
Other fish:+*	0.000	0.000	0.049	0.145	0.004	0.023	(0.015, 0.030)
Total fish	0.047	0.531	2.312	2.936	0.064	0.890	(0.765, 1.015)

N = Sample size.
SE = Standard error.
CI = Confidence interval.
* p <0.05
** p <0.01 comparing two tribes (Wilcoxon-Mann-Whitney test).

Source: Toy et al., 1996.

Table 10-83. Median and Mean Consumption Rates by Gender (g/kg/day) Within Each Tribe

	Tulalip Tribe				Squaxin Island Tribe			
	N	Median	Mean	95% CI	N	Median	Mean	95% CI
Shellfish								
Male	42	0.158	0.370	(0.215, 0.525)	65	0.100	0.202	(0.149, 0.255)
Female	31	0.153	0.353	(0.192, 0.514)	52	0.038	0.155	(0.093, 0.217)
Total finfish								
Male	42	0.414	0.559	(0.370, 0.748)	65	0.500	0.707	(0.576, 0.838)
Female	31	0.236	0.409	(0.218, 0.600)	52	0.272	0.684	(0.486, 0.882)
Total fish[a]								
Male	42	0.623	0.959	(0.666, 1.252)	65	0.775b	0.926	(0.771, 1.081)
Female	31	0.472	0.794	(0.499, 1.089)	52	0.353	0.847	(0.614, 1.080)

[a] Total fish includes anadromous, pelagic, bottom shellfish, finfish, and other fish.b p <.05 for difference in consumption rate by gender within a tribe (Wilcoxon-Mann-Whitney test).

N = Sample size.

CI = Confidence interval.

Source: Toy et al., 1996.

Table 10-84. Median Consumption Rate for Total Fish by Gender and Tribe (g/day)

	Tulalip Tribe	Squaxin Island Tribe
Male	53	66
Female	34	25

Source: Toy et al., 1996.

Table 10-85. Percentiles of Adult Consumption Rates by Age (g/kg/day)

	Tulalip Tribes				Squaxin Island Tribe		
Ages	5%	50%	90%	95%	50%	90%	95%
Shellfish							
18-34	0.00	0.181	1.163	1.676	0.073	0.690	1.141
35-49	0.00	0.161	1.827	1.836	0.073	0.547	1.094
50-64	0.00	0.173	0.549	0.549	0.000	0.671	0.671
65+	0.00	0.034	0.088	0.088	0.035	0.188	0.188
Total finfish							
18-34	0.013	0.156	1.129	1.956	0.289	1.618	2.963
35-49	0.002	0.533	2.188	2.388	0.383	2.052	2.495
50-64	0.156	0.301	1.211	1.211	0.909	3.439	3.439
65+	0.006	0.176	0.531	0.531	0.601	2.049	2.049
Total fish[a]							
18-34	0.044	0.571	2.034	2.615	0.500	2.385	3.147
35-49	0.006	0.968	3.666	4.204	0.483	2.577	3.053
50-64	0.190	0.476	11.586	1.586	1.106	3.589	3.589
65+	0.050	0.195	0.623	0.623	0.775	2.153	2.153

[a] Total fish includes anadromous, pelagic, bottom, shellfish, finfish, and other fish.

Source: Toy et al., 1996.

Table 10-86. Median Consumption Rates by Income (g/kg/day) Within Each Tribe		
Income	Tulalip Tribes	Squaxin Island Tribe
Shellfish		
<= $10,000	0.143	0.078
$10,001 -$15,000	0.071	0.121
$15,001 - $20,000	0.144	0.072
$20,001 - $25,000	0.202	0.000
$25,001 - $35,000	0.416	0.030
$35,001 +	0.175	0.090
Total finfish		
<=$ 10,000	0.235	0.272
$10,001 -$15,000	0.095	0.254
$15,001 -$20,000	0.490	0.915
$20,001 - $25,000	0.421	0.196
$25,001 - $35,000	0.236	0.387
$35,001 +	0.286	0.785
Total fish		
<= $10,000	0.521	0.476
$10,001 -$15,000	0.266	0.432
$15,001 - $20,000	0.640	0.961
$20,001 -$25,000	0.921	0.233
$25,001 - $35,000	0.930	0.426
$35,001 +	0.607	1.085

Source: Toy et al., 1996.

Table 10-87. Mean, 50th, and 90th Percentiles of Consumption Rates for Children Age Birth to Five Years (g/kg/day)

	Mean (SE)	95% CI	50%	90%
Tulalip Tribes (N = 21)				
Shellfish	0.125 (0.056)	(0.014, 0.236)	0.000	0.597
Total finfish	0.114 (0.030)	(0.056, 0.173)	0.060	0.290
Total, all fish	0.239 (0.077)	(0.088, 0.390)	0.078	0.738
Squaxin Island Tribe (N = 48)				
Shellfish	0.228 (0.053)	(0.126, 0.374)	0.045	0.574
Total finfish	0.250 (0.063)	(0.126, 0.374)	0.061	0.826
Total, all fish	0.825 (0.143)	(0.546, 1.105)	0.508	2.056
Both Tribes Combined (weighted)				
Shellfish	0.177 (0.039)	(0.101, 0.253)	0.012	0.574
Total finfish	0.182 (0.035)	(0.104, 0.251)	0.064	0.615
Total, all fish	0.532 (0.081)	(0.373, 0.691)	0.173	1.357

N = Sample size.
SE = Standard error.
CI = Confidence interval.

Source: Toy et al., 1996.

Table 10-88. Adult Consumption Rate (g/kg/day): Individual Finfish and Shellfish and Fish Groups

Species/Group	All Adult Respondents (including non-consumers)											Consumers Only			
	N	Mean	SE	95% LCL	95% UCL	Percentiles 5th	50th	75th	90th	95t	Max	N	%	GM	MSE
Group G															
Abalone	92	0.001	0.001	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.063	3	3	0.007	3.139
Lobster	92	0.022.	0.007	0.008	0.036	0.000	0.000	0.000	0.085	0.139	0.549	22	24	0.052	1.266
Octopus	92	0.019	0.006	0.008	0.030	0.000	0.000	0.015	0.069	0.128	0.407	25	27	0.042	1.231
Limpets	92	0.010	0.009	0.000	. 0.027	0.000	0.000	0.000	0.000	.0.000	0.795	2	2	0.261	3.047
Miscellaneous	92	0.0003	0.0003	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.023	1	1	0.023	
Group A	92	0.618	0.074.	0.473	0.763	0.021	0.350	1.002	1.680	2.177	3.469	92	100	0.274	1.167
Group B	92	0.051	0.016	0.019	0.082	0.000	0.003	0.019	0.128	0.270	1.149	49	53	0.025	1.262
Group C	92	0.136	0.025	0.087	0.185	0.000	0.055	0.141	0.369	0.526	1.716	87	95	0.064	1.147
Group D	92	0.097	0.021	0.056	0.138	0.000	0.029	0.076	0.206	0.613	1.069	76	.83	0.045	1.168
Group E	92	1.629	0.262	1.115	2.143	0.063	0.740	1.688	4.555	7.749	15.886	91	99	0.703	1.160
Group F	92	0.124	0.016	0.092	0.156	0.000	0.068	0.144	0.352	0.533	0.778	85	92	0.070	1.139
Group G	92	0.052	0.017	0.019	0.084	0.000	0.000	0.038	0.128	0.262	1.344	42	46	0.043	1.240
All Finfish	92	1.026	0.113	1.153	2.208	0.087	0.639	1.499	2.526	3.412	5.516	92	100	0.590	1.128
All Shellfish	92	1.680	0.269	2.049	3.364	0.063	0.796	1.825	4.590	7.754	15.976	91	99	0.727	1.160
All Seafood	92	2.707	0.336	0.000	0.000	0.236	1.672	3.598	6.190	10.087	18.400	92	100	1.530	1.123

N = Sample size.
SE = Standard error.
LCL = Lower confidence interval.
UCL = Upper confidence interval.
GM = Geometric Mean.
MSB = Multiplicative Standard Error.
Note: The minimum consumption for all species and groups was zero, except for "Group A"; "all finfish" and "all seafood". The minimum rate for "Group A" was 0.005, for "all finfish" was 0.018, and for "all seafood" was 0.080.

Source: Duncan, 2000.

Table 10-89. Adult Consumption Rate (g/kg/day) for Consumers Only							
		Consumers only					
Group	Species	N	Mean	SE	Median	75th Percentile	90th Percentile
Group A	King	63	0.200	0.031	0.092	0.322	0.581
	Sockeye	59	0.169	0.026	0.070	0.293	0.493
	Coho	50	0.191	0.033	0.084	0.247	0.584
	Chum	42	0.242	0.046	0.147	0.280	0.768
	Pink	17	0.035	0.007	0.034	0.057	0.077
	Other or Unspecified Salmon	32	0.159	0.070	0.043	0.172	0.261
	Steelhead	26	0.102	0.035	0.027	0.103	0.398
	Salmon (gatherings)	85	0.074	.0.012	0.031	0.079	0.205
Group B	Smelt	49	0.078	0.024	0.016	0.078	0.247
	Herring	14	0.059	0.020	0.034	0.093	0.197
Group C	Cod	78	0.126	0.024	0.051	0.140	0.319
	Perch	2	0.012	0.002	0.012	---	---
	Pollock	40	0.054	0.020	0.013	0.060	0.139
	Sturgeon	8	0.041	0.021	0.021	0.053	---
	Sable Fish	5	0.018	0.009	0.014	0.034	---
	Spiny Dogfish	1	0.004	---	---	---	---
	Greenling	2	0.013	0.002	0.013	---	---
	Bull Cod	1	0.016	---	---	---	---
Group D	Halibut	74	0.080	0.018	0.029	0.069	0.213
	Sole/Flounder	20	0.052	0.015	0.022	0.067	0.201
	Rock Fish	12	0.169	0.072	0.066	0.231	0.728
Group E	Manila/Littleneck Clams	84	0.481	0.154	0.088	0.284	1.190
	Horse Clams	52	0.073	0.016	0.025	0.070	0.261
	Butter Clams	72	0.263	0.062	0.123	0.184	0.599
	Geoduck	83	0.184	0.039	0.052	0.167	0.441
	Cockles	61	0.233	0.055	0.099	0.202	0.530
	Oysters	60	0.164	0.034	0.068	0.184	0.567
	Mussels	25	0.059	0.020	0.015	0.085	0.155
	Moon Snails	0	---	---	---	---	---
	Shrimp	86	0.174	0.027	0.088	0.196	0.549
	Dungeness Crab	81	0.164	0.028	0.071	0.185	0.425

Table 10-89. Adult Consumption Rate (g/kg/day) for Consumers Only (continued)							
		Consumers only					
Group	Species	N	Mean	SE	Median	75th Percentile	90th Percentile
Group E	Red Rock Crab	19	0.037	0.010	0.012	0.057	0.117
(cont'd)	Scallops	54	0.037	0.009	0.011	0.040	0.110
	Squid	23	0.041	0.017	0.009	0:032	0.188
	Sea Urchin	6	0.025	0.008	0.019	0.048	---
	Sea Cucumber	5	0.056	0.031	0.008	0.130	---
	Oyster (gatherings)	40	0.061	0.014	0.031	0.088	0.152
	Clams (gatherings)	61	0.071	0.016	0.029	0.064	0.165
	Crab (gatherings)	43	0.056	0.019	0.027	0.042	0.100
	Clams (razor, unspecified)	35	0.124	0.036	0.062	0.138	0.284
	Crab (king/snow)	1	0.017	---	---	---	---
Group F	Cabazon	1	0.080	---	---	---	---
	Blue Back (sockeye)	2	0.006	0.004	0.006	---	---
	Trout/Cutthroat	3	0.112	0.035	0.129	---	---
	Tuna (fresh/canned)	83	0.129	0.017	0.071	0.145	0 .346
	Groupers	1	0.025	---	---	---	---
	Sardine	1	0.049	---	---	---	---
	Grunter	4	0.056	0.026	0.047	0.110	---
	Mackerel	1	0.008	---	---	---	---
	Shark	1	0.002	---	---	---	---
Group G	Abalone	3	0.022	0.020	0.003	---	---
	Lobster	22	0.092	0.025	0.057	0.130	0.172
	Octopus	25	0.071	0.017	0.044	0.123	0.149
	Limpets	2	0.440	0.355	0.440	---	---
	Miscellaneous	1	0.023	---	---	---	---
	Group A	92	0.618	!0.074	0.350	1.002	1.680
	Group B	49	0.095	0.029	0.017	0.098	0.261
	Group C	87	0.144	0.026	0.068	0.141	0.403
	Group D	76	0.118	0.025	0.042	0.091	0.392
	Group E	91	1.647	0.265	0.750	1.691	4.577
	Group F	85	0.134	0.017	0.076	0.163	0.372
	Group G	42	0.113	0.034	0.042	0.118	0.270

Table 10-89 Adult Consumption Rate (g/kg/day) for Consumers Only (continued)							
		Consumers only					
Group	Species	N	Mean	SE	Median	75th	90th
	All Finfish	92	1.026	0.113	0.639	1.499	2.526
	All Shellfish	91	1.699	0.271	0.819	1.837	4.600
	All Seafood	92	2.707	0.336	1.672	3.598	6.190

N = Sample size.
SE = Standard error.

Source: Duncan, 2000.

Table 10-90. Adult Consumption Rate (g/kg/day) by Gender

Species/Group	All Adult Respondents (including non-consumers) N	Mean	SE	95% LCL	95% UCL	Percentiles 5th	50th	75th	90th	95th	Consumers Only N	%	GM[a]	MSE[b]
Group A (p=0.02)														
Male	46	0.817	0.120	0.582	1.052	0.021	0.459	1.463	2.033	2.236	46	100	0.385	1.245
Female	46	0.419	0.077	0.268	0.570	0.018	0.294	0.521	1.028	1.813	46	100	0.195	1.232
Group B (p=0.04)														
Male	46	0.089	0.031	0.028	0.150	0.000	0.008	0.076	0.269	0.623	27	59	0.046	1.378
Female	46	0.013	0.004	0.005	0.021	0.000	0.000	0.013	0.044	0.099	22	48	0.012	1.309
Group C (p=0.03)														
Male	46	0.170	0.043	0.086	0.254	0.007	0.078	0.148	0.432	0.847	46	100	0.075	1.210
Female	46	0.102	0.025	0.053	0.151	0.000	0.047	0.102	0.277	0.496	41	89	0.053	1.215
Group D (p=0.08)														
Male	46	0.135	0.037	0.062	0.208	0.000	0.045	0.133	0.546	0.948	39	85	0.057	1.274
Female	46	0.060	0.018	0.025	0.095	0.000	0.026	0.056	0.105	0.453	37	80	0.035	1.204
Group E (p=0.03)														
Male	46	1.865	0.316	1.246	2.484	0.068	1.101	2.608	4.980	7.453	46	100	0.879	1.238
Female	46	1.392	0.419	0.571	2.213	0.029	0.644	0.936	2.462	9.184	45	98	0.559	1.224
Group F (p=0.6)														
Male	46	0.141	0.026	0.090	0.192	0.000	0.072	0.195	0.413	0.597	40	87	0.089	1.199
Female	46	0.107	0.020	0.068	0.146	0.005	0.052	0.126	0.322	0.451	45	98	0.056	1.198
Group G (p=0.2)														
Male	46	0.081	0.032	0.018	0.144	0.000	0.001	0.070	0.261	0.476	23	50	0.057	1.395
Female	46	0.023	0.007	0.009	0.037	0.000	0.000	0.016	0.093	0.162	19	41	0.031	1.272
All Finfish (p=0.007)														
Male	46	1.351	0.193	0.973	1.729	0.115	0.905	1.871	3.341	4.540	46	100	0.800	1.191
Female	46	0.701	0.100	0.505	0.897	0.083	0.465	0.943	1.751	2.508	46	100	0.434	1.169
All Shellfish (p=0.03)														
Male	46	1.946	0.335	1.289	2.603	0.068	1.121	2.628	5.146	7.453	46	100	0.909	1.240
Female	46	1.415	0.421	0.590	2.240	0.029	0.678	1.007	2.462	9.231	45	98	0.579	1.221
All Seafood (p=0.008)														
Male	46	3.297	0.458	2.399	4.195	0.232	2.473	4.518	8.563	10.008	46	100	1.971	1.188
Female	46	2.116	0.480	1.175	3.057	0.236	0.965	2.219	4.898	10.400	46	100	1.188	1.158

N = Sample size.
SE = Standard error.
LCL = Lower confidence interval.
UCL = Upper confidence interval.
GM = Geometric Mean.
MSB = Multiplicative Standard Error.
P-value is 2-sided and based upon Mann-Whitney test. The 95% CL is based on the normal distribution. The 5th and 95th percentile are not reported for groups with less than 20 respondents.

Source: Duncan, 2000.

Table 10-91. Adult Consumption Rate (g/kg/day) by Age

Species/Group	All Adult Respondents (including non-consumers)										Consumers Only			
	N	Mean	SE	95% LCL	95% UCL	Percentiles 5th	50th	75th	90th	95th	N	%	GM[a]	MSE[b]
Group A (p=0.04)														
16-42 Years	58	0.512	0.083	0.349	0.675	0.015	0.294	0.660	1.544	2.105	58	100	0.215	1.219
43-54 Years	15	1.021	0.233	0.564	1.478		1.020	1.596	2.468		15	100	0.645	1.337
55 Years and Over	19	0.623	0.159	0.311	0.935		0.394	0.868	2.170		19	100	0.294	1.402
Group B (p=0.001)														
16-42 Years	58	0.042	0.022	0.000	0.085	0.000	0.000	0.009	0.098	0.295	22	38	0.023	1.447
43-54 Years	15	0.097	0.047	0.005	0.189		0.019	0.124	0.421		12	80	0.049	1.503
55 Years and Over	19	0.041	0.017	0.008	0.074		0.010	0.054	0.182		15	79	0.017	1.503
Group C (p=0.6)														
16-42 Years	58	0.122	0.026	O.Q71	0.173	0.000	0.055	0.134	0.301	0.578	54	93	0.061	1.186
43-54 Years	15	0.117	0.029	0.060	0.174		0.078	0.146	0.339		15	100	0.072	1.335
55 Years and Over	19	0.193	0.091	0.015	0.371		0.050	0.141	0.503		18	95	0.066	1.429
Group D (p=0.2)														
16-42 Years	58	0.079	0.023	0.034	0.124	0.000	0.026	0.072	0.164	0.610	44	76	0.043	1.218
43-54 Years	15	0.164	0.079	0.009	0.319		0.049	0.094	0.862		15	100	0.056	1.435
55 Years and Over	19	0.102	0.038	0.028	0.176		0.033	0.088	0.513		17	89	0.041	1.434
Group E (p=0.1)														
16-42 Years	58	1.537	0.289	0.971	2.103	0.059	0.740	1.715	3.513	8.259	57	98	0.707	1.199
43-54 Years	15	2.241	0.571	1.122	3.360		1.679	4.403	6.115		15	100	1.188	1.419
55 Years and Over	19	1.425	0.811	0.000	3.015		0.678	1.159	1.662		19	100	0.456	1.415
Group F (p=0.5)														
16-42 Years	58	0.119	0.021	0.078	0.160	0.000	0.044	0.123	0.387	0.563	53	91	0.065	1.180
43-54 Years	15	0.154	0.050	0.056	0.252		0.109	0.217	0.472		14	93	0.098	1.339
55 Years and Over	19	0.115	0.029	0.058	0.172		0.072	0.145	0.302		18	95	0.066	1.350
Group G (p=0.6)														
16-42 Years	58	0.052	0.024	0.005	0.099	0.000	0.006	0.035	0.126	0.241	30	52	0.037	1.259
43-54 Years	15	0.088	0.043	0.004	0.172		0.000	0.116	0.420		5	33	0.207	1.447
55 Years and Over	19	0.023	0.011	0.001	0.045		0.000	0.018	0.091		7	37	0.028	1.875
All Finfish (p=0.03)														
16-42 Years	58	0.874	0.136	0.607	1.141	0.087	0.536	1.062	2.471	2.754	58	100	0.489	1.163
43-54 Years	15	1.554	0.304	0.958	2.150		1.422	2.005	3.578		15	100	1.146	1.249
55 Years and Over	19	1.074	0.247	0.590	1.558		0.861	1.525	2.424		19	100	0.619	1.329
All Shellfish (p=0.1)														
16-42 Years	58	1.589	0.301	3.626	2.179	0.059	0.799	1.834	3.626	8.305	57	98	0.736	1.197
43-54 Years	15	2.330	0.586	1.181	3.479		1.724	4.519	6.447		15	100	1.225	1.426
55 Years and Over	19	1.447	0.815	0.000	3.044		0.688	1.160	1.837		19	100	0.464	1.417

Table 10-91. Adult Consumption Rate (g/kg/day) by Age (continued)

Species/Group	All Adult Respondents (including non-consumers)										Consumers Only			
	N	Mean	SE	95% LCL	95% UCL	Percentiles 5th	50th	75th	90th	95th	N	%	GM[a]	MSE[b]
All Seafood (p=0.09)														
16-42 Years	58	2.463	0.387	1.704	3.222	0.247	1.270	3.410	6.206	9.954	58	100	1.384	1.156
43-54 Years	15	3.884	0.781	2.353	5.415		3.869	4.942	9.725		15	100	2.665	1.295
55 Years and Over	19	2.522	0.927	0.705	4.339		1.393	2.574	5.220		19	100	1.340	1.293

N = Sample size.
SE = Standard error.
LCL = Lower confidence interval.
UCL = Upper confidence interval.
GM = Geometric Mean.
MSB = Multiplicative Standard Error.
P-value is 2-sided and based upon Kruskul-Wallis test. The 95% CL is based on the normal distribution. The 5th and 95th percentiles are not reported for groups with less than 20 respondents.

Source: Duncan, 2000.

Table 10-92. Consumption Rates for Native American Children (g/kg-day), All Children (including non-consumers): Individual Finfish and Shellfish and Fish Groups

Group	Species	N	Mean	SE	95% LCL	95% UCL	P5	Median	P75	P90	P95	Maximum
Group E												
	Manila/Littleneck clams	31	0.095	0.051	0.000	0.195	0.000	0.031	0.063	0.181	0.763	1.597
	Horse clams	31	0.022	0.013	0.000	0.048	0.000	0.000	0.006	0.048	0.269	0.348
	Butter clams	31	0.021	0.014	0.000	0.048	0.000	0.000	0.000	0.041	0.247	0.422
	Geoduck	31	0.112	0.041	0.033	0.191	0.000	0.027	0.116	0.252	0.841	1.075
	Cockles	31	0.117	0.079	0.000	0.271	0.000	0.000	0.054	0.240	1.217	2.433
	Oysters	31	0.019	0.012	0.000	0.043	0.000	0.000	0.056	0.058	0.205	0.362
	Mussels	31	0.001	0.001	0.000	0.002	0.000	0.000	0.000	0.000	0.011	0.026
	Moon snails	31	0.000	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000
	Shrimp	31	0.093	0.038	0.019	0.168	0.000	0.004	0.059	0.394	0.712	0.982
	Dungeness crab	31	0.300	0.126	0.053	0.547	0.000	0.047	0.166	1.251	2.689	2.833
	Red rock crab	31	0.007	0.003	0.001	0.014	0.000	0.000	0.000	0.046	0.064	0.082
	Scallops	31	0.011	0.006	0.000	0.022	0.000	0.000	0.005	0.031	0.089	0.174
	Squid	31	0.002	0.002	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.411
	Sea urchin	31	0.000	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000
	Sea cucumber	31	0.000	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000
Group A[a]		31	0.271	0.117	0.043	0.499	0.000	0.063	0.216	0.532	2.064	3.559
Group B[b]		31	0.004	0.002	0.000	0.008	0.000	0.000	0.000	0.015	0.038	0.069
Group C[c]		31	0.131	0.040	0.052	0.210	0.000	0.036	0.205	0.339	0.838	1.014
Group D[d]		31	0.030	0.011	0.008	0.053	0.000	0.010	0.037	0.081	0.191	0.342
Group F[e]		31	0.240	0.075	0.094	0.387	0.000	0.092	0.254	0.684	1.571	1.901
All Finfish		31	0.677	0.168	0.346	1.007	0.026	0.306	0.740	2.110	3.549	4.101
All Shellfish		31	0.801	0.274	0.265	1.337	0.000	0.287	0.799	2.319	4.994	7.948
All Seafood		31	1.477	0.346	0.799	2.155	0.042	0.724	1.983	3.374	7.272	9.063

[a] Group A is salmon, including king, sockeye, coho, chum, pink, and steelhead.
[b] Group B is finfish, including smelt and herring.
[c] Group C is finfish, including cod, perch, pollock, sturgeon, sablefish, spiny dogfish and greenling.
[d] Group D is finfish, including halibut, sole, flounder and rockfish.
[e] Group F includes tuna, other finfish, and all others not included in Groups A, B, C, and D.
- Not applicable.
N = Sample size.
SE = Standard error
LCL = Lower confidence limit
UCL = Upper confidence limit
P5...P95 = Percentile value.
Note: The minimum consumption for all species and groups was zero, except for “all finfish” and “all seafood.” The minimum rate for “all finfish” was 0.023, and for “all seafood” was
.

Source: Duncan, 2000.

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Table 10-93. Consumption Rates for Native American Children (g/kg-day), Consumers Only: Individual Finfish and Shellfish and Fish Groups

Group	Species	N	Mean	SE	Median	Percentiles 75th	Percentiles 90th
Group E	Manila/Littleneck clams	23	0.128	0.068	0.043	0.066	0.200
	Horse clams	12	0.058	0.032	0.009	0.046	0.308
	Butter clams	6	0.106	0.066	0.032	0.203	-
	Geoduck	22	0.158	0.054	0.053	0.230	0.554
	Cockles	10	0.361	0.233	0.078	0.291	2.230
	Oysters	10	0.060	0.035	0.015	0.074	0.336
	Mussels	1	0.026	-	-	-	-
	Moon snails	0	-	-	-	-	-
	Shrimp	17	0.170	0.064	0.035	0.299	0.621
	Dungeness crab	21	0.443	0.179	0.082	0.305	2.348
	Red rock crab	5	0.046	0.011	0.051	0.067	-
	Scallops	8	0.042	0.019	0.027	0.032	-
	Squid	2	0.033	0.008	0.033	-	-
	Sea urchin	0	-	-	-	-	-
	Sea cucumber	0	-	-	-	-	-
Group A[a]		28	0.300	0.128	0.112	0.246	0.599
Group B[b]		5	0.023	0.012	0.017	0.043	-
Group C[c]		25	0.163	0.048	0.048	0.236	0.493
Group D[d]		17	0.055	0.019	0.033	0.064	0.140
Group F[e] (tuna/other finfish)		24	0.311	0.092	0.177	0.336	1.035
All finfish		31	0.677	0.168	0.306	0.740	2.110
All shellfish		28	0.886	0.299	0.363	0.847	2.466
All seafood		31	1.477	0.346	0.724	1.983	3.374

[a] Group A is salmon, including king, sockeye, coho, chum, pink, and steelhead.
[b] Group B is finfish, including smelt and herring.
[c] Group C is finfish, including cod, perch, pollock, sturgeon, sablefish, spiny dogfish and greenling.
[d] Group D is finfish, including halibut, sole, flounder and rockfish.
[e] Group F includes tuna, other finfish, and all others not included in Groups A, B, C, and D.
N = Sample size.
SE = Standard error.
\- = No data.

Source: Duncan, 2000.

Table 10-94. Percentiles and Mean of Consumption Rates for Adult Consumers Only (g/kg/day)											
					Percentiles						
Species	N	Mean	SD	95% CI	5th	10th	25th	50th	75th	90th	95th
Squaxin Island Tribe											
Anadromous fish	117	0.672	1.174	(0.522 - 1.034)	0.016	0.028	0.093	0.308	0.802	1.563	2.086
Pelagic fish	62	0.099	0.203	(0.064 - 0.181)	0.004	0.007	0.014	0.035	0.086	0.226	0.349
Bottom fish	94	0.093	0.180	(0.065 - 0.140)	0.006	0.007	0.016	0.037	0.079	0.223	0.370
Shellfish	86	0.282	0.511	(0.208 - 0.500)	0.006	0.015	0.051	0.126	0.291	0.659	1.020
Other fish	39	0.046	0.066	(0.031 - 0.073)	0.002	0.005	0.006	0.019	0.046	0.129	0.161
All finfish	117	0.799	1.263	(0.615 - 1.136	0.031	0.056	0.139	0.383	1.004	1.826	2.537
All fish	117	1.021	1.407	(0.826 - 1.368)	0.050	0.097	0.233	0.543	1.151	2.510	3.417
Tulalip Tribe											
Anadromous fish	72	0.451	0.671	(0.321-0.648)	0.010	0.020	0.065	0.194	0.529	1.372	1.990
Pelagic fish	38	0.077	0.100	(0.051-0.118)	0.005	0.011	0.015	0.030	0.088	0.216	0.266
Bottom fish	44	0.062	0.092	(0.043-0.107)	0.006	0.007	0.011	0.030	0.077	0.142	0.207
Shellfish	61	0.559	1.087	(0.382-1.037)	0.037	0.047	0.104	0.196	0.570	1.315	1.824
Other fish	36	0.075	0.119	(0.044-0.130)	0.004	0.004	0.011	0.022	0.054	0.239	0.372
All finfish	72	0.530	0.707	(0.391-0.724)	0.017	0.026	0.119	0.286	0.603	1.642	2.132
All fish	73	1.026	1.563	(0.772-1.635)	0.049	0.074	0.238	0.560	1.134	2.363	2.641

N = Sample size.
SD = Standard deviation.
CI = Confidence interval.

Source: Polissar et al., 2006.

Table 10-95. Percentiles and Mean of Consumption Rates by Gender for Adult Consumers Only (g/kg/day)												
						Percentiles						
Species	Gender	N	Mean	SD	95% CI	5th	10th	25th	50th	75th	90th	95th
Squaxin Island Tribe												
Anadromous fish	Male	65	0.596	0.629	(0.465-0.770)	0.026	0.039	0.163	0.388	0.816	1.313	1.957
	Female	52	0.766	1.618	(0.463-1.458)	0.016	0.023	0.068	0.184	0.656	1.736	3.321
Pelagic fish	Male	39	0.104	0.235	(0.055-0.219)	0.003	0.008	0.013	0.037	0.074	0.181	0.299
	Female	23	0.091	0.136	(0.050-0.160)	0.005	0.007	0.017	0.030	0.096	0.322	0.349
Bottom fish	Male	55	0.091	0.185	(0.060-0.185)	0.005	0.007	0.017	0.041	0.077	0.180	0.365
	Female	39	0.096	0.175	(0.058-0.177)	0.006	0.007	0.014	0.034	0.089	0.226	0.330
Shellfish	Male	52	0.305	0.586	(0.215-0.645)	0.006	0.014	0.052	0.136	0.337	0.662	0.782
	Female	34	0.245	0.372	(0.149-0.407)	0.007	0.018	0.047	0.119	0.250	0.563	1.163
Other fish	Male	27	0.047	0.066	(0.029-0.085)	0.003	0.005	0.006	0.020	0.061	0.124	0.139
	Female	12	0.045	0.068	(0.016-0.100)		0.004	0.008	0.015	0.037	0.144	
All finfish	Male	65	0.735	0.784	(0.586-0.980)	0.044	0.079	0.226	0.500	1.045	1.552	2.181
	Female	52	0.878	1.686	(0.546-1.652)	0.026	0.039	0.115	0.272	0.840	1.908	3.687
All fish	Male	65	0.999	0.991	(0.794-1.291)	0.082	0.157	0.335	0.775	1.196	2.036	2.994
	Female	52	1.049	1.808	(0.712-1.793)	0.041	0.061	0.183	0.353	1.083	2.918	4.410
Tulalip Tribe												
Anadromous fish	Male	41	0.546	0.754	(0.373-0.856)	0.011	0.020	0.066	0.408	0.570	1.433	2.085
	Female	31	0.327	0.528	(0.189-0.578)	0.014	0.028	0.066	0.134	0.290	0.625	1.543
Pelagic fish	Male	24	0.066	0.099	(0.037-0.119)	0.013	0.014	0.016	0.030	0.064	0.175	0.223
	Female	14	0.096	0.103	(0.046-0.153)		0.005	0.016	0.053	0.156	0.227	
Bottom fish	Male	24	0.061	0.106	(0.035-0.147)	0.006	0.006	0.009	0.030	0.070	0.097	0.142
	Female	20	0.063	0.073	(0.039-0.103)	0.007	0.008	0.014	0.029	0.093	0.179	0.214

Table 10-95. Percentiles and Mean of Consumption Rates by Gender for Adult Consumers Only (g/kg/day) (continued)

Species	Gender	N	Mean	SD	95% CI	Percentiles						
						5th	10th	25th	50th	75th	90th	95th
Shellfish	Male	35	0.599	1.261	(0.343-1.499)	0.036	0.048	0.098	0.183	0.505	1.329	1.826
	Female	26	0.505	0.818	(0.292-1.018)	0.043	0.047	0.117	0.215	0.582	1.074	1.357
Other fish	Male	24	0.064	0.114	(0.029-0.134)	0.004	0.004	0.007	0.026	0.043	0.174	0.334
	Female	12	0.097	0.131	(0.041-0.190)		0.011	0.015	0.022	0.142	0.254	
All finfish	Male	41	0.620	0.795	(0.438-0.966)	0.017	0.020	0.098	0.421	0.706	1.995	2.185
	Female	31	0.411	0.561	(0.265-0.678)	0.025	0.036	0.126	0.236	0.404	0.924	1.769
All fish	Male	42	1.140	1.805	(0.785-2.047)	0.049	0.068	0.208	0.623	1.142	2.496	2.638
	Female	31	0.872	1.168	(0.615-1.453)	0.066	0.144	0.305	0.510	0.963	1.938	2.317

N = Sample size.
SD = Standard deviation.
CI = Confidence interval.

Source: Polissar et al., 2006.

Table 10-96. Percentiles and Mean of Consumption Rates by Age for Adult Consumers Only - Squaxin Island Tribe (g/kg/day)

						Percentiles						
Species	Age Group	N	Mean	SD	95% CI	5th	10th	25th	50th	75th	90th	95th
Anadromous fish	18-34	54	0.664	1.392	(0.430-1.438)	0.019	0.026	0.078	0.233	0.863	1.236	1.969
	35-49	41	0.563	0.820	(0.376-0.914)	0.023	0.031	0.073	0.292	0.590	1.354	2.062
	50-64	11	1.126	1.511	(0.595-2.791)		0.212	0.278	0.771	0.948	2.160	
	≥65	11	0.662	0.681	(0.321-1.097)		0.015	0.107	0.522	0.924	1.636	
Pelagic fish	18-34	22	0.067	0.086	(0.040-0.114)	0.006	0.007	0.014	0.035	0.081	0.186	0.228
	35-49	30	0.128	0.269	(0.063-0.272)	0.003	0.005	0.014	0.029	0.101	0.248	0.626
	50-64	4	0.154	0.239	(0.027-0.396)			0.033	0.045	0.166		
	≥65	6	0.036	0.023	(0.020-0.053)			0.017	0.038	0.047		
Bottom fish	18-34	41	0.063	0.102	(0.043-0.120)	0.004	0.006	0.012	0.034	0.069	0.115	0.221
	35-49	35	0.126	0.225	(0.076-0.276)	0.010	0.013	0.023	0.051	0.111	0.273	0.446
	50-64	9	0.159	0.302	(0.029-0.460)		0.009	0.014	0.029	0.067	0.451	
	≥65	9	0.035	0.031	(0.020-0.065)		0.006	0.018	0.034	0.043	0.060	
Shellfish	18-34	44	0.335	0.657	(0.211-0.729)	0.014	0.019	0.041	0.127	0.327	0.698	1.046
	35-49	27	0.264	0.321	(0.171-0.422)	0.016	0.054	0.082	0.146	0.277	0.582	0.984
	50-64	5	0.321	0.275	(0.137-0.589)			0.100	0.335	0.364		
	≥65	10	0.076	0.079	(0.033-0.124)		0.005	0.007	0.042	0.155	0.180	
Other fish	18-34	20	0.079	0.079	(0.053-0.122)	0.004	0.005	0.025	0.046	0.124	0.161	0.218
	35-49	10	0.014	0.008	(0.009-0.019)		0.005	0.007	0.015	0.020	0.022	
	50-64	2	0.007	0.003	(0.005-0.009)				0.007			
	≥65	7	0.010	0.007	(0.006-0.015)			0.006	0.008	0.014		

Table 10-96. Percentiles and Mean of Consumption Rates by Age for Adult Consumers Only - Squaxin Island Tribe (g/kg/day) (continued)

Species	Age Group	N	Mean	SD	95% CI	Percentiles						
						5th	10th	25th	50th	75th	90th	95th
All finfish	18-34	54	0.739	1.417	(0.508-1.372)	0.025	0.039	0.105	0.289	0.887	1.466	2.296
	35-49	41	0.764	1.001	(0.527-1.173)	0.046	0.082	0.226	0.383	0.816	1.859	2.423
	50-64	11	1.312	1.744	(0.690-3.219)		0.212	0.297	0.909	1.119	2.188	
	≥65	11	0.711	0.699	(0.386-1.259)		0.027	0.119	0.601	0.986	1.637	
All fish	18-34	54	1.041	1.570	(0.729-1.741)	0.052	0.107	0.217	0.500	1.117	2.669	3.557
	35-49	41	0.941	1.217	(0.652-1.453)	0.051	0.136	0.248	0.483	0.975	2.227	3.009
	50-64	11	1.459	1.773	(0.770-3.258)		0.317	0.327	1.106	1.301	2.936	
	≥65	11	0.786	0.727	(0.446-1.242)		0.058	0.122	0.775	1.091	1.687	

N = Sample size.
SD = Standard deviation.
CI = Confidence interval.

Source: Polissar et al., 2006.

Table 10-97. Percentiles and Mean of Consumption Rates by Age for Adult Consumers Only - Tulalip Tribe (g/kg/day)

Species	Age Group	N	Mean	SD	95% CI	Percentiles						
						5th	10th	25th	50th	75th	90th	95th
Anadromous fish	18-34	27	0.298	0.456	(0.169-0.524)	0.011	0.016	0.061	0.120	0.315	0.713	1.281
	35-49	23	0.725	0.928	(0.436-1.202)	0.010	0.032	0.078	0.431	0.719	2.001	2.171
	50-64	16	0.393	0.550	(0.225-0.854)		0.059	0.164	0.228	0.420	0.599	
	≥65	6	0.251	0.283	(0.065-0.475)			0.022	0.164	0.425		
Pelagic fish	18-34	12	0.092	0.099	(0.051-0.173)		0.016	0.021	0.054	0.124	0.218	
	35-49	15	0.077	0.118	(0.039-0.206)		0.013	0.015	0.021	0.087	0.189	
	50-64	8	0.077	0.085	(0.037-0.160)			0.027	0.034	0.090		
	≥65	3	0.008	0.009	(0.002-0.014)			0.003	0.004	0.011		
Bottom fish	18-34	14	0.075	0.138	(0.033-0.205)		0.007	0.010	0.020	0.078	0.142	
	35-49	16	0.066	0.069	(0.041-0.112)		0.007	0.023	0.053	0.077	0.152	
	50-64	11	0.051	0.056	(0.026-0.098)		0.007	0.011	0.036	0.069	0.119	
	≥65	3	0.015	0.005	(0.008-0.018)			0.013	0.017	0.018		
Shellfish	18-34	23	0.440	0.487	(0.289-0.702)	0.049	0.053	0.131	0.196	0.582	1.076	1.410
	35-49	19	1.065	1.784	(0.536-2.461)	0.049	0.074	0.123	0.250	1.222	2.265	4.351
	50-64	14	0.245	0.216	(0.158-0.406)		0.048	0.117	0.224	0.282	0.417	
	≥65	5	0.062	0.064	(0.027-0.135)			0.023	0.046	0.060		
Other fish	18-34	15	0.097	0.146	(0.043-0.197)		0.010	0.017	0.033	0.102	0.319	
	35-49	13	0.057	0.085	(0.022-0.123)		0.004	0.006	0.014	0.049	0.187	
	50-64	6	0.075	0.138	(0.015-0.215)			0.012	0.018	0.038		
	≥65	2	0.024	0.015	(0.014-0.024)				0.024			
All finfish	18-34	27	0.378	0.548	(0.222-0.680)	0.018	0.022	0.080	0.156	0.438	0.840	1.677
	35-49	23	0.821	0.951	(0.532-1.315)	0.020	0.047	0.116	0.602	0.898	2.035	2.268
	50-64	16	0.467	0.535	(0.311-0.925)		0.186	0.227	0.301	0.503	0.615	
	≥65	6	0.263	0.293	(0.091-0.518)			0.030	0.176	0.430		
All fish	18-34	27	0.806	0.747	(0.575-1.182)	0.071	0.136	0.231	0.617	1.126	1.960	2.457
	35-49	24	1.661	2.466	(0.974-3.179)	0.017	0.069	0.177	0.968	2.005	3.147	5.707
	50-64	16	0.710	0.591	(0.513-1.144)		0.278	0.370	0.495	0.944	1.070	
	≥65	6	0.322	0.344	(0.107-0.642)			0.062	0.195	0.475		

Source: Polissar et al., 2006

Table 10-98. Percentiles and Mean of Consumption Rates for Child Consumers Only (g/kg/day)

Species	N	Mean	SD	Percentiles						
				5th	10th	25th	50th	75th	90th	95th
Squaxin Island Tribe										
Anadromous fish	33	0.392	1.295	0.005	0.006	0.030	0.049	0.130	0.686	0.786
Pelagic fish	21	0.157	0.245	0.010	0.014	0.019	0.044	0.107	0.547	0.712
Bottom fish	18	0.167	0.362		0.006	0.014	0.026	0.050	0.482	
Shellfish	31	2.311	8.605	0.006	0.025	0.050	0.262	0.404	0.769	4.479
Other fish	30	0.577	0.584	0.012	0.051	0.111	0.400	0.566	1.620	1.628
All finfish	35	0.538	1.340	0.005	0.007	0.046	0.062	0.216	1.698	2.334
All fish	36	2.890	8.433	0.012	0.019	0.244	0.704	1.495	2.831	7.668
Tulalip Tribe										
Anadromous fish	14	0.148	0.229		0.012	0.026	0.045	0.136	0.334	
Pelagic fish	7	0.152	0.178			0.027	0.053	0.165		
Bottom fish	2	0.044	0.005				0.041			
Shellfish	11	0.311	0.392		0.012	0.034	0.036	0.518	0.803	
Other fish	1	0.115	0.115							
All finfish	15	0.310	0.332		0.027	0.082	0.133	0.431	0.734	
All fish	15	0.449	0.529		0.066	0.088	0.215	0.601	0.884	

N = Sample size.
SD = Standard deviation.
CI = Confidence interval.

Source: Polissar et al., 2006.

Table 10-99. Percentiles and Mean of Consumption Rates by Gender for Child Consumers Only (g/kg/day)

Species	Gender	N	Mean	SD	Percentiles						
					5th	10th	25th	50th	75th	90th	95th
Squaxin Island Tribe											
Anadromous fish	Male	15	0.702	1.937		0.009	0.026	0.062	0.331	1.082	
	Female	18	0.155	0.253		0.005	0.025	0.046	0.090	0.600	
Pelagic fish	Male	8	0.102	0.138			0.015	0.058	0.099		
	Female	13	0.179	0.280		0.015	0.020	0.040	0.109	0.681	
Bottom fish	Male	6	0.038	0.057			0.016	0.020	0.026		
	Female	12	0.244	0.442		0.005	0.010	0.028	0.105	0.736	
Shellfish	Male	13	0.275	0.244		0.036	0.047	0.241	0.353	0.462	
	Female	18	3.799	11.212		0.008	0.050	0.229	0.490	1.333	
Other fish	Male	13	0.836	0.663		0.106	0.232	0.448	1.530	1.625	
	Female	17	0.400	0.463		0.013	0.096	0.311	0.486	0.610	
All finfish	Male	15	0.787	1.940		0.009	0.038	0.062	0.521	1.500	
	Female	20	0.372	0.719	0.005	0.005	0.037	0.071	0.179	1.408	2.119
All fish	Male	15	1.700	1.965		0.061	0.476	1.184	1.937	2.444	
	Female	21	3.655	10.738	0.008	0.014	0.160	0.599	0.916	2.764	16.374
Tulalip Tribe											
Anadromous fish	Male	7	0.061	0.052			0.023	0.034	0.067		
	Female	7	0.237	0.306			0.032	0.080	0.198		
Pelagic fish	Male	5	0.106	0.081			0.044	0.053	0.128		
	Female	2	0.265	0.350				0.017			
Bottom fish	Male	0									
	Female	2	0.044	0.005				0.041			
Shellfish	Male	5	0.141	0.221			0.012	0.027	0.110		
	Female	6	0.431	0.459			0.034	0.219	0.651		
Other fish	Male	0									
	Female	1	0.115	0.115							
All finfish	Male	8	0.208	0.176			0.087	0.133	0.322		
	Female	7	0.433	0.440			0.045	0.165	0.652		
All fish	Male	8	0.202	0.169			0.071	0.122	0.233		
	Female	7	0.745	0.670			0.155	0.488	0.835		

N = Sample size.
SD = Standard deviation.
CI = Confidence interval.

Source: Polissar et al., 2006.

Table 10-100. Consumption Rates of API Community Members

Category	N	Median (g/kg/d)	Mean (g/kg/d)	Percentage of Consumption [a]	SE	95% LCI (g/kg/d)	95% UCI (g/kg/d)	90%tile (g/kg/d)
Anadromous Fish	202	0.093	0.201	10.6%	0.008	0.187	0.216	0.509
Pelagic Fish	202	0.215	0.382	20.2%	0.013	0.357	0.407	0.829
Freshwater Fish	202	00.43	0.110	5.8%	0.005	0.101	0.119	0.271
Bottom Fish	202	0.047	0.125	6.6%	0.006	0.113	0.137	0.272
Shellfish Fish	202	0.498	0.867	45.9%	0.023	0.821	0.913	1.727
Seaweed/Kelp	202	0.014	0.084	4.4%	0.005	0.075	0.093	0.294
Miscellaneous Seafood	202	0.056	0.121	6.4%	0.004	0.112	0.130	0.296
All Finfish	202	0.515	0.818	43.3%	0.023	0.774	0.863	1.638
All Fish	202	1.363	1.807	95.6%	0.042	1.724	1.889	3.909
All Seafood	202	1.439	1.891	100.0%	0.043	1.805	1.976	3.928

[a] Percentage of consumption = the percent of each category that makes up the total (i.e., 10.6% of total fish eaten was anadromous fish).

N = Sample size.

SE = Standard error.

LCI = 95% lower confidence interval bound.

UCI = 95% upper confidence interval.

Confidence intervals were computed based on the Student's t-distribution. Rates were weighted across ethnic groups.

U.S. EPA, 1999.

Table 10-101. Demographic Characteristics of "Higher" and "Lower" Seafood Consumers

		All Finfish		Shellfish	
	N	Lower Consumers (%)	Higher Consumers[a] (%)	Lower Consumers (%)	Higher Consumers[a] (%)
Female	107	76	24	71	29
Male	95	81	19	79	21
18-29	78	85	15	73	27
30-54	85	79	21	78	22
55+	39	64	36	72	28
Cambodian	20	90	10	70	30
Chinese	30	83	17	70	30
Filipino	30	80	20	87	13
Japanese	29	48	52	79	21
Korean	22	91	9	68	32
Laotian	20	75	25	75	25
Mien	10	90	10	90	10
Hmong	5	100	0	100	0
Samoan	10	100	0	100	0
Vietnamese	26	69	31	50	50
Non-fishermen	136	82	18	76	24
Fishermen	66	71	29	73	27

[a] Higher Consumer: > 75%tile = 1.144 g/day/kg.
[b] Higher Consumer: > 75%tile = 1.072g/day/kg.
N = Sample size.

Source: U.S. EPA, 1999.

Table 10-102. Seafood Consumption Rates by Ethnicity for Asian and Pacific Islander Community (g/kg/day)[a]

Category	Ethnicity	N	Mean	SE	10%tile	Median	90%tile	% with Non-zero Consumption	Consumers (%)	95% LCI	95% UCI
Anadromous fish (p<0.001)	Cambodian	20	0.118	0.050	0.000	0.030	0.453	18	90	0.014	0.223
	Chinese	30	0.193	0.052	0.012	0.066	0.587	30	100	0.086	0.300
	Filipino	30	0.152	0.027	0.025	0.100	0.384	29	96.7	0.098	0.206
	Japanese	29	0.374	0.056	0.086	0.251	0.921	29	100	0.261	0.488
	Korean	22	0.091	0.026	0.007	0.048	0.248	22	100	0.037	0.146
	Laotian	20	0.187	0.064	0.002	0.069	0.603	18	90	0.054	0.321
	Mien	10	0.018	0.008	0.000	0.011	0.080	7	70	0.000	0.036
	Hmong	5	0.059	0.013	n/a	0.071	n/a	5	100	0.026	0.091
	Samoan	10	0.067	0.017	0.012	0.054	0.185	10	100	0.030	0.104
	Vietnamese	26	0.124	0.026	0.017	0.072	0.349	26	100	0.071	0.176
	All Ethnicity (1)	202	0.201	0.008	0.016	0.093	0.509	194	96	0.187	0.216
Pelagic Fish (p<0.001)	Cambodian	20	0.088	0.021	0.000	0.061	0.293	17	85	0.044	0.131
	Chinese	30	0.325	0.068	0.022	0.171	0.824	30	100	0.187	0.463
	Filipino	30	0.317	0.081	0.051	0.132	0.729	30	100	0.151	0.482
	Japanese	29	0.576	0.079	0.132	0.429	1.072	29	100	0.415	0.737
	Korean	22	0.313	0.056	0.073	0.186	0.843	22	100	0.196	0.429
	Laotian	20	0.412	0.138	0.005	0.115	1.061	20	100	0.124	0.700
	Mien	10	0.107	0.076	0.000	0.09	0.716	7	70	-0.064	0.277
	Hmong	5	0.093	0.028	n/a	0.090	n/a	5	100	0.021	0.164
	Samoan	10	0.499	0.060	0.128	0.535	0.792	10	100	0.365	0.633
	Vietnamese	26	0.377	0.086	0.059	0.208	0.956	26	100	0.201	0.553
	All Ethnicity (1)	202	0.382	0.013	0.046	0.215	0.829	196	97	0.357	0.407
Freshwater Fish (p<0.001)	Cambodian	20	0.139	0.045	0.000	0.045	0.565	18	90	0.045	0.232
	Chinese	30	0.084	0.023	0.000	0.015	0.327	24	80	0.037	0.131
	Filipino	30	0.132	0.034	0.018	0.086	0.273	30	100	0.062	0.202
	Japanese	29	0.021	0.006	0.000	0.007	0.071	20	69	0.010	0.032
	Korean	22	0.032	0.015	0.000	0.008	0.160	13	59.1	0.002	0.062
	Laotian	20	0.282	0.077	0.002	0.099	1.006	18	90	0.122	0.442
	Mien	10	0.097	0.039	0.007	0.070	0.407	10	100	0.010	0.184
	Hmong	5	0.133	0.051	n/a	0.081	n/a	5	100	0.002	0.263
	Samoan	10	0.026	0.007	0.000	0.025	0.061	9	90	0.011	0.041
	Vietnamese	26	0.341	0.064	0.068	0.191	1.036	26	100	0.209	0.472
	All Ethnicity (1)	202	0.110	0.005	0.000	0.043	0.271	173	85.6	0.101	0.119

Category	Ethnicity	N	Mean	SE	10%tile	Median	90%tile	% with Non-zero Consumption	Consumers (%)	95% LCI	95% UCI
Table 10-102. Seafood Consumption Rates by Ethnicity for Asian and Pacific Islander Community (g/kg/day)[a] (continued)											
Bottom Fish (p<0.001)	Cambodian	20	0.045	0.025	0.000	0.003	0.114	10	50	-0.006	0.097
	Chinese	30	0.082	0.026	0.004	0.033	0.212	28	93.3	0.028	0.135
	Filipino	30	0.165	0.043	0.001	0.103	0.560	27	90	0.078	0.253
	Japanese	29	0.173	0.044	0.023	0.098	0.554	28	96.6	0.083	0.263
	Korean	22	0.119	0.026	0.000	0.062	0.270	19	86.4	0.064	0.173
	Laotian	20	0.066	0.031	0.000	0.006	0.173	13	65	0.000	0.131
	Mien	10	0.006	0.003	0.000	0.00	0.026	4	40	-0.001	0.013
	Hmong	5	0.036	0.021	n/a	0.024	n/a	3	60	-0.017	0.088
	Samoan	10	0.029	0.005	0.008	0.026	0.058	10	100	0.018	0.040
	Vietnamese	26	0.102	0.044	0.000	0.030	0.388	21	80.8	0.013	0.192
	All Ethnicity (1)	202	0.125	0.006	0.000	0.047	0.272	163	80.7	0.113	0.137
Shellfish Fish (p<0.001)	Cambodian	20	0.919	0.216	0.085	0.695	2.003	20	100	0.467	1.370
	Chinese	30	0.985	0.168	0.176	0.569	2.804	30	100	0.643	1.327
	Filipino	30	0.613	0.067	0.188	0.505	1.206	30	100	0.477	0.750
	Japanese	29	0.602	0.089	0.116	0.401	1.428	29	100	0.419	0.784
	Korean	22	1.045	0.251	0.251	0.466	2.808	22	100	0.524	1.566
	Laotian	20	0.898	0.259	0.041	0.424	2.990	19	95	0.357	1.439
	Mien	10	0.338	0.113	0.015	0.201	1.058	10	100	0.086	0.590
	Hmong	5	0.248	0.014	n/a	0.252	n/a	5	100	0.212	0.283
	Samoan	10	0.154	0.024	0.086	0.138	0.336	10	100	0.100	0.208
	Vietnamese	26	1.577	0.260	0.247	1.196	4.029	26	100	1.044	2.110
	All Ethnicity (1)	202	0.867	0.023	0.168	0.498	1.727	201	99.5	0.821	0.913
Seaweed/Kelp (p<0.001)	Cambodian	20	0.002	0.001	0.000	0.000	0.008	7	35	0.000	0.004
	Chinese	30	0.062	0.022	0.001	0.017	0.314	29	96.7	0.016	0.107
	Filipino	30	0.009	0.004	0.000	0.000	0.025	15	50	0.002	0.016
	Japanese	29	0.190	0.043	0.019	0.082	0.752	29	100	0.101	0.279
	Korean	22	0.200	0.050	0.011	0.087	0.686	21	95.5	0.096	0.304
	Laotian	20	0.004	0.003	0.000	0.000	0.013	6	30	-0.001	0.009
	Mien	10	0.000	0.000	0.000	0.000	0.000	0	0	0.000	0.000
	Hmong	5	0.002	0.001	n/a	0.001	n/a	3	60	0.000	0.004
	Samoan	10	0.000	0.000	0.000	0.000	0.000	0	0	0.000	0.000
	Vietnamese	26	0.017	0.012	0.000	0.000	0.050	6	23.1	-0.008	0.043
	All Ethnicity (1)	202	0.084	0.005	0.000	0.014	0.294	116	57.4	0.075	0.093

Table 10-102. Seafood Consumption Rates by Ethnicity for Asian and Pacific Islander Community (g/kg/day)[a] (continued)

Category	Ethnicity	N	Mean	SE	10%tile	Median	90%tile	% with Non-zero Consumption	Consumers (%)	95% LCI	95% UCI
Miscellaneous Fish ($p<0.001$)	Cambodian	20	0.113	0.026	0.000	0.087	0.345	18	90	0.058	0.168
	Chinese	30	0.081	0.021	0.003	0.030	0.201	30	100	0.038	0.123
	Filipino	30	0.083	0.025	0.016	0.043	0.182	30	100	0.032	0.134
	Japanese	29	0.246	0.036	0.032	0.206	0.620	29	100	0.173	0.139
	Korean	22	0.092	0.031	0.004	0.047	0.307	21	95.5	0.028	0.156
	Laotian	20	0.074	0.021	0.000	0.025	0.225	15	75	0.029	0.118
	Mien	10	0.015	0.008	0.000	0.002	0.063	7	70	0.003	0.033
	Hmong	5	0.019	0.014	n/a	0.008	n/a	4	80	0.018	0.055
	Samoan	10	0.076	0.028	0.003	0.045	0.276	10	100	0.014	0.138
	Vietnamese	26	0.089	0.013	0.013	0.087	0.184	25	96.2	0.062	0.115
	All Ethnicity (1)	202	0.121	0.004	0.005	0.056	0.296	189	93.6	0.112	0.130
All Finfish ($p<0.001$)	Cambodian	20	0.390	0.098	0.061	0.223	1.379	20	100	0.185	0.594
	Chinese	30	0.683	0.133	0.114	0.338	2.024	30	100	0.412	0.954
	Filipino	30	0.766	0.148	0.268	0.452	1.348	30	100	0.464	1.067
	Japanese	29	1.144	0.124	0.194	1.151	2.170	29	100	0.890	1.398
	Korean	22	0.555	0.079	0.180	0.392	1.204	22	100	0.391	0.719
	Laotian	20	0.947	0.204	0.117	0.722	2.646	20	100	0.523	1.372
	Mien	10	0.228	0.117	0.034	0.097	1.160	10	100	-0.032	0.488
	Hmong	5	0.319	0.073	n/a	0.268	n/a	5	100	0.131	0.507
	Samoan	10	0.621	0.059	0.225	0.682	0.842	10	100	0.490	0.751
	Vietnamese	26	0.944	0.171	0.188	0.543	2.568	26	100	0.593	1.296
	All Ethnicity (1)	202	0.818	0.023	0.166	0.515	1.638	202	100	0.774	0.863
All Fish ($p<0.001$)	Cambodian	20	1.421	0.274	0.245	1.043	3.757	20	100	0.850	1
	Chinese	30	1.749	0.283	0.441	1.337	4.206	30	100	1.172	2.326
	Filipino	30	1.462	0.206	0.660	1.137	2.423	30	100	1.041	1.883
	Japanese	29	1.992	0.214	0.524	1.723	3.704	29	100	1.555	2.429
	Korean	22	1.692	0.275	0.561	1.122	3.672	22	100	1.122	2.262
	Laotian	20	1.919	0.356	0.358	1.467	4.147	20	100	1.176	2.663
	Mien	10	0.580	0.194	0.114	0.288	1.967	10	100	0.149	1.012
	Hmong	5	0.585	0.069	n/a	0.521	n/a	5	100	0.407	0.764
	Samoan	10	0.850	0.078	0.363	0.879	1.188	10	100	0.676	1.025
	Vietnamese	26	2.610	0.377	0.653	2.230	6.542	26	100	1.835	3.385
	All Ethnicity (1)	202	1.807	0.042	0.480	1.363	3.909	202	100	1.724	1.889

Table 10-102. Seafood Consumption Rates by Ethnicity for Asian and Pacific Islander Community (g/kg/day)[a] (continued)											
Category	Ethnicity	N	Mean	SE	10%tile	Median	90%tile	% with Non-zero Consumption	Consumers (%)	95% LCI	95% UCI
All Seafood (p<0.001)	Cambodian	20	1.423	0.274	0.245	1.043	3.759	20	100	0.851	1.995
	Chinese	30	1.811	0.294	0.452	1.354	4.249	30	100	1.210	2.411
	Filipino	30	1.471	0.206	0.660	1.135	2.425	30	100	1.050	1.892
	Japanese	29	2.182	0.229	0.552	1.830	3.843	29	100	1.714	2.650
	Korean	22	1.892	0.294	0.608	1.380	4.038	22	100	1.281	2.503
	Laotian	20	1.923	0.356	0.400	1.467	4.147	20	100	1.181	2.665
	Mien	10	0.580	0.194	0.114	0.288	1.967	10	100	0.149	1.012
	Hmong	5	0.587	0.069	n/a	0.521	n/a	5	100	0.410	0.765
	Samoan	10	0.850	0.078	0.363	0.879	1.188	10	100	0.676	1.025
	Vietnamese	26	2.627	0.378	0.670	2.384	6.613	26	100	1.851	3.404
	All Ethnicity (1)	202	1.891	0.043	0.521	1.439	3.928	202	100	1.805	1.976

[a] All consumption rates in g/kg body weight/d. Weighted by population percentage.
N = Sample size.
SE = Standard error.
LCI = Lower confidence interval.
UCI = Upper confidence interval.
Note: p-value is based on Kruskal Wallis test.

Source: U.S. EPA, 1999.

Table 10-103. Consumption Rates by Gender for All Asian and Pacific Islander Community

	Female				Male			
Category	N	Mean (g/kg/d)	SE	Median (g/kg/d)	N	Mean (g/kg/d)	SE	Median (g/kg/d)
Anadromous Fish (p=0.8)	107	0.165	0.022	0.076	95	0.169	0.024	0.080
Pelagic Fish (p=0.4)	107	0.349	0.037	0.215	95	0.334	0.045	0.148
Freshwater Fish (p=1.0)	107	0.131	0.021	0.054	95	0.137	0.023	0.054
Bottom Fish (p=0. 6)	107	0.115	0.019	0.040	95	0.087	0.017	0.034
Shellfish (p=0.8)	107	0.864	0.086	0.432	95	0.836	0.104	0.490
Seaweed/Kelp (p=0.5)	107	0.079	0.018	0.005	95	0.044	0.010	0.002
Miscellaneous Seafood (p=0.5)	107	0.105	0.013	0.061	95	0.104	0.015	0.055
All Finfish (p=0.8)	107	0.759	0.071	0.512	95	0.726	0.072	0.458
All Fish (p=0.5)	107	1.728	0.135	1.328	95	1.666	0.149	1.202
All Seafood (p=0.4)	107	1.807	0.139	1.417	95	1.710	0.152	1.257

N = Sample size.
SE = Standard error.
P-values are based on Mann-Whitney test.

Source: U.S. EPA, 1999.

Table 10-104. Types of Seafood Consumed/Respondents Who Consumed (%)	
Type of Seafood	(%)
Anadromous Fish	
Salmon	93
Trout	61
Smelt	45
Salmon Eggs	27
Pelagic Fish	
Tuna	86
Cod	66
Mackeral	62
Snapper	50
Rockfish	34
Herring	21
Dogfish	7
Snowfish	6
Freshwater Fish	
Catfish	58
Tilapia	45
Perch	39
Bass	28
Carp	22
Crappie	17
Bottom Fish	
Halibut	65
Sole/Flounder	42
Sturgeon	13
Suckers	4
Shellfish	
Shrimp	98
Crab	96
Squid	82
Oysters	71
Manila/Littleneck Clams	72
Lobster	65
Mussel	62
Scallops	57

Table 10-104. Types of Seafood Consumed/Respondents Who Consumed (%) (continued)	
Type of Seafood	(%)
Butter Clams	39
Geoduck	34
Cockles	21
Abalone	15
Razor Clams	16
Sea Cucumber	15
Sea Urchin	14
Horse Clams	13
Macoma Clams	9
Moonsnail	4
Seaweed/Kelp	
Seaweed	57
Kelp	29

Source: U.S. EPA, 1999.

Table 10-105. Distribution of Quantity of Fish Consumed (in grams) Per Eating Occasion, by Age and Sex

			Percentiles						
Age (years)-Sex Group	Mean	SD	5th	25th	50th	75th	90th	95th	99th
1-2 Male-Female	52	38	8	28	43	58	112	125	168
3-5 Male-Female	70	51	12	36	57	85	113	170	240
6-8 Male-Female	81	58	19	40	72	112	160	170	288
9-14 Male	101	78	28	56	84	113	170	255	425
9-14 Female	86	62	19	45	79	112	168	206	288
15-18 Male	117	115	20	57	85	142	200	252	454
15-18 Female	111	102	24	56	85	130	225	270	568
19-34 Male	149	125	28	64	113	196	284	362	643
19-34 Female	104	74	20	57	85	135	184	227	394
35-64 Male	147	116	28	80	113	180	258	360	577
35-64 Female	119	98	20	57	85	152	227	280	480
65-74 Male	145	109	35	75	113	180	270	392	480
65-74 Female	123	87	24	61	103	168	227	304	448
≥ 75 Male	124	68	36	80	106	170	227	227	336
≥75 Female	112	69	20	61	112	151	196	225	360
Overall	117	98	20	57	85	152	227	284	456

Source: Pao et al., 1982.

Table 10-106. Distribution of Quantity of Canned Tuna Consumed (grams) Per Eating Occasion, by Age and Sex

Age (years)-Sex Group	Mean	SE	Percentiles						
			5th	10th	25th	50th	75th	90th	95th
2 to 5									
Male-Female	37	3	5*	8	14	29	56	73	85*
6 to 11									
Male-Female	58	8	14*	20*	28	49	60	99*	157*
12 to 19									
Male	98*	16*	-	18*	49*	84	162*	170*	186*
Female	64	6	14*	18*	28*	56	77*	105*	156*
20 to 39									
Male	84	7	15*	27*	49	57	113	160*	168*
Female	61	5	14*	14*	34	56	74	110*	142*
40 to 59									
Male	72	4	14*	27	37	57	96	127	168*
Female	60	4	13*	15	28	56	74	112	144
60 and older									
Male	64	5	12*	17*	37	56	81	114*	150*
Female	67	4	12*	23	42	57	85	112	153*

SE = Standard error.
* Indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.
\- Indicates a percentage that could not be estimated.

Source: Smiciklas-Wright et al., 2002 (based on 1994-1996 CSFII data).

Table 10-107. Distribution of Quantity of Other Finfish Consumed (grams) Per Eating Occasion, by Age and Sex									
Age (years)-Sex Group	Mean	SE	Percentiles						
			5th	10th	25th	50th	75th	90th	95th
2 to 5									
Male-Female	64	4	8*	16	33	58	77	124	128*
6 to 11									
Male-Female	93	8	17*	31*	50	77	119	171*	232*
12 to 19									
Male	119*	11*	40*	50*	64*	89	170*	185*	249*
Female	89*	13*	20*	26*	47*	67	124*	164*	199*
20 to 39									
Male	117	8	37*	47	68	100	138	205	256*
Female	111	10	26*	36*	50	85	129	209*	289*
40 to 59									
Male	130	7	29*	47	75	110	153	243	287*
Female	107	9	29*	42	51	85	123	174	244*
60 and older									
Male	111	6	37*	45	57	90	133	220	261*
Female	108	6	33*	42	57	90	130	200	229*

SE = Standard error.
* Indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

Source: Smiciklas-Wright et al., 2002 (based on 1994-1996 CSFII data).

Study	Use Frequency	Bake	Pan Fry	Deep Fry	Broil or Grill	Poach	Boil	Smoke	Raw	Other
Connelly et al., 1992	Always Ever	24(a) 75(a)	51 88	13 59		24(a) 75(a)				
Connelly et al., 1996	Always Ever	13 84	4 72	4 42						
CRITFC, 1994	At least monthly	79	51	14	27	11	46	31	1	34(b) 29(c) 49(d)
	Ever	98	80	25	39	17	73	66	3	67(b) 71(c) 75(d)
Fitzgerald et al., 1995	Not Specified		94(e)(f)	71(e)(g)						
Puffer et al., 1981	As Primary Method	16.3	52.5	12					0.25	19(h)

Table 10-108. Percentage of Individuals Using Various Cooking Methods at Specified Frequencies

[a] 24 and 75 listed as bake, BBQ, or poach
[b] Dried
[c] Roasted
[d] Canned
[e] Not specified whether deep or pan fried
[f] Mohawk women
[g] Control population
[h] boil, stew, soup, or steam

Table 10-109. Mean Percent Moisture and Total Fat Content for Selected Species

Species	Moisture Content (%)	Total Fat Content (%)	Comments
FINFISH			
Anchovy, European	73.37	4.84	Raw
	50.30	9.71	Canned in oil, drained solids
Bass, Freshwater	75.66	3.69	Raw
	68.79	4,73	Cooked, dry heat
Bass, Striped	79.22	2.33	Raw
	73.36	2.99	Cooked, dry heat
Bluefish	70.86	4.24	Raw
	62.64	5.44	Cooked, dry heat
Burbot	79.26	0.81	Raw
	73.41	1.04	Cooked, dry heat
Butterfish	74.13	8.02	Raw
	66.83	10.28	Cooked, dry heat
Carp	76.31	5.60	Raw
	69.63	7.17	Cooked, dry heat
Catfish, Channel, Farmed	75.38	7.59	Raw
	71.58	8.02	Cooked, dry heat
Catfish, Channel, Wild	80.36	2.82	Raw
	77.67	2.85	Cooked, dry heat
Cavier, Black and Red	47.50	17.90	--
Cisco	78.93	69.80	Raw
	1.91	11.90	Smoked
Cod, Atlantic	81.22	0.67	Raw
	75.61	0.86	Canned, solids and liquids
	75.92	0.86	Cooked, dry heat
	16.14	2.37	Dried and salted
Cod, Pacific	81.28	0.63	Raw
	76.00	0.81	Cooked, dry heat
Croaker, Atlantic	78.03	3.17	Raw
	59.76	12.67	Cooked, breaded and fried
Cusk	76.35	0.69	Raw
	69,68	0.88	Cooked, dry heat
Dolphinfish	77.55	0.70	Raw
	71.22	0.90	Cooked, dry heat
Drum, Freshwater	77.33	4.93	Raw
	70.94	6.32	Cooked, dry heat
Eel	69.26	11.66	Raw
	59.31	14.95	Cooked, dry heat
Flatfish, Flounder, and Sole	79.06	1.19	Raw
	73.16	1.53	Cooked, dry heat
Grouper	79.22	1.02	Raw, mixed species
	73.36	1.30	Cooked, dry heat
Haddock	79.92	0.72	Raw
	74.25	0.93	Cooked, dry heat
	71.48	0.96	Smoked
Halibut, Atlantic and Pacific	77.92	2.29	Raw
	71.69	2.94	Cooked, dry heat

Table 10-109. Mean Percent Moisture and Total Fat Content for Selected Species (continued)

Species	Moisture Content (%)	Total Fat Content (%)	Comments
Halibut, Greenland	70.27	13.84	Raw
	61.88	17.74	Cooked, dry heat
Herring, Atlantic	72.05	9.04	Raw
	64.16	11.59	Cooked, dry heat
	59.70	12.37	Kippered
	55.22	18.00	Pickled
Herring, Pacific	71.52	13.88	Raw
	63.49	17.79	Cooked, dry heat
Ling	79.63	0.64	Raw
	73,88	0.82	Cooked, dry heat
Lingcod	81.03	1.06	Raw
	75.68	1.36	Cooked, dry heat
Mackerel, Atlantic	63.55	13.89	Raw
	53.27	17.81	Cooked, dry heat
Mackerel, Jack	69.17	6.30	Canned, drained solids
Mackerel, King	75.85	2.00	Raw
	69.04	2.56	Cooked, dry heat
Mackerel, Pacific and Jack	70.15	7.89	Raw
	61.73	10.12	Cooked, dry heat
Mackerel, Spanish	71.67	6.30	Raw
	68.46	6.32	Cooked, dry heat
Milkfish	70.85	6.73	Raw
	62.63	8.63	Cooked, dry heat
Monkfish	83.24	1.52	Raw
	78.51	1.95	Cooked, dry heat
Mullet, Striped	77.01	3.79	Raw
	70.52	4.86	Cooked, dry heat
Ocean Perch, Atlantic	78.70	1.63	Raw
	72.69	2.09	Cooked, dry heat
Perch	79.13	0.92	Raw
	73.25	1.18	Cooked, dry heat
Pike, Northern	78.92	0.69	Raw
	72.97	0.88	Cooked, dry heat
Pike, Walleye	79.31	1.22	Raw
	73.47	1.56	Cooked, dry heat
Pollock, Atlantic	78.18	0.98	Raw
	72.03	1.26	Cooked, dry heat
Pollock, Walleye	81.56	0.80	Raw
	74.06	1.12	Cooked, dry heat
Pompano, Florida	71.12	9.47	Raw
	62.97	12.14	Cooked, dry heat
Pout, Ocean	81.36	0.91	Raw
	76.10	1.17	Cooked, dry heat
Rockfish, Pacific	79.26	1.57	Raw
	73.41	2.01	Cooked, dry heat
Roe	67.73	6.42	Raw
	58.63	8.23	Cooked, dry heat

Table 10-109. Mean Percent Moisture and Total Fat Content for Selected Species (continued)			
Species	Moisture Content (%)	Total Fat Content (%)	Comments
Roughy, Orange	75.67	0.70	Raw
	66.97	0.90	Cooked, dry heat
Sablefish	71.02	15.30	Raw
	62.85	19.62	Cooked, dry heat
	60.14	20.14	Smoked
Salmon, Atlantic, Farmed	68.90	10.85	Raw
	64.75	12.35	Cooked, dry heat
Salmon, Atlantic, Wild	68.50	6.34	Raw
	59.62	8.13	Cooked, dry heat
Salmon, Chinook	71.64	10.43	Raw
	65.60	13.38	Cooked, dry heat
	72.00	4.32	Smoked
Salmon, Chum	75.38	3.77	Raw
	68.44	4.83	Cooked, dry heat
	70.77	5.50	Drained solids with bone
Salmon, Coho, Farmed	70.47	7.67	Raw
	67.00	8.23	Cooked, dry heat
Salmon, Coho, Wild	72.66	5.93	Raw
	71.50	4.30	Cooked, dry heat
	65.39	7.50	Cooked, moist heat
Salmon, Pink	76.35	3.45	Raw
	69.68	4.42	Cooked, dry heat
	68.81	6.05	Canned, solids with bone and liquid
Salmon, Sockeye	70.24	8.56	Raw
	61.84	10.97	Cooked, dry heat
	67.51	7.31	Canned, drained solids with bone
Sardine, Atlantic	59.61	11.45	Canned in oil, drained solids with bone
Sardine, Pacific	66.65	10.46	Canned in tomato sauce, drained solids with bone
Scup	75.37	2.73	Raw
	68.42	3.50	Cooked, dry heat
Sea Bass	78.27	2.00	Raw
	72.14	2.56	Cooked, dry heat
Seatrout	78.09	3.61	Raw
	71.91	4.63	Cooked, dry heat
Shad, American	68.19	13.77	Raw
	59.22	17.65	Cooked, dry heat
Shark, mixed species	73.58	4.51	Raw
	60.09	13.82	Cooked, batter-dipped and fried
Sheepshead	77.97	2.41	Raw
	69.04	1.63	Cooked, dry heat
Smelt, Rainbow	78.77	2.42	Raw
	72.79	3.10	Cooked, dry heat
Snapper	76.87	1.34	Raw
	70.35	1.72	Cooked, dry heat
Spot	75.95	4.90	Raw
	69.17	6.28	Cooked, dry heat
Sturgeon	76.55	4.04	Raw
	69.94	5.18	Cooked, dry heat
	62.50	4.40	Smoked

Table 10-109. Mean Percent Moisture and Total Fat Content for Selected Species (continued)			
Species	Moisture Content (%)	Total Fat Content (%)	Comments
Sucker, white	79.71	2.32	Raw
	73.99	2.97	Cooked, dry heat
Sunfish, Pumpkinseed	79.50	0.70	Raw
	73.72	0.90	Cooked, dry heat
Surimi	76.34	0.90	-
Swordfish	75.62	4.01	Raw
	68.75	5.14	Cooked, dry heat
Tilapia	78.08	1.70	Raw
	71.59	2.65	Cooked, dry heat
Tilefish	78.90	2.31	Raw
	70.24	4.69	Cooked, dry heat
Trout, Mixed Species	71.42	6.61	Raw
	63.36	8.47	Cooked, dry heat
Trout, Rainbow, Farmed	72.73	5.40	Raw
	67.53	7.20	Cooked, dry heat
Trout, Rainbow, Wild	71.87	3.46	Raw
	70.50	5.82	Cooked, dry heat
Tuna, Fresh, Bluefin	68.09	4.90	Raw
	59.09	6.28	Cooked, dry heat
Tuna, Fresh, Skipjack	70.58	1.01	Raw
	62.28	1.29	Cooked, dry heat
Tuna, Fresh, Yellowfin	70.99	0.95	Raw
	62.81	1.22	Cooked, dry heat
Tuna, Light	59.83	8.21	Canned in oil, drained solids
	74.51	0.82	Canned in water, drained solids
Tuna, White	64.02	8.08	Canned in oil, drained solids
	73.19	2.97	Canned in water, drained solids
Turbot, European	76.95	2.95	Raw
	70.45	3.78	Cooked, dry heat
Whitefish, mixed species	72.77	5.86	Raw
	65.09	7.51	Cooked, dry heat
	70.83	0.93	Smoked
Whiting, mixed species	80.27	1.31	Raw
	74.71	1.69	Cooked, dry heat
Wolffish, Atlantic	79.90	2.39	Raw
	74.23	3.06	Cooked, dry heat
Yellowtail, mixed species	74.52	5.24	Raw
	67.33	6.72	Cooked, dry heat
SHELLFISH			
Abalone	74.56	0.76	Raw
	60.10	6.78	Coofed, fried
Clam	81.82	0.97	Raw
	63.64	1.95	Canned, drained solids
	97.70	0.02	Canned, liquid
	61.55	11.15	Cooked, breaded and fried
	63.64	1.95	Cooked, moist heat
Crab, Alaska King	79.57	0.60	Raw
	77.55	1.54	Cooked, moist heat
	74.66	0.46	Imitation, made from surimi

Table 10-109 Mean Percent Moisture and Total Fat Content for Selected Species (continued)

Species	Moisture Content (%)	Total Fat Content (%)	Comments
Crab, Blue	79.02	1.08	Raw
	79.16	1.23	Canned
	77.43	1.77	Cooked, moist heat
	71.00	7.52	Crab cakes
Crab, Dungeness	79.18	0.97	Raw
	73.31	1.24	Cooked, moist heat
Crab, Queen	80.58	1.18	Raw
	75.10	1.51	Cooked, moist heat
Crayfish, Farmed	84.05	0.97	Raw
	80.80	1.30	Cooked, moist heat
Crayfish, Wild	82.24	0.95	Raw
	79.37	1.20	Cooked, moist heat
Cuttlefish	80.56	0.70	Raw
	61.12	1.40	Cooked, moist heat
Lobster, Northern	76.76	0.90	Raw
	76.03	0.59	Cooked, moist heat
Lobster, Spiny	74.07	1.51	Raw
	66.76	1.94	Cooked, moist heat
Mussel, Blue	80.58	2.24	Raw
	61.15	4.48	Cooked, moist heat
Octopus	80.25	1.04	Raw
	60.50	2.08	Cooked, moist heat
Oyster, Eastern	86.20	1.55	Raw, farmed
	85.16	2.46	Raw, wild
	85.14	2.47	Canned
	64.72	12.58	Cooked, breaded and fried
	81.95	2.12	Cooked, farmed, dry heat
	83.30	1.90	Cooked, wild, dry heat
	70.32	4.91	Cooked, wild, moist heat
Oyster, Pacific	82.06	2.30	Raw
	64.12	4.60	Cooked, moist heat
Scallop, mixed species	78.57	0.76	Raw
	58.44	10.94	Cooked, breaded and fried
	73.10	1.40	Steamed
Shrimp	75.86	1.73	Raw
	75.85	1.36	Canned
	52.86	12.28	Cooked, breaded and fried
	77.28	1.08	Cooked, moist heat
Squid	78.55	1.38	Raw
	64.54	7.48	Cooked, fried

Source: USDA, 2007.

APPENDIX 10A

RESOURCE UTILIZATION DISTRIBUTION

Appendix 10A. Resource Utilization Distribution

The percentiles of the resource utilization distribution of Y are to be distinguished from the percentiles of the (standard) distribution of Y. The latter percentiles show what percentage of individuals in the population are consuming below a given level. Thus, the 50th percentile of the distribution of Y is that level such that 50 percent of individuals consume below it; on the other hand, the 50th percentile of the resource utilization distribution is that level such that 50 percent of the overall consumption in the population is done by individuals consuming below it.

The percentiles of the resource utilization distribution of Y will always be greater than or equal to the corresponding percentiles of the (standard) distribution of Y, and, in the case of recreational fish consumption, usually considerably exceed the standard percentiles.

To generate the resource utilization distribution, one simply weights each observation in the data set by the Y level for that observation and performs a standard percentile analysis of weighted data. If the data already have weights, then one multiplies the original weights by the Y level for that observation, and then performs the percentile analysis.

Under certain assumptions, the resource utilization percentiles of fish consumption may be related (approximately) to the (standard) percentiles of fish consumption derived from the analysis of creel studies. In this instance, it is assumed that the creel survey data analysis did not employ sampling weights (i.e., weights were implicitly set to one); this is the case for many of the published analyses of creel survey data. In creel studies the fish consumption rate for the ith individual is usually derived by multiplying the amount of fish consumption per fishing trip (say C_i) by the frequency of fishing (say f_i). If it is assumed that the probability of sampling of an angler is proportional to fishing frequency, then sampling weights of inverse fishing frequency ($1/f_i$) should be employed in the analysis of the survey data. Above it was stated that for data that are already weighted the resource utilization distribution is generated by multiplying the original weights by the individual's fish consumption level to create new weights. Thus, to generate the resource utilization distribution from the data with weights of ($1/f_i$), one multiplies ($1/f_i$) by the fish consumption level of $f_i C_i$ to get new weights of C_i.

Now if C_i (amount of consumption per fishing trip) is constant over the population, then these new weights are constant and can be taken to be one. But weights of one is what (it is assumed) were used in the original creel survey data analysis. Hence, the resource utilization distribution is exactly the same as the original (standard) distribution derived from the creel survey using constant weights.

The accuracy of this approximation of the resource utilization distribution of fish by the (standard) distribution of fish consumption derived from an unweighted analysis of creel survey data depends then on two factors, how approximately constant the C_i 's are in the population and how approximately proportional the relationship between sampling probability and fishing frequency is. Sampling probability will be roughly proportional to frequency if repeated sampling at the same site is limited or if re-interviewing is performed independent of past interviewing status.

Note: For any quantity Y that is consumed by individuals in a population, the percentiles of the "resource utilization distribution" of Y can be formally defined as follows: Y_p (R) is the pth percentile of the resource utilization distribution if p percent of the overall consumption of Y in the population is done by individuals with consumption below Y_p (R) and 100-p percent is done by individuals with consumption above Y_p(R).

APPENDIX 10B

FISH PREPARATION AND COOKING METHODS

Table 10B-1. Percent of Fish Meals Prepared Using Various Cooking Methods by Residence Size[a]

Residence Size	Large City/Suburb	Small City	Town	Small Town	Rural Non-Farm	Farm
Total Fish						
Cooking Method						
Pan Fried	32.7	31.0	36.0	32.4	38.6	51.6
Deep Fried	19.6	24.0	23.3	24.7	26.2	15.7
Boiled	6.0	3.0	3.4	3.7	3.4	3.5
Grilled/Broiled	23.6	20.8	13.8	21.4	13.7	13.1
Baked	12.4	12.4	10.0	10.3	12.7	6.4
Combination	2.5	6.0	8.3	5.0	2.3	7.0
Other (Smoked, etc.)	3.2	2.8	5.2	1.9	2.9	1.8
Don't Know	0.0000	0.0000	0.0000	0.5	0.2	--
Total (N)[b]	393	317	388	256	483	94
Sport Fish						
Pan Fried	45.8	45.7	47.6	41.4	51.2	63.3
Deep Fried	12.2	14.5	17.5	15.2	21.9	7.3
Boiled	2.8	2.3	2.9	0.5	3.6	0
Grilled/Broiled	20.2	17.6	10.6	25.3	8.2	10.4
Baked	11.8	8.8	6.3	8.7	9.7	6.9
Combination	2.7	8.5	10.4	6.7	1.9	9.3
Other (smoked, etc.)	4.5	2.7	4.9	1.5	3.5	2.8
Don't Know	0	0	0	0.7	0	0
Total (N)	205	171	257	176	314	62

[a] Large City = over 100,000; Small City = 20,000-100,000; Town = 2,000-20,000; Small Town = 100-2,000.
[b] N = Total number of respondents

Source: West et al., 1993.

Table 10B-2. Percent of Fish Meals Prepared Using Various Cooking Methods by Age

Age (years)	17-30	31-40	41-50	51-64	>64	Overall
Total Fish						
Cooking Method						
Pan Fried	45.9	31.7	30.5	33.9	40.7	35.3
Deep Fried	23.0	24.7	26.9	23.7	14.0	23.5
Boiled	0.0000	6.0	3.6	3.9	4.3	3.9
Grilled or Boiled	15.6	15.2	24.3	16.1	18.8	17.8
Baked	10.8	13.0	8.7	12.8	11.5	11.4
Combination	3.1	5.2	2.2	6.5	6.8	4.7
Other (Smoked, etc.)	1.6	4.2	3.5	2.7	4.0	3.2
Don't Know	0.0000	0.0000	0.3	0.4	0.0000	0.2
Total (N)[a]	246	448	417	502	287	1946
Sport Fish						
Pan Fried	57.6	42.6	43.4	46.6	54.1	47.9
Deep Fried	18.2	21.0	17.3	14.8	7.7	16.5
Boiled	0.0000	4.4	0.8	3.2	3.1	2.4
Grilled/Broiled	15.0	10.1	25.9	12.2	12.2	14.8
Baked	3.6	10.4	6.4	11.7	9.9	8.9
Combination	3.8	7.2	3.0	7.5	8.2	5.9
Other (Smoked, etc.)	1.7	4.3	3.2	3.5	4.8	3.5
Don't Know	0.0000	0.0000	0.0000	0.4	0.0000	0.1
Total (N)	174	287	246	294	163	1187

[a] N = Total number of respondents.
Source: West et al., 1993.

Table 10B-3. Percent of Fish Meals Prepared Using Various Cooking Methods by Ethnicity

Ethnicity	Black	Native American	Hispanic	White	Other
Total Fish					
Cooking Method					
Pan Fried	40.5	37.5	16.1	35.8	18.5
Deep Fried	27.0	22.0	83.9	22.7	18.4
Boiled	0	1.1	0	4.3	0
Grilled/Broiled	19.4	9.8	0	17.7	57.6
Baked	1.9	16.3	0	11.7	5.4
Combination	9.5	6.2	0	4.5	0
Other (Smoked, etc.)	1.6	4.2	3.5	2.7	4.0
Don't Know	0	0	0.3	0.4	0
Total (N)[a]	52	84	12	1,744	33
Sport Fish					
Pan Fried	44.9	47.9	52.1	48.8	22.0
Deep Fried	36.2	20.2	47.9	15.7	9.6
Boiled	0	0	0	2.7	0
Grilled/Broiled	0	1.5	0	14.7	61.9
Baked	5.3	18.2	0	8.6	6.4
Combination	13.6	8.6	0	5.6	0
Other (Smoked, etc.)	0	3.6	0	3.7	0
Total (N)	19	60	4	39	0

[a] N = Total number of respondents.
Source: West et al., 1993.

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11 INTAKE OF MEATS, DAIRY PRODUCTS AND FATS

11.1 INTRODUCTION

The American food supply is generally considered to be one of the safest in the world. Nevertheless, meats, dairy products, and fats may become contaminated with toxic chemicals by several pathways. These foods sources can become contaminated if animals are exposed to contaminated media (i.e., soil, water, or feed crops). To assess exposure through this pathway, information on meat, dairy, and fat ingestion rates are needed.

A variety of terms may be used to define intake of meats, dairy products, and fats (e.g., consumer-only intake, per capita intake, total meat, dairy product, or fat intake, as-consumed intake, dry weight intake). As described in Chapter 9, Intake of Fruits and Vegetables, consumer-only intake is defined as the quantity of meats, dairy products, or fats consumed by individuals during the survey period averaged across only the individuals who consumed these food items during the survey period. Per capita intake rates are generated by averaging consumer-only intakes over the entire population In general, per capita intake rates are appropriate for use in exposure assessment for which average dose estimates are of interest because they represent both individuals who ate the foods during the survey period and individuals who may eat the food items at some time, but did not consume them during the survey period. Per capita intake, therefore, represents an average across the entire population of interest, but does so at the expense of underestimating consumption for the subset of the population that consumes the food in question. Total intake refers to the sum of all meats, dairy products, or fats consumed in a day.

Intake rates may be expressed on the basis of the as-consumed weight (e.g., cooked or prepared) or on the uncooked or unprepared weight. As-consumed intake rates are based on the weight of the food in the form that it is consumed and should be used in assessments where the basis for the contaminant concentrations in foods is also indexed to the as-consumed weight. The food ingestion values provided in this chapter are expressed as as-consumed intake rates because this is the fashion in which data were reported by survey respondents. This is of importance because concentration data to be used in the dose equation are often measured in uncooked food samples. It should be recognized that cooking can either increase or decrease food weight. Similarly, cooking can increase the mass of contaminant in food (due to formation reactions, or absorption from cooking oils or water) or decrease the mass of contaminant in food (due to vaporization, fat loss or leaching). The combined effects of changes in weight and changes in contaminant mass can result in either an increase or decrease in contaminant concentration in cooked food. Therefore, if the as-consumed ingestion rate and the uncooked concentration are used in the dose equation, dose may be under-estimated or over-estimated. Ideally, after-cooking food concentrations should be combined with the as-consumed intake rates. In the absence of data, it is reasonable to assume that no change in contaminant concentration occurs after cooking. It is important for the assessor to be aware of these issues and choose intake rate data that best match the concentration data that are being used. For more information on cooking losses and conversions necessary to account for such losses, the reader is referred to Chapter 13 of this handbook.

Sometimes contaminant concentrations in food are reported on a dry weight basis. When these data are used in an exposure assessment, it is recommended that dry-weight intake rates also be used. Dry-weight food concentrations and intake rates are based on the weight of the food consumed after the moisture content has been removed. Similarly, when contaminant concentrations in food are reported on a lipid weight basis, lipid weight intake rates should be used. For information on converting the intake rates presented in this chapter to dry weight or lipid weight intake rates, the reader is referred to Sections 11.5 and 11.6 of this chapter.

The purpose of this chapter is to provide intake data for meats, dairy products, and fats. The recommendations for ingestion rates of meats, dairy products, and fats are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values are based on the key study identified by U.S. EPA for this factor. Following the recommendations, the key study on ingestion of meats, dairy products, and fats are summarized. Relevant data on ingestion of meats, dairy products, and fats are also provided. These studies are presented to provide the reader with added perspective on the current state-of-knowledge pertaining to ingestion of meats, dairy products, and fats.

11.2 RECOMMENDATIONS

Table 11-1 presents a summary of the recommended values for per capita and consumers-only intake of meats, dairy products, and fats, on an as-consumed basis. Confidence ratings for these recommendations are provided in Table 11-2.

U.S.EPA analyses of data from the 1994-96 and 1998 Continuing Survey of Food Intake by

Individuals (CSFII) were used in selecting recommended intake rates for the general population. The U.S. EPA analysis of meat and dairy products was conducted using childhood age groups that differed slightly from U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, for the purposes of the recommendations for children presented here, data were placed in the standardized age categories closest to those used in the analysis. The U.S. EPA analysis of fat intake data from the CSFII used the childhood age groups recommended by U.S. EPA (2005). The CSFII data on which the recommendations for meats, dairy products, and fats are based are short-term survey data and may not necessarily reflect the long-term distribution of average daily intake rates. However, since these broad categories of food (i.e., total meats and dairy products), are eaten on a daily basis throughout the year with minimal seasonality, the short term distribution may be a reasonable approximation of the long-term distribution, although it will display somewhat increased variability. This implies that the upper percentiles shown here will tend to overestimate the corresponding percentiles of the true long-term distribution. It should be noted that because these recommendations are based on 1994-96 and 1998 CSFII data, they may not reflect the most recent changes that may have occurred in consumption patterns.

Table 11-1. Recommended Values for Intake of Meats, Dairy Products, and Fats, As Consumed

Age Group	Per Capita		Consumers Only		Multiple Percentiles	Source
	Mean	95th Percentile	Mean	95th Percentile		
	g/kg-day	g/kg-day	g/kg-day	g/kg-day		
Total Meats[a]						
Birth to 1 year	1.2	6.7	3.0	9.2	See Tables 11-3 and 11-4	U.S. EPA Analysis of CSFII, 1994-96 and 1998, based on USDA (2000) and U.S. EPA (2000).
1 to <2 years	4.1	9.8	4.2	9.8		
2 to <3 years	4.1	9.8	4.2	9.8		
3 to <6 years	4.1	9.4	4.2	9.4		
6 to <11 years	2.9	6.5	2.9	6.5		
11 to <16 years	2.1	4.8	2.1	4.8		
16 to <21 years	2.1	4.8	2.1	4.8		
20 to <50 years	1.9	4.2	1.9	4.2		
50+ years	1.5	3.3	1.5	3.3		
Total Dairy Products[a]						
Birth to 1 year	12.6	48.7	15.9	57.5	See Tables 11-3 and 11-4	U.S. EPA Analysis of CSFII, 1994-96 and 1998, based on USDA (2000) and U.S. EPA (2000).
1 to <2 years	36.7	88.3	36.8	88.3		
2 to <3 years	36.7	88.3	36.8	88.3		
3 to <6 years	23.3	49.4	23.3	49.4		
6 to <11 years	13.6	31.5	13.6	31.5		
11 to <16 years	5.6	15.5	5.6	15.5		
16 to <21 years	5.6	15.5	5.6	15.5		
20 to <50 years	3.3	9.9	3.3	9.9		
50+ years	3.2	8.9	3.2	8.9		
Individual Meat and Dairy Products - See Tables 11-5 and 11-6						

Table 11-1. Recommended Values for Intake of Meats, Dairy Products, and Fats, As Consumed (continued)

Age Group	Per Capita Mean	Per Capita 95th Percentile	Consumers Only Mean	Consumers Only 95th Percentile	Multiple Percentiles	Source
	g/kg-day	g/kg-day	g/kg-day	g/kg-day		
Total Fats						
Birth to <1 month	5.2	16	7.8	16	See Tables 11-27 and 11-29	U.S. EPA (2007)
1 to <3 months	4.5	11	6.0	12		
3 to <6 months	4.1	8.2	4.4	8.3		
6 to <12 months	3.7	7.0	3.7	7.0		
1 to <2 years	4.0	7.1	4.0	7.1		
2 to <3 years	3.6	6.4	3.6	6.4		
3 to <6 years	3.4	5.8	3.4	5.8		
6 to <11 years	2.6	4.2	2.6	4.2		
11 to <16 years	1.6	3.0	1.6	3.0		
16 to <21 years	1.3	2.7	1.3	2.7		
21 to <31 years	1.2	2.3	1.2	2.3		
31 to <41 years	1.1	2.1	1.1	2.1		
41 to <51 years	1.0	1.9	1.0	1.9		
51 to <61 years	0.9	1.7	0.9	1.7		
61 to < 71 years	0.9	1.7	0.9	1.7		
71 to <81 years	0.8	1.5	0.8	1.5		
81+ years	0.9	1.5	0.9	1.5		

[a] Analysis was conducted using slightly different childhood age groups than those recommended in *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA. 2005). Data were placed in the standardized age categories closest to those used in the analysis.

Table 11-2. Confidence in Recommendations for Intake of Meats, Dairy Products, and Fats

General Assessment Factors	Rationale	Rating
Soundness		High
Adequacy of Approach	The survey methodology and data analysis was adequate. The survey sampled approximately 20,000 individuals. An analysis of primary data was conducted.	
Minimal (or Defined) Bias	No physical measurements were taken. The method relied on recent recall of meats and dairy products eaten.	
Applicability and Utility		Medium
Exposure Factor of Interest	The key studies were directly relevant to meat, dairy, and fat intake.	
Representativeness	The data were demographically representative of the U.S. population (based on stratified random sample).	
Currency	Data were collected between 1994 and 1998.	
Data Collection Period	Data were collected for two non-consecutive days.	
Clarity and Completeness		High
Accessibility	The CSFII data are publicly available.	
Reproducibility	The methodology used was clearly described; enough information was included to reproduce the results.	
Quality Assurance	Quality assurance of the CSFII data was good; quality control of the secondary data analysis was not well described.	
Variability and Uncertainty		Medium
Variability in Population	Full distributions were provided for total meats, total dairy products, and total fats. Means were provided for individuals meats and dairy products.	
Uncertainty	Data collection was based on recall of consumption for a 2-day period; the accuracy of using these data to estimate long-term intake (especially at the upper percentiles) is uncertain. However, use of short-term data to estimate chronic ingestion can be assumed for broad categories of foods such as total meats, total dairy products, and total fats. Uncertainty is likely to be greater for individual meats and dairy products.	
Evaluation and Review		Medium
Peer Review	The USDA CSFII survey received a high level of peer review. The U.S. EPA analysis of these data has not been peer reviewed outside the Agency.	
Number and Agreement of Studies	There was 1 key study for intake of meat and dairy products and 1 key study for fat intake. Both were based on the 1994-96, 1998 CSFII.	
Overall Rating		**High** confidence in the averages; **Low** confidence in the long-term upper percentiles

11.3 INTAKE OF MEAT AND DAIRY PRODUCTS

The primary source of recent information on consumption rates of meat and dairy products is the U.S. Department of Agriculture's (USDA) CSFII. Data from the 1994-96 CSFII and the 1998 Children's supplement to the 1994-96 CSFII have been used in various studies to generate consumer-only and per capita intake rates for both individual meats and dairy products and total meats and dairy products. The CSFII is a series of surveys designed to measure the kinds and amounts of foods eaten by Americans. The CSFII 1994-96 was conducted between January 1994 and January 1997 with a target population of non-institutionalized individuals in all 50 states and Washington, D.C. In each of the 3 survey years, data were collected for a nationally representative sample of individuals of all ages. The CSFII 1998 was conducted between December 1997 and December 1998 and surveyed children 9 years of age and younger. It used the same sample design as the CSFII 1994-96 and was intended to be merged with CSFII 1994-96 to increase the sample size for children. The merged surveys are designated as CSFII 1994-96, 1998. Additional information on these surveys can be obtained at http://www.ars.usda.gov/Services/docs.htm?docid=14531.

The CSFII 1994-96, 1998 collected dietary intake data through in-person interviews on 2 non-consecutive days. The data were based on 24-hour recall. A total of 21,662 individuals provided data for the first day; of those individuals, 20,607 provided data for a second day. The 2-day response rate for the 1994-1996 CSFII was approximately 76 percent. The 2-day response rate for CSFII 1998 was 82 percent.

The CSFII 1994-96, 98 surveys were based on a complex multistage area probability sample design. The sampling frame was organized using 1990 U.S. population census estimates, and the stratification plan took into account geographic location, degree of urbanization, and socioeconomic characteristics. Several sets of sampling weights are available for use with the intake data. By using appropriate weights data for all fours years of the surveys can be combined. USDA recommends that all 4 years be combined in order to provide an adequate sample size for children.

11.3.1 Key Meat and Dairy Intake Study

11.3.1.1 *U.S. EPA Analysis of CSFII 1994-96, 1998 based on USDA (2000) and U.S. EPA (2000)*

For many years, the U.S. EPA' Office of Pesticide Programs (OPP) has used food consumption data collected by the U.S. Department of Agriculture (USDA) for its dietary risk assessments. Most recently, OPP, in cooperation with USDA's Agricultural Research Service (ARS), used data from the 1994-96, 1998 CSFII to develop the Food Commodity Intake Database (FCID). CSFII data on the foods people reported eating were converted to the quantities of agricultural commodities eaten. "Agricultural commodity" is a term used by U.S. EPA to mean animal (or plant) parts consumed by humans as food; when such items are raw or unprocessed, they are referred to as "raw agricultural commodities." For example, a beef stew may contain the commodities beef, carrots, and potatoes. FCID contains approximately 553 unique commodity names and 8-digit codes. The FCID commodity names and codes were selected and defined by U.S. EPA and were based on the U.S. EPA Food Commodity Vocabulary (http://www.epa.gov/pesticides/foodfeed/).

The meats and dairy items/groups selected for the U.S. EPA analysis included total meats and total dairy products, and individual meats and dairy such as beef, pork, poultry, and eggs. Appendix 11A presents the food codes and definitions used to determine the various meats and dairy products used in the analysis. Intake rates for these food items/groups represent intake of all forms of the product (e.g., both home produced and commercially produced). Individuals who did not provide information on body weight or for whom identifying information was unavailable were excluded from the analysis. Two-day average intake rates were calculated for all individuals in the database for each of the food items/groups. These average daily intake rates were divided by each individual's reported body weight to generate intake rates in units of grams per kilogram of body weight per day (g/kg-day). The data were weighted according to the four-year, two-day sample weights provided in the 1994-96, 1998 CSFII to adjust the data for the sample population to reflect the national population.

Summary statistics were generated on both a per capita and a consumer only basis. For per capita intake, both users and non-users of the food item were included in the analysis. Consumer only intake rates were calculated using data for only those individuals who ate the food item of interest during the survey period. Intake data from the CSFII are based on as- consumed (i.e., cooked or prepared) forms of the food items/groups. Summary statistics, including: number of observations, percentage of the population consuming the meat or dairy products being analyzed, means intake rate, and standard error of the mean intake rate were calculated for total meats, total dairy products, and selected individual meats and dairy products. Percentiles of the intake rate distribution (1st, 5th, 10th, 25th, 50th, 75th, 90th, 95th, 99th, and maximum value) were also provided for total meats and dairy products. Because these data were developed for use in U.S. EPA's pesticide registration program, the childhood age groups used are slightly different than those recommended in U.S. EPA's Guid*ance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005).

Table 11-3 presents as-consumed per capita intake data for total meats and dairy products in g/kg-day; as-consumed consumer-only intake data for total meats and dairy products in g/kg-day are provided in Table 11-4. Table 11-5 provides per capita intake data for certain individual meats and dairy products and Table 11-6 provides consumer only intake data for these individual meats and dairy products.

It should be noted that the distribution of average daily intake rates generated using short-term data (e.g., 2-day) do not necessarily reflect the long-term distribution of average daily intake rates. The distributions generated from short-term and long-term data will differ to the extent that each individual's intake varies from day to day; the distributions will be similar to the extent that individuals' intakes are constant from day to day. However, for broad categories of foods (e.g., total meats and dairy products) that are eaten on a daily basis throughout the year, the short-term distribution may be a reasonable approximation of the true long-term distribution, although it will show somewhat more variability. In this chapter, distributions are provided only for broad categories of meats and dairy products (i.e., total meats and dairy products). Because of the increased variability of the short-term distribution, the short-term upper percentiles shown here may overestimate the corresponding percentiles of the long-term distribution. For individual foods, only the mean, standard error, and percent consuming are provided.

The strengths of U.S. EPA's analysis are that it provides distributions of intake rates for various age groups, normalized by body weight. The analysis uses the 1994-96, 1998 CSFII data set which was designed to be representative of the U.S. population. The data set includes four years of intake data combined, and is based on a two-day survey period. As discussed above, short-term dietary data may not accurately reflect long-term eating patterns and may under-represent infrequent consumers of a given food. This is particularly true for the tails (extremes) of the distribution of food intake. Although the analysis was conducted using slightly different age groups than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005), given the similarities in the age groups used, the data should provide suitable intake estimates for the childhood age groups of interest**.**

11.3.2 Relevant Meat and Dairy Intake Studies

11.3.2.1 USDA, 1980, 1992, 1996a, 1996b - Food and Nutrient Intakes of Individuals in One Day in the U.S.

USDA calculated mean per capita intake rates for meat and dairy products using Nationwide Food Consumption Survey (NFCS) data from 1977-78 and 1987-88 (USDA, 1980; 1992) and CSFII data from 1994 and 1995 (USDA, 1996a; 1996b). The mean per capita intake rates for meat are presented in Tables 11-7 through 11-9 based on intake data for one day from the 1977-78 (Table 11-7) and 1987-88 NFCSs (Table 11-8), and 1994 and 1995 CSFII (Table 11-9). Tables 11-10 through 11-12 present similar data for dairy products. Note that the age classifications used in the later surveys were slightly different than those used in the 1977-78 NFCS.

The advantages of using these data are that they provide mean intake estimates for all meat, poultry, and dairy products. The consumption estimates are based on short-term (i.e., 1-day) dietary data which may not reflect long-term consumption.

11.3.2.2 *USDA, 1999a - Food and Nutrient Intakes by Children 1994-96, 1998, Table Set 17*

USDA (1999a) calculated national probability estimates of food and nutrient intake by children based on all 4 years of the CSFII (1994-96 and 1998) for children age 9 years and under and on CSFII 1994-96 only for individuals age 10 years and over. Sample weights were used to adjust for non-response, to match the sample to the U.S. population in terms of demographic characteristics, and to equalize intakes over the 4 quarters of the year and the 7 days of the week. A total of 503 breast-fed children were excluded from the estimates, but both consumers and non-consumers were included in the analysis.

USDA (1999a) provided data on the mean per capita quantities (grams) of various food products/groups consumed per individual for one day, and the percent of individuals consuming those foods in one day of the survey. Tables 11-13 and 11-14 present data on the mean quantities (grams) of meat and eggs consumed per individual for one day, and the percentage of survey individuals consuming meats and eggs on that survey day. Tables 11-15 and 11-16 present similar data for dairy products. Data on mean intakes or mean percentages are based on respondents' day-1 intakes.

The advantage of the USDA (1999a) study is that it uses the 1994-96, 98 CSFII data set, which includes four years of intake data, combined, and includes the supplemental data on children. These data are expected to be generally representative of the U.S. population and they include data on a wide variety of meats and dairy products. The data set is one of a series of USDA data sets that are publicly available. One limitation of this data set is that it is based on one-day, and short-term dietary data may not accurately reflect long-term eating patterns. Other limitations of this study are that it only provides mean values of food intake rates, consumption is not normalized by body weight, and presentation of results is not consistent with U.S. EPA's recommended age groups.

11.3.2.3 *Smiciklas-Wright et al., 2002 - Foods Commonly Eaten in the United States: Quantities Consumed per Eating Occasion and in a Day, 1994-1996*

Using data gathered in the 1994-96 USDA CSFII, Smiciklas-Wright et al. (2002) calculated distributions for the quantities of meat, poultry, and dairy products consumed per eating occasion by members of the U.S. population (i.e., serving sizes). The estimates of serving size are based on data obtained from 14,262 respondents, ages 2 and above, who provided 2 days of dietary intake information. Only dietary intake data from users of the specified food were used in the analysis (i.e., consumers only data).

Table 11-17 presents serving size data for meats and dairy products. These data are presented on an as-consumed basis (grams) and represent the quantity of meats and dairy products consumed per eating occasion. These estimates may be useful for assessing acute exposures to contaminants in specific foods, or other assessments where the amount consumed per eating occasion is necessary. Only the mean and standard deviation serving size data and percent of the population consuming the food during the 2-day survey period are presented in this handbook. Percentiles of serving sizes of the foods consumed by these age groups of the U.S. population can be found in Smiciklas-Wright et al. (2002).

The advantages of using these data are that they were derived from the USDA CSFII and are representative of the U.S. population. The analysis conducted by Smiciklas-Wright et al. (2002) accounted for individual foods consumed as ingredients of mixed foods. Mixed foods were disaggregated via recipe files so that the individual ingredients could be grouped together with similar foods that were reported separately. Thus, weights of foods consumed as ingredients were combined with weights of foods reported separately to provide a more thorough representation of consumption. However, it should be noted that since the recipes for the mixed foods consumed were not provided by the respondents, standard recipes were used. As a result, the estimates of quantity consumed for some food types are based on assumptions about the types and quantities of ingredients consumed as part of mixed foods. This study used data from the 1994 to 1996 CSFII; data from the 1998 children's supplement were not included.

11.3.2.4 *Vitolins et al., 2002 - Quality of Diets Consumed by Older Rural Adults*

Vitolins et al. (2002) conducted a survey to evaluate the dietary intake, by food groups, of older (>70 years) rural adults. The sample consisted of 130 community dwelling residents from two rural counties in North Carolina. Data on dietary intake over the preceding year were obtained in face-to-face interviews conducted in participants' homes, or in a few cases, a senior center. The food frequency questionnaire used in the survey was a modified version of the National Cancer Institute Health Habits and History Questionnaire (HHHQ); this modified version included an expanded food list containing a greater number of ethnic foods than the original food frequency form. Demographic and personal data collected included gender, ethnicity, age, education, denture use, marital status, chronic disease, and weight.

Food items reported in the survey were grouped into food groups similar to the USDA Food Guide Pyramid and the National Cancer Institute's 5 A Day for Better Health program. These groups are: (1) fruits and vegetables; (2) bread, cereal, rice, and pasta; (3) milk, yogurt and cheese; (4) meat, fish, poultry, beans and eggs; and (5) fats, oils, sweets, and snacks. Medians, ranges, frequencies and percentages were used to summarize intake of each food group, broken down by demographic and health characteristics. In addition, multiple regression models were used to determine which demographic and health factors were jointly predictive of intake of each of the five food groups.

Thirty-four percent of the survey participants were African American, 36% were European American, and 30% were Native American. Sixty-two percent were female, 62% were not married at the time of the interview, and 65% had some high school education or were high school graduates. Almost all of the participants (95%) had one or more chronic diseases. Sixty percent of the respondents were between 70 and 79 years of age; the median age was 78 years old. The median servings of milk, yogurt and cheese broken down by demographic and health characteristic are presented in Table 11-18. None of the demographic characteristics were significantly associated with milk intake, and only ethnicity was found to be borderline (P = 0.13). In addition, none of the demographic characteristics were jointly predictive of milk, yogurt and cheese consumption.

One limitation of the study, as noted by the study authors, is that the study did not collect information on the length of time the participants had been practicing the dietary behaviors reported in the survey. The questionnaire asked participants to report the frequency of food consumption during the past year. The study authors noted that, currently, there are no dietary assessment tools that allow the collection of comprehensive dietary data over years of food consumption. Another limitation of the study is the small sample size used which makes associations by gender and ethnicity difficult.

11.3.2.5 *Fox et al., 2004 - Feeding Infants and Toddlers Study: What Foods Are Infants and Toddlers Eating*

Fox et al. (2004) used data from the Feeding Infants and Toddlers study (FITS) to assess food consumption patterns in infants and toddlers. The FITS was sponsored by Gerber Products Company and was conducted to obtain current information on food and nutrient intakes of children, ages 4 to 24 months old, in the 50 states and the District of Columbia. The FITS is described in detail in Devaney et al. (2004). FITS was based on a random sample of 3,022 infants and toddlers for which dietary intake data were collected by telephone from their parents or caregivers between March and July 2002. An initial recruitment and household interview was conducted, followed by an interview to obtain information on intake based on 24-hour recall. The interview also addressed growth, development and feeding patterns. A second dietary recall interview was conducted for a subset of 703 randomly selected respondents. The study over-sampled children in the 4 to 6 and 9 to 11 months age groups; sample weights were adjusted for non-response, over-sampling, and under-coverage of some subgroups. The response rate for the FITS was 73 percent for the recruitment interview. Of the recruited households, there was a response rate of 94 percent for the dietary recall interviews (Devaney et al., 2004). The characteristics of the FITS study population are shown in Table 11-19.

Fox et al. (2004) analyzed the first set of 24-hour recall data collected from all study participants. For this analysis, children were grouped into six age categories: 4 to 6 months, 7 to 8 months, 9 to 11 months, 12 to 14 months, 15 to 18 months, and 19 to 24 months. Table 11-20 provides the percentage of infants and toddlers consuming milk, meats or other protein sources at least once in a day. The percentage of children consuming any type of meat or protein source ranged from 14.2 percent for 4 to 6 month olds to 97.2 percent for 19 to 24 month olds (Table 11-20).

The advantages of this study were that the study population represented the U.S. population and the sample size was large. One limitation of the analysis done by Fox et al. (2004) was that only frequency data were provided; no information on actual intake rates was included. In addition, Devaney et al. (2004) noted several limitations associated with the FITS data. For the FITS, a commercial list of infants and toddlers was used to obtain the sample used in the study. Since many of the households could not be located and did not have children in the target population, a lower response rate than would have occurred in a true national sample was obtained (Devaney et al., 2004). In addition, the sample was likely from a higher socioeconomic status when compared with all U.S. infants in this age group (4 to 24 months old) and the use of a telephone survey may have omitted lower-income households without telephones (Devaney et al., 2004).

11.3.2.6 *Ponza et al., 2004 - Nutrient Food Intakes and Food Choices of Infants and Toddlers Participating in WIC*

Ponza et al. (2004) conducted a study using selected data from FITS to assess feeding patterns, food choices and nutrient intake of infants and toddlers participating in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Ponza et al. (2004) evaluated FITS data for the following age groups: 4 to 6 months (N = 862), 7 to 11 months (N = 1159) and 12 to 24 months (N= 996). The total sample size described by WIC participant and non-participant is shown in Table 11-21.

The foods consumed were analyzed by tabulating the percentage of infants who consumed specific foods/food groups per day (Ponza et al., 2004). Weighted data were used in all of the analyses used in the study (Ponza et al., 2004). Table 11-21 presents the demographic data for WIC participants and non-participants. Table 11-22 provides the food choices for infants and toddlers. In general, there was little difference in food choices among WIC participants and non-participants, except for consumption of yogurt by infants 7 to 11 months of age and toddlers 12 to 24 months of age (Table 11-22). Non-participants, 7 to 24 months of age, were more likely to eat yogurt than WIC participants (Ponza et al., 2004).

An advantage of this study is that it had a relatively large sample size and was representative of the U.S. general population of infants and children. A limitation of the study is that intake values for foods were not provided. Other limitations are associated with the FITS data and are described previously in Section 11.3.2.5.

11.3.2.7 *Mennella et al., 2006 - Feeding Infants and Toddlers Study: The Types of Foods Fed to Hispanic Infants and Toddlers*

Mennella et al. (2006) investigated the types of food and beverages consumed by Hispanic infants and toddlers in comparison to the non-Hispanic infants and toddlers in the United States. The FITS 2002 data for children between 4 and 24 months old were used for the study. The data represent a random sample of 371 Hispanic and 2,367 non-Hispanic infants and toddlers (Menella et al., 2006). Menella et al. (2006) grouped the infants as follows: 4 to 5 months (N = 84 Hispanic; 538 non-Hispanic), 6 to 11 months (N = 163 Hispanic and 1,228 non-Hispanic), and 12 to 24 months (N = 124 Hispanic and 871 non-Hispanic) of age.

Table 11-23 provides the percentages of Hispanic and non-Hispanic infants and toddlers consuming milk, meats or other protein sources on a given day. In most instances the percentages consuming the different types of meats and protein sources were similar (Mennella et al., 2006).

The advantage of the study is that it provides information on food preferences for Hispanic and non-Hispanic infants and toddlers. A limitation is that the study did not provide food intake data, but provided frequency of use data instead. Other limitations are those noted previously in Section 11.3.2.5 for the FITS data.

11.3.2.8 *Fox et al., 2006 - Average Portion of Foods Commonly Eaten by Infants and Toddlers in the United States*

Fox et al. (2006) estimated average portion sizes consumed per eating occasion by children 4 to 24 months of age who participated in the FITS. The FITS is a cross-sectional study designed to collect and analyze data on feeding practices, food consumption, and usual nutrient intake of U.S. infants and toddlers and is described in Section 11.3.2.5 of this chapter. It included a stratified random sample of 3,022 children between 4 and 24 months of age.

Using the 24-hour recall data, Fox et al. (2006) derived average portion sizes for six major food groups, including meats and other protein sources. Average portion sizes for select individual foods within these major groups were also estimated. For this analysis, children were grouped into six age categories: 4 to 5 months, 6 to 8 months, 9 to 11 months, 12 to 14 months, 15 to 18 months, and 19 to 24 months. Tables 11-24 and 11-25 present the average portion sizes of meats and dairy products for infants and toddlers, respectively.

11.4 INTAKE OF FAT

11.4.1 Key Fat Intake Study

11.4.1.1 *U.S. EPA, 2007 - Analysis of Fat Intake Based on the U.S. Department of Agriculture's 1994–96, 1998 Continuing Survey of Food Intakes by Individuals (CSFII)*

U.S. EPA conducted an analysis to evaluate the dietary intake of fats by individuals in the United States using data from the USDA's 1994–1996, 1998 CSFII (USDA, 2000). Intakes of CSFII foods were converted to U.S. EPA food commodity codes using data provided in U.S. EPA's FCID (U.S. EPA, 2000). The FCID contains a "translation file" that was used to break down the USDA CSFII food codes into 548 U.S. EPA commodity codes. The method used to translate USDA food codes into U.S. EPA commodity codes is discussed in detail in U.S. EPA (2000).

Each of the 548 U.S. EPA commodity codes was assigned a value between 0 and 1 that indicated the mass fraction of fat in that food item. For many sources of fat, a commodity code existed solely for the nutrient fat portion of the food. For example, beef is represented in the FCID database by ten different commodity codes; several of these codes specifically exclude fat, and one code is described as "nutrient fat only." In these cases, the fat fraction could be expressed as 0 or 1, as appropriate. Most animal food products and food oils were broken down in this way. The fat contents of other foods in the U.S. EPA commodity code list were determined using the USDA Nutrient Database for Standard Reference, Release 13 (USDA, 1999b). For each food item in the U.S. EPA code list, the best available match in the USDA Nutrient database was used. If multiple values were available for different varieties of the same food item (e.g., green, white and red grapes), a mean value was calculated. If multiple values were available for different cooking methods (i.e, fried vs. dry cooked), the method least likely to introduce other substances, such as oil or butter, was preferred. In some cases, not all of the items that fall under a given food commodity code could be assigned a fat content. For example, the food commodity code list identified "turkey, meat byproducts" as including gizzard, heart, neck and tail. Fat contents could be determined only for the gizzard and heart. Because the relative amounts of the different items in the food commodity code was unknown, the mean fat content of these two items was assumed to be the best approximation of the fat content for the food code as a whole.

The analysis was based on respondents who had provided body weights and who had completed both days of the two-day survey process. These individuals were grouped according to various age categories. The mean, standard error, and a range of percentiles of fat intake were calculated for 12 food categories (i.e., all fats, animal fats, meat and meat products, beef, pork, poultry, organ meats, milk and dairy products, fish, oils, and nuts/seeds/beans/legumes/tubers) and 98 demographic cohorts. Fat intake was calculated as a two-day average consumption across both survey days in units of grams per day and grams per kilogram of body weight per day for the whole survey population and for consumers only. A secondary objective of the study was to evaluate fat consumption patterns of individuals who consume high levels of animal fats. The entire data analysis was repeated for a subset of individuals who were identified as high consumers of animal fats. The selection of the high-consumption group was done for each age category individually, rather than on the whole population, because fat intake on a per-body-weight basis is heavily skewed towards young children, and an analysis across the entire American population was desired. For infants, the "less than one year old" group was used instead of the smaller infant groups (<1 month, 1 to <3 months, etc.). Within each of the age categories, individuals that ranked at or above the 90th percentile of consumption of all animal fats on a per-unit body weight basis were identified. Because of the sample weighting factors, the high consumer group was not necessarily 10 percent of each age group. The selected individuals made up a survey population of 2,134 individuals. Fat intake of individuals in this group was calculated in g/day and g/kg-day for the whole population (i.e., per capita) and for consumers only.

The analysis presented in U.S. EPA (2007) was conducted before U.S. EPA published the guidance entitled *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). Therefore, the age groups used for children in U.S. EPA (2007) were not entirely consistent with the age groups recommended in the 2005 guidance. A re-analysis of the some of the data was conducted for the Child-Specific Exposure Factors Handbook to conform with U.S. EPA's recommended age groups for children. The results of this re-analysis are included in Tables 11-26 through 11-31 for all individuals. Only intake rates of all fats are provided in these tables; the reader is referred to U.S. EPA (2007) for fat intake rates from individual food sources. Tables 11-26 and 11-27 present intake rates of all fats for the whole population (i.e., per capita) in g/day and g/kg-day, respectively. Table 11-28 and 11-29 present intake rates of all fats for consumers only in g/day and g/kg-day, respectively. Fat intake rates of all fats for the top decile of animal fat consumers from the consumers only group are presented in Table 11-30 in g/day and in Table 11-31 in g/kg-day (per capita total fat intake rates for the top decile of animal fat consumers are not provided because they are the same as those for consumers only).

11.4.2 Relevant Fat Intake Studies

11.4.2.1 *Cresanta et al., 1988; Nicklas et al., 1993; and Frank et al., 1986 - Bogalusa Heart Study*

Cresanta et al. (1988), Nicklas et al. (1993), and Frank et al. (1986) analyzed dietary fat intake data as part of the Bogalusa heart study. The Bogalusa study, an epidemiologic investigation of cardiovascular risk-factor variables and environmental determinants, collected dietary data on subjects residing in Bogalusa, LA, beginning in 1973. Among other research, the study collected fat intake data for children, adolescents, and young adults. Researchers examined various cohorts of subjects, including (1) six cohorts of 10-year olds, (2) two cohorts of 13-year olds, (3) one cohort of subjects from 6 months to 4 years of age, and (4) one cohort of subjects from 10 to 17 years of age (Nicklas, 1995). To collect the data, interviewers used the 24-hour dietary recall method. According to Nicklas (1995), "the diets of children in the Bogalusa study are similar to those reported in national studies of children." Thus, these data are useful in evaluating the variability of fat intake among the general population. Data for 6-month old to 17-year old individuals collected during 1973 to 1982 are presented in Tables 11-32 and 11-33 (Frank et al., 1986). Data are presented for total fats, animal fats, vegetable fats, and fish fats in units of g/day (Table

11-32) and g/kg/day (Table 11-33).

11.5 CONVERSION BETWEEN WET AND DRY WEIGHT INTAKE RATES

The intake rates presented in this chapter are reported in units of wet weight (i.e., as-consumed or uncooked weight of meats and dairy products consumed per day or per eating occasion). However, data on the concentration of contaminants in meats and dairy products may be reported in units of either wet or dry weight (e.g., mg contaminant per gram-dry-weight of meats and dairy products). It is essential that exposure assessors be aware of this difference so that they may ensure consistency between the units used for intake rates and those used for concentration data (i.e., if the contaminant concentration is measured in dry weight of meats and dairy products, then the dry weight units should be used for their intake values).

If necessary, wet weight (e.g., as consumed) intake rates may be converted to dry weight intake rates using the moisture content percentages presented in Table 11-34 and the following equation:

$$IR_{dw} = IR_{ww}\left[\frac{100-W}{100}\right] \quad \text{(Eqn. 11-1)}$$

where:

IR_{dw} = dry weight intake rate;
IR_{ww} = wet weight intake rate; and
W = percent water content

Alternatively, dry weight residue levels in meat and dairy products may be converted to wet weight residue levels for use with wet weight (e.g., as-consumed) intake rates as follows:

$$C_{ww} = C_{dw}\left[\frac{100-W}{100}\right] \quad \text{(Eqn. 11-2)}$$

where:

C_{ww} = wet weight intake rate;
C_{dw} = dry weight intake rate; and
W = percent water content.

The moisture content data presented in Table 11-34 are for selected meats and dairy products taken from USDA (2007).

11.6 CONVERSION BETWEEN WET WEIGHT AND LIPID WEIGHT INTAKE RATES

In some cases, the residue levels of contaminants in meat and dairy products may be reported as the concentration of contaminant per gram of fat. This may be particularly true for lipophilic compounds. When using these residue levels, the assessor should ensure consistency in the exposure assessment calculations by using consumption rates that are based on the amount of lipids consumed for the meat or dairy product of interest.

If necessary, wet weight (e.g., as-consumed) intake rates may be converted to lipid weight intake rates using the fat content percentages presented in Table 11-34 and the following equation:

$$IR_{lw} = IR_{ww}\left[\frac{L}{100}\right] \quad \text{(Eqn. 11-3)}$$

where:

IR_{lw} = lipid weight intake rate;
Ir_{ww} = wet weight intake rate; and
L = percent lipid (fat) content.

Alternately, wet weight residue levels in meat and dairy products may be estimated by multiplying the levels based on fat by the fraction of fat per product as follows:

$$C_{ww} = C_{lw}\left[\frac{L}{100}\right] \quad \text{(Eqn. 11-4)}$$

where:

C_{ww}= wet weight intake rate;
C_{lw} = lipid weight intake rate; and
L = percent lipid (fat) content.

The resulting residue levels may then be used in conjunction with wet weight (e.g., as-consumed) consumption rates. The total fat content data presented in Table 11-34 are for selected meat and dairy products taken from USDA, 2007.

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Table 11-3. Per Capita Intake of Total Meat and Total Dairy Products (g/kg-day as consumed)

Domain	N	Percent Consuming	Mean	SE	Percentiles									
					1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Total Meat														
Whole Population	20,607	97.5	2.1	0.02	0.0	0.2	0.5	1.0	1.7	2.7	4.0	5.3	8.7	30.3
Age Group														
Birth to 1 year	1,486	40.0	1.2	0.1	0.0	0.0	0.0	0.0	0.0	1.6	4.2	6.7	10.7	29.6
1 to 2 years	2,096	97.3	4.1	0.1	0.0	0.2	0.8	1.9	3.6	5.7	8.0	9.8	14.1	20.6
3 to 5 years	4,391	98.8	4.1	0.05	0.0	0.6	1.2	2.2	3.6	5.4	7.7	9.4	12.7	23.4
6 to 12 years	2,089	98.7	2.9	0.05	0.0	0.4	0.8	1.5	2.5	3.8	5.4	6.5	9.6	18.0
13 to 19 years	1,222	98.8	2.1	0.05	0.0	0.2	0.5	1.0	1.9	2.7	3.8	4.8	7.1	30.3
20 to 49 years	4,677	98.2	1.9	0.04	0.0	0.2	0.5	1.0	1.6	2.5	3.5	4.2	6.9	13.4
50+ years	4,646	98.2	1.5	0.02	0.0	0.2	0.4	0.8	1.3	1.9	2.7	3.3	4.8	9.7
Season														
Fall	4,687	96.8	2.1	0.06	0.0	0.1	0.5	1.0	1.7	2.8	4.2	5.4	8.7	21.2
Spring	5,308	97.6	2.1	0.04	0.0	0.2	0.5	1.0	1.7	2.7	4.0	5.2	8.7	23.6
Summer	5,890	97.4	2.1	0.03	0.0	0.1	0.5	0.9	1.6	2.7	4.0	5.4	8.6	30.3
Winter	4,722	98.0	2.0	0.04	0.0	0.2	0.5	1.0	1.6	2.6	3.8	5.0	7.9	29.6
Race														
American Indian, Alaska Native	177	98.4	2.4	0.25	0.0	0.3	0.5	1.0	2.0	3.3	4.3	6.3	9.0	12.4
Asian, Pacific Islander	557	96.8	2.5	0.17	0.0	0.1	0.3	1.1	2.1	3.5	4.5	6.0	9.6	13.0
Black	2,740	97.9	2.6	0.10	0.0	0.3	0.6	1.2	2.0	3.3	5.4	7.1	10.4	23.6
Other	1,638	96.5	2.5	0.08	0.0	0.2	0.5	1.1	2.0	3.1	4.9	6.5	10.8	29.6
White	15,495	97.5	1.9	0.02	0.0	0.2	0.5	0.9	1.6	2.5	3.7	4.8	7.7	30.3
Region														
Midwest	4,822	97.9	2.2	0.04	0.0	0.3	0.6	1.1	1.8	2.8	4.1	5.3	9.1	30.3
Northeast	3,692	96.3	2.1	0.07	0.0	0.0	0.4	0.9	1.6	2.7	4.1	5.4	8.7	20.5
South	7,208	97.7	2.0	0.03	0.0	0.2	0.5	0.9	1.7	2.6	3.9	5.2	8.3	23.4
Midwest	4,822	97.9	2.2	0.04	0.0	0.3	0.6	1.1	1.8	2.8	4.1	5.3	9.1	30.3
West	4,885	97.6	2.0	0.06	0.0	0.2	0.4	0.9	1.6	2.7	4.0	5.2	8.1	29.6
Urbanization														
MSA, Central City	6,164	97.3	2.1	0.04	0.0	0.1	0.5	0.9	1.7	2.7	4.2	5.6	8.9	23.6
MSA, Outside Central City	9,598	97.3	2.0	0.04	0.0	0.2	0.5	1.0	1.6	2.6	3.9	5.1	8.0	29.6
Non-MSA	4,845	98.1	2.1	0.03	0.0	0.3	0.6	1.0	1.7	2.7	4.1	5.1	8.6	30.3

Table 11-3. Per Capita Intake of Total Meat and Total Dairy Products (g/kg-day as consumed) (continued)														
Domain	N	Percent Consuming	Mean	SE	Percentiles									
					1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Total Dairy Products														
Whole population	20,607	99.5	6.7	0.1	0.01	0.2	0.4	1.2	3.2	7.3	16.1	25.4	52.1	223
Age Group														
Birth to 1 year	1,486	79.5	12.6	0.9	0.0	0.0	0.0	1.0	8.0	14.1	24.1	48.7	127	186
1 to 2 years	2,096	99.8	36.7	0.7	0.4	3.9	7.7	17.4	31.3	49.8	72.1	88.3	126	223
3 to 5 years	4,391	100.0	23.3	0.3	1.1	4.2	7.0	13.0	20.8	30.9	42.0	49.4	67.7	198
6 to 12 years	2,089	100.0	13.6	0.4	0.3	1.8	3.5	6.7	11.7	18.5	26.0	31.5	42.7	80.6
13 to 19 years	1,222	99.8	5.6	0.2	0.01	0.2	0.5	1.5	4.2	8.1	12.5	15.5	25.4	32.7
20 to 49 years	4,677	99.8	3.3	0.1	0.01	0.2	0.3	0.9	2.2	4.6	7.6	9.9	14.9	36.4
50+ years	4,646	99.8	3.2	0.1	0.02	0.2	0.4	1.0	2.4	4.5	6.9	8.9	14.1	42.5
Season														
Fall	4,687	99.7	7.0	0.2	0.0	0.2	0.4	1.3	3.4	8.0	16.9	26.9	55.3	156.8
Spring	5,308	99.5	6.6	0.2	0.0	0.2	0.4	1.3	3.1	7.3	16.2	25.0	52.0	185.6
Summer	5,890	99.6	6.4	0.2	0.0	0.2	0.4	1.2	3.1	6.8	15.2	24.7	52.8	164.8
Winter	4,722	99.4	6.7	0.1	0.0	0.2	0.5	1.3	3.4	7.3	16.4	25.0	49.1	223.2
Race														
American Indian, Alaska Native	177	99.8	8.0	1.1	0.0	0.0	0.1	0.8	3.1	11.0	21.2	30.2	68.9	146.2
Asian, Pacific Islander	557	97.0	6.4	0.4	0.0	0.0	0.0	0.6	3.0	7.4	14.9	28.1	51.7	164.8
Black	2,740	99.6	5.6	0.2	0.0	0.1	0.2	0.6	2.1	6.5	14.7	23.3	45.4	185.6
Other	1,638	99.1	9.5	0.6	0.0	0.1	0.4	1.3	4.2	11.5	25.4	36.3	69.3	185.2
White	15,495	99.6	6.6	0.1	0.0	0.3	0.5	1.4	3.4	7.2	15.6	24.7	51.2	223.2
Region														
Midwest	4,822	99.7	7.0	0.3	0.0	0.3	0.5	1.4	3.5	7.7	16.9	25.8	52.7	198.4
Northeast	3,692	99.6	6.7	0.2	0.0	0.3	0.6	1.5	3.4	7.3	15.9	25.7	54.2	185.6
South	7,208	99.6	6.0	0.1	0.0	0.2	0.3	1.0	2.8	6.3	14.5	23.7	48.6	223.2
West	4,885	99.2	7.4	0.4	0.0	0.2	0.4	1.4	3.7	8.5	17.5	27.6	54.5	185.2
Urbanization														
MSA, Central City	6,164	99.6	6.5	0.2	0.0	0.2	0.4	1.1	3.2	7.1	15.8	25.1	49.8	198.4
MSA, Outside Central City	9,598	99.4	7.0	0.1	0.0	0.2	0.5	1.4	3.4	7.7	16.9	26.3	54.3	223.2
Non-MSA	4,845	99.7	6.3	0.3	0.0	0.2	0.4	1.1	3.0	6.8	15.0	23.9	51.4	180.7

N = Sample size.
SE = Standard error.
AI/AN = American Indian/Alaska Native
Source: Based on unpublished U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 11-4. Consumer Only Intake of Total Meat and Total Dairy Products (g/kg-day as consumed)

Domain	N	Mean	SE	Percentiles									
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Total Meat													
Age Group													
Birth to 1 year	575	3.0	0.2	0.01	0.1	0.3	1.0	2.2	4.2	7.4	9.2	12.9	29.6
1 to 2 years	2,044	4.2	0.1	0.04	0.6	1.0	2.1	3.6	5.7	8.1	9.8	14.1	20.6
3 to 5 years	4,334	4.2	0.1	0.04	0.8	1.2	2.2	3.6	5.5	7.7	9.4	12.7	23.4
6 to 12 years	2,065	2.9	0.1	0.1	0.5	0.9	1.5	2.5	3.9	5.4	6.5	9.6	18.0
13 to 19 years	1,208	2.1	0.05	0.02	0.3	0.6	1.1	1.9	2.8	3.8	4.8	7.1	30.3
20 to 49 years	4,593	1.9	0.04	0.04	0.4	0.6	1.0	1.6	2.5	3.5	4.2	6.9	13.4
50+ years	4,565	1.5	0.02	0.03	0.3	0.5	0.8	1.3	2.0	2.7	3.3	4.8	9.7
Whole population	19,384	2.1	0.02	0.04	0.4	0.6	1.0	1.7	2.7	4.0	5.3	8.7	30.3
Season													
Fall	4,423	96.8	2.2	0.06	0.0	0.4	0.6	1.0	1.7	2.8	4.2	5.5	8.7
Spring	4,995	97.6	2.1	0.04	0.0	0.3	0.6	1.0	1.7	2.7	4.1	5.2	8.8
Summer	5,510	97.4	2.1	0.03	0.0	0.3	0.5	1.0	1.7	2.7	4.0	5.5	8.7
Winter	4,456	98.0	2.0	0.04	0.0	0.4	0.6	1.0	1.7	2.6	3.9	5.0	7.9
Race													
American Indian, Alaska Native	171	98.4	2.5	0.27	0.2	0.4	0.5	1.1	2.1	3.3	4.3	6.3	9.0
Asian, Pacific Islander	503	96.8	2.6	0.18	0.0	0.3	0.6	1.2	2.3	3.5	4.5	6.0	9.6
Black	2,588	97.9	2.6	0.10	0.0	0.5	0.7	1.2	2.0	3.3	5.4	7.2	10.5
Other	1,508	96.5	2.6	0.09	0.1	0.4	0.7	1.2	2.0	3.2	5.0	6.6	10.9
White	14,614	97.5	2.0	0.02	0.0	0.3	0.5	1.0	1.6	2.5	3.7	4.8	7.7
Region													
Midwest	4,573	97.9	2.2	0.04	0.1	0.4	0.7	1.1	1.8	2.8	4.1	5.3	9.2
Northeast	3,448	96.3	2.1	0.07	0.0	0.4	0.5	1.0	1.7	2.7	4.2	5.5	8.7
South	6,798	97.7	2.1	0.03	0.0	0.3	0.5	1.0	1.7	2.7	3.9	5.2	8.3
West	4,565	97.6	2.1	0.06	0.0	0.3	0.5	1.0	1.6	2.7	4.0	5.2	8.1
Urbanization													
MSA, Central City	5,783	97.3	2.2	0.04	0.0	0.3	0.5	1.0	1.7	2.8	4.2	5.6	9.1
MSA, Outside Central City	9,004	97.3	2.1	0.04	0.0	0.3	0.6	1.0	1.7	2.6	3.9	5.2	8.0
Non-MSA	4,597	98.1	2.2	0.02	0.0	0.4	0.6	1.1	1.7	2.8	4.1	5.1	8.6

Table 11-4. Consumer Only Intake of Total Meat and Total Dairy Products (g/kg-day as consumed) (continued)

Domain	N	Mean	SE	Percentiles									
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Total Dairy Products													
Whole population	20,287	6.7	0.1	0.02	0.2	0.4	1.3	3.3	7.4	16.2	25.5	52.2	223.2
Age Group													
Birth to 1 year	1,192	15.9	1.0	0.03	0.8	1.9	5.8	10.2	16.0	27.7	57.5	141.8	185.6
1 to 2 years	2,093	36.8	0.7	0.4	4.2	7.8	17.4	31.3	49.8	72.1	88.3	126.2	223.2
3 to 5 years	4,390	23.3	0.3	1.1	4.2	7.0	13.0	20.8	30.9	42.0	49.4	67.7	198.4
6 to 12 years	2,089	13.6	0.4	0.3	1.8	3.5	6.7	11.7	18.5	26.0	31.5	42.7	80.6
13 to 19 years	1,221	5.6	0.2	0.01	0.3	0.5	1.5	4.2	8.1	12.5	15.5	25.4	32.7
20 to 49 years	4,666	3.3	0.1	0.01	0.2	0.3	0.9	2.3	4.6	7.6	9.9	14.9	36.4
50+ years	4,636	3.2	0.1	0.02	0.2	0.4	1.1	2.4	4.5	6.9	8.9	14.1	42.5
Season													
Fall	4,630	99.7	7.1	0.2	0.0	0.2	0.5	1.3	3.4	8.0	16.9	26.9	55.4
Spring	5,210	99.5	6.6	0.2	0.0	0.2	0.4	1.3	3.2	7.3	16.3	25.1	52.1
Summer	5,801	99.6	6.4	0.2	0.0	0.2	0.4	1.2	3.1	6.8	15.2	24.7	53.0
Winter	4,646	99.4	6.7	0.1	0.0	0.2	0.5	1.3	3.4	7.3	16.5	25.1	49.2
Race													
American Indian, Alaskan Native	176	99.8	8.0	1.1	0.0	0.0	0.1	0.8	3.1	11.1	21.2	30.2	68.9
Asian, Pacific Islander	537	97.0	6.6	0.4	0.0	0.0	0.1	0.6	3.1	7.6	15.6	28.1	51.7
Black	2,708	99.6	5.7	0.2	0.0	0.1	0.2	0.6	2.1	6.6	14.8	23.4	45.4
Other	1,607	99.1	9.6	0.7	0.0	0.2	0.4	1.3	4.3	11.6	25.5	36.5	69.3
White	15,259	99.6	6.7	0.1	0.0	0.3	0.6	1.4	3.4	7.2	15.7	24.7	51.3
Region													
Midwest	4,765	99.7	7.1	0.3	0.1	0.3	0.6	1.4	3.5	7.8	16.9	25.8	52.7
Northeast	3,638	99.6	6.8	0.2	0.0	0.3	0.6	1.5	3.4	7.3	16.0	25.8	54.3
South	7,104	99.6	6.0	0.1	0.0	0.2	0.3	1.0	2.8	6.3	14.6	23.8	48.6
West	4,780	99.2	7.4	0.4	0.0	0.2	0.5	1.5	3.8	8.5	17.8	27.7	54.6
Urbanization													
MSA, Central City	6,072	99.6	6.5	0.2	0.0	0.2	0.4	1.2	3.2	7.2	15.9	25.2	49.8
MSA, Outside Central City	9,440	99.4	7.0	0.1	0.0	0.3	0.5	1.4	3.5	7.8	17.0	26.4	54.3
Non-MSA	4,775	99.7	6.3	0.3	0.0	0.2	0.4	1.1	3.0	6.8	15.0	23.9	51.5

N = Sample size.
SE = Standard error.

Source: Based on unpublished U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 11-5. Per Capita Intake of Individual Meats and Dairy Products (g/kg-day as consumed)

Domain	N	Beef: Percent Consuming	Beef: Mean	Beef: SE	Pork: Percent Consuming	Pork: Mean	Pork: SE	Poultry: Percent Consuming	Poultry: Mean	Poultry: SE	Eggs: Percent Consuming	Eggs: Mean	Eggs: SE
Whole population	20,607	85.9	0.9	0.02	78.5	0.42	0.01	67.6	0.71	0.01	93.4	0.40	0.01
Age Group													
Birth to 1 year	1,486	25.3	0.4	0.04	17.7	0.15	0.02	30.1	0.66	0.05	27.9	0.30	0.04
1 to 2 years	2,096	85.5	1.7	0.06	69.7	0.72	0.03	73.7	1.7	0.05	92.3	1.3	0.04
3 to 5 years	4,391	90.8	1.8	0.04	79.8	0.84	0.02	73.0	1.5	0.03	95.1	0.91	0.03
6 to 12 years	2,089	92.7	1.3	0.04	82.4	0.59	0.03	67.1	0.93	0.03	95.8	0.51	0.02
13 to 19 years	1,222	91.1	1.0	0.05	81.5	0.40	0.03	65.5	0.68	0.03	95.4	0.33	0.02
20 to 49 years	4,677	86.1	0.8	0.03	78.9	0.37	0.01	69.0	0.64	0.02	94.1	0.31	0.01
50+ years	4,646	83.5	0.6	0.02	79.3	0.34	0.01	66.5	0.52	0.02	94.0	0.33	0.01
Season													
Fall	4,687	85.0	0.9	0.05	78.5	0.41	0.02	69.7	0.76	0.03	93.1	0.39	0.02
Spring	5,308	86.4	0.9	0.03	78.1	0.44	0.02	66.8	0.70	0.02	93.5	0.41	0.02
Summer	5,890	85.7	0.9	0.03	78.1	0.42	0.02	65.4	0.69	0.02	93.3	0.39	0.01
Winter	4,722	86.7	0.9	0.02	79.1	0.40	0.02	68.6	0.70	0.02	93.8	0.39	0.02
Race													
American Indian, Alaskan Native	177	87.9	1.3	0.21	85.2	0.49	0.06	78.1	0.62	0.07	94.5	0.49	0.06
Asian, Pacific Islander	557	78.6	0.9	0.08	71.5	0.63	0.11	78.1	0.90	0.09	84.7	0.46	0.05
Black	2,740	85.3	1.1	0.10	82.1	0.53	0.04	73.3	0.93	0.05	93.9	0.48	0.01
Other	1,638	85.0	1.1	0.05	79.4	0.48	0.03	68.7	0.83	0.06	89.9	0.62	0.05
White	15,495	86.4	0.9	0.02	78.0	0.39	0.01	66.1	0.66	0.01	93.9	0.36	0.01
Region													
Midwest	4,822	89.8	1.0	0.02	83.1	0.47	0.02	66.9	0.69	0.03	95.1	0.38	0.01
Northeast	3,692	82.0	0.8	0.08	72.1	0.41	0.02	68.3	0.78	0.04	91.2	0.36	0.02
South	7,208	86.1	0.9	0.02	79.8	0.42	0.02	67.2	0.70	0.02	94.2	0.39	0.01
West	4,885	85.1	0.9	0.04	77.0	0.36	0.03	68.4	0.70	0.03	92.5	0.44	0.02
Urbanization													
MSA, Central City	6,164	84.0	0.9	0.04	77.1	0.41	0.02	70.6	0.78	0.02	92.8	0.41	0.01
MSA, Outside Central City	9,598	85.9	0.9	0.02	77.2	0.39	0.01	68.5	0.72	0.02	93.4	0.39	0.01
Non-MSA	4,845	88.9	1.0	0.04	83.3	0.49	0.02	61.1	0.60	0.03	94.5	0.39	0.01

N =Sample size.
SE =Standard error.

Source: Based on unpublished U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 11-6. Consumer Only Intake of Individual Meats and Dairy Products (g/kg-day as consumed)

Domain	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
	Beef			Pork			Poultry			Eggs		
Whole population	17,116	1.1	0.02	15,431	0.53	0.01	13,702	1.1	0.01	18,450	0.42	0.01
Age Group												
Birth to 1 year	361	1.6	0.2	248	0.83	0.08	434	2.2	0.1	402	1.1	0.1
1 to 2 years	1,795	2.0	0.06	1,488	1.0	0.04	1,552	2.2	0.06	1,936	1.4	0.04
3 to 5 years	3,964	1.9	0.04	3,491	1.1	0.03	3,210	2.0	0.04	4,171	0.96	0.03
6 to 12 years	1,932	1.4	0.04	1,731	0.72	0.03	1,421	1.4	0.04	2,001	0.53	0.02
13 to 19 years	1,118	1.1	0.05	1,002	0.50	0.03	808	1.0	0.04	1,167	0.34	0.02
20 to 49 years	4,058	1.0	0.04	3,732	0.47	0.01	3,221	0.9	0.02	4,399	0.33	0.01
50+ years	3,888	0.7	0.02	3,739	0.43	0.01	3,056	0.8	0.02	4,374	0.35	0.01
Season												
Fall	3,894	1.1	0.06	3,547	0.5	0.02	3,217	1.1	0.03	4,211	0.4	0.02
Spring	4,429	1.0	0.03	3,979	0.6	0.02	3,491	1.1	0.02	4,751	0.4	0.02
Summer	4,855	1.1	0.03	4,354	0.5	0.02	3,810	1.1	0.03	5,245	0.4	0.01
Winter	3,938	1.0	0.02	3,551	0.5	0.02	3,184	1.0	0.03	4,243	0.4	0.02
Race												
American Indian, Alaskan Native	157	1.5	0.15	144	0.6	0.05	116	0.8	0.08	159	0.5	0.07
Asian, Pacific Islander	413	1.2	0.08	359	0.9	0.14	410	1.2	0.11	434	0.5	0.06
Black	2,280	1.3	0.11	2,122	0.6	0.04	2,025	1.3	0.05	2,462	0.5	0.02
Other	1,296	1.3	0.06	1,152	0.6	0.04	1,125	1.2	0.07	1,404	0.7	0.05
White	12,970	1.0	0.02	11,654	0.5	0.01	10,026	1.0	0.02	13,991	0.4	0.01
Region												
Midwest	4,179	1.1	0.02	3,856	0.6	0.01	3,115	1.0	0.03	4,398	0.4	0.01
Northeast	2,936	1.0	0.08	2,502	0.6	0.02	2,522	1.1	0.03	3,236	0.4	0.02
South	6,029	1.0	0.02	5,517	0.5	0.02	4,770	1.0	0.02	6,510	0.4	0.01
West	3,972	1.1	0.04	3,556	0.5	0.03	3,295	1.0	0.03	4,306	0.5	0.02
Urbanization												
MSA, Central City	4,992	1.1	0.05	4,516	0.5	0.02	4,275	1.1	0.02	5,475	0.4	0.01
MSA, Outside Central City	7,937	1.0	0.02	7,028	0.5	0.02	6,461	1.0	0.02	8,565	0.4	0.01
Non-MSA	4,187	1.1	0.03	3,887	0.6	0.02	2,966	1.0	0.03	4,410	0.4	0.01

N =Sample size
SE =Standard error

Source: Based on unpublished U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 11-7. Mean Meat Intakes Per Individual in a Day, by Sex and Age (g/day as consumed)[a] for 1977-1978

Group Age (yrs.)	Total Meat, Poultry and Fish	Beef	Pork	Lamb, Veal, Game	Frankfurters, Sausages, Luncheon Meats, Spreads	Total Poultry	Chicken Only	Meat Mixtures[c]
Males and Females								
1 and Under	72	9	4	3	2	4	1	51
1-2	91	18	6	-[b]	15	16	13	32
3-5	121	23	8	-[b]	15	19	19	49
6-8	149	33	15	1	17	20	19	55
Males								
9-11	188	41	22	3	19	24	21	71
12-14	218	53	18	-[b]	25	27	24	87
15-18	272	82	24	1	25	37	32	93
19-22	310	90	21	2	33	45	43	112
23-34	285	86	27	1	30	31	29	94
35-50	295	75	28	1	26	31	28	113
51-64	274	70	32	1	29	31	29	86
65-74	231	54	25	2	22	29	26	72
75 and Over	196	41	39	7	19	28	25	54
Females								
9-11	162	38	17	1	20	27	23	55
12-14	176	47	19	1	18	23	22	61
15-18	180	46	14	2	16	28	27	61
19-22	184	52	19	1	18	26	24	61
23-34	183	48	17	1	16	24	22	66
35-50	187	49	19	2	14	24	21	63
51-64	187	52	19	2	12	26	24	60
65-74	159	34	21	4	12	30	25	47
75 and Over	134	31	17	2	9	19	16	49
Males and Females								
All Ages	207	54	20	2	20	27	24	72

[a] Based on USDA Nationwide Food Consumption Survey 1977-78 data for one day.
[b] Less than 0.5 g/day but more than 0.
[c] Includes mixtures containing meat, poultry, or fish as a main ingredient.
\- Indicates data is not available

Source: USDA, 1980.

Table 11-8. Mean Meat Intakes Per Capita in a Day, by Sex and Age (g/day as consumed)[a] for 1987-1988

Group Age (yrs.)	Total Meat, Poultry, and Fish	Beef	Pork	Lamb, Veal, Game	Frankfurters, Sausages, Luncheon Meats	Total Poultry	Chicken Only	Meat Mixtures[b]
Males and Females								
5 and Under	92	10	9	<0.5	11	14	12	39
Males								
6-11	156	22	14	<0.5	13	27	24	74
12-19	252	38	17	1	20	27	20	142
20 and over	250	44	19	23	2	31	25	108
Females								
6-11	151	26	9	1	11	20	17	74
12-19	169	31	10	<0.5	18	17	13	80
20 and over	170	29	12	1	13	24	18	73
All individuals	193	32	14	1	17	26	20	86

[a] Based on USDA Nationwide Food Consumption Survey 1987-88 data for one day.
[b] Includes mixtures containing meat, poultry, or fish as a main ingredient.

Source: USDA, 1992.

Table 11-9. Mean Meat Intakes Per Capita in a Day, by Sex and Age (g/day as consumed)[a] for 1994 and 1995

Group Age (yrs.)	Total Meat, Poultry, and Fish		Beef		Pork		Lamb, Veal, Game		Frankfurters, Sausages, Luncheon Meats		Total Poultry		Chicken Only		Meat Mixtures[c]	
	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Males and Females																
5 and Under	94	87	10	8	6	4	(b)	(b)	17	18	16	15	14	14	41	39
Males																
6-11	131	161	19	18	9	7	0	(b)	22	27	19	25	16	22	51	68
12-19	238	256	31	29	11	11	1	1	21	27	40	26	29	23	119	150
20 and over	266	283	35	41	17	14	2	1	29	27	39	31	30	27	124	149
Females																
6-11	117	136	18	16	5	5	(b)	(b)	18	20	19	17	15	14	51	69
12-19	164	158	23	22	5	7	(b)	0	16	10	20	19	15	18	94	82
20 and over	168	167	18	21	9	11	1	1	16	15	25	22	20	19	87	83
All individuals	195	202	24	27	11	10	1	1	21	21	29	24	23	21	98	104

[a] Based on USDA CSFII 1994 and 1995 data for one day.
[b] Less than 0.5 g/day but more than 0.
[c] Includes mixtures containing meat, poultry, or fish as a main ingredient.

Source: USDA, 1996a; 1996b.

Table 11-10. Mean Dairy Product Intakes Per Capita in a Day, by Sex and Age (g/day as consumed)[a] for 1977-1978

Group Age (yrs.)	Total Milk	Fluid Milk	Cheese	Eggs
Males and Females				
1 and Under	618	361	1	5
1-2	404	397	8	20
3-5	353	330	9	22
6-8	433	401	10	18
Males				
9-11	432	402	8	26
12-14	504	461	9	28
15-18	519	467	13	31
19-22	388	353	15	32
23-34	243	213	21	38
35-50	203	192	18	41
51-64	180	173	17	36
65-74	217	204	14	36
75 and Over	193	184	18	41
Females				
9-11	402	371	7	14
12-14	387	343	11	19
15-18	316	279	11	21
19-22	224	205	18	26
23-34	182	158	19	26
35-50	130	117	18	23
51-64	139	128	19	24
65-74	166	156	14	22
75 and Over	214	205	20	19

[a] Based on USDA Nationwide Food Consumption Survey 1977-78 data for one day.

Source: USDA, 1980.

Table 11-11. Mean Dairy Product Intakes Per Capita in a Day, by Sex and Age (g/day as consumed)[a] for 1987-1988

Group Age (yrs.)	Total Fluid Milk	Whole Milk	Lowfat/Skim Milk	Cheese	Eggs
Males and Females					
5 and under	347	177	129	7	11
Males					
6-11	439	224	159	10	17
12-19	392	183	168	12	17
20 and over	202	88	94	17	27
Females					
6-11	310	135	135	9	14
12-19	260	124	114	12	18
20 and over	148	55	81	15	17
All individuals	224	99	102	14	20

[a] Based on USDA Nationwide Food Consumption Survey 1987-88 data for one day.

Source: USDA, 1992.

Table 11-12. Mean Dairy Product Intakes Per Capita in a Day, by Sex and Age (g/day as consumed)[a] for 1994 and 1995										
Group Age (yrs.)	Total Fluid Milk		Whole Milk		Lowfat Milk		Cheese		Eggs	
	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Males and Females										
5 and under	424	441	169	165	130	129	12	9	11	13
Males										
6-11	407	400	107	128	188	164	11	12	13	15
12-19	346	396	105	105	160	176	19	20	18	24
20 and over	195	206	50	57	83	88	19	16	23	23
Females										
6-11	340	330	101	93	136	146	17	13	12	15
12-19	239	235	75	71	88	107	14	13	13	17
20 and over	157	158	37	32	56	57	16	15	15	16
All individuals	229	236	65	66	89	92	17	15	17	19

[a] Based on USDA CSFII 1994 and 1995 data for one day.

Source: USDA, 1996a; 1996b.

Table 11-13. Mean Quantities of Meat and Eggs consumed Daily by Sex and Age, Per Capita (g/day)											
Age Group	Sample Size	Total	Beef	Pork	Lamb, veal, game	Organ meats	Frankfurters, sausages, luncheon meats	Poultry		Eggs	Mixtures, mainly meat/poultry/ fish
								Total	Chicken		
Males and Females											
Under 1 year	1,126	24	1[a]	-[a,b]	-[a,b]	-[a,b]	2	3	2	3	16
1 year	1,016	80	5	2	-[a,b]	-[a,b]	13	12	12	13	43
2 years	1,102	94	7	6	-[a,b]	-[a,b]	18	17	16	18	41
1 to 2 years	2,118	87	6	4	-[a,b]	-[a,b]	15	15	14	16	42
3 years	1,831	101	8	6	-[a,b]	-[a,b]	19	19	18	13	43
4 years	1,859	115	10	6	-[a,b]	-[a,b]	22	20	19	13	49
5 years	884	121	14	6	-[a,b]	-[a,b]	22	22	19	13	51
3 to 5 years	4,574	112	11	6	-[b]	-[a,b]	21	21	19	13	47
5 years and under	7,818	93	8	5	-[b]	-[a,b]	17	16	15	13	42
Males											
6 to 9 years	787	151	18	7	-[a,b]	-[a,b]	24	23	21	11	71
6 to 11 years	1,031	154	19	7	-[a,b]	-[a,b]	24	22	20	12	72
12 to 19 years	737	250	30	12	1[a]	0	28	31	26	22	134
Females											
6 to 9 years	704	121	17	4	-[a,b]	-[a,b]	18	19	16	10	55
6 to 11 years	969	130	18	5	-[a,b]	-[a,b]	19	20	17	11	60
12 to 19 years	732	158	21	5	-[a,b]	-[a,b]	15	21	19	13	85
Males and Females											
9 years and under	9,309	110	12	5	-[b]	-[a,b]	19	18	17	12	50
19 years and under	11,287	152	18	7	-[a,b]	-[a,b]	20	22	19	14	76

[a] Estimate is not statistically reliable due to small sample size reporting intake.
[b] Value less than 0.5, but greater than 0.
Note: Consumption amounts shown are representative of the first day of each participant's survey response.

Source: USDA, 1999a.

Table 11-14. Percentage of Individuals Consuming Meats and Eggs, by Sex and Age (%)

Age Group	Sample Size	Total	Beef	Pork	Lamb, veal, game	Organ meats	Frankfurters, sausages, luncheon meats	Poultry		Eggs	Mixtures, mainly meat/poultry/ fish
								Total	Chicken		
Males and Females											
Under 1 year	1,126	26.0	2.1	1.1 [a]	0.2 [a]	0.2 [a]	6.1	6.3	5.0	6.7	13.7
1 year	1,016	77.4	11.9	7.3	0.8 [a]	0.2 [a]	26.3	24.0	23.1	22.8	32.2
2 years	1,102	85.2	16.2	14.9	0.8 [a]	0.2 [a]	33.2	27.6	25.6	27.3	31.4
1 to 2 years	2,118	81.4	14.1	11.2	0.8 [a]	0.2 [a]	29.9	25.8	24.4	25.1	31.8
3 years	1,831	86.2	13.8	13.3	0.5 [a]	[a,b]	36.4	28.3	26.0	19.8	29.2
4 years	1,859	86.2	16.1	13.8	0.5 [a]	0.2 [a]	37.0	27.4	25.1	16.9	30.5
5 years	884	87.1	18.2	13.2	0.6 [a]	0.2 [a]	35.1	27.7	24.8	16.4	30.8
3 to 5 years	4,574	86.5	16.0	13.4	0.5	0.2 [a]	36.1	27.8	25.3	17.7	30.2
5 years and under	7,818	77.5	13.7	11.2	0.6	0.2 [a]	30.4	24.5	22.6	18.9	28.8
Males											
6 to 9 years	787	87.4	20.1	11.9	0.4 [a]	0.1[a]	37.4	24.8	22.3	15.1	36.2
6 to 11 years	1,031	87.8	22.0	12.2	0.4 [a]	0.2[a]	36.2	22.9	20.5	15.6	35.7
12 to 19 years	737	86.8	24.2	15.8	0.6 [a]	0.0	31.8	20.6	17.6	17.0	38.3
Females											
6 to 9 years	704	84.6	19.4	9.2	0.4 [a]	0.2 [a]	33.5	23.1	20.2	13.4	32.4
6 to 11 years	969	86.5	20.2	10.0	0.4 [a]	0.1 [a]	33.1	22.9	19.8	13.3	32.8
12 to 19 years	732	80.1	22.0	11.2	0.1 [a]	0.1 [a]	24.6	21.6	18.9	15.0	34.0
Males and Females											
9 years and under	9,309	80.9	16.1	10.9	0.5	0.2 [a]	24.3	24.3	22.0	17.1	31.0
19 years and under	11,287	82.8	19.6	12.1	0.4	0.1 [a]	22.7	22.7	20.1	16.4	33.3

[a] Estimate is not statistically reliable due to small sample size reporting intake.
[b] Value less than 0.5, but greater than 0.
Note: Percentages shown are representative of the first day of each participant's survey response.

Source: USDA, 1999a.

Table 11-15. Mean Quantities of Dairy Products Consumed Daily by Sex and Age, Per Capita (g/day)

Age Group	Sample Size	Total Milk and Milk Products	Milk, Milk Drinks, Yogurt						Milk Desserts	Cheese
			Total	Fluid Milk				Yogurt		
				Total	Whole	Lowfat	Skim			
Males and Females										
Under 1 year	1,126	762	757	61	49	11	[a,b]	4	3	1
1 year	1,016	546	526	475	347	115	5[a]	14	11	9
2 years	1,102	405	377	344	181	141	17	10	16	11
1 to 2 years	2,118	474	450	408	262	128	11	12	14	10
3 years	1,831	419	384	347	166	150	26	10	22	12
4 years	1,859	407	369	328	147	149	27	10	23	14
5 years	884	417	376	330	137	159	25	9	25	14
3 to 5 years	4,574	414	376	335	150	153	26	10	23	13
5 years and under	7,818	477	447	327	177	127	18	10	18	11
Males										
6 to 9 years	787	450	405	343	127	176	29	6	31	13
6 to 11 years	1,031	450	402	335	121	172	33	6	35	12
12 to 19 years	737	409	358	303	99	158	40	3[a]	29	19
Females										
6 to 9 years	704	380	337	288	105	146	26	4	29	13
6 to 11 years	969	382	336	283	108	136	29	4	30	14
12 to 19 years	732	269	220	190	66	92	30	4[a]	29	14
Males and Females										
9 years and under	9,309	453	417	323	153	141	22	8	23	12
19 years and under	11,287	405	362	291	121	135	29	6	27	14

[a] Estimate is not statistically reliable due to small sample size reporting intake.

[b] Value less than 0.5, but greater than 0.

Note: Consumption amounts shown are representative of the first day of each participant's survey response.

Source: USDA, 1999a.

Table 11-16. Percentage of Individuals Consuming Dairy Products, by Sex and Age (%)

Age Group	Sample Size	Total Milk and Milk Products	Milk, milk drinks, yogurt						Milk Desserts	Cheese
			Total	Fluid Milk				Yogurt		
				Total	Whole	Lowfat	Skim			
Males and Females										
Under 1 year	1,126	85.4	84.6	11.1	8.3	2.4	0.2[a]	3.1	4.5	6.0
1 year	1,016	95.3	92.7	87.7	61.7	26.5	1.5[a]	10.0	13.9	29.7
2 years	1,102	91.6	87.3	84.3	44.8	36.3	5.2	6.8	17.5	32.6
1 to 2 years	2,118	93.4	90.0	86.0	53.0	31.5	3.4	8.4	15.8	31.2
3 years	1,831	94.3	88.3	84.6	42.5	39.5	6.8	7.3	21.4	37.0
4 years	1,859	93.2	87.8	85.0	41.3	40.4	7.7	5.8	21.7	36.9
5 years	884	93.1	86.4	81.2	38.1	41.7	6.5	5.5	21.4	34.9
3 to 5 years	4,574	93.5	87.5	83.6	40.6	40.6	7.0	6.2	21.5	36.3
5 years and under	7,818	92.5	88.0	75.7	41.0	32.9	4.9	6.6	17.5	30.9
Males										
6 to 9 years	787	93.2	85.5	80.7	32.4	44.3	8.6	3.8	24.0	34.6
6 to 11 years	1,031	92.3	84.6	79.0	30.8	43.1	9.5	3.7	25.0	32.3
12 to 19 years	737	81.3	65.8	59.6	22.6	30.7	7.0	1.7[a]	13.6	37.1
Females										
6 to 9 years	704	90.2	82.5	77.5	31.5	40.8	8.1	2.9	24.1	30.9
6 to 11 years	969	90.2	81.5	76.0	33.2	37.8	8.4	3.0	22.4	31.9
12 to 19 years	732	75.4	54.0	49.7	17.5	23.9	9.5	2.2[a]	17.1	36.1
Males and Females										
9 years and under	9,309	92.2	86.4	77.1	37.4	36.8	6.3	5.3	20.1	31.7
19 years and under	11,287	86.7	75.6	68.1	30.1	33.1	7.5	3.8	18.6	33.5

[a] Estimate is not statistically reliable due to small sample size reporting intake.

Note: Percentages shown are representative of the first day of each participant's survey response.

Source: USDA, 1999a.

Table 11-17. Quantity (as consumed) of Meat and Dairy Products Consumed Per Eating Occasion and Percentage of Individuals Using These Foods in Two Days

Food category	2 to 5 years old Male and Female (N = 2,109)			6 to 11 years old Male and Female (N = 1,432)			12 to 19 years old Male (N = 696)			12 to 19 years old Female (N = 702)		
	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE
Meats												
Beef steaks	11.1	58	4	11.3	87	9	9.5	168	14	9.4	112	10
Beef roasts	5.2	49	5	4.8	67	7	5.1	233[a]	149[a]	5.5	97[a]	16[a]
Ground beef	59.5	31	1	63.7	41	1	73.4	66	3	61.5	52	3
Ham	6.9	35	4	8.5	40	4	11.6	68	7	9.9	40	5
Pork chops	11.0	48	3	10.1	62	4	11.6	100	8	8.5	72	7
Bacon	10.4	15	1	9.7	19	2	14.9	25	2	11.1	18	1
Pork breakfast sausage	5.3	33	2	6.0	32	3	6.3	40[a]	4[a]	3.3	40[a]	5[a]
Frankfurters and luncheon meats	51.7	49	1	50.9	57	2	46.7	76	3	38.5	57	3
Total chicken and turkey	63.8	46	1	53.8	62	2	58.4	100	4	54.1	71	2
Chicken	44.6	52	1	36.0	70	3	34.3	117	5	36.1	80	3
Turkey	5.1	63	7	5.7	66	5	8.2	117	14	5.8	60[a]	9[a]
Dairy Products												
Fluid milk (all)	92.5	196	3	89.2	241	4	72.3	337	8	64.4	262	8
Fluid milk consumed with cereal	68.1	149	4	64.7	202	5	44.4	276	10	42.7	222	8
Whole milk	50.0	202	3	39.5	244	7	30.0	333	13	22.4	258	7
Whole milk consumed with cereal	33.8	161	5	26.2	212	11	14.8	265	18	14.1	235	13
Lowfat milk	47.5	189	3	52.8	238	4	39.6	326	8	32.4	262	13
Lowfat milk consumed with cereal	31.5	136	4	32.7	198	4	24.3	277	12	21.1	227	12
Skim milk	7.8	171	9	11.1	225	9	9.7	375	38	13.5	255	14
Skim milk consumed with cereal	4.9	131	11	7.5	188	14	6.5	285[a]	23[a]	8.3	181	13
Cheese, other than cream or cottage	53.2	24	1	50.4	29	1	61.1	38	2	53.9	27	1
Ice cream and ice milk	18.4	92	3	21.1	135	4	14.2	221	12	15.2	187	14
Boiled, poached, and baked eggs	8.0	36	3	8.2	34	3	5.0	44[a]	9[a]	7.7	45	7
Fried eggs	17.3	48	1	14.0	58	2	14.9	83	5	13.5	59	3
Scrambled eggs	10.4	59	4	7.1	72	5	7.1	72	5	8.9	103	9

Quantity consumed per eating occasion (grams)

[a] Indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.
PC = Percent consuming at least once in 2 days
SEM = Standard error of the mean.

Source: Smiciklas-Wright et al., 2002 (based on 1994-1996 CSFII data).

Table 11-17. Quantity (as consumed) of Meat and Dairy Products Consumed Per Eating Occasion and Percentage of Individuals Using These Foods in Two Days (continued)

	Quantity consumed per eating occasion (grams)																	
	20 to 39 years old						40 to 59 years old						60 years and older					
	Male (N=1,543)			Female (N=1,449)			Male (N=1,663)			Female (N=1,694)			Male (N= 1,545)			Female (N=1,429)		
Food category	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE
Meats																		
Beef steaks	17.1	202	20	11.8	121	8	18.3	159	7	10.7	117	6	13.4	129	7	9.5	95	6
Beef roasts	6.9	132	14	5.8	85	8	9.9	119	8	9.6	74	5	11.7	102	6	8.8	80	4
Ground beef	65.3	80	4	51.5	52	2	50.0	82	3	44.6	57	2	40.7	73	3	36.2	62	3
Ham	10.8	78	7	9.7	47	4	13.5	68	5	12.2	50	4	15.2	56	3	14.4	45	3
Pork chops	12.8	117	8	12.5	71	4	14.3	108	6	13.0	67	4	16.4	89	3	13.1	62	3
Bacon	14.1	26	1	12.4	18	1	17.5	22	1	14.8	18	1	20.6	19	1	17.4	16	1
Pork breakfast sausage	6.6	57	4	5.1	37	3	6.6	48	4	5.8	38	4	10.7	48	4	5.5	34	3
Frankfurters and luncheon meats	46.2	88	6	35.6	61	2	44.9	79	2	34.3	59	2	41.6	62	2	33.9	51	2
Total chicken and turkey	57.3	112	4	57.8	78	2	56.8	111	4	58.7	80	2	53.8	87	3	57.8	71	2
Chicken	37.1	122	3	35.5	92	3	34.5	124	4	36.0	87	2	32.1	99	3	34.0	79	2
Turkey	6.8	131	21	5.6	76	6	8.5	115	12	8.8	81	8	7.7	80	7	7.2	77	7
Dairy Products																		
Fluid milk (all)	58.0	291	9	61.3	209	6	60.5	238	6	60.2	169	5	73.9	189	5	71.6	154	4
Fluid milk consumed with cereal	26.9	275	12	32.4	198	5	30.1	211	7	30.2	166	5	48.1	170	5	46.6	140	6
Whole milk	22.9	278	11	22.4	202	10	20.3	223	15	19.0	142	7	22.3	188	9	19.7	137	8
Whole milk consumed with cereal	7.9	272	16	8.7	216	14	6.2	216	16	6.1	183	10	10.1	177	10	9.9	156	13
Lowfat milk	29.4	298	15	29.4	198	7	31.2	242	7	27.7	159	5	40.2	189	5	37.8	161	6
Lowfat milk consumed with cereal	14.0	284	22	15.2	181	5	16.1	212	10	13.1	151	7	26.5	165	5	24.4	134	5
Skim milk	9.3	318	13	15.5	235	11	15.1	244	12	19.2	193	7	17.7	186	9	21.6	154	9
Skim milk consumed with cereal	5.6	260	12	9.3	207	10	8.7	197	11	11.8	173	7	12.4	174	9	14.2	135	9
Cheese, other than cream or cottage	63.8	39	2	52.6	30	1	48.3	36	1	46.3	29	1	40.9	33	2	35.4	26	1
Ice cream and ice milk	14.7	200	2	13.6	136	6	18.0	173	6	14.2	141	8	22.7	138	5	18.9	107	4
Boiled, poached, and baked eggs	9.4	50	4	10.4	39	3	12.0	45	3	14.2	38	2	15.7	45	3	16.1	39	2
Fried eggs	15.2	86	2	14.6	61	3	20.9	83	2	17.5	60	2	24.6	70	2	18.3	56	2
Scrambled eggs	10.7	89	4	7.8	74	3	11.1	83	3	8.0	66	3	12.0	73	4	9.3	64	5

[a] Indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.
PC = Percent consuming at least once in 2 days
SEM = Standard error of the mean.

Source: Smiciklas-Wright et al., 2002 (based on 1994-1996 CSFII data).

Table 11-18. Consumption of Milk, Yogurt and Cheese: Median Daily Servings (and Ranges) by Demographic and Health Characteristics

Subject Characteristic	N	Milk, Yogurt and Cheese
Gender		
Female	80	1.6 (0.2 - 5.6)
Male	50	1.5 (0.3 - 7.4)
Ethnicity		
African American	44	1.9 (0.2 - 4.5)
European American	47	1.6 (0.2 - 5.6)
Native American	39	1.3 (0.5 - 7.4)
Age		
70 to 74	42	1.8 (0.3 - 7.4)
75 to 79	36	1.6 (0.2 - 5.6)
80 to 84	36	1.4 (0.2 - 4.5)
85+	16	1.6 (0.2 - 3.8)
Marital Status		
Married	49	1.5 (0.2 - 7.4)
Not Married	81	1.7 (0.2 - 5.4)
Education		
8th grade or less	37	1.8 (0.2 - 5.4)
9th to 12th grades	47	1.6 (0.2 - 5.6)
> High School	46	1.4 (0.3 - 7.4)
Dentures		
Yes	83	1.5 (0.2 - 7.4)
No	47	1.6 (0.3 - 5.6)
Chronic Diseases		
0	7	2.0 (0.8 - 4.5)
1	31	1.8 (0.3 - 5.6)
2	56	1.6 (0.2 - 7.4)
3	26	1.2 (0.2 - 4.8)
4+	10	1.5 (0.5 - 4.5)
Weight[a]		
≤130	18	1.3 (0.3 - 5.4)
131 to 150	32	1.6 (0.5 - 5.6)
151 to 170	27	1.8 (0.2 - 4.5)
171 to 190	22	1.6 (0.2 - 3.7)
≥191	29	1.5 (0.2 - 7.4)

a Two missing values.

Source: Vitolins et al., 2002.

Table 11-19. Characteristics of the FITS Sample Population

	Sample Size	Percentage of Sample
Gender		
Male	1,549	51.3
Female	1,473	48.7
Age of Child		
4 to 6 months	862	28.5
7 to 8 months	483	16.0
9 to 11 months	679	22.5
12 to 14 months	374	12.4
15 to 18 months	308	10.2
19 to 24 months	316	10.4
Child's Ethnicity		
Hispanic or Latino	367	12.1
Non-Hispanic or Latino	2,641	87.4
Missing	14	0.5
Child's Race		
White	2,417	80.0
Black	225	7.4
Other	380	12.6
Urbanicity		
Urban	1,389	46.0
Suburban	1,014	33.6
Rural	577	19.1
Missing	42	1.3
Household Income		
Under $10,000	48	1.6
$10,000 to $14,999	48	1.6
$15,000 to $24,999	221	7.3
$25,000 to $34,999	359	11.9
$35,000 to $49,999	723	23.9
$50,000 to $74,999	588	19.5
$75,000 to $99,999	311	10.3
$100,000 and Over	272	9.0
Missing	452	14.9
Receives WIC		
Yes	821	27.2
No	2,196	72.6
Missing	5	0.2
Sample Size (Unweighted)	3,022	100.0

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Devaney et al., 2004.

Table 11-20. Percentage of Infants and Toddlers Consuming Meat or Other Protein Sources

Food Group/Food	Percentage of Infants and Toddlers Consuming at Least Once in a Day					
	4 to 6 months	7 to 8 months	9 to 11 months	12 to14 months	15 to18 months	19 to 24 months
Cow's Milk	0.8	2.9	20.3	84.8	88.3	87.7
Whole	0.5	2.4	15.1	68.8	71.1	58.8
Reduce-fat or non-fat	0.3	0.5	5.3	17.7	20.7	38.1
Unflavored	0.8	2.9	19.5	84.0	87.0	86.5
Flavored	0.0	0.0	0.9	1.8	4.4	5.6
Soy Milk	0.0	0.5	1.7	1.5	3.9	3.8
Any Meat or Protein Source	14.2	54.9	79.2	91.3	92.7	97.2
Baby Food Meat	1.7	4.0	3.1	1.1	0.0	0.0
Non-baby Food Meat	1.5	8.4	33.7	60.3	76.3	83.7
Other Protein Sources	2.7	9.7	36.1	59.2	66.8	68.9
Dried Beans and Peas, Vegetarian Meat Substitutes	0.6	1.3	3.3	7.0	6.6	9.9
Eggs	0.7	2.9	7.3	17.0	25.0	25.2
Peanut Butter, Nuts, and Seeds	0.0	0.5	1.9	8.8	11.6	10.4
Cheese	0.4	2.1	18.5	34.0	39.1	41.1
Yogurt	1.2	4.1	15.7	14.9	20.2	15.3
Protein Sources in Mixed Dishes	11.0	43.3	46.2	30.1	25.5	20.5
Baby Food Dinners	9.5	39.8	33.5	10.2	2.4	1.3
Beans and Rice, Chilli, Other Bean Mixtures	0.0	0.0	0.9	1.2	2.1	2.0
Mixtures with Vegetables and/or Rice/Pasta	0.9	1.2	4.7	8.2	9.0	7.8
Soup[a]	0.9	3.4	10.1	12.5	13.8	11.5
Types of Meat[b]						
Beef	0.9	2.6	7.7	16.1	16.3	19.3
Chicken or Turkey	2.0	7.3	22.4	33.0	46.9	47.3
Fish and Shellfish	0.0	0.5	1.9	5.5	8.7	7.1
Hotdogs, Sausages, and Cold cuts	0.0	2.1	7.1	16.4	20.1	27.0
Pork/Ham	0.3	1.7	4.0	9.7	11.2	13.9
Other	0.3	0.6	2.5	2.8	2.1	3.9

[a] The amount of protein actually provided by soups varies. Soups could not be sorted reliably into different food groups because all soups were assigned the same two-digit food code and many food descriptions lacked detail about major soup ingredients.

[b] Includes baby food and non-baby food sources.

Source: Fox et al., 2004.

Table 11-21. Characteristics of WIC Participants and Non-participants[a] (Percentages)

	Infants 4 to 6 months		Infants 7 to 11 months		Toddlers 12 to 24 months	
	WIC Participant	Non-participant	WIC Participant	Non-participant	WIC Participant	Non-participant
Gender						
Male	55	54	55	51	57	52
Female	45	46	45	49	43	48
Child's Ethnicity		**		**		**
Hispanic or Latino	20	11	24	8	22	10
Non-Hispanic or Latino	80	89	76	92	78	89
Child's Race		**		**		**
White	69	84	63	86	67	84
Black	15	4	17	5	13	5
Other	22	11	20	9	20	11
Child In Day Care				**		*
Yes	39	38	34	46	43	53
No	61	62	66	54	57	47
Age of Mother		**		**		**
14 to 19 years	18	1	13	1	9	1
20 to 24 years	33	13	38	11	33	14
25 to 29 years	29	29	23	30	29	26
30 to 34 years	9	33	15	36	18	34
35 years or Older	9	23	11	21	11	26
Missing	2	2	1	1	0	1
Mother's Education		**		**		**
11th Grade or Less	23	2	15	2	17	3
Completed High School	35	19	42	20	42	19
Some Postsecondary	33	26	32	27	31	28
Completed College	7	53	9	51	9	48
Missing	2	1	2	0	1	2
Parent's Marital Status		**		**		**
Married	49	93	57	93	58	88
Not Married	50	7	42	7	41	11
Missing	1	1	1	0	1	1
Mother or Female Guardian Works				**		*
Yes	46	51	45	60	55	61
No	53	48	54	40	45	38
Missing	1	1	1	0	0	1
Urbanicity		**		**		**
Urban	34	55	37	50	35	48
Suburban	36	31	31	34	35	35
Rural	28	13	30	15	28	16
Missing	2	1	2	1	2	2
Sample Size (Unweighted)	265	597	351	808	205	791

[a] X^2 test were conducted to test for statistical significance in the differences between WIC participants and non-participants within each age group for each variable. The results of X^2 test are listed next to the variable under the column labeled non-participants for each of the three age groups.

* =P<0.05; non-participants significantly different from WIC participants on the variable.

** =P>0.01; non-participants significantly different from WIC participants on the variable.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Ponza et al., 2004.

Table 11-22. Food Choices for Infants and Toddlers by WIC Participation Status

	Infants 4 to 6 months		Infants 7 to 11 months		Toddlers 12 to 24 months	
	WIC Participant	Non-participant	WIC Participant	Non-participant	WIC Participant	Non-participant
Cow's Milk	1.0	0.6	11.4	13.2	92.3	85.8*
Meat or Other Protein Sources						
Baby Food Meat	0.9	2.0	3.3	3.6	0.0	0.3
Non-Baby Meat	3.7	0.5**	25.0	22.0	77.7	75.1
Eggs	0.9	0.6	8.5	4.2**	24.1	23.0
Peanut Butter, Nuts, Seeds	0.0	0.0	1.4	1.3	12.9	9.8
Cheese	0.0	0.6	9.0	12.5	38.5	38.8
Yogurt	0.8	1.4	5.5	13.3**	9.3	18.9**
Sample Size (unweighted)	265	597	351	808	205	791

* = P<0.05; non-participants significantly different from WIC participants.
** = P<0.01; non-participants significantly different from WIC participants.
WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Ponza et al., 2004.

Table 11-23. Percentage of Hispanic and Non-Hispanic Infants and Toddlers Consuming Different Types of Milk, Meats or Other Protein Sources on A Given Day

	Age 4 to 5 months		Age 6 to 11months		Age 12 to 24 months	
	Hispanic (N=84)	Non-Hispanic (N=538)	Hispanic (N=163)	Non-Hispanic (N=1,228)	Hispanic (N=124)	Non-Hispanic (N=871)
Milk						
Fed Any Cow's or Goat Milk	-	-	7.5†	11.3	85.6	87.7
Fed Cow's Milk						
Whole	-	-	5.6†	8.3	61.7	66.3
Reduced Fat or Non-fat	-	-	2.2†	3.0	29.0	27.0
Meat or Other Protein Sources						
Any Meat or Protein Source[a]	9.7†	5.3	71.6	62.0	90.3	94.7
Non-Baby Food Meat	-	-	22.5	19.2	72.3	76.0
Other Protein Sources	1.4†	-	26.5	21.2	70.1	65.3
Beans and Peas	1.4†	-	5.8†	1.8	19.1*	6.5
Eggs	-	-	9.5	4.2	26.4	22.5
Cheese	-	-	11.2	9.4	29.3	40.2
Yogurt	-	-	7.7	9.8	15.7	17.0
Protein Sources in Mixed Dishes	7.5†	4.4	44.8	41.6	33.3	22.7
Baby Food dinners	6.9†	3.9	24.7*	35.3	3.5†	3.9
Soup[b]	-	-	16.3**	5.1	23.4*	10.7
Types of Meat[a]						
Beef	-	-	5.0†	4.6	25.2	16.0
Chicken and Turkey	-	-	11.2	11.9	46.5	43.6
Hotdogs, Sausages, and Cold Cuts	-	-	7.2†	3.4	14.8	23.3
Pork/Ham	-	-	3.8†	1.7	11.7	12.1

[a] Includes baby food and non-baby food sources.
[b] The amount of protein actually provided by soups varies. Soups could not be sorted reliably into different food groups because many food descriptions lacked detail about major soup ingredients.
\- = Less than 1 percent of the group consumed this food on a given day.
* = Significantly different from non-Hispanic at the *P*<0.05.
** = Significantly different from non-Hispanic at the *P*>0.01.
† = Statistic is potentially unreliable because of a high coefficient of variation.
N = Sample size.

Source: Mennella et al., 2006.

Table 11-24. Average Portion Sizes Per Eating Occasion of Meats and Dairy Products Commonly Consumed by Infants from the 2002 Feeding Infants and Toddlers Study

Food group	Reference Unit	4 to 5 months (N=624)	6 to 8 months (N=708)	9 to 11 months (N=687)
			Mean± SEM	
Non-baby food meats	ounce	-	0.9±0.16	0.8±0.05
Cheese	ounce	-	-	0.7±0.05
Scrambled eggs	cup	-	-	0.2±0.02
Yogurt	ounce	-	-	3.1±0.20
Baby food dinners	ounce	2.9±0.24	3.3±0.09	3.8±0.11

\- = Cell size was too small to generate a reliable estimate.
N = Number of respondents.
SEM = Standard error of the mean.

Source: Fox et al., 2006.

Table 11-25. Average Portion Sizes Per Eating Occasion of Meats and Dairy Products Commonly Consumed by Toddlers from the 2002 Feeding Infants and Toddlers Study

Food group	Reference Unit	12 to 14 months (N=371)	15 to 18 months (N=312)	19 to 24 months (N=320)
			Mean± SEM	
Milk				
Milk	fluid ounce	5.6±0.14	5.9±0.14	6.2±0.17
Milk, as a beverage	fluid ounce	5.7±0.14	6.1±0.14	6.4±0.17
Milk, on cereal	fluid ounce	3.4±0.37	2.7±0.26	3.6±0.29
Meats and other protein sources				
All meats	ounce	1.2±0.06	1.3±0.08	1.3±0.07
Beef	ounce	0.8±0.08	1.2±0.15	1.2±0.14
Chicken or turkey, plain	ounce	1.3±0.10	1.3±0.16	1.3±0.10
Hot dogs, luncheon meats, sausages	ounce	1.3±0.13	1.5±0.13	1.5±0.12
Chicken, breaded[a]	ounce	1.5±0.14	1.5±0.13	1.8±0.12
	nugget	2.4±0.22	2.4±0.21	2.8±0.19
Scrambled eggs	cup	0.2±0.02	0.3±0.03	0.3±0.02
Peanut butter	tablespoon	0.7±0.08	0.7±0.09	0.9±0.13
Yogurt	ounce	3.4±0.19	3.8±0.26	3.8±0.28
Cheese	ounce	0.8±0.05	0.8±0.05	0.7±0.04

[a] Not included in total for all meats because weight includes breading.
N = Number of respondents.
SEM = Standard error of the mean.

Source: Fox et al., 2006.

Table 11-26. Total Fat Intake (Per capita; g/day)									
Age Group[a]	N	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
Birth to <1 year									
all	1,422	29	18	0	19	31	40	59	107
female	728	28	17	0	18	30	39	57	92
male	694	30	18	0	20	32	40	61	107
Birth to <1 month									
all	88	17	16	0	0	19	32	52	64
female	50	19	15	0	0	18	29	39	52
male	38	15	18	0	0	19	31	43	64
1 to <3 months									
all	245	22	18	0	0	27	34	47	75
female	110	20	16	0	0	24	33	45	50
male	135	23	19	0	0	28	34	55	75
3 to <6 months									
all	411	28	17	0.1	20	31	39	52	107
female	223	27	17	0	16	29	38	51	74
male	188	30	18	0.2	22	31	39	50	107
6 to <12 months									
all	678	33	17	8.5	25	34	43	62	100
female	345	32	17	5.1	24	33	43	62	92
male	333	34	16	11	25	34	44	62	100
1 to <2 years									
all	1,002	46	19	24	33	43	55	79	159
female	499	45	18	25	33	43	54	77	116
male	503	46	20	23	32	44	56	80	159
2 to <3 years									
all	994	51	21	27	37	48	60	87	197
female	494	49	20	24	35	46	59	83	127
male	500	52	21	29	39	50	61	89	197
3 to <6 years									
all	4,112	59	22	34	44	56	70	99	218
female	2,018	56	21	33	43	54	68	96	194
male	2,094	61	23	35	45	59	72	103	218
6 to <11 years									
all	1,553	68	24	41	50	66	81	111	179
female	742	64	22	38	48	61	77	101	156
male	811	72	25	43	55	70	86	115	179
11 to <16 years									
all	975	80	38	42	56	74	97	145	342
female	493	69	29	37	49	65	82	123	259
male	482	91	42	50	64	84	111	163	342

Table 11-26. Total Fat Intake (Per capita; g/day) (continued)

Age Group[a]	N	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
16 to <21 years									
all	743	85	47	37	54	76	108	168	463
female	372	79	39	35	49	75	96	154	317
male	371	92	53	41	57	77	114	186	463
21 to <31 years									
all	1,412	84	45	36	53	76	104	164	445
female	682	65	31	30	43	59	81	126	201
male	730	103	48	50	68	93	125	181	445
31 to <41 years									
all	1,628	83	43	36	52	74	106	162	376
female	781	64	31	29	42	58	79	121	228
male	847	101	45	49	69	96	127	190	376
41 to <51 years									
all	1644	78	39	36	50	70	99	153	267
female	816	63	29	31	43	59	78	114	208
male	828	93	42	46	63	87	119	166	267
51 to <61 years									
all	1,578	73	37	31	46	66	90	137	306
female	768	58	26	27	39	56	73	104	165
male	810	88	40	39	57	82	110	156	306
61 to <71 years									
all	1,507	66	33	29	42	60	80	123	235
female	719	53	24	26	36	49	68	96	184
male	788	78	35	37	53	73	98	138	235
71 to <81 years									
all	888	60	27	28	41	55	72	104	201
female	421	51	22	27	37	49	62	86	158
male	467	68	29	34	48	67	86	114	201
81+ years									
all	392	57	29	24	36	54	69	102	227
female	190	49	23	22	32	48	64	84	132
male	202	64	32	31	43	61	82	106	227

[a] Age groups are based on U.S. EPA (2005) *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*.

N = Sample size.

SE = Standard error.

Source: Based on U.S. EPA, 2007.

Table 11-27. Total Fat Intake (Per capita; g/kg-day)

Age Group[a]	N	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
Birth to <1 year									
all	1,422	4.0	2.8	0	2.3	4.1	5.6	8.9	20
female	728	4.1	2.8	0	2.4	4.3	5.8	8.7	18
male	694	4.0	2.8	0	2.3	4.0	5.5	9.2	20
Birth to <1 month									
all	88	5.2	4.9	0	0	5.7	9.1	16	20
female	50	5.9	4.6	0	0	6.2	8.4	13	16
male	38	4.3	5.3	0	0	4.7	9.7	18	20
1 to <3 months									
all	245	4.5	3.8	0	0	4.9	6.8	12	18
female	110	4.3	3.6	0	0	4.8	6.5	11	14
male	135	4.7	3.9	0	0	4.9	7.0	10	18
3 to <6 months									
all	411	4.1	2.7	0	2.4	4.3	5.7	8.2	18
female	223	4.2	2.8	0	2.3	4.5	6.0	8.2	18
male	188	4.1	2.5	0	2.6	4.1	5.5	8.2	16
6 to <12 months									
all	678	3.7	1.8	1.0	2.7	3.8	4.8	7.0	11
female	345	3.7	1.9	0.7	2.8	3.8	5.0	7.0	9.8
male	333	3.6	1.7	1.3	2.6	3.7	4.6	6.8	11
1 to <2 years									
all	1,002	4.0	1.7	2.1	2.8	3.7	4.7	7.1	12
female	499	4.1	1.6	2.2	3.0	3.7	5.0	6.9	9.7
male	503	3.9	1.7	1.9	2.6	3.6	4.5	7.2	12
2 to <3 years									
all	994	3.6	1.5	1.9	2.6	3.4	4.4	6.4	12
female	494	3.7	1.6	1.8	2.4	3.4	4.4	6.6	10
male	500	3.6	1.5	2.0	2.6	3.4	4.3	6.1	12
3 to <6 years									
all	4,112	3.4	1.3	1.9	2.4	3.2	4.0	5.8	11
female	2,018	3.4	1.3	1.8	2.4	3.1	4.0	5.8	11
male	2,094	3.5	1.4	1.9	2.4	3.2	4.1	5.8	11
6 to <11 years									
all	1,553	2.6	1.1	1.3	1.7	2.3	3.0	4.2	9.9
female	742	2.4	1.0	1.3	1.6	2.2	2.8	4.0	7.7
male	811	2.7	1.1	1.4	1.8	2.4	3.1	4.4	9.9
11 to <16 years									
all	975	1.6	0.8	0.8	1.1	1.4	2.0	3.0	5.7
female	493	1.4	0.7	0.7	0.9	1.3	1.7	2.6	5.0
male	482	1.8	0.9	0.9	1.2	1.6	2.1	3.3	5.7

Table 11-27. Total Fat Intake (Per capita; g/kg-day) (continued)

Age Group[a]	N	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
16 to <21 years									
all	743	1.3	0.66	0.54	0.81	1.2	1.6	2.7	6.0
female	372	1.1	0.56	0.48	0.75	1.1	1.4	2.1	4.4
male	371	1.4	0.73	0.63	0.85	1.2	1.7	2.9	6.0
21 to <31 years									
all	1,412	1.2	0.61	0.53	0.72	1.1	1.5	2.3	7.3
female	682	1.0	0.52	0.44	0.65	0.9	1.3	2.0	3.7
male	730	1.3	0.66	0.63	0.85	1.2	1.6	2.4	7.3
31 to <41 years									
all	1,628	1.1	0.55	0.49	0.69	1.0	1.4	2.1	4.7
female	781	1.0	0.52	0.45	0.61	0.9	1.3	1.9	4.7
male	847	1.2	0.54	0.59	0.85	1.2	1.5	2.3	4.3
41 to <51 years									
all	1,644	1.0	0.49	0.48	0.66	0.9	1.3	1.9	4.4
female	816	0.9	0.43	0.43	0.61	0.9	1.2	1.7	2.9
male	828	1.1	0.53	0.53	0.72	1.0	1.4	2.0	4.4
51 to <61 years									
all	1,578	0.9	0.46	0.42	0.61	0.86	1.2	1.7	3.8
female	768	0.8	0.38	0.39	0.56	0.79	1.1	1.5	2.4
male	810	1.0	0.50	0.47	0.65	0.95	1.3	1.9	3.8
61 to <71 years									
all	1,507	0.9	0.43	0.40	0.55	0.79	1.1	1.7	3.2
female	719	0.8	0.39	0.36	0.50	0.74	1.0	1.5	3.2
male	788	1.0	0.45	0.46	0.61	0.87	1.2	1.8	3.1
71 to <81 years									
all	888	0.8	0.37	0.40	0.56	0.78	1.0	1.5	3.2
female	421	0.8	0.37	0.39	0.53	0.72	1.0	1.4	3.2
male	467	0.9	0.37	0.42	0.61	0.82	1.1	1.5	2.6
81+ years									
all	392	0.9	0.43	0.37	0.56	0.82	1.1	1.5	3.7
female	190	0.8	0.39	0.35	0.54	0.82	1.1	1.5	2.1
male	202	0.9	0.47	0.39	0.56	0.82	1.1	1.6	3.7

[a] Age groups are based on U.S. EPA (2005) *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*.
N = Sample size.
SE = Standard error.

Source: Based on U.S. EPA, 2007.

Table 11-28. Total Fat Intake (Consumers Only; g/day)									
Age Group[a]	N	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
Birth to <1 year									
all	1,301	31	16	7.0	24	32	41	61	107
female	664	30	16	5.1	24	32	40	58	92
male	637	32	16	9.0	25	33	41	62	107
Birth to <1 month									
all	59	26	13	6.7	17	27	32	52	64
female	37	26	11	7.8	17	25	32	39	52
male	22	25	17	-	-	-	-	-	64
1 to <3 months									
all	182	29	14	5.8	24	31	35	53	75
female	79	28	12	4.3	21	30	35	46	50
male	103	31	16	8.5	27	31	38	59	75
3 to <6 months									
all	384	30	16	2.5	24	32	40	54	107
female	205	29	16	1.2	24	31	39	52	72
male	179	31	17	4.6	25	33	39	53	107
6 to <12 months									
all	676	33	16	8.9	25	34	43	62	100
female	343	32	17	6.2	24	34	43	62	92
male	333	34	16	11	25	34	44	62	100
1 to <2 year									
all	1,002	46	19	24	33	43	55	79	159
female	499	45	18	25	33	43	54	77	116
male	503	46	20	23	32	44	56	80	159
2 to <3 years									
all	994	51	21	27	37	48	60	87	197
female	494	49	20	24	35	46	59	83	127
male	500	52	21	29	39	50	61	89	197
3 to <6 years									
all	4,112	59	22	34	44	56	70	99	218
female	2,018	56	21	33	43	54	68	96	194
male	2,094	61	23	35	45	59	72	103	218
6 to <11 years									
all	1,553	68	24	41	50	66	81	111	179
female	742	64	22	38	48	61	77	101	156
male	811	72	25	43	55	70	86	115	179
11 to <16 years									
all	975	80	38	42	56	74	97	145	342
female	493	69	29	37	49	65	82	123	259
male	482	91	42	50	64	84	111	163	342

Table 11-28. Total Fat Intake (Consumers Only; g/day) (continued)

Age Group[a]	N	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
16 to <21 years									
all	743	85	47	37	54	76	108	168	463
female	372	79	39	35	49	75	96	154	317
male	371	92	53	41	57	77	114	186	463
21 to <31 years									
all	1,412	84	45	36	53	76	104	164	445
female	682	65	31	30	43	59	81	126	201
male	730	103	48	50	68	93	125	181	445
31 to <41 years									
all	1,628	83	43	36	52	74	106	162	376
female	781	64	31	29	42	58	79	121	228
male	847	101	45	49	69	96	127	190	376
41 to <51 years									
all	1,644	78	39	36	50	70	99	153	267
female	816	63	29	31	43	59	78	114	208
male	828	93	42	46	63	87	119	166	267
51 to <61 years									
all	1,578	73	37	31	46	66	90	137	306
female	768	58	26	27	39	56	73	104	165
male	810	88	40	39	57	82	110	156	306
61 to <71 years									
all	1,507	66	33	29	42	60	80	123	235
female	719	53	24	26	36	49	68	96	184
male	788	78	35	37	53	73	98	138	235
71 to <81 years									
all	888	60	27	28	41	55	72	104	201
female	421	51	22	27	37	49	62	86	158
male	467	68	29	34	48	67	86	114	201
81+ years									
all	392	57	29	24	36	54	69	102	227
female	190	49	23	22	32	48	64	84	132
male	202	64	32	31	43	61	82	106	227

[a] Age groups are based on U.S. EPA (2005) *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*.
- = Percentiles were not calculated for sample sizes less than 30.
N = Sample size.
SE = Standard error.

Source: Based on U.S. EPA, 2007.

Table 11-29. Total Fat Intake (Consumers Only; g/kg-day)

Age Group[a]	N	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
Birth to <1 year									
all	1,301	4.4	2.6	0.94	2.9	4.3	5.8	9.2	20
female	664	4.5	2.6	0.67	3.1	4.5	6.0	8.9	18
male	637	4.3	2.6	1.2	2.8	4.1	5.6	9.3	20
Birth to <1 month									
all	59	7.8	4.1	1.4	5.4	8.0	9.7	16	20
female	37	8.0	3.5	2.0	5.3	7.7	9.1	13	16
male	22	7.4	4.9	-	-	-	-	-	20
1 to <3 months									
all	182	6.0	3.1	1.0	4.1	6.0	7.8	12	18
female	79	5.9	2.9	0.80	4.3	6.0	7.7	12	14
male	103	6.1	3.3	1.8	4.1	6.0	7.8	12	18
3 to <6 months									
all	384	4.4	2.5	0.35	3.1	4.5	5.8	8.3	18
female	205	4.5	2.6	0.14	3.1	4.7	6.1	8.2	18
male	179	4.3	2.4	0.57	3.1	4.2	5.6	8.8	16
6 to <12 months									
all	676	3.7	1.8	1.0	2.7	3.8	4.8	7.0	11
female	343	3.7	1.9	0.75	2.8	3.8	5.0	7.0	9.8
male	333	3.6	1.7	1.3	2.6	3.7	4.6	6.8	11
1 to <2 years									
all	1,002	4.0	1.7	2.1	2.8	3.7	4.7	7.1	12
female	499	4.1	1.6	2.2	3.0	3.7	5.0	6.9	9.7
male	503	3.9	1.7	1.9	2.6	3.6	4.5	7.2	12
2 to <3 years									
all	994	3.6	1.5	1.9	2.6	3.4	4.4	6.4	12
female	494	3.7	1.6	1.8	2.4	3.4	4.4	6.6	10
male	500	3.6	1.5	2.0	2.6	3.4	4.3	6.1	12
3 to <6 years									
all	4,112	3.4	1.3	1.9	2.4	3.2	4.0	5.8	11
female	2,018	3.4	1.3	1.8	2.4	3.1	4.0	5.8	11
male	2,094	3.5	1.4	1.9	2.4	3.2	4.1	5.8	11
6 to <11 years									
all	1,553	2.6	1.1	1.3	1.7	2.3	3.0	4.2	9.9
female	742	2.4	1.0	1.3	1.6	2.2	2.8	4.0	7.7
male	811	2.7	1.1	1.4	1.8	2.4	3.1	4.4	9.9
11 to <16 years									
all	975	1.6	0.80	0.77	1.1	1.4	2.0	3.0	5.7
female	493	1.4	0.69	0.67	0.91	1.3	1.7	2.6	5.0
male	482	1.8	0.86	0.88	1.2	1.6	2.1	3.3	5.7

Table 11-29 Total Fat Intake (Consumers Only; g/kg-day) (continued)

Age Group[a]	N	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
16 to <21 years									
all	743	1.3	0.66	0.54	0.81	1.2	1.6	2.7	6.0
female	372	1.1	0.56	0.48	0.75	1.1	1.4	2.1	4.4
male	371	1.4	0.73	0.63	0.85	1.2	1.7	2.9	6.0
21 to <31 years									
all	1,412	1.2	0.61	0.53	0.72	1.1	1.5	2.3	7.3
female	682	1.0	0.52	0.44	0.65	0.93	1.3	2.0	3.7
male	730	1.3	0.66	0.63	0.85	1.2	1.6	2.4	7.3
31 to <41 years									
all	1,628	1.1	0.55	0.49	0.69	1.0	1.4	2.1	4.7
female	781	0.98	0.52	0.45	0.61	0.91	1.3	1.9	4.7
male	847	1.2	0.54	0.59	0.85	1.2	1.5	2.3	4.3
41 to <51 years									
all	1,644	1.0	0.49	0.48	0.66	0.94	1.3	1.9	4.4
female	816	0.92	0.43	0.43	0.61	0.86	1.2	1.7	2.9
male	828	1.1	0.53	0.53	0.72	1.0	1.4	2.0	4.4
51 to <61 years									
all	1,578	0.94	0.46	0.42	0.61	0.86	1.2	1.7	3.8
female	768	0.83	0.38	0.39	0.56	0.79	1.1	1.5	2.4
male	810	1.0	0.50	0.47	0.65	0.95	1.3	1.9	3.8
61 to <71 years									
all	1,507	0.88	0.43	0.40	0.55	0.79	1.1	1.7	3.2
female	719	0.79	0.39	0.36	0.50	0.74	0.99	1.5	3.2
male	788	0.95	0.45	0.46	0.61	0.87	1.2	1.8	3.1
71 to <81 years									
all	888	0.82	0.37	0.40	0.56	0.78	1.0	1.5	3.2
female	421	0.77	0.37	0.39	0.53	0.72	0.95	1.4	3.2
male	467	0.87	0.37	0.42	0.61	0.82	1.1	1.5	2.6
81+ years									
all	392	0.86	0.43	0.37	0.56	0.82	1.1	1.5	3.7
female	190	0.83	0.39	0.35	0.54	0.82	1.1	1.5	2.1
male	202	0.89	0.47	0.39	0.56	0.82	1.1	1.6	3.7

[a] Age groups are based on U.S. EPA (2005) *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*.
- = Percentiles were not calculated for sample sizes less than 30.
N = Sample size.
SE = Standard error.

Source: Based on U.S. EPA, 2007.

Table 11-30. Total Fat Intake - Top 10% of Animal Fat Consumers (Consumers Only; g/day)

Age Group[a]	N	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
Birth to <1 year									
all	140	45	16	28	35	45	54	77	100
female	70	45	15	26	35	45	54	69	92
male	70	45	17	28	34	44	53	79	100
1 to <2 years									
all	109	75	20	52	61	74	85	108	159
female	54	68	16	52	57	70	78	89	114
male	55	81	22	54	67	78	90	125	159
2 to <3 years									
all	103	79	20	55	64	74	85	116	133
female	58	77	16	55	65	74	79	109	116
male	45	81	24	52	61	73	90	121	133
3 to <6 years									
all	461	88	25	62	72	84	102	135	218
female	217	84	24	59	68	80	95	130	194
male	244	92	25	66	76	90	103	136	218
6 to <11 years									
all	198	94	25	66	77	88	105	140	178
female	71	88	21	58	70	86	100	123	156
male	127	97	27	69	78	91	112	168	178
11 to <16 years									
all	96	133	53	85	95	121	154	223	342
16 to <21 years									
all	68	167	64	98	122	154	189	278	463
11 to <21 years									
all	165	146	60	90	105	139	168	254	463
female	53	117	30	81	92	111	140	162	195
male	112	160	65	94	117	151	191	276	463
21 to <31 years									
all	150	151	55	97	113	139	173	236	445
female	44	115	31	80	97	108	131	160	201
male	106	166	56	107	128	161	177	254	445
31 to <41 years									
all	148	147	51	93	110	135	172	352	376
female	48	120	33	79	93	106	132	160	228
male	100	160	53	110	125	149	201	352	376
41 to <51 years									
all	166	137	42	88	110	136	156	208	267
female	49	110	30	72	86	103	130	150	208
male	117	148	41	106	119	142	166	218	267

Table 11-30. Total Fat Intake - Top 10% of Animal Fat Consumers (Consumers Only; g/day) (continued)

Age Group[a]	N	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
51 to <61 years									
all	183	127	41	80	98	118	144	206	306
female	39	96	27	63	74	86	106	126	165
male	144	135	41	96	112	122	151	214	306
61 to <71 years									
all	168	114	35	74	88	108	133	183	235
female	47	91	24	68	74	87	103	120	184
male	121	123	35	87	102	117	140	197	235
71 to <81 years									
all	104	98	28	65	76	92	109	144	201
81+ years									
all	40	97	37	60	67	86	104	137	227
71+ years									
all	144	98	30	62	72	91	107	144	227
female	50	83	25	54	63	72	95	123	147
male	94	105	30	76	88	97	115	165	227

[a] Age groups are based on U.S. EPA (2005) *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*.
N = Sample size.
SE = Standard error.

Source: Based on U.S. EPA, 2007.

Table 11-31. Total Fat Intake - Top 10% of Animal Fat Consumers (Consumers Only; g/kg-day)									
Age Group[a]	N	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
Birth to <1 year									
all	140	4.7	1.7	2.8	3.7	4.6	6.0	7.7	11
female	70	4.8	1.6	2.7	3.7	4.7	6.0	7.7	9.5
male	70	4.6	1.7	2.8	3.6	4.4	5.8	7.5	11
1 to <2 years									
all	109	6.9	1.5	5.1	5.7	6.8	7.7	9.5	12
female	54	6.6	1.2	5.1	5.7	6.7	7.4	9.3	9.7
male	55	7.1	1.6	5.1	5.8	6.9	8.0	9.4	12
2 to <3 years									
all	103	6.1	1.3	4.6	5.2	5.8	6.7	8.3	9.5
female	58	6.2	1.2	4.6	5.2	5.9	6.8	7.9	9.5
male	45	6.1	1.3	4.5	5.2	5.6	6.6	8.4	9.5
3 to <6 years									
all	461	5.6	1.3	4.2	4.7	5.3	6.2	8.3	11
female	217	5.5	1.3	4.2	4.5	5.3	6.0	7.8	11
male	244	5.7	1.3	4.2	4.8	5.3	6.2	8.4	11
6 to <11 years									
all	198	4.2	1.1	3.0	3.4	3.8	4.6	6.0	9.9
female	71	4.2	1.1	2.9	3.3	3.8	4.8	5.8	7.7
male	127	4.2	1.1	3.0	3.4	3.8	4.5	6.3	9.9
11 to <16 years									
all	96	3.0	0.85	2.0	2.4	2.8	3.3	4.6	5.7
16 to <21 years									
all	68	2.5	0.74	1.7	2.0	2.4	2.9	3.7	6.0
11to <21 years									
all	165	2.8	0.84	1.9	2.1	2.7	3.1	4.4	6.0
female	53	2.6	0.65	1.7	2.0	2.3	2.7	3.4	4.6
male	112	2.9	0.90	1.9	2.3	2.8	3.1	4.5	6.0
21 to <31 years									
all	150	2.2	0.73	1.5	1.7	2.1	2.4	3.2	7.3
female	44	2.0	0.54	1.5	1.8	1.9	2.3	3.1	3.7
male	106	2.2	0.79	1.6	1.7	2.1	2.4	3.2	7.3
31 to <41 years									
all	148	2.1	0.59	1.5	1.7	1.9	2.4	3.9	4.7
female	48	2.1	0.62	1.5	1.7	1.9	2.2	2.8	4.7
male	100	2.1	0.58	1.5	1.6	2.0	2.6	3.9	4.3
41 to <51 years									
all	166	1.8	0.49	1.3	1.5	1.8	2.1	2.8	4.0
female	49	1.8	0.45	1.3	1.4	1.8	2.1	2.6	2.9
male	117	1.9	0.50	1.4	1.6	1.8	2.0	2.8	4.0

Table 11-31. Total Fat Intake - Top 10% of Animal Fat Consumers (Consumers Only; g/kg-day) (continued)

Age Group[a]	N	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
51 to <61 years									
all	183	1.7	0.46	1.2	1.3	1.6	1.9	2.5	3.8
female	39	1.5	0.34	1.1	1.3	1.4	1.7	2.0	2.4
male	144	1.7	0.48	1.2	1.4	1.6	1.9	2.6	3.8
61 to <71 years									
all	168	1.6	0.42	1.2	1.3	1.5	1.8	2.5	3.2
female	47	1.6	0.42	1.1	1.3	1.5	1.7	2.3	3.2
male	121	1.6	0.43	1.2	1.3	1.5	1.8	2.5	3.1
71 to <81 years									
all	104	1.4	0.37	1.0	1.1	1.3	1.5	2.0	3.2
81+ years									
all	40	1.6	0.48	1.1	1.2	1.4	1.7	2.0	3.7
71+ years									
all	144	1.4	0.41	1.0	1.1	1.3	1.6	2.0	3.7
female	50	1.4	0.41	0.96	1.1	1.4	1.6	1.8	3.2
male	94	1.5	0.41	1.1	1.2	1.3	1.5	2.1	3.7

[a] Age groups are based on U.S. EPA (2005) *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*.
N = Sample size.
SE = Standard error.

Source: Based on U.S. EPA, 2007.

Table 11-32. Fat Intake Among Children Based on Data from the Bogalusa Heart Study, 1973-1982 (g/day)

Age	N	Mean	SD	Percentiles					Minimum	Maximum
				10th	25th	50th	75th	90th		
Total Fat Intake										
6 months	125	37.1	17.5	18.7	25.6	33.9	46.3	60.8	3.4	107.6
1 year	99	59.1	26.0	29.1	40.4	56.1	71.4	94.4	21.6	152.7
2 years	135	86.7	41.3	39.9	55.5	79.2	110.5	141.1	26.5	236.4
3 years	106	91.6	38.8	50.2	63.6	82.6	114.6	153.0	32.6	232.5
4 years	219	98.6	56.1	46.0	66.8	87.0	114.6	163.3	29.3	584.6
10 years	871	93.2	50.8	45.7	60.5	81.4	111.3	154.5	14.6	529.5
13 years	148	107.0	53.9	53.0	69.8	90.8	130.7	184.1	9.8	282.2
15 years	108	97.7	48.7	46.1	65.2	85.8	124.0	165.2	10.0	251.3
17 years	159	107.8	64.3	41.4	59.7	97.3	140.2	195.1	8.5	327.4
Total Animal Fat										
6 months	125	18.4	16.0	0.7	4.2	13.9	28.4	42.5	0.0	61.1
1year	99	36.5	20.0	15.2	23.1	33.0	45.9	65.3	0.0	127.1
2 years	135	49.5	28.3	20.1	28.9	42.1	66.0	81.4	10.0	153.4
3 years	106	50.1	29.4	21.3	29.1	42.9	64.4	88.9	14.1	182.6
4 years	219	50.8	31.7	21.4	28.1	42.6	66.4	92.6	5.9	242.2
10 years	871	54.1	39.6	20.3	30.6	45.0	64.6	97.5	0.0	412.3
13 years	148	56.2	39.8	19.8	28.5	44.8	72.8	109.4	4.7	209.6
15 years	108	53.8	35.1	15.9	28.3	44.7	67.9	105.8	0.6	182.1
17 years	159	64.4	48.5	15.2	30.7	51.6	86.6	128.8	2.6	230.3
Total Vegetable Fat Intake										
6 months	125	9.2	12.8	0.6	1.2	2.8	11.6	29.4	0.0	53.2
1 year	99	15.4	14.3	3.7	6.1	11.3	18.1	38.0	0.2	70.2
2 years	135	19.3	16.3	3.8	7.9	14.8	26.6	42.9	0.7	96.6
3 years	106	21.1	15.5	3.9	8.6	18.7	26.6	45.2	1.0	70.4
4 years	219	24.5	18.6	5.7	10.4	21.8	33.3	48.5	0.9	109.0
10 years	871	23.7	21.6	4.3	9.5	18.3	30.6	49.0	0.6	203.7
13 years	148	34.3	27.4	8.4	17.9	31.2	44.6	57.5	0.0	238.3
15 years	108	27.3	22.8	5.1	11.9	22.6	38.1	54.4	0.7	132.2
17 years	159	25.7	21.3	4.2	11.7	20.8	32.9	47.6	0.0	141.5

Table 11-32. Fat Intake Among Children Based on Data from the Bogalusa Heart Study, 1973-1982 (g/day) (continued)

Age	N	Mean	SD	Percentiles					Minimum	Maximum
				10th	25th	50th	75th	90th		
Total Fish Fat Intake										
6 months	125	0.05	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.9
1 year	99	0.05	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.9
2 years	135	0.04	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.9
3 years	106	0.1	0.6	0.0	0.0	0.0	0.0	0.0	0.0	4.5
4 years	219	2.3	31.1	0.0	0.0	0.0	0.0	0.0	0.0	459.2
10 years	871	0.3	1.5	0.0	0.0	0.0	0.0	0.0	0.0	19.2
13 years	148	0.3	2.2	0.0	0.0	0.0	0.0	0.0	0.0	25.4
15 years	108	0.4	1.5	0.0	0.0	0.0	0.0	1.5	0.0	9.5
17 years	159	0.5	2.0	0.0	0.0	0.0	0.0	0.4	0.0	15.3

N = Sample size.
SD = Standard deviation.

Source: Frank et al., 1986.

Table 11-33. Fat Intake Among Children Based on Data from the Bogalusa Heart Study, 1973-1982 (g/kg-day)

Age	N	Mean	SD	Percentiles					Minimum	Maximum
				10th	25th	50th	75th	90th		
Total Fat Intake										
6 months	125	4.9	2.3	2.4	3.3	4.7	6.2	8.0	0.4	13.2
1 year	99	6.1	2.8	3.0	4.1	5.7	7.5	9.5	2.3	16.4
2 years	132	7.0	3.3	3.4	4.5	6.2	8.6	11.9	2.1	18.7
3 years	106	6.4	2.7	3.6	4.6	5.5	8.2	9.9	2.2	16.7
4 years	218	6.1	3.7	2.9	4.0	5.2	7.0	10.0	2.0	38.2
10 years	861	2.7	1.5	1.2	1.7	2.4	3.3	4.5	0.3	13.9
13 years	147	2.3	1.3	1.0	1.5	2.0	2.8	3.8	0.2	10.2
15 years	105	1.7	0.8	0.8	1.2	1.5	2.1	3.1	0.2	4.7
17 years	149	1.8	1.0	0.7	0.9	1.6	2.2	3.1	0.2	6.2
Total Animal Fat										
6 months	125	2.4	2.1	0.08	0.6	2.0	3.7	5.5	0.0	9.0
1 year	99	3.8	2.1	1.7	2.4	3.4	4.9	6.5	0.0	13.6
2 years	132	4.0	2.3	1.7	2.3	3.4	5.2	6.7	0.7	13.4
3 years	106	3.5	2.0	1.6	2.1	3.1	4.2	6.1	0.9	13.1
4 years	218	3.1	2.1	1.3	1.7	2.6	4.0	5.4	0.4	15.4
10 years	861	16	1.2	0.6	0.8	1.3	1.9	2.8	0.00	10.8
13 years	147	1.2	0.9	0.4	0.6	0.9	1.6	2.3	0.08	5.2
15 years	105	1.0	0.6	0.3	0.5	0.8	1.3	1.9	0.01	3.1
17 years	149	1.0	0.8	0.3	0.5	0.8	1.4	2.0	0.05	4.2
Total Vegetable Fat Intake										
6 months	125	1.2	1.8	0.08	0.2	0.4	1.6	4.1	0.0	8.2
1year	99	1.6	1.6	0.4	0.6	1.2	1.9	3.8	0.02	7.6
2 years	132	1.6	1.4	0.3	0.7	1.1	2.0	3.5	0.06	8.5
3 years	106	1.5	1.1	0.3	0.6	1.4	2.0	3.0	0.08	5.1
4 years	218	1.5	1.2	0.4	0.6	1.2	2.1	2.8	0.06	7.3
10 years	861	0.7	0.6	0.1	0.3	0.5	0.9	1.4	0.02	4.2
13 years	147	0.8	0.8	0.2	0.4	0.6	0.9	1.3	0.0	8.6
15 years	105	0.5	0.4	0.09	0.2	0.4	0.7	0.9	0.01	2.2
17 years	149	0.4	0.4	0.07	0.2	0.4	0.6	0.9	0.0	2.1

Table 11-33. Fat Intake Among Children Based on Data from the Bogalusa Heart Study, 1973-1982 (g/kg-day) (continued)

Age	N	Mean	SD	Percentiles					Minimum	Maximum
				10th	25th	50th	75th	90th		
Total Fish Fat Intake										
6 months	125	0.01	0.02	0.0	0.0	0.0	0.0	0.02	0.0	0.1
1 year	99	0.01	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2 years	132	0.003	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3 years	106	0.01	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.3
4 years	218	0.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0
10 years	861	0.01	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.6
13 years	147	0.01	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.4
15 years	105	0.01	0.03	0.0	0.0	0.0	0.0	0.04	0.0	0.2
17 years	149	0.01	0.03	0.0	0.0	0.0	0.0	0.008	0.0	0.2

N = Sample size.
SD = Standard deviation.

Source: Frank et al., 1986.

Table 11-34. Mean Percent Moisture and Total Fat Content of Selected Meat and Dairy Products[a]

Product	Moisture Content (%)	Total Fat Content (%)	Comment
Meats			
Beef (composite of trimmed retail cuts; all grades)	70.62	6.16	Raw; lean only
	59.25	9.91	Cooked; lean only
	60.44	19.24	Raw; lean and fat, 1/4 in. fat trim
	51.43	21.54	Cooked; lean and fat, 1/4 in. fat trim
Pork (composite of trimmed retail cuts)	72.34	5.88	Raw; lean only
	60.31	9.66	Cooked; lean only
	65.11	14.95	Raw; lean and fat
	54.55	17.18	Cooked; lean and fat
Cured ham	63.46	12.90	Center slice, unheated; lean and fat
	55.93	8.32	Raw, center slice, country style; lean only
Cured bacon	40.20	45.04	Raw
	12.52	43.27	Cooked, baked
	12.32	41.78	Cooked, broiled
	12.12	40.30	Cooked, pan-fried
	16.49	37.27	Cooked, microwaved
Lamb (composite of trimmed retail cuts)	73.42	5.25	Raw; lean only
	61.96	9.52	Cooked; lean only
	60.70	21.59	Raw; lean and fat, 1/4 in. fat trim
	53.72	20.94	Cooked; lean and fat, 1/4 in. fat trim
Veal (composite of trimmed retail cuts)	75.91	2.87	Raw; lean only
	60.16	6.58	Cooked; lean only
	72.84	6.77	Raw; lean and fat, 1/4 in. fat trim
	57.08	11.39	Cooked; lean and fat, 1/4 in. fat trim
Rabbit (domesticated)	72.82	5.55	Raw
	60.61	8.05	Cooked, roasted
	58.82	8.41	Cooked, stewed
Chicken (broilers or fryers)	75.46	3.08	Raw; meat only
	66.81	6.71	Cooked, stewed; meat only
	63.79	7.41	Cooked, roasted; meat only
	57.53	9.12	Cooked, fried; meat only
	65.99	15.06	Raw; meat and skin
	63.93	12.56	Cooked, stewed; meat and skin
	59.45	13.60	Cooked, roasted; meat and skin
	52.41	14.92	Cooked, fried, flour; meat and skin
Duck (domesticated)	73.77	5.95	Raw; meat only
	64.22	11.20	Cooked, roasted; meat only
	48.50	39.34	Raw; meat and skin
	51.84	28.35	Cooked, roasted; meat and skin
Turkey (all classes)	74.16	2.86	Raw; meat only
	64.88	4.97	Cooked, roasted; meat only
	70.40	8.02	Raw; meat and skin
	61.70	9.73	Cooked, roasted; meat and skin
	71.97	8.26	Raw; ground
	59.42	13.15	Cooked; ground

Table 11-34. Mean Percent Moisture and Total Fat Content of Selected Meat and Dairy Products[a] (continued)

Product		Moisture Content (%)	Total Fat Content (%)	Comment
Dairy				
Milk				
	Whole	88.32	3.25	3.25% milkfat
	Human	87.50	4.38	Whole, mature, fluid
	Lowfat (1%)	89.81	0.97	Fluid, with added non-fat milk solids and vitamin A
	Reduced fat (2%)	88.86	1.92	Fluid, with added non-fat milk solids and vitamin A
	Skim or fat free	90.38	0.25	Fluid, with added non-fat milk solids and vitamin A
Cream				
	Half and half	80.57	11.50	Fluid
	Light (coffee cream or table cream)	73.75	19.31	Fluid
	Heavy-whipping	57.71	37.00	Fluid
	Sour	70.95	20.96	Cultured
	Sour, reduced fat	80.14	12.00	Cultured
Butter		15.87	81.11	Salted
Cheese				
	American	39.16	31.25	Pasteurized
	Cheddar	36.75	33.14	
	Swiss	37.12	27.80	
	Cream	53.75	34.87	
	Parmesan	29.16; 20.84	25.83; 28.61	Hard; grated
	Cottage, lowfat	82.48; 79.31	1.02; 1.93	1% fat; 2% fat
	Colby	38.20	32.11	
	Blue	42.41	28.74	
	Provolone	40.95	26.62	
	Mozzarella	50.01; 53.78	22.35; 15.92	Whole milk; Skim milk
Yogurt		85.07; 87.90	1.55; 3.25	Plain, lowfat; Plain, with fat
Eggs		75.84	9.94	Chicken, whole raw, fresh

[a] Based on the water and lipid content in 100 grams, edible portion. Total Fat Content = saturated, monosaturated and polyunsaturated. For additional information, consult the USDA nutrient database.

Source: USDA, 2007.

APPENDIX 11A

CODES AND DEFINITIONS USED TO DETERMINE THE VARIOUS MEATS AND DAIRY PRODUCTS USED IN THE U.S. EPA ANALYSIS OF CSFII DATA IN FCID

Table 11A-1 Food Codes and Definitions Used in Analysis of the 1994-96, 1998 USDA CSFII Data

Food Category	**EPA Food Commodity Codes**			
Total Meats	21000440	Beef, meat	21000480	Beef, kidney
	21000441	Beef, meat-babyfood	21000490	Beef, liver
	21000450	Beef, meat, dried	21000491	Beef, liver-babyfood
	21000460	Beef, meat byproducts	23001690	Goat, meat
	21000461	Beef, meat byproducts-babyfood	23001700	Goat, meat byproducts
	21000470	Beef, fat	23001710	Goat, fat
	21000471	Beef, fat-babyfood	23001720	Goat, kidney
	23001730	Goat, liver	40000950	Chicken, meat byproducts
	24001890	Horse, meat	40000951	Chicken, meat byproducts-babyfood
	25002900	Pork, meat	40000960	Chicken, fat
	25002901	Pork, meat-babyfood	40000961	Chicken, fat-babyfood
	25002910	Pork, skin	40000970	Chicken, skin
	25002920	Pork, meat byproducts	40000971	Chicken, skin-babyfood
	25002921	Pork, meat byproducts-babyfood	50003820	Turkey, meat
	25002930	Pork, fat	50003821	Turkey, meat-babyfood
	25002931	Pork, fat-babyfood	50003830	Turkey, liver
	25002940	Pork, kidney	50003831	Turkey, liver-babyfood
	25002950	Pork, liver	50003840	Turkey, meat byproducts
	26003390	Sheep, meat	50003841	Turkey, meat byproducts-babyfood
	26003391	Sheep, meat-babyfood	50003850	Turkey, fat
	26003400	Sheep, meat byproducts	50003851	Turkey, fat-babyfood
	26003410	Sheep, fat	50003860	Turkey, skin
	26003411	Sheep, fat-babyfood	50003861	Turkey, skin-babyfood
	26003420	Sheep, kidney	60003010	Poultry, other, meat
	26003430	Sheep, liver	60003020	Poultry, other, liver
	28002210	Meat, game	60003030	Poultry, other, meat byproducts
	29003120	Rabbit, meat	60003040	Poultry, other, fat
	40000930	Chicken, meat	60003050	Poultry, other, skin
	40000931	Chicken, meat-babyfood		
	40000940	Chicken, liver		
Total Dairy	27002220	Milk, fat	27022241	Milk, water-babyfood/infant formula
	27002221	Milk, fat - baby food/infant formula	27032251	Milk, sugar (lactose)-baby food/infant formula
	27012230	Milk, non-fat solids		
	27012231	Milk, non-fat solids-baby food/infant formula		
	27022240	Milk, water		
Beef	21000440	Beef, meat	21000470	Beef, fat
	21000441	Beef, meat-babyfood	21000471	Beef, fat-babyfood
	21000450	Beef, meat, dried	21000480	Beef, kidney
	21000460	Beef, meat byproducts	21000490	Beef, liver
	21000461	Beef, meat byproducts-babyfood	21000491	Beef, liver-babyfood
Eggs	70001450	Egg, whole	70001461	Egg, white (solids)-babyfood
	70001451	Egg, whole-babyfood	70001470	Egg, yolk
	70001460	Egg, white	70001471	Egg, yolk-babyfood
Pork	25002900	Pork, meat	25002930	Pork, fat
	25002901	Pork, meat-babyfood	25002931	Pork, fat-babyfood
	25002910	Pork, skin	25002940	Pork, kidney
	25002920	Pork, meat byproducts	25002950	Pork, liver
	25002921	Pork, meat byproducts-babyfood		
Poultry	40000930	Chicken, meat	50003831	Turkey, liver-babyfood
	40000931	Chicken, meat-babyfood	50003840	Turkey, meat byproducts
	40000940	Chicken, liver	50003841	Turkey, meat byproducts-babyfood
	40000950	Chicken, meat byproducts	50003850	Turkey, fat
	40000951	Chicken, meat byproducts-babyfood	50003851	Turkey, fat-babyfood
	40000960	Chicken, fat	50003860	Turkey, skin
	40000961	Chicken, fat-babyfood	50003861	Turkey, skin-babyfood
	40000970	Chicken, skin	60003010	Poultry, other, meat
	40000971	Chicken, skin-babyfood	60003020	Poultry, other, liver
	50003820	Turkey, meat	60003030	Poultry, other, meat byproducts
	50003821	Turkey, meat-babyfood	60003040	Poultry, other, fat
	50003830	Turkey, liver	60003050	Poultry, other, skin

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12 INTAKE OF GRAIN PRODUCTS

12.1 INTRODUCTION

The American food supply is generally considered to be one of the safest in the world. Nevertheless, grain products may become contaminated with toxic chemicals by several different pathways. Ambient air pollutants may be deposited on or absorbed by the plants, or dissolved in rainfall or irrigation waters that contact the plants. Pollutants may also be absorbed through plant roots from contaminated soil and ground water. The addition of pesticides, soil additives, and fertilizers may also result in contamination of grain products. To assess exposure through this pathway, information on ingestion rates of grain products are needed.

A variety of terms may be used to define intake of grain products (e.g., consumer-only intake, per capita intake, total grain intake, as-consumed intake, dry weight intake). As described in Chapter 9, Intake of Fruits and Vegetables, consumer-only intake is defined as the quantity of grain products consumed by individuals during the survey period. These data are generated by averaging intake across only the individuals in the survey who consumed these food items. Per capita intake rates are generated by averaging consumer-only intakes over the entire population (including those that reported no intake). In general, per capita intake rates are appropriate for use in exposure assessment for which average dose estimates for individuals are of interest because they represent both individuals who ate the foods during the survey period and those who may eat the food items at some time, but did not consume them during the survey period. Per capita intake, therefore, represents an average across the entire population of interest, but does so at the expense of underestimating consumption for the subset of the population that consumed the food in question. Total grain intake refers to the sum of all grain products consumed in a day.

Intake rates may be expressed on the basis of the as-consumed weight (e.g., cooked or prepared) or on the uncooked or unprepared weight. As-consumed intake rates are based on the weight of the food in the form that it is consumed and should be used in assessments where the basis for the contaminant concentrations in foods is also indexed to the as-consumed weight. The food ingestion values provided in this chapter are expressed as as-consumed intake rates because this is the fashion in which data were reported by survey respondents. This is of importance because concentration data to be used in the dose equation are often measured in uncooked food samples. It should be recognized that cooking can either increase or decrease food weight. Similarly, cooking can increase the mass of contaminant in food (due to formation reactions, or absorption from cooking oils or water) or decrease the mass of contaminant in food (due to vaporization, fat loss or leaching). The combined effects of changes in weight and changes in contaminant mass can result in either an increase or decrease in contaminant concentration in cooked food. Therefore, if the as-consumed ingestion rate and the uncooked concentration are used in the dose equation, dose may be under-estimated or over-estimated. Ideally, after-cooking food concentrations should be combined with the as-consumed intake rates. In the absence of data, it is reasonable to assume that no change in contaminant concentration occurs after cooking. It is important for the assessor to be aware of these issues and choose intake rate data that best match the concentration data that are being used. For more information on cooking losses and conversions necessary to account for such losses, the reader is referred to Chapter 13 of this handbook.

Sometimes contaminant concentrations in food are reported on a dry weight basis. When these data are used in an exposure assessment, it is recommended that dry-weight intake rates also be used. Dry-weight food concentrations and intake rates are based on the weight of the food consumed after the moisture content has been removed. For information on converting the intake rates presented in this chapter to dry weight intake rates, the reader is referred to Section 12.4.

The purpose of this chapter is to provide intake data for grain products for the general population. The recommendations for ingestion rates of grain products are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values are based on the key study identified by U.S. EPA for this factor. Following the recommendations, the key study on ingestion of grain products is summarized. Relevant data on ingestion of grain products are also provided. These data are presented to provide the reader with added perspective on the current state-of-knowledge pertaining to ingestion of grain products among children.

12.2 RECOMMENDATIONS

Table 12-1 presents a summary of the recommended values for per capita and consumer-only intake of grain products, on an as-consumed basis. Confidence ratings for the grain intake recommendations for the general population are provided in Table 12-2.

The U.S. EPA analysis of data from the 1994-96 and 1998 Continuing Survey of Food Intake by Individuals (CSFII) was used in selecting recommended intake rates. The U.S. EPA analysis was conducted using childhood age groups that differed slightly from U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, for the purposes of the recommendations presented here, data were placed in the standardized age categories closest to those used in the analysis. Also, the CSFII data on which the recommendations are based are short term survey data and may not necessarily reflect the long-term distribution of average daily intake rates. However, for broad categories of food (i.e., total grains), because they are eaten on a daily basis throughout the year with minimal seasonality, the short term distribution may be a reasonable approximation of the long-term distribution, although it will display somewhat increased variability. This implies that the upper percentiles shown here will tend to overestimate the corresponding percentiles of the true long-term distribution. It should also be noted that because these recommendations are based on 1994-96 and 1998 CSFII data, they may not reflect the most recent changes that may have occurred in consumption patterns. More current data from the National Health and Nutrition Survey (NHANES) will be incorporated as the data become available and are analyzed.

Table 12-1. Recommended Values for Intake of Grains, As Consumed[a]						
Age Group	Per Capita		Consumers Only		Multiple Percentiles	Source
	Mean	95th Percentile	Mean	95th Percentile		
	g/kg-day	g/kg-day	g/kg-day	g/kg-day		
Total Grains						
Birth to 1 year	2.5	8.6	3.6	9.2	See Tables 12-3 and 12-4	U.S. EPA Analysis of CSFII, 1994-96 and 1998, based on USDA (2000) and U.S. EPA (2000).
1 to <2 years	6.4	12	6.4	12		
2 to <3 years	6.4	12	6.4	12		
3 to <6 years	6.3	12	6.3	12		
6 to <11 years	4.3	8.2	4.3	8.2		
11 to <16 years	2.5	5.1	2.5	5.1		
16 to <21 years	2.5	5.1	2.5	5.1		
20 to <50	2.2	4.7	2.2	4.7		
≥50 years	1.7	3.5	1.7	3.5		
Individual Grain Products - See Tables 12-5 and 12-6						

[a] Analysis was conducted using slightly different childhood age groups than those recommended in *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA. 2005). Data were placed in the standardized age categories closest to those used in the analysis.

Table 12-2. Confidence in Recommendations for Intake of Grain Products		
General Assessment Factors	Rationale	Rating
Soundness		High
Adequacy of Approach	The survey methodology and data analysis was adequate. The survey sampled more than 20,000 individuals. An analysis of primary data was conducted.	
Minimal (or defined) Bias	No physical measurements were taken. The method relied on recent recall of grain products eaten.	
Applicability and Utility		Medium
Exposure Factor of Interest	The key study was directly relevant to grain intake.	
Representativeness	The data were demographically representative of the U.S. population (based on stratified random sample).	
Currency	Data were collected between 1994 and 1998.	
Data Collection Period	Data were collected for two non-consecutive days.	
Clarity and Completeness		High
Accessibility	The CSFII data are publicly available.	
Reproducibility	The methodology used was clearly described; enough information was included to reproduce the results.	
Quality Assurance	Quality assurance of the CSFII data was good; quality control of the secondary data analysis was not well described.	
Variability and Uncertainty		Medium
Variability in Population	Full distributions were provided for total grains. Means were provided for individual grain products.	
Minimal Uncertainty	Data collection was based on recall for a 2-day period; the accuracy of using these data to estimate long-term intake (especially at the upper percentiles) is uncertain. However, use of short-term data to estimate chronic ingestion can be assumed for broad categories of foods such as total grains. Uncertainty is likely to be greater for individual grain products.	
Evaluation and Review		Medium
Peer Review	The USDA CSFII survey received a high level of peer review. The U.S. EPA analysis of these data has not been peer reviewed outside the Agency.	
Number and Agreement of Studies	There was 1 key study.	
Overall Rating		**Medium-High** confidence in the averages; **Low** confidence in the long-term upper percentiles

12.3 INTAKE STUDIES

The primary source of recent information on consumption rates of grain products is the U.S. Department of Agriculture's (USDA) CSFII. Data from the 1994-96 CSFII and the 1998 Children's supplement to the 1994-96 CSFII have been used in various studies to generate consumer-only and per capita intake rates for both individual grain products and total grains. The CSFII is a series of surveys designed to measure the kinds and amounts of foods eaten by Americans. The CSFII 1994-96 was conducted between January 1994 and January 1997 with a target population of non-institutionalized individuals in all 50 states and Washington, D.C. In each of the 3 survey years, data were collected for a nationally representative sample of individuals of all ages. The CSFII 1998 was conducted between December 1997 and December 1998 and surveyed children 9 years of age and younger. It used the same sample design as the CSFII 1994-96 and was intended to be merged with CSFII 1994-96 to increase the sample size for children. The merged surveys are designated as CSFII 1994-96, 1998. Additional information on these surveys can be obtained at http://www.ars.usda.gov/Services/docs.htm?docid=14531.

The CSFII 1994-96, 1998 collected dietary intake data through in-person interviews on 2 non-consecutive days. The data were based on 24-hour recall. A total of 21,662 individuals provided data for the first day; of those individuals, 20,607 provided data for a second day. The 2-day response rate for the 1994-1996 CSFII was approximately 76 percent. The 2-day response rate for CSFII 1998 was 82 percent.

The CSFII 1994-96, 98 surveys were based on a complex multistage area probability sample design. The sampling frame was organized using 1990 U.S. population census estimates, and the stratification plan took into account geographic location, degree of urbanization, and socioeconomic characteristics. Several sets of sampling weights are available for use with the intake data. By using appropriate weights, data for all fours years of the surveys can be combined. USDA recommends that all 4 years be combined in order to provide an adequate sample size for children.

12.3.1 Key Grain Intake Study

12.3.1.1 *U.S. EPA Analysis of CSFII 1994-96, 1998*

For many years, the U.S. EPA's Office of Pesticide Programs (OPP) has used food consumption data collected by the U.S. Department of Agriculture (USDA) for its dietary risk assessments. Most recently, OPP, in cooperation with USDA's Agricultural Research Service (ARS), used data from the 1994-96, 1998 CSFII to develop the Food Commodity Intake Database (FCID). CSFII data on the foods people reported eating were converted to the quantities of agricultural commodities eaten. "Agricultural commodity" is a term used by U.S. EPA to mean plant (or animal) parts consumed by humans as food; when such items are raw or unprocessed, they are referred to as "raw agricultural commodities." For example, an apple pie may contain the commodities apples, flour, fat, sugar and spices. FCID contains approximately 553 unique commodity names and 8-digit codes. The FCID commodity names and codes were selected and defined by U.S. EPA and were based on the U.S. EPA Food Commodity Vocabulary (http://www.epa.gov/pesticides/foodfeed/).

The grain items/groups selected for the U.S. EPA analysis included total grains, and individual grain products such as cereal and rice. Appendix 12A presents the food codes and definitions used to determine the various grain products used in the analysis. Intake rates for these food items/groups represent intake of all forms of the product (e.g., both home produced and commercially produced). Individuals who provided data for two days of the survey were included in the intake estimates. Individuals who did not provide information on body weight or for whom identifying information was unavailable were excluded from the analysis. Two-day average intake rates were calculated for all individuals in the database for each of the food items/groups. These average daily intake rates were divided by each individual's reported body weight to generate intake rates in units of grams per kilogram of body weight per day (g/kg-day). The data were weighted according to the four-year, two-day sample weights provided in the 1994-96, 1998 CSFII to adjust the data for the sample population to reflect the national population.

Summary statistics were generated on both a per capita and a consumer only basis. For per capita intake, both users and non-users of the food item were included in the analysis. Consumer-only intake rates were calculated using data for only those individuals who ate the food item of interest during the survey period. Intake data from the CSFII are based on as-consumed (i.e., cooked or prepared) forms of the food items/groups. Summary statistics, including: number of observations, percentage of the population consuming the grain product being analyzed, mean intake rate, and standard error of the mean intake rate were calculated for total grains and selected individual grain products. Percentiles of the intake rate distribution (i.e., 1st, 5th, 10th, 25th, 50th, 75th, 90th, 95th, 99th, and maximum value) were also provided for total grains. Because these data were developed for use in U.S. EPA's pesticide registration program, the childhood age groups used are slightly different than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005).

Tables 12-3 presents as-consumed per capita intake data for total grains in g/kg-day; as-consumed consumer only intake data for total grains in g/kg-day are provided in Table 12-4. Table 12-5 provides per capita intake data for individual grain products and Table 12-6 provides consumer only intake data for individual grain products.

Tables 12-7 through 12-14 present per capita intake data for individual grain products. The data come from CSFII 1994-96 only. The results are presented in units of g/kg-day.

The use of these data in calculating potential dose does not require the body weight factor to be included in the denominator of the average daily dose (ADD) equation. It should be noted that converting these intake rates into units of g/day by multiplying by a single average body weight is inappropriate, because individual intake rates were indexed to the reported body weights of the survey respondents. However, if there is a need to compare the intake data presented here to intake data in units of g/day, a body weight less than 70 kg (i.e., approximately 60 kg; calculated based on the number of respondents in each age category and the average body weights for these age groups, as presented in Chapter 8) should be used because the total survey population included children as well as adults.

It should be noted that the distribution of average daily intake rates generated using short-term data (e.g., 2-day) do not necessarily reflect the long-term distribution of average daily intake rates. The distributions generated from short-term and long-term data will differ to the extent that each individual's intake varies from day to day; the distributions will be similar to the extent that individuals' intakes are constant from day to day. However, for broad categories of foods (e.g., total grains) that are eaten on a daily basis throughout the year, the short-term distribution may be a reasonable approximation of the true long-term distribution, although it will show somewhat more variability. In this chapter, distributions are provided only for total grains. Because of the increased variability of the short-term distribution, the short-term upper percentiles shown here may overestimate the corresponding percentiles of the long-term distribution. For individual grains, only the mean, standard error, and percent consuming are provided.

The strengths of U.S. EPA's analysis are that it provides distributions of intake rates for various age groups of individuals, normalized by body weight. The analysis uses the 1994-96, 1998 CSFII data set which was designed to be representative of the U.S. population. The data set includes four years of intake data combined, and is based on a two-day survey period. As discussed above, short-term dietary data may not accurately reflect long-term eating patterns and may under-represent infrequent consumers of a given food. This is particularly true for the tails (extremes) of the distribution of food intake. Also, the analysis was conducted using slightly different childhood age groups than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, given the similarities in the childhood age groups used, the data should provide suitable intake estimates for the age groups of interest.

12.3.2 Relevant Grain Intake Studies

12.3.2.1 *USDA, 1980, 1992, 1996a, 1996b - Food and Nutrient Intakes of Individuals in One Day in the U.S.*

USDA calculated mean per capita intake rates for total and individual grain products using Nationwide Food Consumption Survey (NFCS) data from 1977-78 and 1987-88 (USDA 1980; 1992) and CSFII data from 1994 and 1995 (USDA, 1996a; 1996b). The mean per capita intake rates for grain products are presented in Tables 12-15 and 12-16 for the two NFCS survey years, respectively. Table 12-17 presents similar data from the 1994 and 1995 CSFII for grain products.

The advantages of using these data are that they provide mean intake estimates for various grain products. The consumption estimates are based on short-term (i.e., 1-day) dietary data which may not reflect long-term consumption.

12.3.2.2 *USDA, 1999a - Food Consumption, Prices, and Expenditures, 1970-98*

The USDA's Economic Research Service (ERS) calculates the amount of food available for human consumption in the United States annually. Supply and utilization balance sheets are generated. These are based on the flow of food items from production to end uses. Total available supply is estimated as the sum of production (i.e., some products are measured at the farm level or during processing), starting inventories, and imports

(USDA, 1999a). The availability of food for human use commonly termed as "food disappearance" is determined by subtracting exported foods, products used in industries, farm inputs (seed and feed) and end-of-the year inventories from the total available supply (USDA, 1999a). USDA (1999a) calculates the per capita food consumption by dividing the total food disappearance by the total U.S. population.

USDA (1999a) estimated per capita consumption data for grain products from 1970-1998 (1998 data are preliminary). In this section, the 1997 values, which are the most recent final data, are presented. Table 12-18 presents per capita consumption in 1997 for grains.

One of the limitations of this study is that disappearance data do not account for losses from the food supply from waste, spoilage, or foods fed to pets. Thus, intake rates based on these data may overestimate daily consumption because they are based on the total quantity of marketable commodity utilized. Therefore, these data may be useful for estimating bounding exposure estimates. It should also be noted that per capita estimates based on food disappearance are not a direct measure of actual consumption or quantity ingested, instead the data are used as indicators of changes in usage over time (USDA, 1999a). An advantage of this study is that it provides per capita consumption rates for grains which are representative of long-term intake because disappearance data are generated annually. Daily per capita intake rates are generated by dividing annual consumption by 365 days/year.

12.3.2.3 *USDA, 1999b - Food and Nutrient Intakes by Children 1994-96, 1998, Table Set 17*

USDA (1999b) calculated national probability estimates of food and nutrient intake by children based on all 4 years of the CSFII (1994-96 and 1998) for children age 9 years and under, and on CSFII 1994-96 only for individuals age 10 years and over. Sample weights were used to adjust for non-response, to match the sample to the U.S. population in terms of demographic characteristics, and to equalize intakes over the 4 quarters of the year and the 7 days of the week. A total of 503 breast-fed children were excluded from the estimates, but both consumers and non-consumers were included in the analysis.

USDA (1999b) provided data on the mean per capita quantities (grams) of various food products/groups consumed per individual for one day, and the percent of individuals consuming those foods in one day of the survey. Tables 12-19 and 12-20 present data on the mean quantities (grams) of grain products consumed per individual for one day, and the percentage of survey individuals consuming grain products that survey day. Data on mean intakes or mean percentages are based on respondents' day-1 intakes.

The advantages of USDA (1999b) study is that it uses the 1994-96, 98 CSFII data set, which includes four years of intake data, combined, and includes the supplemental data on children. These data are expected to be generally representative of the U.S. population and they include data on a wide variety of grain products. The data set is one of a series of USDA data sets that are publicly available. One limitation of this data set is that it is based on a one-day, and short-term dietary data may not accurately reflect long-term eating patterns. Other limitations of this study are that it only provides mean values of food intake rates, consumption is not normalized by body weight, and presentation of results is not consistent with U.S. EPA's recommended age groups.

12.3.2.4 *Smiciklas-Wright et al., 2002 - Foods Commonly Eaten in the United States: Quantities Consumed per Eating Occasion and in a Day, 1994-1996*

Using data gathered in the 1994-96 USDA CSFII, Smiciklas-Wright et al. (2002) calculated distributions for the quantities of grain products consumed per eating occasion by members of the U.S. population (i.e., serving sizes). The estimates of serving size are based on data obtained from 14,262 respondents, ages 2 and above, who provided 2 days of dietary intake information. Only dietary intake data from users of the specified food were used in the analysis (i.e., consumers only data). Table 12-21 presents, as consumed, the quantity of grain products consumed per eating occasion and the percentage of individuals using these foods in a two day period for a selected variety of grain products. Table 12-22 presents the same data by sex and age.

These data are presented on an as-consumed basis (grams) and represent the quantity of grain products consumed per eating occasion. These estimates may be useful for assessing acute exposures to contaminants in specific foods, or other assessments where the amount consumed per eating occasion is necessary. Only the mean and standard deviation serving size data and percent of the population consuming the food during the 2-day survey period are presented in this handbook. Percentiles of serving sizes of the foods consumed by these age groups of the U.S. population can be found in Smiciklas-Wright et al. (2002).

The advantages of using these data are that they were derived from the USDA CSFII and are representative of the U.S. population. The analysis conducted by Smiciklas-Wright et al. (2002) accounted for individual foods consumed as ingredients of mixed foods. Mixed foods were disaggregated via recipe files so that the individual ingredients could be grouped together with similar foods that were reported separately. Thus, weights of foods consumed as ingredients were combined with weights of foods reported separately to provide a more thorough representation of consumption. However, it should be noted that since the recipes for the mixed foods consumed were not provided by the respondents, standard recipes were used. As a result, the estimates of quantity consumed for some food types are based on assumptions about the types and quantities of ingredients consumed as part of mixed foods. This study used data from the 1994 to 1996 CSFII; data from the 1998 children's supplement were not included.

12.3.2.5 *Vitolins et al., 2002 - Quality of Diets Consumed by Older Rural Adults*

Vitolins et al. (2002) conducted a survey to evaluate the dietary intake, by food groups, of older (>70 years) rural adults. The sample consisted of 130 community dwelling residents from two rural counties in North Carolina. Data on dietary intake over the preceding year were obtained in face-to-face interviews conducted in participants' homes, or in a few cases, a senior center. The food frequency questionnaire used in the survey was a modified version of the National Cancer Institute Health Habits and History Questionnaire (HHHQ); this modified version included an expanded food list containing a greater number of ethnic foods than the original food frequency form. Demographic and personal data collected included gender, ethnicity, age, education, denture use, marital status, chronic disease, and weight.

Food items reported in the survey were grouped into food groups similar to the USDA Food Guide Pyramid and the National Cancer Institute's 5 A Day for Better Health program. These groups are: (1) fruits and vegetables; (2) bread, cereal, rice, and pasta; (3) milk, yogurt and cheese; (4) meat, fish, poultry, beans and eggs; and (5) fats, oils, sweets, and snacks. Medians, ranges, frequencies and percentages were used to summarize intake of each food group, broken down by demographic and health characteristics. In addition, multiple regression models were used to determine which demographic and health factors were jointly predictive of intake of each of the five food groups.

Thirty-four percent of the survey participants were African American, 36% were European American, and 30% were Native American. Sixty-two percent were female, 62% were not married at the time of the interview, and 65% had some high school education or were high school graduates. Almost all of the participants (95%) had one or more chronic diseases. Sixty percent of the respondents were between 70 and 79 years of age; the median age was 78 years old. The median servings of bread, cereal, rice and pasta broken down by demographic and health characteristic are presented in Table 12-23. Only gender was statistically predictive of bread, cereal, rice and pasta intake ($P < 0.01$), with males consuming approximately an extra serving per day compared to women. Also, the multiple regression model indicated that gender was predictive of breads, cereal, rice, and pasta intake after controlling for other demographic variables.

One limitation of the study, as noted by the study authors, is that the study did not collect information on the length of time the participants had been practicing the dietary behaviors reported in the survey. The questionnaire asked participants to report the frequency of food consumption during the past year. The study authors noted that, currently, there are no dietary assessment tools that allow the collection of comprehensive dietary data over years of food consumption. Another limitation of the study is that the small sample size used makes associations by gender and ethnicity difficult.

12.3.2.6 *Fox et al., 2004 - Feeding Infants and Toddlers study: What Foods Are Infants and Toddlers Eating*

Fox et al. (2004) used data from the Feeding Infants and Toddlers study (FITS) to assess food consumption patterns in infants and toddlers. The FITS was sponsored by Gerber Products Company and was conducted to obtain current information on food and nutrient intakes of children, ages 4 to 24 months old, in the 50 states and the District of Columbia. The FITS is described in detail in Devaney et al. (2004). FITS was based on a random sample of 3,022 infants and toddlers for which dietary intake data were collected by telephone from their parents or caregivers between March and July 2002. An initial recruitment and household interview was conducted, followed by an interview to obtain information on intake based on 24-hour recall. The interview also addressed growth, development and feeding patterns. A second dietary recall interview was conducted for a subset of 703 randomly selected respondents. The study over-sampled children in the 4 to 6 and 9 to11 months age groups; sample weights were adjusted for non-response, over sampling, and under coverage of some subgroups. The response rate for the FITS was 73 percent for the recruitment interview. Of the recruited households, there was a response rate of 94 percent for the dietary recall interviews (Devaney et al., 2004). The characteristics of the FITS study population are shown in Table 12-24.

Fox et al. (2004) analyzed the first set of 24-hour recall data collected from all study participants. For this analysis, children were grouped into six age categories: 4 to 6 months, 7 to 8 months, 9 to 11 months, 12 to 14 months, 15 to 18 months, and 19 to 24 months. Table 12-25 provides the percentage of infants and toddlers consuming different types of grains or grain products at least once in a day. The percentages of children eating any type of grain or grain product ranged from 65.8 percent for 4 to 6 month olds to 99.2 percent for 19 to 24 month olds.

The advantages of this study were that the study population represents the U.S. population and the sample size was large. One limitation of the analysis done by Fox et al. (2004) is that only frequency data were provided; no information on actual intake rates was included. In addition, Devaney et al. (2004) noted several limitations associated with the FITS data. For the FITS, a commercial list of infants and toddlers was used to obtain the sample used in the study. Since many of the households could not be located and did not have children in the target population, a lower response rate than would have occurred in a true national sample was obtained (Devaney et al., 2004). In addition, the sample was likely from a higher socioeconomic status when compared with all U.S. infants in this age group (4 to 24 months old) and the use of a telephone survey may have omitted lower-income households without telephones (Devaney et al., 2004).

12.3.2.7 *Ponza et al., 2004 - Nutrient Food Intakes and Food Choices of Infants and Toddlers Participating in WIC*

Ponza et al. (2004) conducted a study using selected data from the FITS to assess feeding patterns, food choices and nutrient intake of infants and toddlers participating in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Ponza et al. (2004) evaluated FITS data for the following age groups: 4 to 6 months (N = 862), 7 to 11 months (N = 1,159) and 12 to 24 months (N= 996). The total sample size described by WIC participants and non-participants is shown in Table 12-26.

The foods consumed were analyzed by tabulating the percentage of infants who consumed specific foods/food groups per day (Ponza et al., 2004). Weighted data were used in all of the analyses used in the study (Ponza et al., 2004). Table 12-26 presents the demographic data for WIC participants and non-participants. Table 12-27 provides information on the food choices for the infants and toddlers studied. In general, there was little difference in grain product choices among WIC participants and non-participants, except for the 7 to 11 months age category (Table 12-27). Nonparticipants, ages 7 to 11 months, were more likely to eat non-infant cereals than WIC participants.

An advantage of this study is that it had a relatively large sample size and was representative of the U.S. general population of infants and children. A limitation of the study is that intake values for foods were not provided. Other limitations are those associated with the FITS data, as described previously in Section 12.3.2.6.

12.3.2.8 *Fox et al., 2006 - Average Portion of Foods Commonly Eaten by Infants and Toddlers in the United States*

Fox et al. (2006) estimated average portion sizes consumed per eating occasion by children 4 to 24 months of age who participated in the FITS. The FITS is a cross-sectional study designed to collect and analyze data on feeding practices, food consumption, and usual nutrient intake of U.S. infants and toddlers and is described in Section 12.3.2.6 of this chapter. It included a stratified random sample of 3,022 children between 4 and 24 months of age.

Using the 24-hour recall data, Fox et al. (2006) derived average portion sizes for six major food groups, including breads and grains. Average portion sizes for select individual foods within these major groups were also estimated. For this analysis, children were grouped into six age categories: 4 to 5 months, 6 to 8 months, 9 to 11 months, 12 to 14 months, 15 to 18 months, and 19 to 24 months. Tables 12-28 and 12-29 present the average portion sizes for grain products for infants and toddlers, respectively.

12.3.2.9 *Mennella et al., 2006 - Feeding Infants and Toddlers Study: The Types of Foods Fed to Hispanic Infants and Toddlers*

Menella et al. (2006) investigated the types of food and beverages consumed by Hispanic infants and toddlers in comparison to the non-Hispanic infants and toddlers in the United States. The FITS 2002 data for children between 4 and 24 months of age were used for the study. The data represent a random sample of 371 Hispanic and 2,367 non-Hispanic infants and toddlers (Menella et al., 2006).

Menella et al. (2006) grouped the infants as follows: 4 to 5 months (N = 84 Hispanic; 538 non-Hispanic), 6 to 11 months (N = 163 Hispanic and 1,228 non-Hispanic), and 12 to 24 months (N = 124 Hispanic and 871 non-Hispanic) of age.

Table 12-30 provides the percentage of Hispanic and non-Hispanic infants and toddlers consuming grain products. In most instances the percentages consuming the different types are similar. However, 6 to 11 month old Hispanic children were more likely to eat rice and pasta than non-Hispanic children in this age groups.

The advantage of the study is that it provides information on food preferences for Hispanic and non-Hispanic infants and toddlers. A limitation is that the study did not provide food intake data, but provided frequency of use data instead. Other limitations are those noted previously in Section 12.3.2.6 for the FITS data.

12.4 CONVERSION BETWEEN WET AND DRY WEIGHT INTAKE RATES

The intake data presented in this chapter are reported in units of wet weight (i.e., as-consumed or uncooked weight of grain products consumed per day or per eating occasion). However, data on the concentration of contaminants in grain products may be reported in units of either wet or dry weight.(e.g., mg contaminant per gram dry-weight of grain products.) It is essential that exposure assessors be aware of this difference so that they may ensure consistency between the units used for intake rates and those used for concentration data (i.e., if the contaminant concentration is measured in dry weight of grain products, then the dry weight units should be used for their intake values).

If necessary, wet weight (e.g., as consumed) intake rates may be converted to dry weight intake rates using the moisture content percentages presented in Table 12-31 and the following equation:

$$IR_{dw} = IR_{ww}\left[\frac{100-W}{100}\right] \qquad \text{(Eqn. 12-1)}$$

where:

IR_{dw} = dry weight intake rate;
IR_{ww} = wet weight intake rate; and
W = percent water content

Alternatively, dry weight residue levels in grain products may be converted to wet weight residue levels for use with wet weight (e.g., as-consumed) intake rates as follows:

$$C_{ww} = C_{dw}\left[\frac{100-W}{100}\right] \qquad \text{(Eqn. 12-2)}$$

where:

C_{ww} = wet weight intake rate;
C_{dw} = dry weight intake rate; and
W = percent water content.

The moisture data presented in Table 12-31 are for selected grain products taken from USDA (2007).

12.5 REFERENCES FOR CHAPTER 12

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Table 12-3. Per Capita Intake of Total Grains (g/kg-day as consumed)

Domain	N	Percent Consuming	Mean	SE	Percentiles									
					1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	20,607	99.5	2.7	0.0	0.2	0.6	0.9	1.3	2.1	3.3	5.2	6.8	10.3	31.6
Age group														
Birth to 1 year	1,486	70.5	2.5	0.1	0.0	0.0	0.0	0.0	1.6	3.8	6.2	8.6	12.7	26.3
1 to 2 years	2,096	99.8	6.4	0.1	1.1	2.1	2.8	4.2	5.9	7.9	10.4	12.1	16.8	31.6
3 to 5 years	4,391	100.0	6.3	0.1	1.8	2.6	3.2	4.3	5.9	7.8	9.9	11.5	15.6	27.0
6 to 12 years	2,089	100.0	4.3	0.1	0.9	1.7	2.0	2.8	4.0	5.4	7.0	8.2	11.1	17.2
13 to 19 years	1,222	100.0	2.5	0.1	0.4	0.8	1.1	1.5	2.3	3.1	4.4	5.1	7.9	12.4
20 to 49 years	4,677	99.9	2.2	0.0	0.3	0.6	0.8	1.3	1.9	2.8	3.9	4.7	7.1	16.1
≥ 50 years	4,646	100.0	1.7	0.0	0.3	0.6	0.7	1.1	1.5	2.1	2.8	3.5	4.9	11.2
Season														
Fall	4,687	99.5	2.6	0.0	0.2	0.6	0.9	1.3	2.1	3.3	5.0	6.6	10.0	26.3
Spring	5,308	99.6	2.7	0.0	0.2	0.6	0.8	1.3	2.1	3.4	5.5	7.0	10.5	29.4
Summer	5,890	99.5	2.6	0.0	0.3	0.7	0.9	1.3	2.1	3.3	5.1	6.8	10.5	28.2
Winter	4,722	99.5	2.7	0.0	0.2	0.6	0.9	1.4	2.1	3.3	5.2	6.8	10.1	31.6
Race														
Asian, Pacific Islander	557	98.5	3.6	0.2	0.0	1.1	1.5	2.3	3.2	4.7	6.2	7.3	11.2	24.6
Black	2,740	99.4	2.6	0.1	0.1	0.5	0.7	1.1	1.9	3.3	5.4	7.3	11.5	29.4
American Indian, Alaskan Native	177	99.7	2.9	0.2	0.3	0.5	0.8	1.3	2.2	4.2	6.3	7.5	12.0	16.8
Other/NA	1,638	98.8	3.1	0.1	0.0	0.7	0.9	1.5	2.4	4.1	6.1	7.7	11.7	27.0
White	15,495	99.6	2.6	0.0	0.3	0.7	0.9	1.3	2.0	3.2	5.0	6.6	9.8	31.6
Region														
Midwest	4,822	99.7	2.7	0.0	0.3	0.7	0.9	1.4	2.1	3.4	5.3	7.0	10.4	23.8
Northeast	3,692	99.6	2.8	0.0	0.3	0.7	1.0	1.4	2.2	3.5	5.3	6.8	11.0	31.6
South	7,208	99.5	2.5	0.0	0.2	0.6	0.8	1.2	1.9	3.0	5.0	6.6	9.7	28.2
West	4,885	99.4	2.8	0.1	0.2	0.7	0.9	1.4	2.2	3.5	5.4	7.0	10.3	20.8
Urbanization														
Central City	6,164	99.5	2.7	0.0	0.1	0.6	0.9	1.3	2.1	3.5	5.4	7.0	10.7	29.4
Suburban	9,598	99.5	2.7	0.0	0.3	0.7	0.9	1.4	2.1	3.4	5.3	6.9	10.0	31.6
Non-metropolitan	4,845	99.6	2.4	0.1	0.3	0.6	0.8	1.2	1.9	2.9	4.8	6.3	10.4	23.8

N = Sample size.
SE = Standard error.

Source: Based on unpublished U.S. EPA analysis of 1994-96, 1998 CSFII.

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Table 12-4. Consumer Only Intake of Total Grains (g/kg-day as consumed)

Domain	N	Mean	SE	Percentiles									
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	20,157	2.7	0.0	0.3	0.7	0.9	1.3	2.1	3.3	5.2	6.8	10.3	31.6
Age Group													
Birth to 1 year	1,048	3.6	0.1	0.1	0.3	0.6	1.4	2.8	4.8	7.4	9.2	13.4	26.3
1 to 2 years	2,092	6.4	0.1	1.2	2.1	2.8	4.2	5.9	7.9	10.4	12.1	16.8	31.6
3 to 5 years	4,389	6.3	0.1	1.8	2.6	3.2	4.3	5.9	7.8	9.9	11.5	15.6	27.0
6 to 12 years	2,089	4.3	0.1	0.9	1.7	2.0	2.8	4.0	5.4	7.0	8.2	11.1	17.2
13 to 19 years	1,222	2.5	0.1	0.4	0.8	1.1	1.5	2.3	3.1	4.4	5.1	7.9	12.4
20 to 49 years	4,673	2.2	0.0	0.3	0.6	0.8	1.3	1.9	2.8	3.9	4.7	7.1	16.1
≥ 50 years	4,644	1.7	0.0	0.3	0.6	0.7	1.1	1.5	2.1	2.8	3.5	4.9	11.2
Season													
Fall	4,587	2.6	0.0	0.3	0.7	0.9	1.3	2.1	3.3	5.0	6.6	10.0	26.3
Spring	5,190	2.7	0.0	0.3	0.7	0.9	1.3	2.1	3.4	5.5	7.0	10.6	29.4
Summer	5,751	2.7	0.0	0.4	0.7	0.9	1.4	2.1	3.3	5.2	6.8	10.5	28.2
Winter	4,629	2.7	0.0	0.3	0.7	0.9	1.4	2.1	3.3	5.2	6.8	10.1	31.6
Race													
Asian, Pacific Islander	527	3.7	0.2	0.8	1.2	1.6	2.3	3.2	4.7	6.2	7.3	11.2	24.6
Black	2,675	2.6	0.1	0.2	0.5	0.7	1.1	1.9	3.3	5.4	7.3	11.5	29.4
American Indian, Alaskan Native	175	3.0	0.2	0.3	0.5	0.8	1.3	2.2	4.2	6.3	7.5	12.0	16.8
Other/NA	1,570	3.2	0.1	0.5	0.7	1.0	1.5	2.4	4.1	6.2	7.7	11.7	27.0
White	15,210	2.6	0.0	0.4	0.7	0.9	1.3	2.0	3.2	5.1	6.6	9.8	31.6
Region													
Midwest	4,743	2.7	0.0	0.4	0.7	0.9	1.4	2.1	3.4	5.3	7.0	10.4	23.8
Northeast	3,628	2.8	0.0	0.4	0.8	1.0	1.4	2.2	3.5	5.3	6.8	11.0	31.6
South	7,053	2.5	0.0	0.3	0.6	0.8	1.2	1.9	3.0	5.0	6.6	9.8	28.2
West	4,733	2.8	0.1	0.4	0.7	0.9	1.4	2.2	3.5	5.4	7.0	10.3	20.8
Urbanization													
Central City	6,023	2.8	0.0	0.3	0.7	0.9	1.3	2.1	3.5	5.4	7.0	10.7	29.4
Suburban	9,378	2.7	0.0	0.4	0.7	0.9	1.4	2.1	3.4	5.3	6.9	10.0	31.6
Non-metropolitan	4,756	2.4	0.1	0.3	0.6	0.8	1.2	1.9	2.9	4.8	6.4	10.4	23.8

N = Sample size.
SE = Standard error.

Source: Based on unpublished U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 12-5. Per Capita Intake of Individual Grain Products (g/kg-day as consumed)

Age Group	N	Cereal			Rice		
		Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
Whole Population	20,607	99.6	3.7	0.03	86.5	0.3	0.01
Age Group							
Birth to 1 year	1,486	74.6	4.0	0.14	60.2	0.7	0.04
1 to 2 years	2,096	99.8	8.4	0.08	86.4	0.6	0.03
3 to 5 years	4,391	100.0	8.7	0.07	87.9	0.5	0.03
6 to 12 years	2,089	100.0	6.2	0.06	88.0	0.4	0.02
13 to 19 years	1,222	100.0	4.1	0.06	85.8	0.3	0.02
20 to 49 years	4,677	99.9	3.1	0.04	88.3	0.3	0.01
≥ 50 years	4,646	100.0	2.2	0.02	84.5	0.2	0.01
Season							
Fall	4,687	99.6	3.7	0.06	85.1	0.3	0.02
Spring	5,308	99.6	3.8	0.07	87.1	0.3	0.02
Summer	5,890	99.5	3.8	0.06	86.9	0.3	0.02
Winter	4,722	99.6	3.7	0.05	87.1	0.3	0.02
Race							
Asian, Pacific Islander	557	98.5	4.4	0.20	96.6	1.7	0.19
Black	2,740	99.5	3.8	0.12	86.3	0.3	0.02
American Indian, Alaskan Native	177	99.7	4.2	0.15	92.6	0.3	0.10
Other/NA	1,638	98.9	4.3	0.12	85.9	0.6	0.08
White	15,495	99.7	3.7	0.04	86.2	0.2	0.01
Region							
Midwest	4,822	99.7	3.9	0.09	88.2	0.2	0.02
Northeast	3,692	99.7	3.7	0.06	87.2	0.3	0.03
South	7,208	99.6	3.6	0.04	85.0	0.2	0.01
West	4,885	99.4	3.8	0.09	86.7	0.4	0.03
Urbanization							
Central City	6,164	99.6	3.8	0.06	87.2	0.4	0.02
Suburban	9,598	99.5	3.8	0.05	86.6	0.3	0.02
Non-metropolitan	4,845	99.7	3.5	0.06	85.6	0.2	0.01

N = Sample size.
SE = Standard error.

Source: Based on unpublished U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 12-6. Consumer Only Intake of Individual Grain Products (g/kg-day as consumed)						
Age Group	Cereal			Rice		
	N	Mean	SE	N	Mean	SE
Whole Population	20,227	3.8	0.03	17,481	0.3	0.01
Age Group						
Birth to 1 year	1,116	5.4	0.16	900	1.2	0.07
1 to 2 years	2,092	8.4	0.08	1,819	0.7	0.04
3 to 5 years	4,389	8.7	0.07	3,869	0.6	0.03
6 to 12 years	2,089	6.2	0.06	1,847	0.4	0.02
13 to 19 years	1,222	4.1	0.06	1,038	0.3	0.03
20 to 49 years	4,674	3.1	0.04	4,102	0.3	0.01
≥ 50 years	4,645	2.2	0.02	3,906	0.2	0.01
Season						
Fall	4,598	3.7	0.06	3,957	0.3	0.02
Spring	5,213	3.8	0.07	4,530	0.3	0.02
Summer	5,768	3.8	0.06	4,989	0.3	0.02
Winter	4,648	3.7	0.06	4,005	0.3	0.02
Race						
Asian, Pacific Islander	529	4.5	0.20	513	1.8	0.19
Black	2,683	3.8	0.12	2,346	0.4	0.02
American Indian, Alaskan Native	175	4.3	0.15	151	0.3	0.10
Other/NA	1,579	4.4	0.13	1,375	0.7	0.08
White	15,261	3.7	0.04	13,096	0.2	0.01
Region						
Midwest	4,759	3.9	0.09	4,186	0.2	0.02
Northeast	3,639	3.7	0.06	3,152	0.4	0.04
South	7,081	3.6	0.04	6,029	0.3	0.01
West	4,748	3.9	0.09	4,114	0.5	0.03
Urbanization						
Central City	6,039	3.8	0.06	5,303	0.5	0.03
Suburban	9,410	3.8	0.05	8,105	0.3	0.02
Non-metropolitan	4,778	3.6	0.06	4,073	0.2	0.02

N = Sample size.
SE = Standard error.

Source: Based on unpublished U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 12-7. Per Capita Intake of Breads[a] (g/kg-day as consumed)

Group	Percent consuming	Mean	SE	Percentile 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	87.2	1.1	0.01	0.0	0.0	0.0	0.4	0.9	1.5	2.3	3.1	5.1	20.0
Age Group													
≤ 5 months	0.9	0.0	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
6 to 12 months	30.2	0.5	0.16	0.0	0.0	0.0	0.0	0.0	0.5	1.8	3.0	4.8	7.3
<1 years	14.6	0.3	0.11	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.7	4.6	7.3
1 to 2 years	77.2	2.0	0.06	0.0	0.0	0.0	0.4	1.4	2.9	4.4	6.0	8.5	20.0
3 to 5 years	86.5	2.3	0.05	0.0	0.0	0.0	0.9	2.0	3.3	4.7	5.8	8.7	13.2
6 to 11 years	87.1	1.7	0.04	0.0	0.0	0.0	0.7	1.4	2.4	3.5	4.3	6.7	11.3
12 to 19 years	86.2	1.1	0.03	0.0	0.0	0.0	0.4	0.9	1.5	2.3	2.8	4.0	7.5
20 to 39 years	88.1	0.9	0.02	0.0	0.0	0.0	0.4	0.8	1.3	2.0	2.5	3.9	6.2
40 to 69 years	90.0	0.9	0.01	0.0	0.0	0.0	0.4	0.8	1.3	1.9	2.3	3.5	8.4
≥70 years	91.6	0.9	0.02	0.0	0.0	0.2	0.4	0.8	1.3	1.9	2.3	2.9	4.3
Season													
Fall	87.4	1.1	0.02	0.0	0.0	0.0	0.4	0.9	1.5	2.4	3.1	4.9	14.6
Spring	87.1	1.1	0.02	0.0	0.0	0.0	0.4	0.9	1.5	2.3	3.1	5.1	11.6
Summer	87.3	1.1	0.02	0.0	0.0	0.0	0.4	0.9	1.5	2.4	3.1	5.2	17.1
Winter	86.9	1.1	0.02	0.0	0.0	0.0	0.4	0.8	1.4	2.3	3.1	5.1	20.0
Race													
Asian	69.1	0.8	0.06	0.0	0.0	0.0	0.0	0.4	1.2	1.9	2.9	4.5	14.6
Black	83.1	1.1	0.03	0.0	0.0	0.0	0.3	0.7	1.4	2.3	3.3	6.3	11.6
American Indian/Alaska Native	82.2	1.4	0.18	0.0	0.0	0.0	0.3	0.9	1.7	3.6	4.1	6.2	20.0
Other/NA	80.4	1.2	0.04	0.0	0.0	0.0	0.3	0.9	1.6	2.7	3.4	5.6	7.5
White	89.0	1.1	0.01	0.0	0.0	0.0	0.4	0.9	1.5	2.3	3.0	4.9	17.1
Region													
Midwest	89.1	1.2	0.02	0.0	0.0	0.0	0.4	0.9	1.5	2.5	3.3	5.7	12.0
Northeast	88.3	1.1	0.02	0.0	0.0	0.0	0.4	0.9	1.5	2.3	2.9	4.5	9.8
South	87.5	1.1	0.02	0.0	0.0	0.0	0.4	0.9	1.5	2.3	3.1	4.9	17.1
West	83.7	1.1	0.02	0.0	0.0	0.0	0.3	0.8	1.4	2.4	3.2	5.1	20.0
Urbanization													
Central City	85.6	1.1	0.02	0.0	0.0	0.0	0.4	0.8	1.4	2.3	3.1	5.1	13.2
Suburban	87.7	1.1	0.01	0.0	0.0	0.0	0.4	0.9	1.5	2.4	3.1	5.0	14.6
Nonmetropolitan	88.5	1.1	0.02	0.0	0.0	0.0	0.4	0.9	1.5	2.3	3.1	5.0	20.0

[a] Includes breads, rolls, muffins, bagels, biscuits, cornbread, and tortillas.
SE = Standard error.

Source: Based on U.S. EPA's analysis of the 1994-96 CSFII.

Table 12-8. Per Capita Intake of Sweets[a] (g/kg-day as consumed)

Group	Percent consuming	Mean	SE	Percentile									
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	52.6	0.6	0.01	0.0	0.0	0.0	0.0	0.1	0.8	1.8	2.5	4.6	22.0
Age Group													
≤5 months	2.5	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.6
6 to 12 months	23.0	0.3	0.14	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.0	3.6	6.4
<1 years	12.1	0.2	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	3.6	6.4
1 to 2 years	53.2	1.2	0.07	0.0	0.0	0.0	0.0	0.3	1.7	3.5	4.8	7.2	19.3
3 to 5 years	62.1	1.3	0.06	0.0	0.0	0.0	0.0	0.8	1.9	3.6	4.6	8.8	22.0
6 to 11 years	64.2	1.2	0.06	0.0	0.0	0.0	0.0	0.6	1.7	3.2	3.9	6.7	20.9
12 to 19 years	54.3	0.6	0.03	0.0	0.0	0.0	0.0	0.2	1.0	1.8	2.4	3.7	10.7
20 to 39 years	47.2	0.4	0.02	0.0	0.0	0.0	0.0	0.0	0.6	1.4	1.9	3.2	11.1
40 to 69 years	52.9	0.5	0.02	0.0	0.0	0.0	0.0	0.1	0.7	1.3	1.9	3.2	7.3
≥70 years	58.6	0.5	0.03	0.0	0.0	0.0	0.0	0.2	0.8	1.6	2.1	3.6	5.7
Season													
Fall	53.7	0.6	0.03	0.0	0.0	0.0	0.0	0.2	0.9	1.8	2.5	4.7	20.9
Spring	52.2	0.6	0.02	0.0	0.0	0.0	0.0	0.1	0.8	1.8	2.6	4.7	22.0
Summer	50.0	0.5	0.02	0.0	0.0	0.0	0.0	0.0	0.7	1.6	2.3	4.1	18.2
Winter	54.5	0.6	0.03	0.0	0.0	0.0	0.0	0.2	0.9	1.9	2.6	4.8	12.3
Race													
Asian	40.2	0.4	0.08	0.0	0.0	0.0	0.0	0.0	0.6	1.4	2.0	3.1	15.7
Black	41.4	0.5	0.04	0.0	0.0	0.0	0.0	0.0	0.6	1.5	2.3	4.7	19.3
American Indian/Alaska Native	35.3	0.4	0.11	0.0	0.0	0.0	0.0	0.0	0.3	1.7	2.1	2.8	2.9
Other/NA	35.0	0.4	0.05	0.0	0.0	0.0	0.0	0.0	0.5	1.3	1.9	4.1	7.0
White	56.3	0.6	0.01	0.0	0.0	0.0	0.0	0.2	0.9	1.8	2.5	4.7	22.0
Region													
Midwest	60.1	0.7	0.03	0.0	0.0	0.0	0.0	0.3	1.0	2.0	2.9	5.3	22.0
Northeast	55.4	0.6	0.03	0.0	0.0	0.0	0.0	0.2	0.9	1.7	2.5	4.8	12.7
South	49.1	0.6	0.02	0.0	0.0	0.0	0.0	0.0	0.8	1.7	2.3	4.4	20.9
West	47.7	0.5	0.02	0.0	0.0	0.0	0.0	0.0	0.7	1.6	2.3	3.8	15.7
Urbanization													
Central City	51.2	0.6	0.02	0.0	0.0	0.0	0.0	0.1	0.8	1.6	2.3	4.6	20.9
Suburban	54.6	0.6	0.02	0.0	0.0	0.0	0.0	0.2	0.9	1.8	2.6	4.5	12.7
Non-metropolitan	50.5	0.6	0.03	0.0	0.0	0.0	0.0	0.1	0.8	1.8	2.5	5.1	22.0

[a] Includes breakfast foods made with grains such as pancakes, waffles, and french toast.
SE = Standard error.

Source: Based on U.S. EPA's analysis of the 1994-96 CSFII.

Table 12-9. Per Capita Intake of Snacks Containing Grains[a] (g/kg-day as consumed)

Group	Percent consuming	Mean	SE	Percentile									
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	43.1	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.7	1.2	2.6	9.1
Age Group													
≤5 months	1.0	0.0	0.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.7
6 to 12 months	29.0	0.3	0.08	0.0	0.0	0.0	0.0	0.0	0.2	0.9	2.2	2.5	2.8
<1 years	14.1	0.1	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.9	2.2	3.7
1 to 2 years	58.1	0.7	0.04	0.0	0.0	0.0	0.0	0.4	1.1	2.0	2.8	5.0	8.9
3 to 5 years	56.7	0.7	0.04	0.0	0.0	0.0	0.0	0.3	0.9	1.8	3.2	5.9	9.1
6 to 11 years	51.3	0.5	0.03	0.0	0.0	0.0	0.0	0.1	0.6	1.3	1.9	4.6	7.3
12 to 19 years	45.0	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.4	0.9	1.4	2.4	5.1
20 to 39 years	41.1	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.9	1.8	5.5
40 to 69 years	41.1	0.1	0.01	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.7	1.4	5.6
≥70 years	37.7	0.1	0.01	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.5	0.8	1.8
Season													
Fall	42.3	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.7	1.0	2.3	8.0
Spring	43.6	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.8	1.3	2.9	8.9
Summer	40.6	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.2	0.7	1.0	2.3	7.1
Winter	45.8	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.3	0.8	1.3	2.9	9.1
Race													
Asian	24.1	0.1	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	2.3	4.4
Black	29.5	0.2	0.02	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.9	2.1	7.4
American Indian/Alaska Native	38.3	0.2	0.08	0.0	0.0	0.0	0.0	0.0	0.2	0.6	1.1	3.2	4.9
Other/NA	28.4	0.2	0.03	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.8	2.4	8.7
White	47.1	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.8	1.2	2.7	9.1
Region													
Midwest	49.2	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.8	1.2	2.7	8.9
Northeast	41.9	0.2	0.02	0.0	0.0	0.0	0.0	0.0	0.2	0.7	1.2	2.7	9.1
South	41.1	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.2	0.7	1.1	2.4	8.0
West	40.7	0.2	0.02	0.0	0.0	0.0	0.0	0.0	0.2	0.7	1.2	2.6	8.7
Urbanization													
Central City	40.1	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.2	0.7	1.1	2.6	7.8
Suburban	44.6	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.7	1.2	2.7	9.1
Non-metropolitan	44.1	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.7	1.1	2.3	8.1

[a] Includes grain snacks such as crackers, salty snacks, popcorn, and pretzels.
SE = Standard error.

Source: Based on U.S. EPA's analysis of the 1994-96 CSFII.

Table 12-10. Per Capita Intake of Breakfast Foods[a] (g/kg-day as consumed)

Group	Percent consuming	Mean	SE	Percentile									
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	11.8	0.1	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	2.4	13.6
Age Group													
≤5 months	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 to 12 months	4.2	0.1	0.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	4.1
<1 years	2.0	0.1	0.16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	4.1
1 to 2 years	20.4	0.4	0.07	0.0	0.0	0.0	0.0	0.0	0.0	1.9	2.7	4.8	13.6
3 to 5 years	20.8	0.4.	0.06	0.0	0.0	0.0	0.0	0.0	0.0	1.6	2.5	4.5	8.0
6 to 11 years	23.7	0.4	0.05	0.0	0.0	0.0	0.0	0.0	0.0	1.5	2.2	3.4	6.5
12 to 19 years	13.0	0.1	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.9	2.3	3.9
20 to 39 years	8.9	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.5	3.0
40 to 69 years	9.5	0.1	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.4	3.8
≥70 years	10.4	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.7	1.2	3.5
Season													
Fall	11.6	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	2.3	13.6
Spring	11.6	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	2.3	6.4
Summer	12.8	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	2.4	6.0
Winter	11.3	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.9	2.6	8.0
Race													
Asian	5.9	0.1	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.0	2.8
Black	12.7	0.1	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.2	2.1	6.7
American Indian/Alaska Native	8.8	0.1	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.2	1.2
Other/NA	10.2	0.1	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.6	8.0
White	12.0	0.1	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	2.4	13.6
Region													
Midwest	12.1	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.1	2.6	6.7
Northeast	12.7	0.1	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.2	2.3	8.0
South	10.7	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8	2.2	7.8
West	12.4	0.2	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	2.6	13.6
Urbanization													
Central City	12.0	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	2.5	13.6
Suburban	12.2	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	2.4	7.8
Nonmetropolitan	10.7	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.9	2.2	6.4

[a] Includes breakfast food made with grains such as pancakes, waffles, and french toast.
SE = Standard error.

Source: Based on U.S. EPA's analysis of the 1994-96 CSFII.

Table 12-11. Per Capita Intake of Pasta (g/kg-day as consumed)

Group	Percent consuming	Mean	SE	Percentile									
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	13.0	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.2	5.1	29.1
Age Group													
≤5 months	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 to 12 months	7.5	0.1	0.22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	3.3	6.7
<1 years	3.5	0.1	0.15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	6.7
1 to 2 years	16.0	0.8	0.15	0.0	0.0	0.0	0.0	0.0	0.0	3.4	6.2	10.6	16.7
3 to 5 years	12.8	0.6	0.13	0.0	0.0	0.0	0.0	0.0	0.0	2.1	4.4	8.4	14.3
6 to 11 years	13.4	0.5	0.12	0.0	0.0	0.0	0.0	0.0	0.0	2.0	3.8	7.5	11.9
12 to 19 years	11.7	0.3	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.1	4.2	29.1
20 to 39 years	13.9	0.3	0.04	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.2	4.1	11.2
40 to 69 years	13.7	0.2	0.03	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.9	3.6	11.8
≥70 years	9.0	0.2	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	2.9	7.7
Season													
Fall	13.6	0.3	0.05	0.0	0.0	0.0	0.0	0.0	0.0	1.2	2.4	4.7	16.7
Spring	13.2	0.3	0.05	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.3	5.8	14.7
Summer	12.6	0.3	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.1	5.2	15.4
Winter	12.6	0.3	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.1	5.1	29.1
Race													
Asian	19.4	0.5	0.17	0.0	0.0	0.0	0.0	0.0	0.0	2.0	3.3	6.6	11.2
Black	7.0	0.2	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	3.6	29.1
American Indian/Alaska Native	1.8	0.1	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	3.6
Other/NA	9.6	0.2	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	3.5	15.4
White	14.1	0.3	0.03	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.3	5.3	16.7
Region													
Midwest	12.1	0.3	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.1	5.2	16.7
Northeast	20.1	0.5	0.05	0.0	0.0	0.0	0.0	0.0	0.0	1.9	2.8	5.9	15.4
South	9.5	0.2	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	4.4	29.1
West	13.2	0.3	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.2	5.7	14.1
Urbanization													
Central City	13.4	0.3	0.05	0.0	0.0	0.0	0.0	0.0	0.0	1.2	2.5	5.3	29.1
Suburban	14.0	0.3	0.03	0.0	0.0	0.0	0.0	0.0	0.0	1.2	2.2	5.3	16.7
Nonmetropolitan	10.3	0.2	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.5	4.2	14.1

SE = Standard error.

Source: Based on U.S. EPA's analysis of the 1994-96 CSFII.

Table 12-12. Per Capita Intake of Cooked Cereals (g/kg-day as consumed)

Group	Percent consuming	Mean	SE	Percentile 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	10.4	0.4	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.3	7.2	72.5
Age Group													
≤5 months	0.9	0.1	0.54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6
6 to 12 months	16.6	1.9	1.18	0.0	0.0	0.0	0.0	0.0	0.0	9.4	16.1	22.8	22.8
<1 years	8.3	0.9	0.82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	22.8	22.8
1 to 2 years	18.4	1.6	0.29	0.0	0.0	0.0	0.0	0.0	0.0	6.9	10.7	20.6	33.9
3 to 5 years	16.0	1.3	0.28	0.0	0.0	0.0	0.0	0.0	0.0	5.3	7.9	16.1	72.5
6 to 11 years	8.7	0.5	0.17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	9.4	24.1
12 to 19 years	5.6	0.2	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	4.3	10.6
20 to 39 years	6.2	0.1	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	3.3	9.2
40 to 69 years	11.6	0.3	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.9	4.4	8.7
≥70 years	24.5	0.6	0.07	0.0	0.0	0.0	0.0	0.0	0.0	2.2	3.4	5.6	10.6
Season													
Fall	12.0	0.4	0.08	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.6	8.1	45.9
Spring	9.1	0.3	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	6.4	20.9
Summer	9.3	0.3	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	6.9	72.5
Winter	11.1	0.4	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.5	7.4	44.5
Race													
Asian	4.4	0.2	0.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	16.1
Black	20.1	0.7	0.10	0.0	0.0	0.0	0.0	0.0	0.0	2.2	4.4	10.9	33.9
American Indian/Alaska Native	7.6	0.3	0.32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	5.8	12.3
Other/NA	7.6	0.4	0.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	10.6	72.5
White	9.3	0.3	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	6.1	45.9
Region													
Midwest	9.6	0.3	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	5.7	45.9
Northeast	9.0	0.3	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	5.9	72.5
South	12.4	0.4	0.06	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.6	7.9	31.7
West	9.4	0.4	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	8.0	39.5
Urbanization													
Central City	11.6	0.4	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.6	8.1	72.5
Suburban	9.9	0.3	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	6.9	45.9
Nonmetropolitan	9.7	0.3	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	5.7	26.9

SE = Standard error.

Source: Based on U.S. EPA's analysis of the 1994-96 CSFII.

Table 12-13. Per Capita Intake of Ready-to-Eat Cereals[a] (g/kg-day as consumed)

Group	Percent consuming	Mean	SE	Percentile 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	39.7	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.4	1.0	1.5	2.9	10.1
Age													
≤5 months	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 to 12 months	19.9	0.1	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.0	1.8	2.6
<1 years	9.3	0.1	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.7	2.6
1 to 2 years	64.9	1.0	0.04	0.0	0.0	0.0	0.0	0.7	1.5	2.5	3.3	4.9	8.8
3 to 5 years	69.8	1.1	0.04	0.0	0.0	0.0	0.0	0.9	1.7	2.6	3.3	4.8	10.1
6 to 11 years	64.0	0.8	0.03	0.0	0.0	0.0	0.0	0.6	1.2	2.0	2.5	4.0	8.0
12 to 19 years	45.7	0.4	0.02	0.0	0.0	0.0	0.0	0.0	0.6	1.1	1.5	2.2	6.4
20 to 39 years	30.5	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.7	1.0	1.7	5.3
40 to 69 years	31.8	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.9	1.4	5.2
≥70 years	47.9	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.4	0.7	0.9	1.5	2.7
Season													
Fall	39.1	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.4	1.1	1.6	2.9	8.8
Spring	40.1	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.4	1.0	1.5	2.9	7.7
Summer	39.6	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.4	1.1	1.6	3.0	7.8
Winter	39.9	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.5	1.0	1.4	2.7	10.1
Race													
Asian	25.4	0.2	0.05	0.0	0.0	0.0	0.0	0.0	0.1	0.8	1.2	2.7	4.9
Black	34.0	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.4	1.0	1.5	3.2	10.1
American Indian/Alaska Native	33.1	0.3	0.09	0.0	0.0	0.0	0.0	0.0	0.4	0.8	1.4	2.6	4.4
Other/NA	33.3	0.3	0.04	0.0	0.0	0.0	0.0	0.0	0.3	1.1	1.7	3.0	6.6
White	41.7	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.5	1.1	1.5	2.8	8.8
Region													
Midwest	42.2	0.4	0.02	0.0	0.0	0.0	0.0	0.0	0.5	1.1	1.6	2.9	8.0
Northeast	42.3	0.4	0.02	0.0	0.0	0.0	0.0	0.0	0.5	1.1	1.6	2.9	8.0
South	37.4	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.4	1.0	1.3	2.8	10.1
West	38.4	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.4	1.1	1.6	3.1	8.8
Urbanization													
Central City	40.0	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.5	1.1	1.5	2.8	10.1
Suburban	41.2	0.4	0.01	0.0	0.0	0.0	0.0	0.0	0.5	1.1	1.6	3.1	8.0
Non-metropolitan	35.8	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.4	0.8	1.2	2.6	8.8

[a] Includes dry ready-to-eat corn, rice, wheat, and bran cereals in the form of flakes, puffs, etc.
SE = Standard error.

Source: Based on U.S. EPA's analysis of the 1994-96 CSFII.

Table 12-14. Per Capita Intake of Baby Cereals (g/kg-day as consumed)

Group	Percent consuming	Mean	SE	Percentile									
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	1.0	0.0	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	37.6
Age (years)													
≤5 months	40.8	0.8	0.24	0.0	0.0	0.0	0.0	0.0	1.0	2.4	3.1	8.8	26.6
6 to 12 months	67.8	2.5	0.45	0.0	0.0	0.0	0.0	0.8	2.8	6.9	11.3	21.1	37.6
<1 years	53.4	1.6	0.27	0.0	0.0	0.0	0.0	0.2	1.7	4.1	7.3	19.7	37.6
1 to 2 years	6.2	0.2	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	5.8	12.5
3 to 5 years	0.3	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8
6 to 11 years	0.1	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
12 to 19 years	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20 to 39 years	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40 to 69 years	0.1	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
≥70 years	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Season													
Fall	0.9	0.0	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.1
Spring	1.2	0.0	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	26.6
Summer	0.8	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.0
Winter	1.1	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	37.6
Race													
Asian	0.7	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1
Black	1.0	0.0	0.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.6
American Indian/Alaska Native	0.6	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Other/NA	1.7	0.1	0.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	26.6
White	1.0	0.0	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.0
Region													
Midwest	1.1	0.0	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	21.1
Northeast	1.2	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	12.5
South	0.9	0.0	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.6
West	0.9	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.6
Urbanization													
Central City	1.1	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	37.6
Suburban	1.1	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	21.1
Nonmetropolitan	0.8	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.0

[a] Data presented only for children less than 1 year of age. Available data for other age groups was based on a very small number of observations.
SE = Standard error.

Source: Based on U.S. EPA's analysis of the 1994-96 CSFII.

Table 12-15. Mean Grain Intake Per Individual in a Day by Sex and Age (g/day as consumed)[a] for 1977-1978

Group Age (years)	Total Grains	Breads, Rolls, Biscuits	Other Baked Goods	Cereals, Pasta	Mixtures, Mainly Grain[b]
Males and Females					
< 1	42	4	5	30	3
1-2	158	27	24	44	63
3-5	181	46	37	54	45
6-8	206	53	56	60	38
Males					
9-11	238	67	56	51	64
12-14	288	76	80	57	74
15-18	303	91	77	53	82
19-22	253	84	53	64	52
23-34	256	82	60	40	74
35-50	234	82	58	44	50
51-64	229	78	57	48	46
65-74	235	71	60	69	35
≥ 75	196	70	50	58	19
Females					
9-11	214	58	59	44	53
12-14	235	57	61	45	72
15-18	196	57	43	41	55
19-22	161	44	36	33	48
23-34	163	49	38	32	44
35-50	161	49	37	32	43
51-64	155	52	40	36	27
65-74	175	57	42	47	29
≥ 75	178	54	44	58	22
Males and Females					
All Ages	204	62	49	44	49

[a] Based on USDA Nationwide Food Consumption Survey 1977-78 data for one day.
[b] Includes mixtures containing grain as the main ingredient.

Source: USDA, 1980.

Table 12-16. Mean Grain Intakes Per Individual in a Day by Sex and Age (g/day as consumed)[a] for 1987-1988

Group Age (years)	Total Grains	Yeast Breads and Rolls	Quick Breads, Pancakes, French Toast	Cakes, Cookies, Pastries, Pies	Crackers, Popcorn, Pretzels, Corn Chips	Cereals and Pastas	Mixtures, Mostly Grain[b]
Males and Females ≤ 5	167	30	8	22	4	52	51
Males							
6-11	268	51	16	37	8	74	83
12-19	304	65	28	45	10	72	82
≥ 20	272	65	20	37	8	58	83
Females							
6-11	231	43	19	30	6	66	68
12-19	239	45	13	29	7	52	91
≥ 20	208	45	14	28	6	53	62
All Individuals	237	52	16	32	7	57	72

[a] Based on USDA Nationwide Food Consumption Survey 1987-88 data for one day.
[b] Includes mixtures containing grain as the main ingredient.

Source: USDA, 1992.

Table 12-17. Mean Grain Intakes Per Individual in a Day by Sex and Age (g/day as consumed)[a] for 1994 and 1995

Group Age (years)	Total Grains		Yeast Breads and Rolls		Quick Breads, Pancakes, French Toast		Cakes, Cookies, Pastries, Pies		Crackers, Popcorn, Pretzels, Corn Chips		Cereals and Pastas		Mixtures, Mostly Grain[b]	
	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Males and Females ≤ 5	213	210	26	28	11	11	22	23	8	7	58	57	89	84
Males														
6-11	285	341	51	45	15	21	42	46	12	18	66	97	101	115
12-19	417	364	53	54	30	21	54	43	17	22	82	84	180	138
≥ 20	357	365	64	61	22	24	43	46	13	15	86	91	128	128
Females														
6-11	260	286	43	46	16	21	37	51	11	14	57	54	94	100
12-19	317	296	40	37	16	14	39	35	17	16	63	52	142	143
≥ 20	254	257	44	45	16	15	33	34	9	10	59	69	92	83
All Individuals	300	303	50	49	18	19	38	39	12	13	70	76	112	107

[a] Based on USDA CSFII 1994 and 1995 data for one day.
[b] Includes mixtures containing grain as the main ingredient.

Source: USDA, 1996a; 1996b.

Table 12-18. Per Capita Consumption of Flour and Cereal Products in 1997[a]

Food Item	Per Capita Consumption (g/day)[a]
Total Wheat Flour[b]	186
Rye Flour	0.7
Rice[c]	24
Total Corn Products[d]	29
Oat Products[e]	8
Barley Products[f]	0.9
Total Flour and Cereal Products[g]	249

[a] Original data were presented in lbs/yr; data were converted to g/day by multiplying by a factor of 454 g/lb and dividing by 365 days/yr. Consumption of most items at the processing level. Excludes quantities used in alcoholic beverages and fuel.
[b] Includes white, whole wheat, and durum flour.
[c] Milled basis.
[d] Includes corn flour and meal, hominy and grits, and corn starch.
[e] Includes rolled oats, ready-to-eat oat cereals, oat flour, and oat bran.
[f] Includes barley flour, pearl barley, and malt and malt extract used in food processing.
[g] Excludes wheat not ground into flour.

Source: USDA, 1999a.

Table 12-19. Mean Quantities of Grain Products Consumed by Children Under 20 Years of Age, by Sex and Age, Per Capita (g/day)											
Age Group	Sample Size	Total	Yeast, breads, and rolls	Cereals and Pasta				Quick breads, pancakes, French toast	Cakes, cookies, pastries, pies	Crackers, popcorn, pretzels, corn chips	Mixtures, mainly grain
				Total	Ready-to-eat cereals	Rice	Pasta				
Males and Females											
<1 year	1,126	56	2	2	1	2	1[a]	1	3	1	20
1 year	1,016	192	16	16	11	9	9	9	16	7	87
2 years	1,102	219	26	26	16	15	12	12	22	9	87
1 to 2 years	2,118	206	21	21	13	12	11	11	19	8	87
3 years	1,831	242	30	30	19	13	12	16	23	11	98
4 years	1,859	264	36	36	22	15	11	17	30	13	102
5 years	884	284	41	41	24	17	11	15	33	13	107
3 to 5 years	4,574	264	36	36	22	15	11	16	29	12	102
≤5 years	7,818	219	27	27	16	13	10	12	22	9	87
Males											
6 to 9 years	787	310	45	77	28	18	15	23	39	16	109
6 to 11 years	1,031	318	46	80	31	16	18	23	40	15	115
12 to 19 years	737	406	54	82	29	27	17	26	49	19	175
Females											
6 to 9 years	704	284	43	61	21	12	15	18	42	13	107
6 to 11 years	969	280	43	62	20	14	15	19	42	14	101
12 to 19 years	732	306	40	67	17	19	22	15	37	15	132
Males and Females											
≤9 years	9,309	250	34	64	20	14	12	16	30	12	96
≤19 years	11,287	298	40	69	22	17	15	18	36	14	120

[a] Estimate is not statistically reliable due to small sample size reporting intake.

Note: Consumption amounts shown are representative of the first day of each participant's survey response.

Source: USDA, 1999b.

Table 12-201. Percentage of Individuals Under 20 Years of Age Consuming Grain Products, by Sex and Age (%)												
Age Group	Sample Size	Total	Yeast, breads and rolls	Cereals and Pasta				Quick breads, pancakes, French toast	Cakes, cookies, pastries, pies	Crackers, popcorn, pretzels, corn chips	Mixtures, mainly grain
				Total	Ready-to-eat cereals	Rice	Pasta				
Males and Females											
<1 year	1,126	70.6	10.9	62.8	9.1	3.4	2.1	4.4	16.5	10.3	15.0
1 year	1,016	98.2[a]	48.4	70.6	45.3	11.3	9.4	23.0	47.0	39.0	47.8
2 years	1,102	99.0[a]	58.7	71.1	51.9	14.4	9.4	27.5	46.6	37.9	45.3
1 to 2 years	2,118	98.7	53.7	70.9	48.7	12.9	9.4	25.3	46.8	38.4	46.5
3 years	1,831	99.4[a]	64.1	69.7	53.3	11.1	8.6	28.8	46.1	38.5	49.0
4 years	1,859	99.5[a]	67.0	69.1	54.8	11.4	7.1	28.6	52.3	39.4	46.2
5 years	884	99.9[a]	69.2	70.4	54.9	11.4	6.8	25.2	52.4	32.1	47.4
3 to 5 years	4,574	99.6[a]	66.8	69.7	54.3	11.3	7.5	27.5	50.3	36.7	47.5
≤5 years	7,818	95.8	55.5	69.3	46.9	10.9	7.5	24.0	45.0	34.1	43.3
Males											
6 to 9 years	787	98.9[a]	69.8	62.6	50.8	10.5	7.4	28.1	52.5	36.0	44.5
6 to 11 years	1,031	99.0[a]	69.1	64.0	52.4	9.7	8.1	27.1	52.3	33.8	45.3
12 to 19 years	737	98.2[a]	62.7	44.6	33.2	10.0	5.9	24.4	41.3	27.2	46.2
Females											
6 to 9 years	704	99.7[a]	71.5	61.2	47.6	9.0	7.9	26.3	57.1	38.3	48.0
6 to 11 years	969	99.3[a]	71.0	59.3	45.6	9.4	7.1	27.1	55.0	37.1	45.7
12 to 19 years	732	97.6[a]	60.9	45.9	30.3	8.6	9.3	19.8	40.6	30.9	46.1
Males and Females											
≤ 9 years	9,309	97.2	61.6	66.4	47.9	10.5	7.6	25.3	48.9	35.3	44.4
≤ 19 years	11,287	97.6	62.4	57.6	41.7	9.9	7.6	24.2	46.1	32.5	45.1

[a] Estimate is not statistically reliable due to small sample size reporting intake.

Note: Percentages shown are representative of the first day of each participant's survey response.

Source: USDA, 1999b.

Food category	% Indiv. using food at least once in 2 days	Quantity consumed per eating occasion (g)		Consumers-only Quantity consumed per eating occasion at Specified Percentiles (g)						
		Average	SE	5th	10th	25th	50th	75th	90th	95th
White bread	59.6	50	1	21	24	33	46	52	78	104
Whole grain and wheat bread	28.1	50	1	24	25	37	50	56	72	92
Rolls	48.0	58	1	27	33	43	48	70	89	110
Biscuits	10.9	61	1	19	19	35	57	76	104	139
Tortillas	15.5	60	1	14	21	32	48	79	107	135
Quickbreads and muffins	12.5	82	2	21	28	52	60	94	142	187
Doughnuts and sweet rolls	12.4	77	1	26	36	47	65	93	133	164
Crackers	17.4	26	1	6	9	12	18	30	47	62
Cookies	30.7	40	1	9	12	20	31	50	75	96
Cake	16.2	92	3	22	28	41	77	116	181	217
Pie	8.5	150	3	52	72	102	143	168	246	300
Pancakes and waffles	10.3	85	3	21	35	42	75	109	158	205
Cooked cereal	10.3	248	6	81	117	157	233	291	455	484
Oatmeal	6.1	264	6	116	117	176	232	333	454	473
Ready-to-east cereal	40.6	54	1	18	24	30	46	67	93	113
Corn flakes	8.1	46	1	17	22	25	37	56	75	100
Toasted oat rings	6.8	42	1	14	16	27	38	54	65	83
Rice	28.0	150	3	27	40	76	131	192	312	334
Pasta	36.0	162	3	26	43	73	133	210	318	420
Macaroni and cheese	8.5	244	9	53	81	121	191	324	477	556
Spaghetti with tomato sauce	8.0	436	15	122	124	246	371	494	740	983
Pizza	19.9	169	5	36	52	78	140	214	338	422

Table 12-21. Quantity (as consumed) of Grain Products Consumed Per Eating Occasion and the Percentage of Individuals Using These Foods in Two Days

SE = standard error.

Source: Smiciklas-Wright et al., 2002 (based on 1994-1996 CSFII data).

Table 12-22. Quantity (as consumed) of Grain Products Consumed Per Eating Occasion and Percentage of Individuals Using These Foods in Two Days, by Sex and Age

Food Category	Quantity consumed per eating occasion (grams)											
	2 to 5 years			6 to 11 years			12 to 19 years					
	Male and Female (N = 2,109)			Male and Female (N = 1,432)			Male (N = 696)			Female (N = 702)		
	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE
White bread	66.9	34	[a]	67.1	42	1	61.3	56	1	57.9	47	1
Whole grain and wheat bread	24.3	37	1	20.5	44	1	14.5	60	2	17.6	53	2
Rolls	40.0	39	1	53.5	48	1	61.9	69	2	48.8	51	1
Biscuits	8.3	38	2	9.7	48	3	12.2	72	4	10.3	55	4
Tortillas	14.6	32	2	16.4	47	2	22.9	76	5	20.1	56	3
Quickbreads and muffins	9.6	55	4	9.6	67	5	11.0	125	12	11.0	79	10
Doughnuts and sweet rolls	11.3	59	2	13.4	69	2	17.3	102	12	13.8	78	5
Crackers	25.4	17	1	17.2	26	2	10.6	39	5	14.2	26	3
Cookies	51.0	28	1	46.7	37	2	29.0	53	3	31.8	42	2
Cake	14.6	70	3	19.7	79	4	15.1	99	9	15.5	85	8
Pie	2.9	76	8	5.6	116	8	6.6	188	15	4.8	138[b]	12[b]
Pancakes and waffles	19.1	49	1	21.5	77	3	13.5	96	6	8.2	74	5
Cooked cereal	16.8	211	10	9.0	245	14	5.2	310[b]	29[b]	6.0	256[b]	31[b]
Oatmeal	10.4	221	9	5.7	256	19	2.4	348[b]	45[b]	2.3	321[b]	40[b]
Ready-to-eat cereal	72.9	33	1	67.3	47	1	45.6	72	3	46.3	52	2
Corn flakes	11.2	33	2	13.1	42	2	10.4	62	4	8.7	49	4
Toasted oat rings	20.6	30	1	12.5	45	2	7.3	62	5	8.1	42	3
Rice	29.6	84	3	24.6	124	6	24.2	203	10	28.8	157	10
Pasta	49.4	90	3	41.4	130	5	33.4	203	9	37.8	155	9
Macaroni and cheese	17.8	159	8	13.2	217	13	7.5	408	46	10.7	260	30
Spaghetti with tomato sauce	16.8	242	11	11.5	322	18	10.1	583	46	8.5	479	51
Pizza	23.7	86	3	32.8	108	6	39.6	205	13	30.5	143	8
Corn chips	19.6	29	2	25.6	33	2	26.9	58	5	25.1	44	3
Popcorn	11.6	20	1	12.7	31	2	7.8	54	5	10.5	37	4

Table 12-22. Quantity (as consumed) of Grain Products Consumed Per Eating Occasion and Percentage of Individuals Using These Foods in Two Days, by Sex and Age (continued)

Food category	Quantity consumed per eating occasion (grams)																	
	20 to <40 years						40 to <60 years						≥60 years					
	Male (N = 1,543)			Female (N = 1,449)			Male (N = 1,663)			Female (N = 1,694)			Male (N = 1,545)			Female (N = 1,429)		
	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE
White bread	63.0	63	2	54.9	47	1	59.7	59	2	55.3	46	1	59.3	51	1	54.8	41	1
Whole grain and wheat bread	25.3	63	1	25.2	48	1	32.8	57	1	32.3	46	2	39.8	48	1	43.1	41	1
Rolls	62.0	73	4	46.4	53	1	47.9	65	1	43.4	52	1	37.8	54	1	30.6	43	1
Biscuits	11.5	73	3	9.4	55	2	13.4	80	3	11.2	56	2	13.0	58	3	9.8	48	3
Tortillas	20.6	79	4	20.1	53	2	13.4	67	3	12.7	52	2	4.2	47	4	5.4	41	2
Quickbreads and muffins	8.0	93	7	11.3	79	5	15.7	93	7	14.9	72	4	17.4	86	5	18.3	72	4
Doughnuts and sweet rolls	13.3	94	5	11.2	68	2	13.4	88	4	11.0	72	4	11.4	65	2	10.4	56	2
Crackers	11.9	36	3	15.6	28	2	16.6	30	1	17.5	24	1	25.6	23	1	25.9	17	1
Cookies	20.8	56	4	26.5	39	2	27.6	47	2	29.0	36	1	29.7	40	2	32.2	30	1
Cake	13.5	113	6	14.9	94	7	16.5	108	6	16.8	83	4	19.2	85	4	18.3	87	7
Pie	5.8	161	7	7.2	150	9	11.8	162	6	9.9	151	8	16.4	154	7	13.3	137	5
Pancakes and waffles	8.0	126	15	7.4	80	6	7.5	117	8	8.0	74	5	10.8	99	5	8.2	68	4
Cooked cereal	5.2	313	30	7.3	219	11	9.7	300	16	10.3	243	11	20.9	255	8	20.2	216	8
Oatmeal	2.7	360[a]	42[a]	3.7	258	17	6.0	332	16	6.2	242	10	13.6	257	10	12.9	224	10
Ready-to-eat cereal	26.9	77	3	34.7	55	1	29.8	68	2	29.7	51	1	44.6	53	1	44.0	41	1
Corn flakes	6.5	73	6	5.3	43	2	5.9	49	3	5.2	40	3	12.4	37	2	10.4	30	1
Toasted oat rings	4.2	62	4	5.4	42	2	4.8	46	2	4.1	35	2	4.3	36	3	4.9	27	2
Rice	30.8	199	9	32.1	139	6	29.4	167	5	28.8	130	4	23.1	147	6	21.4	118	5
Pasta	37.1	214	8	37.1	155	6	34.3	208	7	34.7	140	5	27.9	167	7	27.9	132	5
Macaroni and cheese	7.8	301	19	7.8	235	19	6.1	302	31	6.0	210	12	7.1	230	13	6.5	215	18
Spaghetti with tomato sauce	8.6	630	48	7.8	385	22	5.5	543	59	5.4	386	18	5.0	450	22	4.5	379	33
Pizza	23.7	253	12	20.2	150	6	13.0	220	13	14.5	147	8	5.3	187	18	4.7	109	8
Corn chips	16.2	61	5	17.9	35	2	12.8	47	4	12.0	33	2	4.8	30	3	5.3	21	2
Popcorn	8.1	63	6	9.7	35	2	9.6	50	4	10.9	39	3	6.1	52	4	7.6	34	3

[a] Indicates a SE value that is greater than 0 but less than 0.5.
[b] Indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.
PC = Percent consuming at least once in 2 days.
SE = Standard error of the mean.

Source: Smiciklas-Wright et al., 2002 (based on 1994-1996 CSFII data).

Table 12-23. Consumption of Major Food Groups by Older Adults: Median Daily Servings (and Ranges) by Demographic and Health Characteristics

Subject Characteristic	N	Bread, Cereal, Rice and Pasta
Gender		*
Female	80	2.7 (0.9 - 6.5)
Male	50	3.6 (1.4 - 7.3)
Ethnicity		
African American	44	3.3 (1.4 - 6.4)
European American	47	3.2 (0.9 - 6.8)
Native American	39	2.9 (1.1 - 7.3)
Age		
70 to 74	42	3.3 (1.1 - 6.3)
75 to 79	36	3.0 (0.9 - 6.8)
80 to 84	36	3.2 (1.5 - 6.4)
≥ 85	16	3.6 (1.6 - 7.3)
Marital Status		
Married	49	3.3 (1.1 - 5.8)
Not Married	81	3.0 (0.9 - 7.3)
Education		
8th grade or less	37	3.1 (1.1 - 7.3)
9th to 12th grades	47	3.3 (1.1 - 6.8)
> High School	46	3.2 (0.9 - 6.5)
Dentures		
Yes	83	3.3 (1.1 - 6.4)
No	47	3.1 (0.9 - 7.3)
Chronic Diseases		
0	7	4.1 (2.2 - 6.4)
1	31	3.3 (0.9 - 7.3)
2	56	3.1 (1.1 - 5.8)
3	26	3.7 (1.1 - 5.8)
≥ 4	10	2.9 (1.4 - 5.3)
Weight[a]		
≤130	18	3.1 (1.1 - 5.4)
131 to 150	32	3.3 (0.9 - 5.2)
151 to 170	27	3.1 (1.4 - 7.3)
171 to 190	22	3.6 (1.4 - 6.2)
≥ 191	29	3.0 (1.1 - 6.8)

a Two missing values.
* $p < 0.05$

Source: Vitolins et al., 2002.

Table 12-24. Characteristics of the FITS Sample Population		
	Sample Size	Percentage of Sample
Gender		
Male	1,549	51.3
Female	1,473	48.7
Age of Child		
4 to 6 months	862	28.5
7 to 8 months	483	16.0
9 to 11 months	679	22.5
12 to 14 months	374	12.4
15 to 18 months	308	10.2
19 to 24 months	316	10.4
Child's Ethnicity		
Hispanic or Latino	367	12.1
Non-Hispanic or Latino	2,641	87.4
Missing	14	0.5
Child's Race		
White	2,417	80.0
Black	225	7.4
Other	380	12.6
Urbanicity		
Urban	1,389	46.0
Suburban	1,014	33.6
Rural	577	19.1
Missing	42	1.3
Household Income		
Under $10,000	48	1.6
$10,000 to $14,999	48	1.6
$15,000 to $24,999	221	7.3
$25,000 to $34,999	359	11.9
$35,000 to $49,999	723	23.9
$50,000 to $74,999	588	19.5
$75,000 to $99,999	311	10.3
$100,000 and Over	272	9.0
Missing	452	14.9
Receives WIC		
Yes	821	27.2
No	2,196	72.6
Missing	5	0.2
Sample Size (Unweighted)	3,022	100.0

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Devaney et al., 2004.

Table 12-25. Percentage of Infants and Toddlers Consuming Different Types of Grain Products

Food Group/Food	Percentage of Infants and Toddlers Consuming at Least Once in a Day					
	4 to 6 months	7 to 8 months	9 to 11 months	12 to 14 months	15 to 18 months	19 to 24 months
Any Grain or Grain Product	65.8	91.5	97.5	97.8	98.6	99.2
Infant Cereals	64.8	81.2	63.8	23.9	9.2	3.1
Noninfant Cereals[a]	0.6	18.3	44.3	58.9	60.5	51.9
not Pre-sweetened	0.5	17.0	37.0	44.5	40.6	31.9
Pre-sweetened[b]	0.0	1.8	9.0	17.7	26.4	22.7
Breads and Rolls[c]	0.6	9.9	24.5	47.3	52.7	53.1
Crackers, Pretzels, Rice Cakes	3.0	16.2	33.4	45.2	46.4	44.7
Cereal or Granola Bars	0.0	1.1	3.4	9.8	10.0	9.7
Pancakes, Waffles, French Toast	0.1	0.8	7.5	15.1	16.1	15.4
Rice and Pasta[d]	2.3	4.5	18.2	26.2	39.0	35.9
Other	0.2	0.1	2.7	2.8	2.5	4.5
Grains in Mixed Dishes	0.4	5.3	24.1	48.3	52.0	55.1
Sandwiches	0.0	1.1	8.6	21.5	25.8	25.8
Burrito, Taco, Enchilada, Nachos	0.0	0.0	1.0	4.5	2.8	2.1
Macaroni and Cheese	0.2	1.6	4.9	14.6	15.0	15.0
Pizza	0.1	0.7	2.2	6.8	9.0	9.4
Pot Pie/Hot Pocket	0.0	0.9	0.5	2.0	1.0	1.8
Spaghetti, Ravioli, Lasagna	0.1	1.8	9.9	15.3	12.1	8.8

[a] Includes both ready-to-eat and cooked cereals.
[b] Defined as cereals with more than 21.1 g sugar per 100 g.
[c] Does not include bread in sandwiches. Sandwiches are included in mixed dishes.
[d] Does not include rice or pasta in mixed dishes.

Source: Fox et al., 2004.

Table 12-26. Characteristics of WIC Participants and Non-participants[a] (Percentages)						
	Infants 4 to 6 months		Infants 7 to 11 months		Toddlers 12 to 24 months	
	WIC Participant	Non-participant	WIC Participant	Non-participant	WIC Participant	Non-participant
Gender						
Male	55	54	55	51	57	52
Female	45	46	45	49	43	48
Child's Ethnicity		**		**		**
Hispanic or Latino	20	11	24	8	22	10
Non-Hispanic or Latino	80	89	76	92	78	89
Child's Race		**		**		**
White	69	84	63	86	67	84
Black	15	4	17	5	13	5
Other	22	11	20	9	20	11
Child In Day Care				**		*
Yes	39	38	34	46	43	53
No	61	62	66	54	57	47
Age of Mother		**		**		**
14 to 19	18	1	13	1	9	1
20 to 24	33	13	38	11	33	14
25 to 29	29	29	23	30	29	26
30 to 34	9	33	15	36	18	34
$\geq$ 35	9	23	11	21	11	26
Missing	2	2	1	1	0	1
Mother's Education		**		**		**
11^{th} Grade or Less	23	2	15	2	17	3
Completed High School	35	19	42	20	42	19
Some Postsecondary	33	26	32	27	31	28
Completed College	7	53	9	51	9	48
Missing	2	1	2	0	1	2
Parent's Marital Status		**		**		**
Married	49	93	57	93	58	88
Not Married	50	7	42	7	41	11
Missing	1	1	1	0	1	1
Mother or Female Guardian Works				**		*
Yes	46	51	45	60	55	61
No	53	48	54	40	45	38
Missing	1	1	1	0	0	1

Table 12-26. Characteristics of WIC Participants and Nonparticipants[a] (Percentages) (continued)						
	Infants 4 to 6 months		Infants 7 to 11 months		Toddlers 12 to 24 months	
	WIC Participant	Non-participant	WIC Participant	Non-participant	WIC Participant	Non-participant
Urbanicity		**		**		**
Urban	34	55	37	50	35	48
Suburban	36	31	31	34	35	35
Rural	28	13	30	15	28	16
Missing	2	1	2	1	2	2
Sample Size (Unweighted)	265	597	351	808	205	791

a X^2 test were conducted to test for statistical significance in the differences between WIC participants and non-participants within each age group for each variable. The results of X^2 test are listed next to the variable under the column labeled non-participants for each of the three age groups.

* P<0.05 non-participants significantly different from WIC participants on the variable.

** P>0.01 non-participants significantly different from WIC participants on the variable.

WIC =Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Ponza et al., 2004.

Table 12-27. Food Choices for Infants and Toddlers by WIC Participation Status						
	Infants 4 to 6 months		Infants 7 to 11 months		Toddlers 12 to 24 months	
	WIC Participant	Non-participant	WIC Participant	Non-participant	WIC Participant	Non-participant
Infant Cereals	69.7	62.5	74.7	69.7	13.5	9.2
Noninfant Cereals, Total	0.9	0.5	21.7	38.5*	58.1	56.0
Not Pre-sweetened	0.5	0.5	18.7	32.9*	43.7	36.3
Pre-sweetened	0.0	0.0	4.0	6.9	17.7	24.1
Grains in Combination Foods	0.9	0.1	18.8	14.7	50.3	52.9
Sample Size (unweighted)	265	597	351	808	205	791

* = P<0.01 non-participants significantly different from WIC participants.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Ponza et al., 2004.

Table 12-28. Average Portion Sizes Per Eating Occasion of Grain Products Commonly Consumed by Infants from the 2002 Feeding Infants and Toddlers Study

Food group	Reference unit	4 to 5 months (N=624)	6 to 8 months (N=708)	9 to 11 months (N=687)
		Mean± SEM		
Infant cereal, dry	tablespoon	3.1±0.14	4.5±0.14	5.2±0.18
Infant cereal, jarred	tablespoon	-	5.6±0.26	7.4±0.34
Ready-to-eat cereal	tablespoon	-	2.3±0.34	3.4±0.21
Crackers	ounce	-	0.2±0.02	0.3±0.01
Crackers	saltine	-	2.2±0.14	2.7±0.12
Bread	slice	-	0.5±0.10	0.8±0.06

- = Cell size was too small to generate a reliable estimate.
N = Number of respondents.
SEM = Standard error of the mean.

Source: Fox et al., 2006.

Table 12-29. Average Portion Sizes Per Eating Occasion of Grain Products Commonly Consumed by Toddlers from the 2002 Feeding Infants and Toddlers Study

Food Group	Reference Unit	12 to 14 months (N=371)	15 to 18 months (N=312)	19 to 24 months (N=320)
		Mean± SEM		
Bread	slice	0.8±0.04	0.9±0.05	0.9±0.05
Rolls	ounce	0.9±0.11	1.0±0.10	0.9±0.15
Ready-to-eat cereal	cup	0.3+0.02	0.5±0.03	0.6±0.04
Hot cereal, prepared	cup	0.6±0.05	0.6±0.05	0.7±0.05
Crackers	ounce	0.3+0.02	0.4±0.02	0.4±0.02
Crackers	saltine	3.3+0.22	3.5±0.22	3.7±0.22
Pasta	cup	0.4±0.04	0.4+0.04	0.5±0.05
Rice	cup	0.3+0.04	0.4±0.05	0.4±0.05
Pancakes and waffles	1 (4-inch diameter)	1.0+0.08	1.4±0.21	1.4±0.17

N = Number of respondents.
SEM = Standard error of the mean.

Source: Fox et al., 2006.

Table 12-30. Percentage of Hispanic and Non-Hispanic Infants and Toddlers Consuming Different Types of Grain Products on A Given Day

	Age 4 to 5 months		Age 6 to11 months		Age 12 to 24 months	
	Hispanic (n=84)	Non-Hispanic (n=538)	Hispanic (n=163)	Non-Hispanic (n=1,228)	Hispanic (n=124)	Non-Hispanic (n=871)
Any Grain or Grain Product	56.5	56.9	95.0	93.5	97.1	98.9
Infant Cereal	55.2	56.5	74.1	73.6	15.9	9.3
Non-infant Cereal	-	-	18.5*	29.2	45.3	57.8
Breads[a]	1.4†	-	18.2	15.1	44.0	52.9
Tortillas	1.4†	-	4.0†	-	6.7†*	0.6†
Crackers, Pretzels, Rice Cakes	1.3†	-	27.8	22.5	35.6	46.9
Pancakes, Waffles, French Toast	-	-	1.4†	4.3	13.0	16.0
Rice and Pasta[b]	-	-	20.1*	10.3	44.3	32.9
Rice	-	-	15.9**	4.7	26.9†*	13.0
Grains in Mixed Dishes	-	-	15.9	13.0	38.8*	54.4
Sandwiches	-	-	4.0†	4.6	24.2	24.9
Burrito, Taco, Enchilada, Nachos	-	-	1.3†	-	2.1†	3.0
Macaroni and Cheese	-	-	3.0†	3.1	10.1	15.5
Pizza	-	-	-	1.4	1.0**†	9.7
Spaghetti, Ravioli, Lasagna	-	-	8.3†	4.6	9.3†	12.1

[a] Does not include bread in sandwiches. Sandwiches are included in mixed dishes. Includes tortillas, also shown separately.

[b] Does not include rice or pasta in mixed dishes. Includes rice (e.g. white, brown, wild, and Spanish rice without meat) and pasta (e.g. spaghetti, macaroni, and egg noodles). Rice is also shown separately.

\- = Less than 1 percent of the group consumed this food on a given day.

* = Significantly different from non-Hispanic at the $P<0.05$.

** = Significantly different from non-Hispanic at the $P>0.01$.

† = Statistic is potentially unreliable because of a high coefficient of variation.

Source: Mennella et al., 2006.

Table 12-31. Mean Moisture Content of Selected Grain Products Expressed as Percentages of Edible Portions (grams per 100g of Edible Portion)

Food	Moisture Content		Comments
	Raw	Cooked	
Barley – pearled	10.09	68.80	
Corn - grain – endosperm	10.37	-	
Corn - grain – bran	4.71	-	crude
Millet	8.67	71.41	
Oats	8.22	-	
Rice - white - long-grained	11.62	68.44	
Rye	10.95	-	
Rye - flour – medium	9.85	-	
Sorghum	9.20	-	
Wheat - hard white	9.57	-	
Wheat – germ	11.12	-	crude
Wheat – bran	9.89	-	crude
Wheat - flour - whole grain	10.27	-	

- Indicates that the grain product was not assessed for water content under these conditions.

Source: USDA, 2007.

APPENDIX 12A

CODES AND DEFINITIONS USED TO DETERMINE THE VARIOUS GRAIN PRODUCTS USED IN THE U.S. EPA ANALYSIS OF CSFII DATA IN FCID

Table 12A-1. Food Codes and Definitions Used in Analysis of the 1994-96, 1998 USDA CSFII Data				
Total Grains	95000060	Amaranth, grain	15002331	Oat, groats/rolled oats-babyfood
	15000250	Barley, pearled barley	95003060	Psyllium, seed
	15000251	Barley, pearled barley-babyfood	95003110	Quinoa, grain
	15000260	Barley, flour	15003230	Rice, white
	15000261	Barley, flour-babyfood	15003231	Rice, white-babyfood
	15000270	Barley, bran	15003240	Rice, brown
	15000650	Buckwheat	15003241	Rice, brown-babyfood
	15000660	Buckwheat, flour	15003250	Rice, flour
	15001200	Corn, field, flour	15003251	Rice, flour-babyfood
	15001201	Corn, field, flour-babyfood	15003260	Rice, bran
	15001210	Corn, field, meal	15003261	Rice, bran-babyfood
	15001211	Corn, field, meal-babyfood	15003280	Rye, grain
	15001220	Corn, field, bran	15003290	Rye, flour
	15001230	Corn, field, starch	15003440	Sorghum, grain
	15001231	Corn, field, starch-babyfood	15003810	Triticale, flour
	15001260	Corn, pop	15003811	Triticale, flour-babyfood
	15001270	Corn, sweet	15004010	Wheat, grain
	15001271	Corn, sweet-babyfood	15004011	Wheat, grain-babyfood
	15002260	Millet, grain	15004020	Wheat, flour
	15002310	Oat, bran	15004021	Wheat, flour-babyfood
	15002320	Oat, flour	15004030	Wheat, germ
	15002321	Oat, flour-babyfood	15004040	Wheat, bran
	15002330	Oat, groats/rolled oats	15004050	Wild rice
Cereal Grains	15000250	Barley, pearled barley	15003230	Rice, white
	15000251	Barley, pearled barley-babyfood	15003231	Rice, white-babyfood
	15000260	Barley, flour	15003240	Rice, brown
	15000261	Barley, flour-babyfood	15003241	Rice, brown-babyfood
	15000270	Barley, bran	15003250	Rice, flour
	15000650	Buckwheat	15003251	Rice, flour-babyfood
	15000660	Buckwheat, flour	15003260	Rice, bran
	15001200	Corn, field, flour	15003261	Rice, bran-babyfood
	15001201	Corn, field, flour-babyfood	15003280	Rye, grain
	15001210	Corn, field, meal	15003290	Rye, flour
	15001211	Corn, field, meal-babyfood	15003440	Sorghum, grain
	15001220	Corn, field, bran	15003450	Sorghum, syrup
	15001230	Corn, field, starch	15003810	Triticale, flour
	15001231	Corn, field, starch-babyfood	15003811	Triticale, flour-babyfood
	15001240	Corn, field, syrup	15004010	Wheat, grain
	15001241	Corn, field, syrup-babyfood	15004011	Wheat, grain-babyfood
	15001260	Corn, pop	15004020	Wheat, flour
	15001270	Corn, sweet	15004021	Wheat, flour-babyfood
	15001271	Corn, sweet-babyfood	15004030	Wheat, germ
	15002260	Millet, grain	15004040	Wheat, bran
	15002310	Oat, bran	15004050	Wild rice
	15002320	Oat, flour	95000060	Amaranth, grain
	15002321	Oat, flour-babyfood	95003060	Psyllium, seed
	15002330	Oat, groats/rolled oats	95003110	Quinoa, grain
	15002331	Oat, groats/rolled oats-babyfood		
Rice	15003260	Rice, bran	15003250	Rice, flour
	15003261	Rice, bran-babyfood	15003251	Rice, flour-babyfood
	15003240	Rice, brown	15003230	Rice, white
	15003241	Rice, brown-babyfood	15003231	Rice, white-babyfood

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Chapter 13 - Intake of Home-Produced Foods

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13 INTAKE OF HOME-PRODUCED FOODS

13.1 INTRODUCTION

Ingestion of home-produced foods can be a pathway for exposure to environmental contaminants. Home-produced foods can become contaminated in a variety of ways. Ambient pollutants in the air may be deposited on plants, adsorbed onto or absorbed by the plants, or dissolved in rainfall or irrigation waters that contact the plants. Pollutants may also be adsorbed onto plant roots from contaminated soil and water. Finally, the addition of pesticides, soil additives, and fertilizers to crops or gardens may result in contamination of food products. Meat and dairy products can become contaminated if animals consume contaminated soil, water, or feed crops. Farmers, as well as rural and urban residents who consume home-produced foods, may be potentially exposed if these foods become contaminated. Exposure via the consumption of home-produced foods may be a significant route of exposure for these populations (U.S. EPA, 1989; U.S. EPA, 1996). For example, consumption of home-produced fruits, vegetables, game, and fish has been shown to have an impact on blood lead levels in areas where soil lead contamination exists (U.S. EPA, 1994). At Superfund sites where soil contamination is found, ingestion of home-produced foods has been considered a potential route of exposure (U.S. EPA, 1991; U.S. EPA, 1993). Assessing exposures to individuals who consume home-produced foods requires knowledge of intake rates of such foods.

Data from the 1987-1988 Nationwide Food Consumption Survey (NFCS) were used to generate intake rates for home-produced foods.

The methods used to analyze the 1987-1988 NFCS data are presented in Section 13.3.

13.2 RECOMMENDATIONS

The data presented in this section may be used to assess exposure to contaminants in foods grown, raised, or caught at a specific site. The recommended values for mean and upper percentile (i.e., 95th percentile) intake rates among consumers of the various home-produced food groups are presented in Table 13-1; these rates can be converted to per capita rates by multiplying by the fraction of the population consuming these food groups during the survey period (See Section 13.3). Table 13-2 presents the confidence ratings for home-produced food intake. The data presented in this chapter for consumers of home-produced foods represent average daily intake rates of food items/groups over the seven-day survey period and do not account for variations in eating habits during the rest of the year; thus the recommended upper percentile values, as well as the percentiles of the distributions presented in Section 13.3 may not necessarily reflect the long-term distribution of average daily intake of home-produced foods.

Because the home-produced food intake rates presented in this chapter are based on foods as brought into the household and not in the form in which they are consumed, preparation loss factors should be applied, as appropriate. These factors are necessary to convert to intake rates to those that are representative of foods “as consumed.” Additional conversions may be necessary to ensure that the form of the food used to estimate intake (e.g., wet or dry weight) is consistent with the form used to measure contaminant concentration (see Section 13.3).

The NFCS data used to generate intake rates of home-produced foods are over 20 years old and may not be reflective of current eating patterns among consumers of home-produced foods. Although USDA and others have conducted other food consumption studies since the release of the 1987-1988 NFCS, these studies do not include information on home-produced foods.

Because this analysis was conducted prior to issuance of U.S. EPA’s *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005), the age groups used are not entirely consistent with recent guidelines. Also, recommended home-produced food intake rates are not provided for children under 1 year of age because the methodology used is based on apportionment of home-produced foods used by a household among the members of that household that consume those foods. It was assumed that the diets of children under 1 year of age differ markedly from that of other household members; thus, they were not assumed to consume any portion of the home-produced food brought into the home.

Table 13-1. Summary of Recommended Values for Intake of Home-produced Foods (Consumers Only)

Age Group[a]	Mean (g/kg-day)	95th Percentile (g/kg-day)	Multiple Percentiles	Source
Home-produced Fruits				
1 to 2 years	8.7	60.6	See Table 13-5	U.S. EPA Analysis of 1987-1988 NFCS
3 to 5 years	4.1	8.9		
6 to 11 years	3.6	15.8		
12 to 19 years	1.9	8.3		
20 to 39 years	2.0	6.8		
40 to 69 years	2.7	13.0		
≥70 years	2.3	8.7		
Home-produced Vegetables				
1 to 2 years	5.2	19.6	See Table 13-10	U.S. EPA Analysis of 1987-1988 NFCS
3 to 5 years	2.5	7.7		
6 to 11 years	2.0	6.2		
12 to 19 years	1.5	6.0		
20 to 39 years	1.5	4.9		
40 to 69 years	2.1	6.9		
≥70 years	2.5	8.2		
Home-produced Meats				
1 to 2 years	3.7	10.0	See Table 13-15	U.S. EPA Analysis of 1987-1988 NFCS
3 to 5 years	3.6	9.1		
6 to 11 years	3.7	14.0		
12 to 19 years	1.7	4.3		
20 to 39 years	1.8	6.2		
40 to 69 years	1.7	5.2		
≥70 years	1.4	3.5		
Home Caught Fish				
1 to 2 years	-[b]	-	See Table 13-20	U.S. EPA Analysis of 1987-1988 NFCS
3 to 5 years	-	-		
6 to 11 years	2.8	7.1		
12 to 19 years	1.5	4.7		
20 to 39 years	1.9	4.5		
40 to 69 years	1.8	4.4		
≥70 years	1.2	3.7		

[a] Analysis was conducted prior to Agency's issuance of *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005).
[b] Data not presented for age groups/food groups where less than 20 observations were available.

Table 13-2. Confidence in Recommendations for Intake of Home-produced Foods		
General Assessment Factors	Rationale	Rating
Soundness		**Medium** (Means) **Low** (Distributions)
Adequacy of Approach	The survey methodology and the approach to data analysis were adequate, but individual intakes were inferred from household consumption data. The sample size was large (approximately 10,000 individuals).	
Minimal (or Defined) Bias	Non-response bias cannot be ruled out due to low response rate. Also, some biases may have occurred from using household data to estimate individual intake.	
Applicability and Utility		**Low** (Means & Short-term distributions) **Low** (Long-term distributions)
Exposure Factor of Interest	The analysis specifically addressed home-produced intake.	
Representativeness	Data from a nationwide survey, representative of the general U.S. population was used.	
Currency	The data were collected in 1987-1988.	
Data Collection Period	Household data were collected over 1 week.	
Clarity and Completeness		**High**
Accessibility	The methods used described to analyze the data are described in detail in this handbook; the primary data are accessible through USDA.	
Reproducibility	Sufficient details on the methods used to analyze the data are presented to allow for the results to be reproduced.	
Quality Assurance	Quality assurance of NFCS data was good; quality control of the secondary data was sufficient.	
Variability and Uncertainty		**Low** to **Medium**
Variability in Population	Full distributions of home-produced intake rates were provided.	
Uncertainty	Sources of uncertainty include: individuals' estimates of food weights, allocation of household food to family members, and potential changes in eating patterns since these data were collected,	
Evaluation and Review		**Medium**
Peer Review	The study was reviewed by USDA and U.S. EPA.	
Number and Agreement of Studies	There was one key study.	
Overall Rating		**Low-Medium** (means and short-term distributions) **Low** (long-term distributions)

13.3 KEY STUDY FOR INTAKE OF HOME - PRODUCED FOODS

13.3.1 U.S. EPA Analysis of NFCS 1987-1988; Moya and Phillips (2001)

U.S. EPA's National Center for Environmental Assessment (NCEA) analyzed USDA's 1987-1988 NFCS data to generate intake rates for home-produced foods. In addition, Moya and Phillips (2001) present a summary of these analyses. For the purposes of this study, home-produced foods were defined as homegrown fruits and vegetables, meat and dairy products derived from consumer-raised livestock or game meat, and home caught fish.

Until 1988, USDA conducted the NFCS every 10 years to analyze the food consumption behavior and dietary status of Americans (USDA, 1992). While more recent food consumption surveys have been conducted to estimate food intake among the general population (e.g., USDA's Continuing Survey of Food Intake among Individuals [CSFII] and the National Health and Nutrition Examination Survey [NHANES]), these surveys have not collected data that can be used to estimate consumption of home-produced foods. Thus, the 1987-1988 NFCS data set is currently the best available source of information for this factor.

The 1987-1988 NFCS was conducted between April 1987 and August 1988. The survey used a statistical sampling technique designed to ensure that all seasons, geographic regions of the 48 conterminous states in the U.S., and socioeconomic and demographic groups were represented (USDA, 1994). There were two components of the NFCS. The household component collected information over a seven-day period on the socioeconomic and demographic characteristics of households, and the types, amount, value, and sources of foods consumed by the household (USDA, 1994). The individual intake component collected information on food intakes of individuals within each household over a three-day period (USDA, 1993). The sample size for the 1987-1988 survey was approximately 4,300 households (over 10,000 individuals; approximately 3,000 children). This was a decrease over the previous survey conducted in 1977-1978, which sampled approximately 15,000 households (over 36,000 individuals) (USDA, 1994). The sample size was lower in the 1987-1988 survey as a result of budgetary constraints and low response rate (38 percent for the household survey and 31 percent for the individual survey) (USDA, 1993).

The USDA data were adjusted by applying sample weights calculated by USDA to the data set prior to analysis. The USDA sample weights were designed to "adjust for survey non-response and other vagaries of the sample selection process" (USDA, 1987-88). Also the USDA weights are calculated "so that the weighted sample total equals the known population total, in thousands, for several characteristics thought to be correlated with eating behavior" (USDA 1987-88).

The food groups selected for analysis of home-produced food intake included major food groups (such as total fruits, total vegetables, total meats, total dairy, total fish and shellfish) and individual food items for which >30 households reported eating the home-produced form of the item, fruits and vegetables categorized as exposed, protected, and roots, and various USDA fruit and vegetable subcategories (i.e., dark green vegetables, citrus fruits, etc.). These food groups were identified in the NFCS data base according to NFCS-defined food codes. Appendix 13A presents the codes and definitions used to determine the major food groups. Foods with these codes, for which the source was identified as home-produced, were included in the analysis. The codes and definitions for individual items in these food groups, as well as other subcategories (e.g., exposed, protected, dark green, citrus, etc.) that are considered to be home-produced are in Appendix 13B.

Although the individual intake component of the NFCS gives the best measure of the amount of each food group eaten by each individual in the household, it could not be used directly to measure consumption of home-produced food because the individual component does not identify the source of the food item (i.e., as home-produced or not). Therefore, an analytical method which incorporated data from both the household and individual survey components was developed to estimate individual home-produced food intake.

The household data were used to determine 1) the amount of each home-produced food item used during a week by household members, and 2) the number of meals eaten in the household by each household member during a week. Note that the household survey reports the total amount of a each food item used in the household (whether by guests or household members); the amount used by household members was derived by multiplying the total amount used in the household by the proportion of all meals served in the household (during the survey week) that were consumed by household members. The individual survey data were used to generate average sex- and age-specific serving sizes for each food item. The age categories used in the analysis were as follows: 1 to 2 years; 3 to 5 years; 6 to 11 years; 12 to 19 years; 20 to 39 years; 40 to 69 years; and over 70 years (intake rates were not calculated for children under 1; the rationale for this is discussed below). The serving sizes were used during subsequent analyses to generate home-produced food intake rates for individual household members. Assuming that the proportion of the household quantity of each home-produced food item/group was a function of the number of meals and the mean sex- and age-specific serving size for each family member, individual intakes of home-produced food were calculated for all members of the survey population using the following general equation:

$$w_i = w_f \left[\frac{m_i q_i}{\sum_{i=l}^{n} m_i q_i} \right] \qquad \text{(Eqn. 13-1)}$$

where:

- w_i = Home-produced amount of food item/group attributed to member *i* during the week (g/week);
- w_f = Total quantity of home-produced food item/group used by the family members (g/week);
- m_i = Number of meals of household food consumed by member *i* during the week (meals/week); and
- q_i = Serving size for an individual within the age and sex category of the member (g/meal).

Daily intake of a home-produced food group was determined by dividing the weekly value (w_i) by seven. Intake rates were indexed to the self-reported body weight of the survey respondent and reported in units of g/kg-day. Intake rates were not calculated for children under one year of age because their diet differs markedly from that of other household members, and thus the assumption that all members share all foods would be invalid for this age group.

For the major food groups (fruits, vegetables, meats, dairy, and fish) and individual foods consumed by at least 30 households, distributions of home-produced intake among consumers were generated for the entire data set and for the following subcategories: age groups, urbanization categories, seasons, racial classifications, regions, and responses to questionnaire.

Consumers were defined as members of survey households who reported consumption of the food item/group of interest during the one week survey period.

In addition, for the major food groups, distributions were generated for each region by season, urbanization, and responses to the questionnaire. Table 13-3 presents the codes, definitions, and a description of the data included in each of the subcategories. Intake rates were not calculated for food items/groups for which less than 30 households reported home-produced usage because the number of observations may be inadequate for generating distributions that would be representative of that segment of consumers. Fruits and vegetables were also classified as exposed, protected, or roots, as shown in Appendix 13B of this document. Exposed foods are those that are grown above ground and are likely to be contaminated by pollutants deposited on surfaces of the foods that are eaten. Protected products are those that have outer protective coatings that are typically removed before consumption. Distributions of intake were tabulated for these food classes for the same subcategories listed above. Distributions were also tabulated for the following USDA food classifications: dark green vegetables, deep yellow vegetables, other vegetables, citrus fruits, and other fruits. Finally, the percentages of total intake of the food items/groups consumed within survey households that can be attributed to home production were tabulated. The percentage of intake that was homegrown was calculated as the ratio of total intake of the homegrown food item/group by the survey population to the total intake of all forms of the food by the survey population.

Percentiles of average daily intake derived from short time intervals (e.g., 7 days) will not, in general, be reflective of long term patterns. This is especially true regarding consumption of many homegrown products (e.g., fruits, vegetables), where there is often a strong seasonal component associated with their use. To try to derive, for the major food categories, the long term distribution of average daily intake rates from the short-term data available here, an approach was developed which attempted to account for seasonal variability in consumption. This approach used regional "seasonally adjusted distributions" to approximate regional long term distributions and then combined these regional adjusted distributions (in proportion to the weights for each region) to obtain a U.S. adjusted distribution which approximated the U.S. long term distribution. See Moya and Phillips (2001) for details.

The percentiles of the seasonally adjusted distribution for a given region were generated by averaging the corresponding percentiles of each of the four seasonal distributions of the region. More formally, the seasonally adjusted distribution for each region is such that its inverse cumulative distribution function is the average of the inverse cumulative distribution functions of each of the seasonal distributions of that region. The use of regional seasonally adjusted distributions to approximate regional long term distributions is based on the assumption that each individual consumes the same regional percentile levels for each season and consumes as a constant weekly rate throughout a given season. Thus, for instance if the 60th percentile weekly intake level in the South is 14.0 g in the summer and 7.0 g in each of the three other seasons, then the individual in the South with an average weekly intake of 14.0 g over the summer would be assumed to have an intake of 14.0 g for each week of the summer and an intake of 7.0 g for each week of the other seasons.

Note that the seasonally adjusted distributions were generated using the overall distributions, i.e., both consumers and non-consumers. However, since all the other distributions presented in this section are based on consumers only, the percentiles for the adjusted distributions have been revised to reflect the percentiles among consumers only. Given the above assumption about how each individual consumes, the percentage consuming for the seasonally adjusted distributions give an estimate of the percentage of the population consuming the specified food category at any time during the year.

The intake data presented here for consumers of home-produced foods and the total number of individuals surveyed may be used to calculate the mean and the percentiles of the distribution of home-produced food consumption in the overall population (consumers and non-consumers) as follows:

Assuming that IR_p is the home-produced intake rate of the food group at the p^{th} percentile and N_c is the weighted number of individuals consuming the home-produced food item, and N_T is the weighted total number of individuals surveyed, then $N_T - N_c$ is the weighted number of individuals who reported zero consumption of the food item. In addition, there are ($p/100 \times N_c$) individuals below the p^{th} percentile. Therefore, the percentile that corresponds to a particular intake rate (IR_p) for the overall distribution of home-produced food consumption (including consumers and non-consumers) can be obtained by:

$$P^{th}_{overall} = 100\, x \frac{\left(\frac{P}{100}\, x\, N_c + \left(N_T - N_c\right)\right)}{N_T} \quad \text{(Eqn. 13-2)}$$

For example, the percentile of the overall population that is equivalent to the 50th percentile consumer only intake rate for homegrown fruits would be calculated as follows:

From Table 13-5, the 50th percentile homegrown fruit intake rate (IR_{50}) is 1.07 g/kg-day. The weighted number of individuals consuming fruits (N_c) is 14,744,000. From Table 13-70, the weighted total number of individuals surveyed (N_T) is 188,019,000. The number of individuals consuming fruits below the 50th percentile is:

$p/100 \; x \; N_c = (0.5) \; x \; (14{,}744{,}000)$

$= 7{,}372{,}000$

The number of individuals that did not consume fruit during the survey period is:

$N_T - N_c = 188{,}019{,}000 - 14{,}744{,}000$

$= 173{,}275{,}000$

The total number of individuals with homegrown intake rates at or below 1.07 g/kg-day is

$(p/100 \; x \; N_c)+(N_T - N_c) = 7{,}372{,}000+173{,}275{,}000$

$= 180{,}647{,}000$

The percentile of the overall population that is represented by this intake rate is:

$P^{th}_{overall} \quad 100 \; x \; (180{,}647{,}000 \,/\, 188{,}109{,}000)$

96^{th} *percentile*

Therefore, an intake rate of 1.07 g/kg-day of homegrown fruit corresponds to the 96^{th} percentile of the overall population.

Following the same procedure described above, 5.97 g/kg-day, which is the 90th percentile of the consumers only population, corresponds to the 99th percentile of the overall population. Likewise, 0.063 g/kg-day, which is the 1st percentile of the consumers only population, corresponds to the 92nd percentile of the overall population. Note that the consumers only distribution corresponds to the tail of the distribution for the overall population. Consumption rates below the 92nd percentile are very close to zero. The mean intake rate for the overall population can be calculated by multiplying the mean intake rate among consumers by the proportion of individuals consuming the homegrown food item, N_c/N_T.

Table 13-4 displays the weighted numbers N_T, as well as the unweighted total survey sample sizes, for each subcategory and overall. It should be noted that the total unweighted number of observations in Table 13-4 (9,852) is somewhat lower than the number of observations reported by USDA because this study only used observations for family members for which age and body weight were specified.

The intake rate distributions (among consumers) for total home-produced fruits, vegetables, meats, fish and dairy products are shown, respectively, in Tables 13-5 through 13-29. Also shown in these tables is the proportion of respondents consuming the item during the (one-week) survey period. Homegrown vegetables were the most commonly consumed of the major food groups (18.3%), followed by fruit (7.8%), meat (4.9%), fish (2.1%), and dairy products (0.7%). The intake rates for the major food groups vary according to region, age, urbanization code, race, and response to survey questions. In general, intake rates of home-produced foods are higher among populations in non-metropolitan and suburban areas and lowest in central city areas. Results of the regional analyses indicate that intake of homegrown fruits, vegetables, meat and dairy products is generally highest for individuals in the Midwest and South and lowest for those in the Northeast. Intake rates of home caught fish were generally highest among consumers in the South. Homegrown intake was generally higher among individuals who indicated that they operate a farm, grow their own vegetables, raise animals, and catch their own fish. The results of the seasonal analyses for all regions combined indicated that, in general, homegrown fruits and vegetables were eaten at a higher rate in summer, and home caught fish was consumed at a higher rate in spring; however, seasonal intake varied based on individual regions. Seasonally adjusted intake rate distributions for the major food groups are presented in Table 13-30.

Tables 13-31 through 13-57 present distributions of intake for individual home-produced food items for households that reported consuming the homegrown form of the food during the survey period. Intake rate distributions among consumers for homegrown foods categorized as exposed fruits and vegetables, protected fruits and vegetables, and root vegetables are presented in Tables 13-58 through 13-62; the intake distributions for various USDA classifications (e.g., dark green vegetables) are presented in Tables 13-63 through 13-67. The results are presented in units of g/kg-day. Table 13-68 presents the fraction of household intake attributed to home-produced forms of the food items/groups evaluated. Thus, use of these data in calculating potential dose does not require the body weight factor to be included in the denominator of the average daily dose (ADD) equation. It should be noted that converting these intake rates into units of g/day by multiplying by a single average body weight is inappropriate, because individual intake rates were indexed to the reported body weights of the survey respondents.

As mentioned above, the intake rates derived in this section are based on the amount of household food consumption. As measured by the NFCS, the amount of food “consumed” by the household is a measure of consumption in an economic sense, i.e., a measure of the weight of food brought into the household that has been consumed (used up) in some manner. In addition to food being consumed by persons, food may be used up by spoiling, by being discarded (e.g., inedible parts), through cooking processes, etc.

USDA estimated preparation losses for various foods (USDA, 1975). For meats, a net cooking loss, which includes dripping and volatile losses, and a net post-cooking loss, which involves losses from cutting, bones, excess fat, scraps and juices, were derived for a variety of cuts and cooking methods. For each meat type, U.S. EPA has averaged these losses across all cuts and cooking methods to obtain a mean net cooking loss and a mean net post-cooking loss. Mean percentage values for all meats and fish are provided in Table 13-69. For individual fruits and vegetables, USDA (1975) also gave cooking and post-cooking losses. These data, averaged across all types of fruits and vegetables to give mean net cooking and post cooking losses, are also provided in Table 13-69.

The following formula can be used to convert the home-produced intake rates tabulated here to rates reflecting actual consumption:

$$I_A = I \ x \left(1 - L_1\right) x \left(1 - L_2\right) \qquad \text{(Eqn. 13-3)}$$

where:

I_A = the adjusted intake rate;
I = the tabulated intake rate;
L_1 = the cooking or preparation loss; and
L_2 = the post-cooking loss.

For fruits, corrections based on post-cooking losses only apply to fruits that are eaten in cooked forms. For raw forms of the fruits, paring or preparation loss data should be used to correct for losses from removal of skin, peel, core, caps, pits, stems, and defects, or draining of liquids from canned or frozen forms. To obtain preparation losses for food categories, the preparation losses of the individual foods making up the category can be averaged.

In calculating ingestion exposure, assessors should use consistent forms (e.g., "as-consumed" or dry weight) in combining intake rates with contaminant concentrations, as discussed in Chapter 9 of this handbook.

The USDA NFCS data set is the largest publicly available source of information on home-produced food consumption habits in the United States. The advantages of using this data set are that it is expected to be representative of the U.S. population and that it provides information on a wide variety of food groups. However, the data collected by the USDA NFCS are based on short-term dietary recall and the intake distributions generated from this data set may not accurately reflect long-term intake patterns, particularly with respect to the tails (extremes) of the distributions. Also, the two survey components (i.e., household and individual) do not define food items/groups in a consistent manner; as a result, some errors may be introduced into these analyses because the two survey components are linked. The results presented here may also be biased by assumptions that are inherent in the analytical method utilized. The analytical method may not capture all high-end consumers within households because average serving sizes are used in calculating the proportion of home-produced food consumed by each household member. Thus, for instance, in a two-person household where one member had high intake and one had low intake, the method used here would assume that both members had an equal and moderate level of intake. In addition, the analyses assume that all family members consume a portion of the home-produced food used within the household. However, not all family members may consume each home-produced food item and serving sizes allocated here may not be entirely representative of the portion of household foods consumed by each family member. As was mentioned earlier, no analyses were performed for children under 1 year age.

The preparation loss factors discussed above are intended to convert intake rates based on "household consumption" to rates reflective of what individuals actually consume. However, these factors do not include losses to spoilage, feeding to pets, food thrown away, etc. It should also be noted that because this analysis is based on the 1987-1988 NFCS, it may not reflect recent changes in food consumption patterns. The low response rate associated with the 1987-1988 NFCS also contributes to the uncertainty of the home-produced intake rates generated using these data.

13.4 RELEVANT STUDY FOR INTAKE OF HOME - PRODUCED FOODS

13.4.1 National Gardening Association (2009)

According to a survey by the National Gardening Association (2009), an estimated 36 million (or 31 percent) U.S. households participated in food gardening in 2008. Food gardening includes growing vegetables, berries, fruit, and herbs. Of the estimated 36 million food-gardening households, 23 percent participated in vegetable gardening, 12 percent participated in herb gardening, 10 percent participated in growing fruit trees, and 6 percent grew berries. Table 13-70 contains demographic data on food gardening in 2008 by gender, age, education, household income, and household size. Table13-71 contains information on the types of vegetables grown by home gardeners in 1986. Tomatoes, cucumbers, peppers, beans, carrots, summer squash, onions, lettuce, peas and corn are among the vegetables grown by the largest percentage of gardeners.

13.5 REFERENCES FOR CHAPTER 13

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Table 13-3. Sub-category Codes and Definitions

Code	Definition	Description
		Region[a]
1	Northeast	Includes Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont
2	Midwest	Includes Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin
3	South	Includes Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia
4	West	Includes Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming
		Urbanization
1	Central City	Cities with populations of 50,000 or more that is the main city within the metropolitan statistical area (MSA).
2	Suburban	An area that is generally within the boundaries of an MSA, but is not within the legal limit of the central city.
3	Non-Metropolitan	An area that is not within an MSA.
		Race
1	--	White (Caucasian)
2	--	Black
3	--	Asian and Pacific Islander
4	--	Native American, Aleuts, and Eskimos
5, 8, 9	Other/NA	Don't know, no answer, some other race
		Responses to Survey Questions
Grow	Question 75	Did anyone in the household grow any vegetables or fruit for use in the household?
Raise Animals	Question 76	Did anyone in the household produce any animal products such as milk, eggs, meat, or poultry for home use in your household?
Fish/Hunt	Question 77	Did anyone in the household catch any fish or shoot game for home use?
Farm	Question 79	Did anyone in the household operate a farm or ranch?
		Season
Spring	-	April, May, June
Summer	-	July, August, September
Fall	-	October, November, December
Winter	-	January, February, March

[a] Alaska and Hawaii were not included.
Source: USDA 1987-88.

Table 13-4. Weighted and Unweighted Number of Observations (Individuals) for NFCS Data Used in Analysis of Food Intake										
	All Regions		Northeast		Midwest		South		West	
	wgtd	unwgtd	wgtd	unwgtd	wgtd	unwgtd	wgtd	unwgtd	wgtd	unwgtd
Total	188,019,000	9,852	41,167,000	2,018	46,395,000	2,592	64,331,000	3,399	36,066,000	1,841
Age (years)										
< 1	2,814,000	156	545,000	29	812,000	44	889,000	51	568,000	32
1-2	5,699,000	321	1,070,000	56	1,757,000	101	1,792,000	105	1,080,000	59
3-5	8,103,000	461	1,490,000	92	2,251,000	133	2,543,000	140	1,789,000	95
6-11	16,711,000	937	3,589,000	185	4,263,000	263	5,217,000	284	3,612,000	204
12-19	20,488,000	1,084	4,445,000	210	5,490,000	310	6,720,000	369	3,833,000	195
20-39	61,606,000	3,058	12,699,000	600	15,627,000	823	21,786,000	1,070	11,494,000	565
40-69	56,718,000	3,039	13,500,000	670	13,006,000	740	19,635,000	1,080	10,577,000	549
≥ 70	15,880,000	796	3,829,000	176	3,189,000	178	5,749,000	300	3,113,000	142
Season										
Fall	47,667,000	1,577	9,386,000	277	14,399,000	496	13,186,000	439	10,696,000	365
Spring	46,155,000	3,954	10,538,000	803	10,657,000	1,026	16,802,000	1,437	8,158,000	688
Summer	45,485,000	1,423	9,460,000	275	10,227,000	338	17,752,000	562	7,986,000	246
Winter	48,712,000	2,898	11,783,000	663	11,112,000	732	16,591,000	961	9,226,000	542
Urbanization										
Central City	56,352,000	2,217	9,668,000	332	17,397,000	681	17,245,000	715	12,042,000	489
Non-Metropolitan	45,023,000	3,001	5,521,000	369	14,296,000	1,053	19,100,000	1,197	6,106,000	382
Surburban	86,584,000	4,632	25,978,000	1,317	14,702,000	858	27,986,000	1,487	17,918,000	970
Race										
Asian	2,413,000	114	333,000	13	849,000	37	654,000	32	577,000	32
Black	21,746,000	1,116	3,542,000	132	2,794,000	126	13,701,000	772	1,709,000	86
Native American	1,482,000	91	38,000	4	116,000	6	162,000	8	1,166,000	73
Other/NA	4,787,000	235	1,084,000	51	966,000	37	1,545,000	86	1,192,000	61
White	157,531,000	8,294	36,170,000	1,818	41,670,000	2,386	48,269,000	2,501	31,422,000	1,589
Response to Questionnaire										
Do you garden?	6,8152,000	3,744	12,501,000	667	22,348,000	1,272	20,518,000	1,136	12,725,000	667
Do you raise animals?	10,097,000	631	1,178,000	70	3,742,000	247	2,603,000	162	2,574,000	152
Do you hunt?	20,216,000	1,148	3,418,000	194	6,948,000	411	6,610,000	366	3,240,000	177
Do you fish?	39,733,000	2,194	5,950,000	321	12,621,000	725	13,595,000	756	7,567,000	392
Do you farm?	7,329,000	435	830,000	42	2,681,000	173	2,232,000	130	1,586,000	90

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-5. Consumer Only Intake of Homegrown Fruits (g/kg-day) - All Regions Combined

Population Group	Nc wgtd	Nc Unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	14,744,000	817	7.84	2.68	0.19	0.06	0.17	0.28	0.50	1.07	2.37	5.97	11.10	24.00	60.60
Age (years)															
1-2	360,000	23	6.32	8.74	3.10	0.96	1.09	1.30	1.64	3.48	7.98	19.30	60.60	60.60	60.60
3-5	550,000	34	6.79	4.07	1.48	0.01	0.01	0.36	0.98	1.92	2.73	6.02	8.91	48.30	48.30
6-11	1,044,000	75	6.25	3.59	0.68	0.01	0.19	0.40	0.70	1.31	3.08	11.80	15.80	32.20	32.20
12-19	1,189,000	67	5.80	1.94	0.37	0.09	0.13	0.27	0.44	0.66	2.35	6.76	8.34	18.50	18.50
20-39	3,163,000	164	5.13	1.95	0.33	0.08	0.13	0.20	0.37	0.70	1.77	4.17	6.84	16.10	37.00
40-69	5,633,000	309	9.93	2.66	0.30	0.06	0.19	0.29	0.47	1.03	2.33	5.81	13.00	23.80	53.30
≥ 70	2,620,000	134	16.50	2.25	0.23	0.04	0.22	0.38	0.61	1.18	2.35	5.21	8.69	11.70	15.30
Season															
Fall	3,137,000	108	6.58	1.57	0.16	0.26	0.30	0.39	0.57	1.04	1.92	3.48	4.97	10.60	10.60
Spring	2,963,000	301	6.42	1.58	0.14	0.09	0.20	0.25	0.42	0.86	1.70	4.07	5.10	8.12	31.70
Summer	4,356,000	145	9.58	3.86	0.64	0.01	0.09	0.16	0.45	1.26	3.31	10.90	14.60	53.30	60.60
Winter	4,288,000	263	8.80	3.08	0.34	0.04	0.17	0.27	0.56	1.15	2.61	8.04	15.30	24.90	48.30
Urbanization															
Central City	3,668,000	143	6.51	2.31	0.26	0.04	0.18	0.33	0.57	1.08	2.46	5.34	10.50	14.30	19.30
Non-Metropolitan	4,118,000	278	9.15	2.41	0.31	0.06	0.13	0.23	0.45	1.15	2.42	4.46	8.34	24.00	53.30
Suburban	6,898,000	394	7.97	3.07	0.32	0.13	0.23	0.30	0.49	0.99	2.33	7.26	15.20	37.00	60.60
Race															
Black	450,000	20	2.07	1.87	0.85	0.13	0.28	0.46	0.61	1.13	1.53	2.29	2.29	19.30	19.30
White	14,185,000	793	9.00	2.73	0.19	0.07	0.18	0.28	0.51	1.07	2.46	6.10	11.70	24.00	60.60
Questionnaire Response															
Households who garden	12,742,000	709	18.70	2.79	0.21	0.06	0.18	0.29	0.53	1.12	2.50	6.10	11.80	24.90	60.60
Households who farm	1,917,000	112	26.16	2.58	0.26	0.07	0.28	0.41	0.75	1.61	3.62	5.97	7.82	15.80	15.80

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Moya and Phillips, 2001. (Based on EPA's analyses of the 1987-88 NFCS).

Table 13-6. Consumer Only Intake of Homegrown Fruits (g/kg-day) - Northeast

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,279,000	72	3.11	0.93	0.22	0.08	0.08	0.16	0.31	0.49	0.78	1.29	2.16	11.70	11.70
Season															
Fall	260,000	8	2.77	*	*	*	*	*	*	*	*	*	*	*	*
Spring	352,000	31	3.34	0.88	0.23	0.09	0.16	0.17	0.29	0.49	0.88	1.83	2.16	7.13	7.13
Summer	271,000	9	2.86	*	*	*	*	*	*	*	*	*	*	*	*
Winter	396,000	24	3.36	0.71	0.11	0.18	0.21	0.23	0.29	0.54	0.88	1.38	1.79	2.75	2.75
Urbanization															
Central City	50,000	3	0.52	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	176,000	10	3.19	*	*	*	*	*	*	*	*	*	*	*	*
Suburban	1,053,000	59	4.05	1.05	0.26	0.18	0.23	0.29	0.44	0.54	0.81	1.29	2.75	11.70	11.70
Questionnaire Response															
Households who garden	983,000	59	7.86	1.04	0.26	0.09	0.18	0.21	0.38	0.54	0.88	1.38	2.75	11.70	11.70
Households who farm	132,000	4	15.90	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-7. Consumer Only Intake of Homegrown Fruits (g/kg-day) - Midwest

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	4,683,000	302	10.09	3.01	0.41	0.04	0.13	0.24	0.47	1.03	2.31	6.76	13.90	53.30	60.60
Season															
Fall	1,138,000	43	7.90	1.54	0.19	0.26	0.30	0.47	0.61	1.07	1.92	3.48	4.34	5.33	5.33
Spring	1,154,000	133	10.83	1.69	0.28	0.09	0.21	0.26	0.42	0.92	1.72	2.89	4.47	16.00	31.70
Summer	1,299,000	44	12.70	7.03	1.85	0.06	0.09	0.13	0.43	1.55	8.34	16.10	37.00	60.60	60.60
Winter	1,092,000	82	9.83	1.18	0.18	0.03	0.06	0.15	0.36	0.61	1.42	2.61	3.73	10.90	10.90
Urbanization															
Central City	1,058,000	42	6.08	1.84	0.39	0.04	0.10	0.26	0.52	1.07	1.90	2.82	9.74	10.90	10.90
Non-Metropolitan	1,920,000	147	13.43	2.52	0.54	0.06	0.11	0.15	0.40	1.03	2.07	4.43	6.84	53.30	53.30
Suburban	1,705,000	113	11.60	4.29	0.87	0.09	0.20	0.31	0.48	0.76	3.01	13.90	18.00	60.60	60.60
Response to Questionnaire															
Households who garden	4,060,000	267	18.17	3.27	0.47	0.04	0.10	0.20	0.45	1.07	2.37	7.15	14.60	53.30	60.60
Households who farm	694,000	57	25.89	2.59	0.30	0.06	0.19	0.41	1.26	1.63	3.89	6.76	8.34	11.10	11.10

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-8. Consumer Only Intake of Homegrown Fruits (g/kg-day) - South

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	4,148,000	208	6.45	2.97	0.30	0.11	0.24	0.36	0.60	1.35	3.01	8.18	14.10	23.80	24.00
Season															
Fall	896,000	29	6.80	1.99	0.44	0.39	0.43	0.45	0.65	1.13	1.96	4.97	8.18	10.60	10.60
Spring	620,000	59	3.69	2.05	0.26	0.16	0.28	0.31	0.45	1.06	4.09	5.01	6.58	7.05	7.05
Summer	1,328,000	46	7.48	2.84	0.65	0.08	0.16	0.27	0.44	1.31	2.83	6.10	14.30	24.00	24.00
Winter	1,304,000	74	7.86	4.21	0.65	0.11	0.24	0.38	0.89	1.88	3.71	14.10	19.70	23.80	23.80
Urbanization															
Central City	1,066,000	39	6.18	3.33	0.54	0.24	0.39	0.46	0.83	2.55	4.77	8.18	10.60	14.30	14.30
Non-Metropolitan	1,548,000	89	8.10	2.56	0.39	0.08	0.27	0.34	0.61	1.40	2.83	5.97	10.40	24.00	24.00
Suburban	1,534,000	80	5.48	3.14	0.60	0.11	0.16	0.28	0.51	1.10	2.29	11.80	15.50	23.80	23.80
Response to Questionnaire															
Households who garden	3,469,000	174	16.91	2.82	0.29	0.16	0.28	0.38	0.65	1.39	2.94	6.10	14.10	21.10	24.00
Households who farm	296,000	16	13.26	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-9. Consumer Only Intake of Homegrown Fruits (g/kg-day) - West

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	4,574,000	233	12.68	2.62	0.31	0.15	0.28	0.33	0.62	1.20	2.42	5.39	10.90	24.90	48.30
Season															
Fall	843,000	28	7.88	1.47	0.25	0.29	0.29	0.30	0.48	1.04	2.15	2.99	4.65	5.39	5.39
Spring	837,000	78	10.26	1.37	0.16	0.17	0.20	0.25	0.51	0.98	1.61	2.95	5.29	6.68	7.02
Summer	1,398,000	44	17.51	2.47	0.47	0.19	0.28	0.40	0.62	1.28	3.14	7.26	10.90	13.00	13.00
Winter	1,496,000	83	16.22	4.10	0.79	0.07	0.30	0.33	0.77	1.51	3.74	11.10	18.50	48.30	48.30
Urbanization															
Central City	1,494,000	59	12.41	1.99	0.42	0.07	0.24	0.34	0.53	0.86	2.04	4.63	9.52	19.30	19.30
Non-Metropolitan	474,000	32	7.76	2.24	0.53	0.18	0.28	0.42	0.63	0.77	2.64	4.25	10.90	10.90	10.90
Suburban	2,606,000	142	14.54	3.04	0.46	0.18	0.28	0.31	0.71	1.39	3.14	5.81	10.30	32.20	48.30
Response to Questionnaire															
Households who garden	4,170,000	207	32.77	2.76	0.34	0.10	0.28	0.31	0.63	1.20	2.54	5.81	10.90	24.90	48.30
Households who farm	795,000	35	50.13	1.85	0.26	0.28	0.28	0.60	0.71	1.26	2.50	4.63	5.00	6.81	6.81

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-10. Consumer Only Intake of Homegrown Vegetables (g/kg-day) - All Regions Combined

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	34,392,000	1,855	18.29	2.08	0.07	0.00	0.11	0.18	0.45	1.11	2.47	5.20	7.54	15.50	27.00
Age															
1-2	951,000	53	16.69	5.20	0.85	0.02	0.25	0.38	1.23	3.27	5.83	13.10	19.60	27.00	27.00
3-5	1,235,000	76	15.24	2.46	0.28	0.00	0.05	0.39	0.71	1.25	3.91	6.35	7.74	10.60	12.80
6-11	3,024,000	171	18.10	2.02	0.25	0.01	0.10	0.16	0.40	0.89	2.21	4.64	6.16	17.60	23.60
12-19	3,293,000	183	16.07	1.48	0.14	0.00	0.06	0.15	0.32	0.81	1.83	3.71	6.03	7.71	9.04
20-39	8,593,000	437	13.95	1.47	0.10	0.02	0.08	0.16	0.27	0.76	1.91	3.44	4.92	10.50	20.60
40-69	12,828,000	700	22.62	2.07	0.10	0.01	0.12	0.21	0.53	1.18	2.47	5.12	6.94	14.90	22.90
≥ 70	4,002,000	211	25.20	2.51	0.19	0.01	0.15	0.24	0.58	1.37	3.69	6.35	8.20	12.50	15.50
Seasons															
Fall	11,026,000	394	23.13	1.88	0.13	0.05	0.11	0.18	0.41	0.98	2.11	4.88	6.94	12.50	18.90
Spring	6,540,000	661	14.17	1.36	0.07	0.00	0.04	0.14	0.32	0.70	1.63	3.37	5.21	8.35	23.60
Summer	11,081,000	375	24.36	2.86	0.19	0.07	0.16	0.22	0.71	1.62	3.44	6.99	9.75	18.70	27.00
Winter	5,745,000	425	11.79	1.79	0.11	0.00	0.04	0.16	0.47	1.05	2.27	3.85	6.01	10.60	20.60
Urbanizations															
Central City	6,183,000	228	10.97	1.40	0.12	0.01	0.07	0.15	0.30	0.75	1.67	3.83	4.67	9.96	16.60
Non-Metropolitan	13,808,000	878	30.67	2.68	0.12	0.02	0.16	0.26	0.60	1.45	3.27	6.35	9.33	17.50	27.00
Suburban	14,341,000	747	16.56	1.82	0.09	0.00	0.11	0.16	0.39	0.96	2.18	4.32	6.78	12.50	20.60
Race															
Black	1,872,000	111	8.61	1.78	0.23	0.00	0.08	0.14	0.44	0.93	2.06	4.68	5.70	8.20	18.90
White	31,917,000	1,714	20.26	2.10	0.07	0.01	0.11	0.18	0.45	1.12	2.48	5.18	7.68	15.50	27.00
Response to Questionnaire															
Households who garden	30,217,000	1,643	44.34	2.17	0.07	0.01	0.11	0.19	0.48	1.18	2.68	5.35	7.72	15.50	23.60
Households who farm	4,319,000	262	58.93	3.29	0.25	0.00	0.16	0.29	0.85	1.67	3.61	8.88	11.80	17.60	23.60

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Moya and Phillips, 2001. (Based on EPA's analyses of the 1987-88 NCFS).

Table 13-11 Consumer Only Intake of Homegrown Vegetables (g/kg-day) – Northeast

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	4,883,000	236	11.86	1.78	0.17	0.00	0.08	0.14	0.28	0.75	1.89	6.03	7.82	12.70	14.90
Seasons															
Fall	1,396,000	41	14.87	1.49	0.41	0.08	0.13	0.17	0.27	0.58	1.17	6.64	9.97	10.20	10.20
Spring	1,204,000	102	11.43	0.82	0.11	0.00	0.00	0.04	0.17	0.46	0.95	2.26	3.11	6.52	6.78
Summer	1,544,000	48	16.32	2.83	0.47	0.11	0.15	0.16	0.74	1.29	3.63	7.82	9.75	14.90	14.90
Winter	739,000	45	6.27	1.67	0.27	0.00	0.00	0.09	0.26	1.25	2.77	3.63	6.10	8.44	8.44
Urbanizations															
Central City	380,000	14	3.93	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	787,000	48	14.25	3.05	0.54	0.00	0.05	0.11	0.20	2.18	4.61	9.04	12.70	14.90	14.90
Suburban	3,716,000	174	14.30	1.59	0.17	0.00	0.08	0.14	0.28	0.72	1.64	4.82	6.80	10.20	10.20
Response to Questionnaire															
Households who garden	4,381,000	211	35.05	1.92	0.18	0.00	0.08	0.14	0.31	0.88	2.18	6.16	7.82	12.70	14.90
Households who farm	352,000	19	42.41	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers; Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-12. Consumer Only Intake of Homegrown Vegetables (g/kg-day) - Midwest

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	12,160,000	699	26.21	2.26	0.12	0.02	0.08	0.18	0.49	1.15	2.58	5.64	7.74	17.50	23.60
Seasons															
Fall	4,914,000	180	34.13	1.84	0.18	0.01	0.07	0.16	0.42	1.03	2.10	5.27	6.88	13.10	13.10
Spring	2,048,000	246	19.22	1.65	0.15	0.06	0.15	0.22	0.46	0.91	1.72	4.49	5.83	12.80	23.60
Summer	3,319,000	115	32.45	3.38	0.39	0.11	0.16	0.30	0.85	2.07	3.94	7.72	14.00	19.60	22.90
Winter	1,879,000	158	16.91	2.05	0.26	0.00	0.02	0.07	0.36	0.88	2.13	5.32	7.83	16.70	20.60
Urbanizations															
Central City	3,177,000	113	18.26	1.36	0.19	0.00	0.06	0.11	0.25	0.71	1.67	3.94	5.50	9.96	16.60
Non-Metropolitan	5,344,000	379	37.38	2.73	0.19	0.02	0.11	0.26	0.60	1.31	3.15	7.19	10.60	17.50	23.60
Suburban	3,639,000	207	24.75	2.35	0.22	0.03	0.15	0.22	0.64	1.39	2.75	4.87	7.18	19.60	20.60
Response to Questionnaire															
Households who garden	10,927,000	632	48.89	2.33	0.13	0.02	0.10	0.18	0.50	1.18	2.74	5.81	7.75	16.70	23.60
Households who farm	1,401,000	104	52.26	3.97	0.43	0.14	0.34	0.55	0.87	2.18	5.24	10.60	14.40	17.50	23.60

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-13. Consumer Only Intake of Homegrown Vegetables (g/kg-day) - South

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	11,254,000	618	17.49	2.19	0.12	0.03	0.16	0.24	0.56	1.24	2.69	4.92	7.43	17.00	27.00
Seasons															
Fall	2,875,000	101	21.80	2.07	0.28	0.10	0.11	0.19	0.52	1.14	2.69	4.48	6.02	15.50	18.90
Spring	2,096,000	214	12.47	1.55	0.11	0.01	0.09	0.26	0.53	0.94	2.07	3.58	4.81	8.35	10.30
Summer	4,273,000	151	24.07	2.73	0.32	0.11	0.17	0.25	0.62	1.54	3.15	5.99	9.70	23.60	27.00
Winter	2,010,000	152	12.12	1.88	0.14	0.00	0.16	0.35	0.64	1.37	2.69	3.79	5.35	7.47	8.36
Urbanizations															
Central City	1,144,000	45	6.63	1.10	0.16	0.01	0.10	0.15	0.26	0.62	1.37	2.79	3.70	4.21	4.58
Non-Metropolitan	6,565,000	386	34.37	2.78	0.18	0.05	0.22	0.35	0.71	1.66	3.31	5.99	9.56	18.90	27.00
Suburban	3,545,000	187	12.67	1.44	0.11	0.00	0.11	0.20	0.40	0.93	1.72	3.61	5.26	8.20	8.20
Response to Questionnaire															
Households who garden	9,447,000	522	46.04	2.27	0.12	0.03	0.16	0.26	0.61	1.37	3.02	5.18	7.43	15.50	23.60
Households who farm	1,609,000	91	72.09	3.34	0.46	0.00	0.13	0.23	1.03	1.72	3.15	9.56	11.80	23.60	23.60

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-14. Consumer Only Intake of Homegrown Vegetables (g/kg-day) - West															
Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	6,035,000	300	16.73	1.81	0.14	0.01	0.10	0.17	0.38	0.90	2.21	4.64	6.21	11.40	15.50
Seasons															
Fall	1,841,000	72	17.21	2.01	0.29	0.10	0.15	0.20	0.48	1.21	2.21	4.85	7.72	12.50	12.50
Spring	1,192,000	99	14.61	1.06	0.17	0.00	0.01	0.05	0.20	0.36	0.91	3.37	5.54	8.60	8.60
Summer	1,885,000	59	23.6	2.39	0.37	0.07	0.10	0.25	0.55	1.37	3.23	4.67	8.36	15.50	15.50
Winter	1,117,000	70	12.11	1.28	0.17	0.01	0.15	0.20	0.48	0.77	1.43	2.81	5.12	7.57	7.98
Urbanizations															
Central City	1,482,000	56	12.31	1.80	0.28	0.03	0.07	0.16	0.48	1.10	2.95	4.64	4.85	11.40	11.40
Non-Metropolitan	1,112,000	65	18.21	1.52	0.22	0.00	0.01	0.20	0.27	0.68	2.13	4.13	5.12	8.16	8.16
Suburban	3,441,000	179	19.20	1.90	0.20	0.01	0.10	0.15	0.39	0.93	2.20	4.63	7.98	12.50	15.50
Response to Questionnaire															
Households who garden	5,402,000	276	42.45	1.91	0.00	0.01	0.10	0.17	0.43	1.07	2.37	4.67	6.21	12.50	15.50
Households who farm	957,000	48	60.34	2.73	0.00	0.12	0.41	0.47	0.77	1.42	3.27	6.94	10.90	15.50	15.50

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-15. Consumer Only Intake of Home-produced Meats (g/kg-day) - All Regions Combined																
Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	9,257,000	569	4.92	2.21	0.11	0.12	0.24	0.37	0.66	1.39	2.89	4.89	6.78	14.00	23.20
Age															
1-2	276,000	22	4.84	3.65	0.61	0.39	0.95	0.95	1.19	2.66	4.72	8.68	10.00	11.50	11.50
3-5	396,000	26	4.89	3.61	0.51	0.80	0.80	1.51	2.17	2.82	3.72	7.84	9.13	13.00	13.00
6-11	1,064,000	65	6.37	3.65	0.45	0.37	0.65	0.72	1.28	2.09	4.71	8.00	14.00	15.30	15.30
12-19	1,272,000	78	6.21	1.70	0.17	0.19	0.32	0.47	0.62	1.23	2.35	3.66	4.34	6.78	7.51
20-39	2,732,000	158	4.43	1.82	0.15	0.12	0.19	0.30	0.53	1.11	2.65	4.52	6.23	9.17	10.90
40-69	2,872,000	179	5.06	1.72	0.11	0.02	0.21	0.34	0.58	1.17	2.38	3.67	5.16	5.90	7.46
≥ 70	441,000	28	2.78	1.39	0.23	0.09	0.09	0.13	0.55	1.01	1.81	2.82	3.48	7.41	7.41
Seasons															
Fall	2,852,000	107	5.98	1.57	0.14	0.12	0.21	0.35	0.52	1.11	2.27	3.19	4.41	6.78	7.84
Spring	1,726,000	197	3.74	2.37	0.15	0.24	0.32	0.45	0.78	1.69	3.48	5.00	6.67	10.10	13.00
Summer	2,368,000	89	5.21	3.10	0.38	0.02	0.19	0.41	0.85	1.77	4.34	7.01	10.50	22.30	22.30
Winter	2,311,000	176	4.74	1.98	0.17	0.14	0.24	0.37	0.65	1.33	2.43	3.96	6.40	10.90	23.20
Urbanizations															
Central City	736,000	28	1.31	1.15	0.18	0.18	0.19	0.21	0.44	0.72	1.58	2.69	3.40	3.64	3.64
Non-Metropolitan	4,932,000	315	10.95	2.70	0.18	0.12	0.26	0.41	0.75	1.63	3.41	6.06	8.47	15.30	23.20
Suburban	3,589,000	226	4.15	1.77	0.10	0.03	0.29	0.37	0.68	1.33	2.49	3.66	4.71	7.20	10.10
Race															
Black	128,000	6	0.59	*		*	*	*	*	*	*	*	*	*	*
White	8,995,000	556	5.71	2.26	0.11	0.09	0.26	0.39	0.68	1.41	2.91	5.00	7.01	14.00	23.20
Response to Questionnaire															
Households who raise animals	5,256,000	343	52.06	2.80	0.15	0.21	0.39	0.62	1.03	1.94	3.49	5.90	7.84	14.00	23.20

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Moya and Phillips, 2001. (Based on EPA's analyses of the 1987-88 NFCS).

Table 13-16. Consumer Only Intake of Home-produced Meats (g/kg-day) - Northeast

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,113,000	52	2.70	1.46	0.21	0.29	0.34	0.35	0.64	0.89	1.87	2.68	2.89	10.90	10.90
Seasons															
Fall	569,000	18	6.06	*	*	*	*	*	*	*	*	*	*	*	*
Spring	66,000	8	0.63	*	*	*	*	*	*	*	*	*	*	*	*
Summer	176,000	6	1.86	*	*	*	*	*	*	*	*	*	*	*	*
Winter	302,000	20	2.56	2.02	0.56	0.29	0.31	0.43	0.62	1.11	2.38	2.93	7.46	10.90	10.90
Urbanizations															
Central City	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Non-Metropolitan	391,000	17	7.08	*	*	*	*	*	*	*	*	*	*	*	*
Suburban	722,000	35	2.78	1.49	0.15	0.29	0.35	0.43	0.68	1.39	2.34	2.68	2.89	3.61	3.61
Response to Questionnaire															
Households who raise animals	509,000	25	43.21	2.03	0.39	0.62	0.65	0.65	0.88	1.62	2.38	2.93	7.46	10.90	10.90
Households who farm	373,000	15	44.94	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-17. Consumer Only Intake of Home-produced Meats (g/kg-day) - Midwest

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	3,974,000	266	8.57	2.55	0.18	0.13	0.26	0.39	0.66	1.40	3.39	5.75	7.20	15.30	22.30
Seasons															
Fall	1,261,000	49	8.76	1.76	0.23	0.21	0.26	0.37	0.50	1.19	2.66	3.49	6.06	6.78	6.78
Spring	940,000	116	8.82	2.58	0.22	0.24	0.31	0.41	0.73	1.98	3.67	5.14	7.79	11.50	13.00
Summer	930,000	38	9.09	4.10	0.75	0.09	0.13	0.58	0.89	2.87	5.42	8.93	15.30	22.30	22.30
Winter	843,000	63	7.59	2.00	0.24	0.12	0.24	0.33	0.65	1.36	2.69	4.11	5.30	8.10	12.20
Urbanizations															
Central City	460,000	18	2.64	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	2,477,000	175	17.33	3.15	0.26	0.09	0.30	0.43	0.82	2.38	4.34	6.15	9.17	15.30	22.30
Suburban	1,037,000	73	7.05	1.75	0.20	0.29	0.37	0.41	0.66	1.11	2.03	4.16	5.39	7.20	10.10
Response to Questionnaire															
Households who raise animals	2,165,000	165	57.86	3.20	0.22	0.26	0.39	0.58	1.07	2.56	4.42	6.06	9.13	15.30	15.30
Households who farm	1,483,000	108	55.32	3.32	0.29	0.37	0.54	0.59	1.07	2.75	4.71	6.78	9.17	15.30	15.30

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Table 13-18. Consumer Only Intake of Home-produced Meats (g/kg-day) - South															
Total	2,355,000	146	3.66	2.24	0.19	0.02	0.16	0.30	0.72	1.53	3.07	5.07	6.71	14.00	14.00
Seasons															
Fall	758,000	28	5.75	1.81	0.29	0.12	0.16	0.19	0.82	1.53	2.38	3.19	4.41	7.84	7.84
Spring	511,000	53	3.04	2.33	0.27	0.19	0.30	0.50	0.75	1.80	2.82	5.16	6.71	7.51	7.51
Summer	522,000	18	2.94	*	*	*	*	*	*	*	*	*	*	*	*
Winter	564,000	47	3.40	1.80	0.25	0.04	0.20	0.25	0.72	1.40	2.17	3.55	4.58	8.47	8.47
Urbanizations															
Central City	40,000	1	0.23	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	1,687,000	97	8.83	2.45	0.26	0.12	0.19	0.40	0.78	1.61	3.19	6.09	7.84	14.00	14.00
Suburban	628,000	48	2.24	1.79	0.23	0.02	0.03	0.04	0.63	1.40	2.31	4.56	4.61	6.40	6.40
Response to Questionnaire															
Households who raise animals	1,222,000	74	46.95	3.16	0.32	0.26	0.67	0.84	1.34	2.11	3.79	6.67	8.47	14.00	14.00
Households who farm	1,228,000	72	55.02	2.85	0.32	0.20	0.50	0.60	1.01	1.93	3.48	6.23	8.47	14.00	14.00

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-19. Consumer Only Intake of Home-produced Meats (g/kg-day) - West

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,815,000	105	5.03	1.89	0.21	0.15	0.23	0.39	0.66	1.42	2.49	3.66	4.71	8.00	23.20
Seasons															
Fall	264,000	12	2.47	*	*	*	*	*	*	*	*	*	*	*	*
Spring	209,000	20	2.56	1.86	0.23	0.30	0.43	0.87	1.22	1.56	2.43	3.48	4.20	4.20	4.20
Summer	740,000	27	9.27	2.20	0.32	0.19	0.41	0.54	1.07	1.69	3.27	4.44	4.71	8.00	8.00
Winter	602,000	46	6.53	2.11	0.46	0.14	0.36	0.43	0.67	1.19	2.35	3.64	7.02	23.20	23.20
Urbanizations															
Central City	236,000	9	1.96	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	377,000	26	6.17	2.10	0.70	0.33	0.33	0.41	0.67	1.19	1.77	3.72	4.97	23.20	23.20
Suburban	1,202,000	70	6.71	1.95	0.20	0.15	0.23	0.37	0.78	1.52	2.71	4.20	4.71	8.00	8.00
Response to Questionnaire															
Households who raise animals	1,360,000	79	52.84	2.12	0.27	0.15	0.23	0.39	0.82	1.56	2.71	4.20	4.97	8.00	23.20
Households who farm	758,000	48	47.79	2.41	0.43	0.14	0.33	0.47	0.79	1.55	2.91	4.71	7.02	23.20	23.20

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-20. Consumer Only Intake of Home Caught Fish (g/kg-day) - All Regions Combined

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	3,914,000	239	2.08	2.07	0.24	0.08	0.09	0.20	0.23	0.43	1.00	2.17	4.68	7.83	15.50
Age															
1-2	82,000	6	1.44	*	*	*	*	*	*	*	*	*	*	*	*
3-5	142,000	11	1.75	*	*	*	*	*	*	*	*	*	*	*	*
6-11	382,000	29	2.29	2.78	0.84	0.16	0.16	0.18	0.23	0.55	1.03	3.67	7.05	7.85	25.30
12-19	346,000	21	1.69	1.52	0.41	0.20	0.20	0.20	0.20	0.31	0.98	1.79	4.68	6.67	8.44
20-39	962,000	59	1.56	1.91	0.33	0.08	0.08	0.09	0.12	0.44	1.06	2.18	4.46	9.57	13.00
40-69	1,524,000	86	2.69	1.79	0.26	0.09	0.09	0.21	0.28	0.35	0.99	1.99	4.43	6.56	10.80
≥ 70	450,000	24	2.83	1.22	0.23	0.10	0.10	0.23	0.23	0.57	0.76	1.56	3.73	3.73	5.12
Season															
Fall	1,220,000	45	2.56	1.31	0.22	0.18	0.18	0.20	0.21	0.32	0.92	1.79	2.64	3.73	6.56
Spring	1,112,000	114	2.41	3.08	0.56	0.10	0.12	0.31	0.34	0.56	1.27	2.64	6.68	10.80	37.30
Summer	911,000	29	2.00	1.88	0.42	0.08	0.08	0.09	0.20	0.30	0.76	3.19	4.43	5.65	9.57
Winter	671,000	51	1.38	2.05	0.37	0.09	0.09	0.11	0.16	0.51	1.06	2.09	5.89	7.85	13.10
Urbanization															
Central City	999,000	46	1.77	1.79	0.34	0.09	0.09	0.16	0.28	0.61	1.07	1.85	3.73	9.57	9.57
Non-Metropolitan	1,174,000	94	2.61	3.15	0.57	0.10	0.12	0.31	0.36	0.57	1.88	3.86	6.52	7.83	37.30
Suburban	1,741,000	99	2.01	1.50	0.23	0.08	0.08	0.18	0.20	0.29	0.59	1.38	4.37	7.05	10.80
Race															
Black	593,000	41	2.73	1.81	0.37	0.18	0.18	0.20	0.29	0.32	0.98	2.17	4.68	9.57	9.57
White	3,228,000	188	2.05	2.07	0.28	0.08	0.08	0.16	0.23	0.39	1.00	2.16	4.99	6.68	16.10
Response to Questionnaire															
Households who fish	3,553,000	220	8.94	2.22	0.26	0.08	0.08	0.18	0.23	0.47	1.09	2.23	5.61	7.85	16.10

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Moya and Phillips, 2001. (Based on EPA's analyses of the 1987-88 NFCS).

Table 13-21. Consumer Only Intake of Home Caught Fish (g/kg-day) - Northeast															
Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	334,000	12	0.81	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	135,000	4	1.44	*	*	*	*	*	*	*	*	*	*	*	*
Spring	14,000	2	0.13	*	*	*	*	*	*	*	*	*	*	*	*
Summer	132,000	3	1.40	*	*	*	*	*	*	*	*	*	*	*	*
Winter	53,000	3	0.45	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City		0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Non-Metropolitan	42,000	4	0.76	*	*	*	*	*	*	*	*	*	*	*	*
Suburban	292,000	8	1.12	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who fish	334,000	12	5.61	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-22. Consumer Only Intake of Home Caught Fish (g/kg-day) - Midwest															
Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,113,000	71	2.40	2.13	0.42	0.08	0.08	0.20	0.23	0.47	1.03	1.95	6.10	6.56	16.10
Season															
Fall	362,000	13	2.51	*	*	*	*	*	*	*	*	*	*	*	*
Spring	224,000	27	2.10	3.45	1.22	0.12	0.12	0.12	0.31	0.49	0.82	1.67	15.50	16.10	25.30
Summer	264,000	8	2.58	*	*	*	*	*	*	*	*	*	*	*	*
Winter	263,000	23	2.37	2.38	0.53	0.51	0.51	0.51	0.55	1.03	1.56	2.13	5.89	6.10	13.10
Urbanization															
Central City	190,000	9	1.09	*		*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	501,000	40	3.50	3.42	0.72	0.12	0.12	0.33	0.47	0.53	1.88	5.65	6.56	13.10	25.30
Suburban	422,000	22	2.87	0.91	0.18	0.08	0.08	0.08	0.20	0.30	0.55	1.28	2.09	2.78	3.73
Response to Questionnaire															
Households who fish	956,000	60	7.57	2.35	0.49	0.08	0.08	0.12	0.23	0.47	1.12	2.16	6.52	6.56	25.30

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-23. Consumer Only Intake of Home Caught Fish (g/kg-day) - South

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,440,000	101	2.24	2.74	0.48	0.09	0.09	0.20	0.29	0.51	1.48	3.37	5.61	8.44	37.30
Season															
Fall	274,000	11	2.08	*	*	*	*	*	*	*	*	*	*	*	*
Spring	538,000	58	3.20	4.00	0.94	0.31	0.31	0.39	0.45	0.87	1.94	3.71	8.33	13.00	45.20
Summer	376,000	14	2.12	*	*	*	*	*	*	*	*	*	*	*	*
Winter	252,000	18	1.52	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	281,000	16	1.63	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	550,000	41	2.88	3.33	1.06	0.29	0.29	0.34	0.51	1.12	1.94	3.19	4.43	6.67	45.20
Suburban	609,000	44	2.18	2.73	0.50	0.20	0.20	0.28	0.29	0.43	1.08	4.37	8.33	10.40	13.00
Response to Questionnaire															
Households who fish	1,280,000	95	9.42	3.00	0.51	0.09	0.09	0.20	0.28	0.71	1.93	3.67	6.68	8.44	37.30

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-24. Consumer Only Intake of Home Caught Fish (g/kg-day) - West

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,027,000	55	2.85	1.57	0.27	0.10	0.16	0.20	0.24	0.44	0.84	1.79	3.73	5.67	9.57
Season															
Fall	449,000	17	4.20	*	*	*	*	*	*	*	*	*	*	*	*
Spring	336,000	27	4.12	1.35	0.29	0.10	0.10	0.24	0.33	0.44	0.61	1.68	4.68	5.61	5.67
Summer	139,000	4	1.74	*	*	*	*	*	*	*	*	*	*	*	*
Winter	103,000	7	1.12	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	528,000	21	4.38	2.03	0.53	0.33	0.33	0.43	0.53	0.71	1.45	1.85	3.73	9.57	9.57
Non-Metropolitan	81,000	9	1.33	*	*	*	*	*	*	*	*	*	*	*	*
Suburban	418,000	25	2.33	1.09	0.25	0.18	0.18	0.20	0.21	0.31	0.59	1.21	2.90	4.68	5.61
Response to Questionnaire														*	
Households who fish	983,000	53	12.99	1.63	0.28	0.10	0.16	0.20	0.22	0.55	0.96	1.79	3.73	5.67	9.57

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-25. Consumer Only Intake of Home-produced Dairy (g/kg-day) - All Regions

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,409,000	89	0.75	14.00	1.62	0.18	0.45	0.51	3.18	10.20	19.50	34.20	44.00	72.60	111.00
Age															
1-2	79,000	6	1.39	*	*	*	*	*	*	*	*	*	*	*	*
3-5	57,000	5	0.70	*	*	*	*	*	*	*	*	*	*	*	*
6-11	264,000	16	1.58	*	*	*	*	*	*	*	*	*	*	*	*
12-19	84,000	5	0.41	*	*	*	*	*	*	*	*	*	*	*	*
20-39	612,000	36	0.99	7.41	1.02	0.21	0.40	0.45	1.89	6.46	12.10	15.40	19.50	23.00	23.00
40-69	216,000	16	0.38	*	*	*	*	*	*	*	*	*	*	*	*
≥ 70	77,000	3	0.48	*	*	*	*	*	*	*	*	*	*	*	*
Seasons															
Fall	211,000	7	0.44	*	*	*	*	*	*	*	*	*	*	*	*
Spring	253,000	27	0.55	17.80	4.27	0.63	0.65	0.67	5.06	12.20	19.50	50.90	80.10	111.00	111.00
Summer	549,000	22	1.21	15.30	2.73	0.45	0.45	0.51	5.36	10.60	25.10	34.90	36.70	46.80	46.80
Winter	396,000	33	0.81	8.08	1.99	0.18	0.21	0.28	0.74	5.47	11.50	19.80	20.40	72.60	72.60
Urbanizations															
Central City	115,000	7	0.20	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	988,000	59	2.19	16.80	2.10	0.48	0.96	1.89	6.74	10.80	20.40	34.90	44.00	80.10	111.00
Suburban	306,000	23	0.35	9.86	2.38	0.40	0.40	0.45	0.57	5.36	13.10	28.10	28.90	50.90	50.90
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	1,382,000	86	0.88	14.30	1.65	0.18	0.45	0.51	3.82	10.30	19.50	34.20	44.00	80.10	111.00
Response to Questionnaire															
Households who raise animals	1,228,000	80	12.16	15.90	1.73	0.18	0.40	1.89	6.13	10.80	19.60	34.90	44.00	80.10	111.00
Households who farm	1,020,000	63	13.92	17.10	1.99	0.40	0.74	3.18	9.06	12.10	20.40	34.90	44.00	80.10	111.00

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Moya and Phillips, 2001. (Based on EPA's analyses of the 1987-88 NFCS).

Table 13-26. Consumer Only Intake of Home-produced Dairy (g/kg-day) - Northeast

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	312,000	16	0.76	*	*	*	*	*	*	*	*	*	*	*	*
Seasons															
Fall	48,000	2	0.51	*	*	*	*	*	*	*	*	*	*	*	*
Spring	36,000	4	0.34	*	*	*	*	*	*	*	*	*	*	*	*
Summer	116,000	4	1.23	*	*	*	*	*	*	*	*	*	*	*	*
Winter	112,000	6	0.95	*	*	*	*	*	*	*	*	*	*	*	*
Urbanizations															
Central City	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Non-Metropolitan	240,000	10	4.35	*	*	*	*	*	*	*	*	*	*	*	*
Suburban	72,000	6	0.28	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who raise animals	312,000	16	26.49	*	*	*	*	*	*	*	*	*	*	*	*
Households who farm	312,000	16	37.59	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-27. Consumer Only Intake of Home-produced Dairy (g/kg-day) - Midwest

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	594,000	36	1.28	18.60	3.15	0.45	0.45	1.97	8.27	12.40	23.00	44.00	46.80	111.00	111.00
Seasons															
Fall	163,000	5	1.13	*	*	*	*	*	*	*	*	*	*	*	*
Spring	94,000	12	0.88	*	*	*	*	*	*	*	*	*	*	*	*
Summer	252,000	11	2.46	*	*	*	*	*	*	*	*	*	*	*	*
Winter	85,000	8	0.76	*	*	*	*	*	*	*	*	*	*	*	*
Urbanizations															
Central City	43,000	1	0.25	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	463,000	31	3.24	23.30	3.40	4.25	8.27	9.06	12.10	16.00	31.40	44.00	46.80	111.00	111.00
Suburban	88,000	4	0.60	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who raise animals	490,000	32	13.09	22.30	3.33	4.25	5.36	8.27	10.80	15.40	31.40	44.00	46.80	111.00	111.00
Households who farm	490,000	32	18.28	22.30	3.33	4.25	5.36	8.27	10.80	15.40	31.40	44.00	46.80	111.00	111.00

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-28. Consumer Only Intake of Home-produced Dairy (g/kg-day) - South															
Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	242,000	17	0.38	*	*	*	*	*	*	*	*	*	*	*	*
Seasons															
Fall	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Spring	27,000	3	0.16	*	*	*	*	*	*	*	*	*	*	*	*
Summer	131,000	5	0.74	*	*	*	*	*	*	*	*	*	*	*	*
Winter	84,000	9	0.51	*	*	*	*	*	*	*	*	*	*	*	*
Urbanizations															
Central City	27,000	3	0.16	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	215,000	14	1.13	*	*	*	*	*	*	*	*	*	*	*	*
Suburban	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Response to Questionnaire															
Households who raise animals	215,000	14	8.26	*	*	*	*	*	*	*	*	*	*	*	*
Households who farm	148,000	8	6.63	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-29. Consumer Only Intake of Home-produced Dairy (g/kg-day) - West

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	261,000	20	0.72	10.00	2.75	0.18	0.18	0.21	0.51	6.10	13.30	28.10	28.90	50.90	50.90
Seasons															
Fall	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Spring	96,000	8	1.18	*	*	*	*	*	*	*	*	*	*	*	*
Summer	50,000	2	0.63	*	*	*	*	*	*	*	*	*	*	*	*
Winter	115,000	10	1.25	*	*	*	*	*	*	*	*	*	*	*	*
Urbanizations															
Central City	45,000	3	0.37	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	70,000	4	1.15	*	*	*	*	*	*	*	*	*	*	*	*
Suburban	146,000	13	0.81	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who raise animals	211,000	18	8.20	*	*	*	*	*	*	*	*	*	*	*	*
Households who farm	70,000	7	4.41	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-30. Seasonally Adjusted Consumer Only Homegrown Intake (g/kg-day)

Population Group	Percent Consuming	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total Vegetables											
Northeast	16.50	0.00	0.02	0.04	0.20	0.46	1.37	3.32	5.70	8.78	10.10
Midwest	33.25	0.00	0.04	0.08	0.29	0.81	1.96	4.40	7.41	1.31	20.10
South	24.00	0.00	0.03	0.06	0.21	0.61	1.86	3.95	5.63	12.00	16.20
West	23.75	0.00	0.02	0.04	0.11	0.49	1.46	2.99	5.04	8.91	11.20
All Regions	24.60	0.01	0.03	0.06	0.22	0.64	1.80	4.00	6.08	11.70	20.10
Total Fruit											
Northeast	3.50	0.00	0.02	0.05	0.17	0.36	0.66	1.48	3.00	5.10	5.63
Midwest	12.75	0.00	0.01	0.01	0.14	0.79	2.98	5.79	9.52	22.20	27.10
South	8.00	0.01	0.03	0.11	0.38	0.95	2.10	6.70	10.20	14.90	16.40
West	17.75	0.00	0.06	0.09	0.29	0.69	1.81	4.75	8.54	14.50	18.40
All Regions	10.10	0.00	0.02	0.06	0.25	0.75	2.35	5.61	9.12	17.60	27.10
Total Meat											
Northeast	6.25	0.00	0.03	0.08	0.13	0.21	0.70	1.56	1.91	4.09	4.80
Midwest	9.25	0.00	0.04	0.22	0.05	1.61	3.41	5.25	7.45	11.90	13.60
South	5.75	0.01	0.03	0.05	0.19	0.53	1.84	3.78	4.95	8.45	9.45
West	9.50	0.00	0.03	0.10	0.24	0.56	1.30	2.29	3.38	7.20	9.10
All Regions	7.40	0.00	0.04	0.09	0.22	0.66	1.96	4.05	5.17	9.40	13.60

Source Moya and Phillips, 2001. (Based on U.S. EPA's analyses of the 1987-88 NFCS).

Table 13-31. Consumer Only Intake of Homegrown Apples (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	5,306,000	272	2.82	1.19	0.08	0.08	0.23	0.28	0.45	0.82	1.47	2.38	3.40	5.42	10.10
Age															
1-2	199,000	12	3.49	*	*	*	*	*	*	*	*	*	*	*	*
3-5	291,000	16	3.59	*	*	*	*	*	*	*	*	*	*	*	*
6-11	402,000	25	2.41	1.28	0.19	0.47	0.47	0.56	0.74	0.96	1.29	2.98	4.00	4.00	4.00
12-19	296,000	12	1.44	*	*	*	*	*	*	*	*	*	*	*	*
20-39	1,268,000	61	2.06	0.80	0.11	0.19	0.23	0.26	0.30	0.60	0.92	1.55	1.97	5.42	5.42
40-69	1,719,000	90	3.03	0.96	0.14	0.06	0.09	0.26	0.40	0.65	1.08	1.59	2.38	9.83	9.83
≥ 70	1,061,000	52	6.68	1.45	0.14	0.20	0.26	0.45	0.63	1.18	1.82	3.40	3.62	4.20	4.20
Season															
Fall	1,707,000	60	3.58	1.28	0.12	0.26	0.30	0.32	0.58	1.03	1.66	2.69	3.40	4.25	4.25
Spring	639,000	74	1.38	0.95	0.11	0.19	0.24	0.28	0.38	0.57	1.10	2.00	2.78	5.87	5.87
Summer	1,935,000	68	4.25	1.12	0.17	0.06	0.09	0.19	0.40	0.69	1.41	2.29	2.98	9.83	9.83
Winter	1,025,000	70	2.10	1.30	0.18	0.19	0.23	0.32	0.57	0.88	1.59	2.75	3.40	10.10	10.10
Urbanization															
Central City	912,000	30	1.62	1.24	0.26	0.23	0.26	0.39	0.51	0.92	1.59	2.19	2.26	10.10	10.10
Non-Metropolitan	2,118,000	122	4.70	1.27	0.13	0.06	0.12	0.25	0.41	0.90	1.55	2.92	3.48	9.83	9.83
Suburban	2,276,000	120	2.63	1.09	0.09	0.19	0.24	0.29	0.44	0.77	1.29	2.29	3.40	5.42	5.42
Race															
Black	84,000	4	0.39	*	*	*	*	*	*	*	*	*	*	*	*
White	5,222,000	268	3.31	1.18	0.08	0.08	0.23	0.28	0.45	0.80	1.41	2.38	3.40	5.42	10.10
Region															
Midwest	2,044,000	123	4.41	1.38	0.15	0.22	0.29	0.30	0.52	0.92	1.61	2.69	3.40	9.83	10.10
Northeast	442,000	18	1.07	*	*	*	*	*	*	*	*	*	*	*	*
South	1,310,000	65	2.04	1.10	0.11	0.20	0.24	0.30	0.44	0.92	1.38	1.90	2.98	4.00	4.91
West	1,510,000	66	4.19	1.20	0.13	0.06	0.19	0.26	0.47	0.79	1.82	2.75	3.62	4.25	4.25
Response to Questionnaire															
Households who garden	4,707,000	246	6.91	1.21	0.08	0.13	0.25	0.30	0.47	0.82	1.47	2.38	3.40	5.87	10.10
Households who farm	1,299,000	68	17.72	1.39	0.13	0.06	0.36	0.54	0.70	0.96	1.58	2.99	4.00	4.91	5.87

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-32. Consumer Only Intake of Homegrown Asparagus (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	763,000	66	0.41	0.56	0.05	0.10	0.14	0.19	0.28	0.40	0.71	1.12	1.63	1.97	1.97
Age															
1-2	8,000	1	0.14	*	*	*	*	*	*	*	*	*	*	*	*
3-5	25,000	3	0.31	*	*	*	*	*	*	*	*	*	*	*	*
6-11	31,000	3	0.19	*	*	*	*	*	*	*	*	*	*	*	*
12-19	70,000	5	0.34	*	*	*	*	*	*	*	*	*	*	*	*
20-39	144,000	11	0.23	*	*	*	*	*	*	*	*	*	*	*	*
40-69	430,000	38	0.76	0.47	0.05	0.11	0.11	0.18	0.23	0.40	0.60	0.88	1.24	1.75	1.75
≥ 70	55,000	5	0.35	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	62,000	2	0.13	*	*	*	*	*	*	*	*	*	*	*	*
Spring	608,000	59	1.32	0.61	0.06	0.10	0.16	0.19	0.30	0.45	0.88	1.18	1.63	1.97	1.97
Summer	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Winter	93,000	5	0.19	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	190,000	9	0.34	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	215,000	27	0.48	0.76	0.12	0.10	0.11	0.14	0.23	0.54	1.24	1.75	1.92	1.97	1.97
Suburban	358,000	30	0.41	0.43	0.04	0.11	0.17	0.18	0.28	0.37	0.58	0.70	0.93	1.12	1.12
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	763,000	66	0.48	0.56	0.05	0.10	0.14	0.19	0.28	0.40	0.71	1.12	1.63	1.97	1.97
Region															
Midwest	368,000	33	0.79	0.48	0.06	0.10	0.11	0.14	0.23	0.40	0.61	0.93	1.12	1.97	1.97
Northeast	270,000	20	0.66	0.72	0.10	0.18	0.23	0.23	0.37	0.60	0.93	1.24	1.63	1.92	1.92
South	95,000	9	0.15	*	*	*	*	*	*	*	*	*	*	*	*
West	30,000	4	0.08	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who garden	669,000	59	0.98	0.53	0.06	0.10	0.14	0.18	0.28	0.40	0.70	1.12	1.63	1.97	1.97
Households who farm	157,000	16	2.14	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-33. Consumer Only Intake of Home-produced Beef (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	4,958,000	304	2.64	2.45	0.15	0.18	0.37	0.47	0.88	1.61	3.07	5.29	7.24	13.30	19.40
Age															
1-2	110,000	8	1.93	*	*	*	*	*	*	*	*	*	*	*	*
3-5	234,000	13	2.89	*	*	*	*	*	*	*	*	*	*	*	*
6-11	695,000	38	4.16	3.77	0.59	0.35	0.66	0.75	1.32	2.11	4.43	11.40	12.50	13.30	13.30
12-19	656,000	41	3.20	1.72	0.16	0.38	0.48	0.51	0.90	1.51	2.44	3.53	3.57	4.28	4.28
20-39	1,495,000	83	2.43	2.06	0.20	0.27	0.35	0.39	0.68	1.59	2.73	4.88	6.50	8.26	8.26
40-69	1,490,000	105	2.63	1.84	0.14	0.18	0.36	0.46	0.83	1.52	2.38	4.10	5.39	5.90	5.90
≥ 70	188,000	11	1.18	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	1,404,000	55	2.95	1.55	0.17	0.18	0.35	0.36	0.52	1.33	2.01	2.86	3.90	7.24	7.24
Spring	911,000	108	1.97	2.32	0.16	0.27	0.39	0.51	1.04	1.96	3.29	4.22	5.23	8.62	9.28
Summer	1,755,000	69	3.86	3.48	0.41	0.10	0.61	0.75	1.02	2.44	4.43	7.51	11.40	18.70	18.70
Winter	888,000	72	1.82	1.95	0.28	0.04	0.38	0.39	0.67	1.33	2.14	4.23	5.39	19.40	19.40
Urbanization															
Central City	100,000	5	0.18	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	3,070,000	194	6.82	2.80	0.22	0.18	0.38	0.50	0.86	1.81	3.57	6.03	8.44	18.70	19.40
Suburban	1,788,000	105	2.07	1.93	0.15	0.27	0.38	0.42	0.91	1.52	2.44	4.06	5.10	7.51	9.28
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	4,950,000	303	3.14	2.45	0.15	0.18	0.37	0.47	0.88	1.61	3.07	5.29	7.24	13.30	19.40
Region															
Midwest	2,261,000	161	4.87	2.83	0.23	0.18	0.35	0.42	0.85	2.01	3.66	5.90	8.39	18.70	18.70
Northeast	586,000	25	1.42	1.44	0.21	0.35	0.35	0.47	0.74	1.06	1.68	2.62	2.62	6.03	6.03
South	1,042,000	61	1.62	2.45	0.35	0.10	0.39	0.58	0.82	1.59	2.41	6.36	7.24	13.30	13.30
West	1,069,000	57	2.96	2.20	0.28	0.31	0.38	0.56	1.04	1.60	2.86	4.06	4.42	7.51	19.40
Response to Questionnaire															
Households who raise animals	3,699,000	239	36.63	2.66	0.16	0.18	0.39	0.66	1.04	1.83	3.48	5.39	7.51	12.50	19.40
Households who farm	2,850,000	182	38.89	2.63	0.20	0.27	0.39	0.59	0.90	1.64	3.25	5.39	7.51	11.30	19.40

* Intake data not provided for subpopulations for which there were less than 20 observations.
- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-34. Consumer Only Intake of Homegrown Beets (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	2,214,000	125	1.18	0.51	0.05	0.03	0.07	0.11	0.19	0.40	0.59	1.03	1.36	3.69	4.08
Age															
1-2	27,000	2	0.47	*	*	*	*	*	*	*	*	*	*	*	*
3-5	51,000	4	0.63	*	*	*	*	*	*	*	*	*	*	*	*
6-11	167,000	10	1.00	*	*	*	*	*	*	*	*	*	*	*	*
12-19	227,000	13	1.11	*	*	*	*	*	*	*	*	*	*	*	*
20-39	383,000	22	0.62	0.38	0.06	0.08	0.08	0.12	0.14	0.29	0.56	1.00	1.00	1.12	1.12
40-69	951,000	51	1.68	0.43	0.04	0.05	0.07	0.07	0.21	0.40	0.55	0.93	1.15	1.40	1.40
≥ 70	408,000	23	2.57	0.58	0.09	0.03	0.03	0.05	0.27	0.45	0.91	1.36	1.36	1.59	1.59
Season															
Fall	562,000	21	1.18	0.55	0.09	0.03	0.05	0.05	0.26	0.36	0.95	1.36	1.36	1.40	1.40
Spring	558,000	55	1.21	0.47	0.09	0.07	0.08	0.11	0.14	0.27	0.45	0.87	1.59	4.08	4.08
Summer	676,000	22	1.49	0.39	0.05	0.08	0.12	0.12	0.18	0.40	0.55	0.62	0.91	0.91	0.91
Winter	418,000	27	0.86	0.73	0.15	0.07	0.07	0.07	0.28	0.52	0.83	1.13	2.32	3.69	3.69
Urbanization															
Central City	651,000	27	1.16	0.52	0.12	0.11	0.14	0.18	0.26	0.40	0.55	0.91	1.12	3.69	3.69
Non-Metropolitan	758,000	51	1.68	0.58	0.09	0.05	0.07	0.07	0.18	0.39	0.66	1.36	1.40	4.08	4.08
Suburban	805,000	47	0.93	0.45	0.06	0.03	0.05	0.08	0.14	0.40	0.56	0.93	1.00	2.32	2.32
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	2,186,000	124	1.39	0.52	0.05	0.03	0.07	0.11	0.21	0.40	0.59	1.03	1.36	3.69	4.08
Region															
Midwest	885,000	53	1.91	0.63	0.08	0.05	0.11	0.18	0.32	0.45	0.91	1.15	1.36	3.69	3.69
Northeast	230,000	13	0.56	*	*	*	*	*	*	*	*	*	*	*	*
South	545,000	31	0.85	0.45	0.12	0.07	0.08	0.08	0.18	0.26	0.48	0.66	0.94	4.08	4.08
West	554,000	28	1.54	0.40	0.08	0.03	0.05	0.07	0.12	0.29	0.55	0.62	0.70	2.32	2.32
Response to Questionnaire															
Households who garden	2,107,000	120	3.09	0.53	0.05	0.03	0.07	0.10	0.21	0.40	0.61	1.03	1.36	3.69	4.08
Households who farm	229,000	11	3.12	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-35. Consumer Only Intake of Homegrown Broccoli (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,745,000	80	0.93	0.42	0.05	0.08	0.08	0.16	0.20	0.29	0.46	0.82	0.97	2.48	3.02
Age															
1-2	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
3-5	13,000	1	0.16	*	*	*	*	*	*	*	*	*	*	*	*
6-11	187,000	9	1.12	*	*	*	*	*	*	*	*	*	*	*	*
12-19	102,000	4	0.50	*	*	*	*	*	*	*	*	*	*	*	*
20-39	486,000	19	0.79	*	*	*	*	*	*	*	*	*	*	*	*
40-69	761,000	37	1.34	0.41	0.07	0.08	0.11	0.16	0.22	0.35	0.46	0.61	0.82	3.02	3.02
≥ 70	196,000	10	1.23	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	624,000	20	1.31	0.29	0.04	0.08	0.08	0.08	0.18	0.23	0.38	0.45	0.53	0.82	0.82
Spring	258,000	27	0.56	0.54	0.12	0.05	0.15	0.17	0.27	0.33	0.59	1.25	2.37	3.02	3.02
Summer	682,000	22	1.50	0.51	0.11	0.08	0.13	0.18	0.22	0.40	0.66	0.89	0.97	2.48	2.48
Winter	181,000	11	0.37	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	165,000	5	0.29	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	647,000	34	1.44	0.42	0.04	0.05	0.13	0.17	0.22	0.37	0.59	0.75	0.89	0.97	0.97
Suburban	933,000	41	1.08	0.43	0.08	0.08	0.08	0.14	0.21	0.24	0.44	0.68	2.37	2.48	3.02
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	1,719,000	79	1.09	0.42	0.05	0.08	0.08	0.16	0.20	0.29	0.46	0.82	0.97	2.48	3.02
Region															
Midwest	792,000	38	1.71	0.26	0.06	0.08	0.08	0.08	0.18	0.21	0.28	0.34	0.40	3.02	3.02
Northeast	427,000	19	1.04	*	*	*	*	*	*	*	*	*	*	*	*
South	373,000	16	0.58	*	*	*	*	*	*	*	*	*	*	*	*
West	153,000	7	0.42	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who garden	1,729,000	78	2.54	0.42	0.05	0.08	0.08	0.16	0.20	0.29	0.46	0.82	0.97	2.48	3.02
Households who farm	599,000	29	8.17	0.47	0.08	0.05	0.08	0.15	0.20	0.31	0.66	0.89	0.97	3.02	3.02

*	Intake data not provided for subpopulations for which there were less than 20 observations.
-	Indicates data are not available.
SE	= standard error.
P	= percentile of the distribution.
Nc wgtd	= weighted number of consumers.
Nc unwgtd	= unweighted number of consumers in survey.
Source:	Based on EPA's analyses of the 1987-88 NFCS.

Table 13-36. Consumer Only Intake of Homegrown Cabbage (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	2,019,000	89	1.07	1.03	0.10	0.11	0.20	0.32	0.42	0.78	1.33	1.97	2.35	5.43	5.43
Age															
1-2	14,000	2	0.25	*	*	*	*	*	*	*	*	*	*	*	*
3-5	29,000	1	0.36	*	*	*	*	*	*	*	*	*	*	*	*
6-11	61,000	3	0.37	*	*	*	*	*	*	*	*	*	*	*	*
12-19	203,000	9	0.99	*	*	*	*	*	*	*	*	*	*	*	*
20-39	391,000	16	0.63	*	*	*	*	*	*	*	*	*	*	*	*
40-69	966,000	44	1.70	1.14	0.18	0.22	0.22	0.33	0.41	0.71	1.41	1.82	5.29	5.43	5.43
≥ 70	326,000	13	2.05	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	570,000	21	1.20	1.28	0.32	0.19	0.19	0.20	0.39	0.54	1.49	5.29	5.43	5.43	5.43
Spring	126,000	15	0.27	*	*	*	*	*	*	*	*	*	*	*	*
Summer	1,142,000	39	2.51	0.97	0.09	0.20	0.22	0.33	0.56	0.83	1.24	1.79	2.35	2.77	2.77
Winter	181,000	14	0.37	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	157,000	5	0.28	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	1,079,000	48	2.40	0.94	0.09	0.20	0.32	0.34	0.45	0.71	1.33	1.79	2.35	2.77	2.77
Suburban	783,000	36	0.90	1.26	0.21	0.03	0.22	0.33	0.45	1.05	1.37	2.17	5.29	5.43	5.43
Race															
Black	7,000	1	0.03	*	*	*	*	*	*	*	*	*	*	*	*
White	1,867,000	83	1.19	1.05	0.11	0.11	0.20	0.25	0.41	0.79	1.37	1.97	2.35	5.43	5.43
Region															
Midwest	884,000	37	1.91	0.74	0.07	0.11	0.19	0.22	0.36	0.60	1.10	1.29	1.49	1.82	1.98
Northeast	277,000	11	0.67	*	*	*	*	*	*	*	*	*	*	*	*
South	616,000	32	0.96	1.11	0.13	0.03	0.20	0.22	0.45	0.85	1.79	2.17	2.35	2.77	2.77
West	242,000	9	0.67	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who garden	1,921,000	86	2.82	1.07	0.10	0.11	0.20	0.32	0.45	0.79	1.37	1.97	2.35	5.43	5.43
Households who farm	546,000	26	7.45	1.00	0.12	0.20	0.21	0.35	0.59	0.83	1.37	1.79	2.35	2.35	2.35

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-37. Consumer Only Intake of Homegrown Carrots (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	4,322,000	193	2.30	0.44	0.04	0.04	0.06	0.09	0.18	0.33	0.53	0.80	1.08	2.21	7.79
Age															
1-2	51,000	4	0.89	*	*	*	*	*	*	*	*	*	*	*	*
3-5	53,000	3	0.65	*	*	*	*	*	*	*	*	*	*	*	*
6-11	299,000	14	1.79	*	*	*	*	*	*	*	*	*	*	*	*
12-19	389,000	17	1.90	*	*	*	*	*	*	*	*	*	*	*	*
20-39	1,043,000	46	1.69	0.28	0.03	0.04	0.05	0.08	0.12	0.20	0.41	0.56	0.76	1.19	1.19
40-69	1,848,000	82	3.26	0.43	0.03	0.04	0.07	0.12	0.22	0.37	0.55	0.78	1.01	1.53	2.21
≥ 70	574,000	24	3.61	0.44	0.06	0.07	0.18	0.20	0.26	0.37	0.54	0.96	1.08	1.08	1.08
Season															
Fall	1,810,000	66	3.80	0.46	0.10	0.09	0.11	0.12	0.20	0.31	0.51	0.78	1.08	1.71	7.79
Spring	267,000	28	0.58	0.56	0.10	0.14	0.15	0.20	0.22	0.39	0.61	0.99	2.11	2.94	2.94
Summer	1,544,000	49	3.39	0.39	0.04	0.04	0.05	0.07	0.16	0.38	0.51	0.84	0.96	1.19	1.19
Winter	701,000	50	1.44	0.44	0.07	0.04	0.04	0.06	0.16	0.23	0.64	1.05	1.53	3.06	3.06
Urbanization															
Central City	963,000	29	1.71	0.28	0.04	0.04	0.06	0.08	0.16	0.21	0.39	0.53	0.59	0.96	0.96
Non-Metropolitan	1,675,000	94	3.72	0.52	0.09	0.04	0.05	0.07	0.20	0.33	0.51	0.96	1.19	7.79	7.79
Suburban	1,684,000	70	1.94	0.45	0.04	0.07	0.09	0.12	0.20	0.38	0.64	0.80	1.09	1.71	1.71
Race															
Black	107,000	7	0.49	*	*	*	*	*	*	*	*	*	*	*	*
White	3,970,000	178	2.52	0.41	0.03	0.04	0.08	0.11	0.19	0.33	0.53	0.78	1.01	1.59	3.06
Region															
Midwest	2,001,000	97	4.31	0.46	0.04	0.04	0.08	0.14	0.20	0.37	0.54	0.96	1.10	2.11	3.06
Northeast	735,000	29	1.79	0.41	0.09	0.04	0.05	0.06	0.09	0.15	0.64	1.09	1.71	2.21	2.21
South	378,000	20	0.59	0.63	0.36	0.04	0.04	0.05	0.15	0.27	0.41	0.50	0.99	7.79	7.79
West	1,208,000	47	3.35	0.37	0.03	0.07	0.09	0.14	0.19	0.33	0.46	0.76	0.84	0.96	0.96
Response to Questionnaire															
Households who garden	4,054,000	182	5.95	0.40	0.03	0.04	0.07	0.09	0.18	0.33	0.51	0.76	1.08	1.71	3.06
Households who farm	833,000	40	11.37	0.36	0.06	0.09	0.09	0.11	0.18	0.23	0.46	0.62	1.19	2.11	2.94

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-38. Consumer Only Intake of Homegrown Corn (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	6,891,000	421	3.67	0.89	0.06	0.05	0.12	0.17	0.24	0.48	0.91	1.88	3.37	7.44	9.23
Age															
1-2	205,000	13	3.60	*	*	*	*	*	*	*	*	*	*	*	*
3-5	313,000	24	3.86	1.25	0.26	0.33	0.33	0.40	0.60	1.00	1.21	1.67	5.35	5.35	5.35
6-11	689,000	43	4.12	0.93	0.17	0.11	0.12	0.19	0.25	0.51	1.08	3.13	3.37	4.52	4.52
12-19	530,000	32	2.59	0.59	0.10	0.10	0.11	0.14	0.21	0.34	0.71	1.55	1.88	1.88	1.88
20-39	1,913,000	108	3.11	0.60	0.06	0.07	0.14	0.15	0.21	0.37	0.71	1.53	2.04	3.70	3.70
40-69	2,265,000	142	3.99	0.86	0.11	0.11	0.15	0.17	0.26	0.52	0.88	1.42	3.22	7.44	7.44
≥ 70	871,000	53	5.48	0.94	0.26	0.04	0.05	0.11	0.19	0.36	0.76	1.34	6.49	9.23	9.23
Season															
Fall	2,458,000	89	5.16	0.54	0.08	0.04	0.11	0.14	0.19	0.32	0.55	1.27	1.42	5.35	5.69
Spring	1,380,000	160	2.99	0.64	0.06	0.14	0.17	0.19	0.26	0.45	0.77	1.21	1.57	5.15	6.68
Summer	1,777,000	62	3.91	1.82	0.26	0.07	0.18	0.34	0.64	0.94	2.13	4.52	6.84	9.23	9.23
Winter	1,276,000	110	2.62	0.55	0.05	0.11	0.12	0.15	0.22	0.41	0.61	1.16	1.47	2.04	3.94
Urbanization															
Central City	748,000	27	1.33	0.74	0.14	0.04	0.04	0.05	0.18	0.55	0.93	2.04	2.23	3.04	3.04
Non-Metropolitan	4,122,000	268	9.16	0.96	0.08	0.07	0.12	0.17	0.25	0.53	1.00	2.13	3.38	7.44	8.97
Suburban	2,021,000	126	2.33	0.80	0.13	0.11	0.15	0.17	0.24	0.40	0.65	1.34	1.71	9.23	9.23
Race															
Black	188,000	9	0.86	*	*	*	*	*	*	*	*	*	*	*	*
White	6,703,000	412	4.26	0.89	0.07	0.05	0.12	0.16	0.24	0.48	0.88	1.88	3.22	7.44	9.23
Region															
Midwest	2,557,000	188	5.51	0.93	0.10	0.04	0.12	0.17	0.25	0.46	0.93	2.28	3.22	6.84	7.44
Northeast	586,000	33	1.42	0.61	0.08	0.10	0.17	0.19	0.24	0.38	0.88	1.34	1.71	1.71	1.71
South	2,745,000	153	4.27	0.87	0.10	0.07	0.12	0.17	0.28	0.56	0.94	1.55	3.37	5.69	8.97
West	1,003,000	47	2.78	1.00	0.28	0.11	0.15	0.15	0.18	0.40	0.75	2.23	6.49	9.23	9.23
Response to Questionnaire															
Households who garden	6233000	387	9.15	0.88	0.06	0.05	0.14	0.17	0.24	0.50	0.91	1.82	3.13	6.84	9.23
Households who farm	1739000	114	23.73	1.20	0.18	0.04	0.11	0.17	0.23	0.38	0.97	3.37	6.49	9.23	9.23

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-39. Consumer Only Intake of Homegrown Cucumbers (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	3,994,000	141	2.12	1.02	0.16	0.03	0.07	0.11	0.24	0.54	1.13	2.11	2.79	13.40	13.70
Age															
1-2	132,000	5	2.32	*	*	*	*	*	*	*	*	*	*	*	*
3-5	107,000	4	1.32	*	*	*	*	*	*	*	*	*	*	*	*
6-11	356,000	12	2.13	*	*	*	*	*	*	*	*	*	*	*	*
12-19	254,000	10	1.24	*	*	*	*	*	*	*	*	*	*	*	*
20-39	864,000	29	1.40	0.50	0.09	0.03	0.05	0.06	0.18	0.31	0.62	1.35	1.49	2.12	2.12
40-69	1,882,000	68	3.32	1.33	0.30	0.04	0.07	0.18	0.39	0.68	1.29	2.11	3.27	13.70	13.70
≥ 70	399,000	13	2.51	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	370,000	12	0.78	*	*	*	*	*	*	*	*	*	*	*	*
Spring	197,000	15	0.43	*	*	*	*	*	*	*	*	*	*	*	*
Summer	3,427,000	114	7.53	1.06	0.18	0.00	0.07	0.11	0.24	0.52	1.13	2.12	2.79	13.40	13.70
Winter	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Urbanization															
Central City	640,000	18	1.14	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	1,530,000	64	3.40	1.74	0.34	0.10	0.12	0.19	0.39	1.06	1.67	3.09	4.50	13.70	13.70
Suburban	1,824,000	59	2.11	0.67	0.08	0.00	0.07	0.16	0.28	0.50	0.83	1.34	1.73	3.27	3.27
Race															
Black	86,000	2	0.40	*	*	*	*	*	*	*	*	*	*	*	*
White	3,724,000	132	2.36	0.94	0.16	0.03	0.06	0.10	0.22	0.50	1.03	1.49	2.40	13.40	13.70
Region															
Midwest	969,000	31	2.09	1.00	0.39	0.03	0.04	0.05	0.14	0.45	1.03	2.35	2.45	13.40	13.40
Northeast	689,000	22	1.67	1.92	0.68	0.23	0.28	0.28	0.48	0.68	1.53	4.18	11.70	13.70	13.70
South	1,317,000	54	2.05	0.89	0.11	0.00	0.12	0.18	0.29	0.75	1.28	1.73	2.13	4.50	4.50
West	1,019,000	34	2.83	0.60	0.11	0.07	0.07	0.10	0.21	0.43	0.70	1.29	2.11	3.27	3.27
Response to Questionnaire															
Households who garden	3,465,000	123	5.08	1.05	0.18	0.03	0.07	0.10	0.28	0.52	1.13	2.11	2.79	13.40	13.70
Households who farm	710,000	29	9.69	0.70	0.11	0.00	0.00	0.14	0.19	0.39	1.27	1.49	1.71	2.09	2.09

* Intake data not provided for subpopulations for which there were less than 20 observations.
- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-40. Consumer Only Intake of Home-produced Eggs (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	2,075,000	124	1.10	0.73	0.10	0.07	0.15	0.18	0.27	0.47	0.90	1.36	1.69	6.58	13.50
Age															
1-2	21,000	3	0.37	*	*	*	*	*	*	*	*	*	*	*	*
3-5	20,000	2	0.25	*	*	*	*	*	*	*	*	*	*	*	*
6-11	170,000	12	1.02	*	*	*	*	*	*	*	*	*	*	*	*
12-19	163,000	14	0.80	*	*	*	*	*	*	*	*	*	*	*	*
20-39	474,000	30	0.77	0.63	0.09	0.07	0.07	0.22	0.30	0.42	0.81	1.32	1.93	2.50	2.50
40-69	718,000	43	1.27	0.59	0.06	0.14	0.14	0.15	0.32	0.51	0.84	1.30	1.36	1.38	1.38
≥ 70	489,000	18	3.08	*	*	*	*	*	*	*	*	*	*	*	*
Seasons															
Fall	542,000	18	1.14	*	*	*	*	*	*	*	*	*	*	*	*
Spring	460,000	54	1.00	1.31	0.29	0.16	0.33	0.39	0.50	0.67	1.31	2.10	3.26	13.50	13.50
Summer	723,000	26	1.59	0.50	0.08	0.07	0.14	0.14	0.26	0.33	0.54	1.36	1.51	1.65	1.65
Winter	350,000	26	0.72	0.86	0.10	0.17	0.18	0.22	0.40	0.75	1.17	1.62	1.93	1.93	1.93
Urbanization															
Central City	251,000	9	0.45	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	1,076,000	65	2.39	0.73	0.12	0.07	0.14	0.17	0.26	0.47	0.92	1.34	1.65	6.58	9.16
Suburban	748,000	50	0.86	0.85	0.20	0.14	0.15	0.21	0.38	0.59	1.17	1.36	1.85	13.50	13.50
Race															
Black	63,000	9	0.29	*	*	*	*	*	*	*	*	*	*	*	*
White	2,012,000	115	1.28	0.74	0.11	0.07	0.15	0.18	0.27	0.48	0.90	1.36	1.69	6.58	13.50
Region															
Midwest	665,000	37	1.43	0.79	0.20	0.07	0.14	0.14	0.22	0.34	1.08	1.51	2.10	9.16	9.16
Northeast	87,000	7	0.21	*	*	*	*	*	*	*	*	*	*	*	*
South	823,000	44	1.28	0.54	0.06	0.15	0.18	0.20	0.26	0.36	0.60	1.18	1.62	1.93	1.93
West	500,000	36	1.39	0.92	0.28	0.17	0.21	0.21	0.46	0.67	1.05	1.36	1.36	13.50	13.50
Response to Questionnaire															
Households who raise animals	1,824,000	113	18.06	0.75	0.11	0.07	0.15	0.17	0.26	0.48	0.90	1.36	1.85	6.58	13.50
Households who farm	741,000	44	10.11	0.90	0.17	0.15	0.17	0.18	0.27	0.67	1.19	1.65	1.85	6.58	9.16

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-41. Consumer Only Intake of Home-produced Game (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	2,707,000	185	1.44	0.97	0.06	0.00	0.12	0.21	0.40	0.71	1.22	2.27	2.67	3.61	4.59
Age															
1-2	89,000	8	1.56	*	*	*	*	*	*	*	*	*	*	*	*
3-5	94,000	8	1.16	*	*	*	*	*	*	*	*	*	*	*	*
6-11	362,000	28	2.17	1.09	0.14	0.12	0.23	0.43	0.63	0.76	1.48	2.67	2.85	2.90	2.90
12-19	462,000	27	2.25	1.04	0.14	0.21	0.21	0.29	0.63	0.85	1.22	1.99	3.13	3.13	3.13
20-39	844,000	59	1.37	0.82	0.11	0.10	0.12	0.19	0.30	0.63	1.09	1.57	2.50	4.59	4.59
40-69	694,000	41	1.22	0.96	0.14	0.12	0.17	0.29	0.34	0.51	1.41	2.51	3.19	3.61	3.61
≥ 70	74,000	7	0.47	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	876,000	31	1.84	1.00	0.16	0.12	0.15	0.22	0.43	0.63	1.19	2.50	3.13	3.19	3.19
Spring	554,000	68	1.20	0.91	0.09	0.00	0.10	0.17	0.44	0.75	1.22	1.75	2.52	3.61	3.61
Summer	273,000	9	0.60	*	*	*	*	*	*	*	*	*	*	*	*
Winter	1,004,000	77	2.06	1.07	0.11	0.00	0.00	0.17	0.39	0.82	1.52	2.20	2.67	4.59	4.59
Urbanization															
Central City	506,000	20	0.90	0.69	0.13	0.00	0.00	0.19	0.28	0.63	0.77	1.48	1.99	2.34	2.34
Non-Metropolitan	1,259,000	101	2.80	0.95	0.09	0.00	0.12	0.17	0.32	0.66	1.19	2.27	3.05	4.59	4.59
Suburban	942,000	64	1.09	1.15	0.10	0.00	0.26	0.40	0.52	0.82	1.52	2.51	2.85	3.13	3.61
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	2,605,000	182	1.65	0.98	0.06	0.00	0.12	0.20	0.38	0.73	1.38	2.34	2.85	3.61	4.59
Region															
Midwest	1,321,000	97	2.85	0.88	0.08	0.00	0.08	0.22	0.34	0.61	1.10	1.99	2.51	4.59	4.59
Northeast	394,000	20	0.96	1.13	0.22	0.29	0.29	0.32	0.43	0.77	1.41	3.13	3.13	3.61	3.61
South	609,000	47	0.95	1.26	0.13	0.00	0.12	0.15	0.63	1.09	1.93	2.38	3.19	3.19	3.19
West	383,000	21	1.06	0.63	0.07	0.12	0.15	0.19	0.40	0.63	0.77	1.12	1.22	1.52	1.52
Response to Questionnaire															
Households who hunt	2,357,000	158	11.66	1.04	0.07	0.00	0.14	0.28	0.44	0.75	1.44	2.38	2.90	3.61	4.59

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-42. Consumer Only Intake of Home-produced Lettuce (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,520,000	80	0.81	0.39	0.03	0.00	0.04	0.09	0.17	0.28	0.55	0.84	1.03	1.05	1.28
Age															
1-2	54,000	4	0.95	*	*	*	*	*	*	*	*	*	*	*	*
3-5	25,000	2	0.31	*	*	*	*	*	*	*	*	*	*	*	*
6-11	173,000	7	1.04	*	*	*	*	*	*	*	*	*	*	*	*
12-19	71,000	3	0.35	*	*	*	*	*	*	*	*	*	*	*	*
20-39	379,000	17	0.62	*	*	*	*	*	*	*	*	*	*	*	*
40-69	485,000	26	0.86	0.48	0.06	0.12	0.12	0.12	0.22	0.49	0.68	0.89	1.05	1.28	1.28
≥ 70	317,000	20	2.00	0.45	0.07	0.05	0.07	0.11	0.22	0.29	0.57	1.03	1.03	1.03	1.03
Season															
Fall	214,000	8	0.45	*	*	*	*	*	*	*	*	*	*	*	*
Spring	352,000	35	0.76	0.45	0.05	0.05	0.07	0.12	0.20	0.45	0.58	0.80	0.99	1.28	1.28
Summer	856,000	30	1.88	0.30	0.04	0.02	0.03	0.05	0.14	0.23	0.42	0.60	0.81	0.89	0.89
Winter	98,000	7	0.20	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	268,000	8	0.48	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	566,000	36	1.26	0.37	0.05	0.02	0.03	0.04	0.12	0.29	0.55	0.81	0.89	1.28	1.28
Suburban	686,000	36	0.79	0.35	0.04	0.00	0.09	0.10	0.15	0.23	0.49	0.77	0.99	1.05	1.05
Race															
Black	51,000	3	0.23	*	*	*	*	*	*	*	*	*	*	*	*
White	1,434,000	75	0.91	0.38	0.03	0.00	0.04	0.09	0.16	0.28	0.55	0.89	1.03	1.05	1.28
Region															
Midwest	630,000	33	1.36	0.38	0.06	0.02	0.03	0.04	0.16	0.23	0.57	0.94	1.03	1.03	1.03
Northeast	336,000	16	0.82	*	*	*	*	*	*	*	*	*	*	*	*
South	305,000	20	0.47	0.35	0.06	0.00	0.00	0.13	0.16	0.28	0.48	0.58	1.04	1.28	1.28
West	249,000	11	0.69	*	*	*	*	*	*	*	*	*	*	*	*
Responses to Questionnaire															
Households who garden	1,506,000	78	2.21	0.39	0.03	0.00	0.04	0.09	0.17	0.28	0.55	0.84	1.03	1.05	1.28
Households who farm	304,000	18	4.15	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-43. Consumer Only Intake of Home-produced Lima Beans (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,917,000	109	1.02	0.45	0.04	0.00	0.09	0.12	0.19	0.29	0.55	0.99	1.69	1.86	1.91
Age															
1-2	62,000	3	1.09	*	*	*	*	*	*	*	*	*	*	*	*
3-5	35,000	2	0.43	*	*	*	*	*	*	*	*	*	*	*	*
6-11	95,000	7	0.57	*	*	*	*	*	*	*	*	*	*	*	*
12-19	108,000	6	0.53	*	*	*	*	*	*	*	*	*	*	*	*
20-39	464,000	20	0.75	0.38	0.07	0.03	0.11	0.13	0.18	0.23	0.49	0.94	1.10	1.10	1.10
40-69	757,000	44	1.33	0.45	0.06	0.09	0.11	0.12	0.20	0.29	0.56	0.87	1.71	1.91	1.91
≥ 70	361,000	25	2.27	0.52	0.11	0.08	0.19	0.19	0.23	0.29	0.64	1.86	1.86	1.86	1.86
Season															
Fall	375,000	14	0.79	*	*	*	*	*	*	*	*	*	*	*	*
Spring	316,000	39	0.68	0.42	0.06	0.08	0.09	0.13	0.23	0.31	0.55	0.75	1.31	1.91	1.91
Summer	883,000	29	1.94	0.50	0.10	0.00	0.09	0.12	0.17	0.29	0.49	1.53	1.71	1.86	1.86
Winter	343,000	27	0.70	0.53	0.06	0.00	0.03	0.11	0.31	0.54	0.76	0.86	0.87	1.69	1.69
Urbanization															
Central City	204,000	8	0.36	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	1,075,000	69	2.39	0.30	0.03	0.03	0.09	0.12	0.17	0.21	0.32	0.49	0.77	1.69	1.91
Suburban	638,000	32	0.74	0.75	0.10	0.00	0.08	0.09	0.32	0.68	0.99	1.71	1.86	1.86	1.86
Race															
Black	213,000	9	0.98	*	*	*	*	*	*	*	*	*	*	*	*
White	1,704,000	100	1.08	0.38	0.03	0.00	0.09	0.11	0.18	0.25	0.49	0.86	0.99	1.53	1.91
Region															
Midwest	588,000	36	1.27	0.43	0.06	0.00	0.00	0.11	0.25	0.31	0.42	0.99	1.53	1.69	1.69
Northeast	68,000	6	0.17	*	*	*	*	*	*	*	*	*	*	*	*
South	1,261,000	67	1.96	0.47	0.06	0.03	0.10	0.13	0.18	0.25	0.63	1.10	1.71	1.86	1.91
West	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Response to Questionnaire															
Households who garden	1,610,000	97	2.36	0.45	0.04	0.03	0.09	0.12	0.18	0.29	0.53	0.94	1.71	1.86	1.91
Households who farm	62,000	6	0.85	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-44. Consumer Only Intake of Homegrown Okra (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,696,000	82	0.90	0.39	0.04	0.00	0.05	0.10	0.15	0.30	0.46	0.78	1.21	1.53	1.53
Age															
1-2	53,000	2	0.93	*	*	*	*	*	*	*	*	*	*	*	*
3-5	68,000	3	0.84	*	*	*	*	*	*	*	*	*	*	*	*
6-11	218,000	11	1.30	*	*	*	*	*	*	*	*	*	*	*	*
12-19	194,000	9	0.95	*	*	*	*	*	*	*	*	*	*	*	*
20-39	417,000	18	0.68	*	*	*	*	*	*	*	*	*	*	*	*
40-69	587,000	32	1.03	0.40	0.05	0.07	0.11	0.14	0.25	0.31	0.46	0.78	1.14	1.14	1.14
≥ 70	130,000	6	0.82	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	228,000	9	0.48	*	*	*	*	*	*	*	*	*	*	*	*
Spring	236,000	24	0.51	0.39	0.06	0.03	0.05	0.07	0.11	0.41	0.60	0.78	1.00	1.07	1.07
Summer	1,144,000	41	2.52	0.39	0.06	0.00	0.05	0.10	0.14	0.30	0.44	1.15	1.53	1.53	1.53
Winter	88,000	8	0.18	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	204,000	6	0.36	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	1,043,000	55	2.32	0.37	0.05	0.00	0.03	0.08	0.15	0.26	0.44	0.78	1.53	1.53	1.53
Suburban	449,000	21	0.52	0.51	0.07	0.07	0.10	0.11	0.31	0.46	0.60	1.14	1.15	1.15	1.15
Race															
Black	236,000	13	1.09	*	*	*	*	*	*	*	*	*	*	*	*
White	1,419,000	68	0.90	0.43	0.04	0.00	0.07	0.10	0.18	0.33	0.52	1.14	1.21	1.53	1.53
Region															
Midwest	113,000	7	0.24	*	*	*	*	*	*	*	*	*	*	*	*
Northeast															
South	1,443,000	70	2.24	0.37	0.04	0.00	0.05	0.08	0.14	0.26	0.44	0.75	1.21	1.53	1.53
West	140,000	5	0.39	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who garden	1,564,000	77	2.29	0.38	0.04	0.00	0.05	0.10	0.15	0.30	0.45	1.07	1.21	1.53	1.53
Households who farm	233,000	14	3.18	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-45. Consumer Only Intake of Homegrown Onions (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	6,718,000	370	3.57	0.30	0.02	0.00	0.01	0.03	0.09	0.21	0.38	0.61	0.91	1.49	3.11
Age															
1-2	291,000	17	5.11	*	*	*	*	*	*	*	*	*	*	*	*
3-5	178,000	9	2.20	*	*	*	*	*	*	*	*	*	*	*	*
6-11	530,000	31	3.17	0.30	0.06	0.01	0.01	0.03	0.11	0.23	0.38	0.61	1.36	1.36	1.36
12-19	652,000	37	3.18	0.21	0.04	0.01	0.01	0.01	0.06	0.14	0.26	0.57	0.76	0.91	0.91
20-39	1,566,000	78	2.54	0.29	0.03	0.01	0.04	0.06	0.09	0.19	0.30	0.64	0.94	1.49	1.49
40-69	2,402,000	143	4.23	0.25	0.02	0.00	0.00	0.01	0.08	0.17	0.36	0.55	0.69	1.11	1.41
≥ 70	1,038,000	52	6.54	0.43	0.09	0.00	0.01	0.03	0.14	0.29	0.46	0.56	2.68	3.11	3.11
Season															
Fall	1,557,000	59	3.27	0.38	0.07	0.00	0.03	0.06	0.12	0.26	0.44	0.60	0.78	3.11	3.11
Spring	1,434,000	147	3.11	0.20	0.02	0.00	0.01	0.03	0.06	0.11	0.26	0.43	0.52	1.41	1.77
Summer	2,891,000	101	6.36	0.31	0.03	0.01	0.02	0.04	0.11	0.23	0.38	0.69	0.97	1.49	1.49
Winter	836,000	63	1.72	0.29	0.04	0.00	0.00	0.01	0.03	0.20	0.46	0.64	0.92	1.36	1.36
Urbanization															
Central City	890,000	37	1.58	0.22	0.03	0.00	0.01	0.03	0.07	0.19	0.30	0.52	0.56	0.56	0.56
Non-Metropolitan	2,944,000	177	6.54	0.32	0.02	0.01	0.03	0.07	0.14	0.26	0.43	0.63	0.91	1.49	1.77
Suburban	2,884,000	156	3.33	0.29	0.04	0.00	0.01	0.01	0.06	0.13	0.36	0.64	0.97	3.11	3.11
Race															
Black	253,000	16	1.16	*	*	*	*	*	*	*	*	*	*	*	*
White	6,266,000	345	3.98	0.31	0.02	0.00	0.01	0.03	0.09	0.22	0.39	0.62	0.94	1.77	3.11
Region															
Midwest	2,487,000	143	5.36	0.27	0.02	0.00	0.04	0.06	0.10	0.22	0.34	0.56	0.72	1.34	1.34
Northeast	876,000	52	2.13	0.23	0.04	0.00	0.00	0.01	0.01	0.11	0.35	0.64	1.05	1.36	1.41
South	1,919,000	107	2.98	0.33	0.03	0.00	0.03	0.04	0.15	0.25	0.39	0.69	1.08	1.49	1.77
West	1,436,000	68	3.98	0.33	0.07	0.00	0.01	0.02	0.06	0.15	0.39	0.55	0.97	3.11	3.11
Response to Questionnaire															
Households who garden	6,441,000	356	9.45	0.30	0.02	0.00	0.01	0.03	0.09	0.21	0.38	0.61	0.92	1.77	3.11
Households who farm	1,390,000	81	18.97	0.38	0.04	0.03	0.04	0.05	0.11	0.28	0.52	0.94	1.11	1.49	1.49

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-46. Consumer Only Intake of Homegrown Other Berries (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,626,000	99	0.86	0.48	0.04	0.00	0.05	0.09	0.23	0.38	0.59	1.07	1.28	2.21	2.21
Age															
1-2	41,000	2	0.72	*	*	*	*	*	*	*	*	*	*	*	*
3-5	53,000	3	0.65	*	*	*	*	*	*	*	*	*	*	*	*
6-11	106,000	10	0.63	*	*	*	*	*	*	*	*	*	*	*	*
12-19	79,000	5	0.39	*	*	*	*	*	*	*	*	*	*	*	*
20-39	309,000	20	0.50	0.39	0.06	0.08	0.09	0.09	0.13	0.33	0.55	0.79	1.07	1.07	1.07
40-69	871,000	51	1.54	0.49	0.06	0.08	0.10	0.13	0.25	0.39	0.61	0.77	1.28	2.21	2.21
≥ 70	159,000	7	1.00	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	379,000	13	0.80	*	*	*	*	*	*	*	*	*	*	*	*
Spring	287,000	29	0.62	0.31	0.04	0.05	0.05	0.08	0.18	0.25	0.41	0.54	0.72	1.07	1.07
Summer	502,000	18	1.10	*	*	*	*	*	*	*	*	*	*	*	*
Winter	458,000	39	0.94	0.54	0.07	0.00	0.10	0.16	0.23	0.39	0.62	1.07	1.95	2.08	2.08
Urbanization															
Central City	378,000	15	0.67	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	466,000	37	1.04	0.64	0.09	0.00	0.09	0.10	0.25	0.44	1.02	1.31	2.21	2.21	2.21
Suburban	722,000	45	0.83	0.45	0.05	0.09	0.13	0.16	0.26	0.38	0.54	0.59	0.90	2.08	2.08
Race															
Black	76,000	4	0.35	*	*	*	*	*	*	*	*	*	*	*	*
White	1,490,000	93	0.95	0.50	0.04	0.05	0.09	0.10	0.25	0.40	0.60	1.07	1.31	2.21	2.21
Region															
Midwest	736,000	56	1.59	0.46	0.06	0.00	0.08	0.09	0.13	0.30	0.59	1.12	1.28	2.21	2.21
Northeast	211,000	11	0.51	*	*	*	*	*	*	*	*	*	*	*	*
South	204,000	12	0.32	*	*	*	*	*	*	*	*	*	*	*	*
West	415,000	18	1.15	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who garden	1,333,000	84	1.96	0.47	0.05	0.01	0.00	0.09	0.20	0.35	0.55	1.07	1.28	2.21	2.21
Households who farm	219,000	16	2.99	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-47. Consumer Only Intake of Homegrown Peaches (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	2,941,000	193	1.56	1.67	0.17	0.05	0.17	0.23	0.47	0.90	1.88	3.79	6.36	12.30	22.30
Age															
1-2	103,000	8	1.81	*	*	*	*	*	*	*	*	*	*	*	*
3-5	65,000	6	0.80	*	*	*	*	*	*	*	*	*	*	*	*
6-11	329,000	26	1.97	3.11	0.63	0.10	0.10	0.14	0.63	1.13	6.36	8.53	8.53	11.50	11.50
12-19	177,000	13	0.86	*	*	*	*	*	*	*	*	*	*	*	*
20-39	573,000	35	0.93	1.17	0.17	0.05	0.06	0.23	0.47	0.81	1.30	2.92	2.99	5.27	5.27
40-69	1,076,000	70	1.90	1.53	0.28	0.06	0.19	0.24	0.56	0.89	1.61	2.63	4.43	12.30	12.30
≥ 70	598,000	33	3.77	1.01	0.20	0.09	0.14	0.18	0.28	0.82	1.19	1.60	3.79	7.13	7.13
Season															
Fall	485,000	19	1.02	*	*	*	*	*	*	*	*	*	*	*	*
Spring	756,000	91	1.64	1.67	0.30	0.05	0.06	0.10	0.28	0.77	1.45	4.44	6.77	22.30	22.30
Summer	1,081,000	35	2.38	2.26	0.48	0.17	0.23	0.36	0.57	1.12	2.99	6.36	8.53	12.30	12.30
Winter	619,000	48	1.27	1.25	0.10	0.04	0.24	0.56	0.78	1.04	1.71	2.35	2.60	3.56	3.56
Urbanization															
Central City	429,000	12	0.76	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	1,110,000	99	2.47	1.87	0.26	0.06	0.26	0.39	0.65	1.02	2.18	3.86	6.36	11.50	22.30
Suburban	1,402,000	82	1.62	1.47	0.18	0.05	0.14	0.20	0.46	0.92	1.87	3.79	4.43	7.37	7.37
Race															
Black	39,000	1	0.18	*	*	*	*	*	*	*	*	*	*	*	*
White	2,861,000	191	1.82	1.70	0.17	0.05	0.17	0.23	0.50	0.90	1.96	3.79	6.36	12.30	22.30
Region															
Midwest	824,000	75	1.78	1.39	0.29	0.18	0.22	0.26	0.46	0.74	1.19	3.06	3.56	11.50	22.30
Northeast	75,000	5	0.18	*	*	*	*	*	*	*	*	*	*	*	*
South	852,000	51	1.32	1.67	0.26	0.04	0.14	0.18	0.64	1.02	1.96	3.83	6.36	8.53	8.53
West	1,190,000	62	3.30	1.80	0.33	0.05	0.14	0.23	0.47	0.86	1.94	4.43	7.37	12.30	12.30
Response to Questionnaire															
Households who garden	2,660,000	174	3.90	1.75	0.19	0.05	0.17	0.26	0.53	0.93	1.96	3.79	6.36	12.30	22.30
Households who farm	769,000	54	10.49	1.56	0.25	0.07	0.18	0.23	0.46	0.90	2.02	2.99	6.36	8.53	8.53

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-48. Consumer Only Intake of Homegrown Pears (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,513,000	94	0.80	0.94	0.10	0.10	0.18	0.24	0.43	0.68	1.09	1.60	2.76	5.16	5.16
Age															
1-2	24,000	3	0.42	*	*	*	*	*	*	*	*	*	*	*	*
3-5	45,000	3	0.56	*	*	*	*	*	*	*	*	*	*	*	*
6-11	145,000	10	0.87	*	*	*	*	*	*	*	*	*	*	*	*
12-19	121,000	7	0.59	*	*	*	*	*	*	*	*	*	*	*	*
20-39	365,000	23	0.59	0.62	0.06	0.11	0.32	0.38	0.43	0.50	0.68	1.22	1.24	1.24	1.24
40-69	557,000	33	0.98	0.66	0.06	0.10	0.11	0.33	0.42	0.65	0.92	1.10	1.13	1.51	1.51
≥ 70	256,000	15	1.61	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	308,000	11	0.65	*	*	*	*	*	*	*	*	*	*	*	*
Spring	355,000	39	0.77	0.69	0.08	0.10	0.11	0.18	0.34	0.60	0.87	1.15	1.83	2.54	2.54
Summer	474,000	16	1.04	*	*	*	*	*	*	*	*	*	*	*	*
Winter	376,000	28	0.77	1.48	0.28	0.11	0.11	0.38	0.65	0.95	1.38	4.82	5.16	5.16	5.16
Urbanization															
Central City	222,000	11	0.39	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	634,000	44	1.41	0.78	0.09	0.33	0.35	0.42	0.44	0.57	0.81	1.56	1.86	2.88	2.88
Suburban	657,000	39	0.76	0.85	0.12	0.10	0.11	0.18	0.39	0.73	1.10	1.50	2.57	4.79	4.79
Race															
Black	51,000	3	0.23	*	*	*	*	*	*	*	*	*	*	*	*
White	1,462,000	91	0.93	0.97	0.10	0.11	0.24	0.35	0.44	0.70	1.09	1.60	2.88	5.16	5.16
Region															
Midwest	688,000	57	1.48	0.87	0.09	0.22	0.34	0.38	0.44	0.65	1.04	1.60	2.57	4.79	4.79
Northeast	18,000	2	0.04	*	*	*	*	*	*	*	*	*	*	*	*
South	377,000	13	0.59	*	*	*	*	*	*	*	*	*	*	*	*
West	430,000	22	1.19	1.14	0.29	0.10	0.11	0.11	0.36	0.75	1.13	2.76	4.82	5.16	5.16
Response to Questionnaire															
Households who garden	1,312,000	85	1.93	0.95	0.10	0.10	0.18	0.35	0.43	0.68	1.09	1.56	2.88	5.16	5.16
Households who farm	528,000	35	7.20	1.09	0.21	0.11	0.22	0.38	0.43	0.61	1.09	2.76	4.82	5.16	5.16

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-49. Consumer Only Intake of Homegrown Peas (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	4,252,000	226	2.26	0.51	0.03	0.05	0.10	0.14	0.23	0.32	0.62	1.04	1.46	2.66	2.89
Age															
1-2	163,000	9	2.86	*	*	*	*	*	*	*	*	*	*	*	*
3-5	140,000	7	1.73	*	*	*	*	*	*	*	*	*	*	*	*
6-11	515,000	26	3.08	0.61	0.09	0.15	0.15	0.22	0.30	0.39	0.90	1.35	1.40	2.06	2.06
12-19	377,000	22	1.84	0.41	0.04	0.06	0.13	0.16	0.24	0.36	0.50	0.71	0.82	0.82	0.82
20-39	1,121,000	52	1.82	0.41	0.06	0.10	0.12	0.14	0.18	0.25	0.41	0.85	1.36	2.71	2.71
40-69	1,366,000	80	2.41	0.46	0.05	0.07	0.10	0.12	0.23	0.30	0.61	1.00	1.30	2.36	2.36
≥ 70	458,000	26	2.88	0.33	0.06	0.03	0.03	0.05	0.18	0.27	0.37	1.00	1.00	1.46	1.46
Season															
Fall	1,239,000	41	2.60	0.30	0.03	0.03	0.05	0.12	0.21	0.26	0.35	0.60	0.71	1.00	1.00
Spring	765,000	78	1.66	0.44	0.04	0.06	0.11	0.12	0.19	0.33	0.52	0.92	1.40	2.06	2.06
Summer	1,516,000	51	3.33	0.59	0.07	0.07	0.13	0.17	0.22	0.39	0.82	1.35	1.60	2.66	2.66
Winter	732,000	56	1.50	0.75	0.09	0.12	0.18	0.21	0.27	0.54	0.95	1.54	2.36	2.89	2.89
Urbanization															
Central City	558,000	19	0.99	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	2,028,000	126	4.50	0.48	0.04	0.08	0.14	0.17	0.25	0.35	0.58	1.04	1.36	1.89	2.89
Suburban	1,666,000	81	1.92	0.51	0.05	0.07	0.12	0.13	0.23	0.39	0.68	1.00	1.30	2.28	2.36
Race															
Black	355,000	19	1.63	*	*	*	*	*	*	*	*	*	*	*	*
White	3,784,000	203	2.40	0.50	0.03	0.03	0.10	0.13	0.22	0.33	0.60	1.00	1.40	2.66	2.89
Region															
Midwest	1,004,000	55	2.16	0.40	0.07	0.03	0.05	0.10	0.14	0.25	0.35	0.88	1.54	2.71	2.89
Northeast	241,000	14	0.59	*	*	*	*	*	*	*	*	*	*	*	*
South	2,449,000	132	3.81	0.57	0.04	0.13	0.17	0.20	0.26	0.37	0.68	1.24	1.60	2.66	2.66
West	558,000	25	1.55	0.38	0.06	0.07	0.07	0.10	0.22	0.27	0.48	0.90	0.94	1.40	1.40
Response to Questionnaire															
Households who garden	3,980,000	214	5.84	0.51	0.03	0.03	0.10	0.14	0.23	0.32	0.63	1.04	1.54	2.66	2.89
Households who farm	884,000	55	12.06	0.46	0.06	0.03	0.05	0.09	0.21	0.35	0.52	0.90	1.40	1.60	2.89

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-50. Consumer Only Intake of Homegrown Peppers (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	5,153,000	208	2.74												
Age															
1-2	163,000	6	2.86	*	*	*	*	*	*	*	*	*	*	*	*
3-5	108,000	5	1.33	*	*	*	*	*	*	*	*	*	*	*	*
6-11	578,000	26	3.46	0.23	0.04	0.00	0.00	0.03	0.09	0.16	0.30	0.43	0.77	0.85	0.85
12-19	342,000	16	1.67	*	*	*	*	*	*	*	*	*	*	*	*
20-39	1,048,000	40	1.70	0.22	0.06	0.02	0.03	0.06	0.09	0.12	0.22	0.40	0.62	2.48	2.48
40-69	2,221,000	88	3.92	0.25	0.03	0.01	0.03	0.05	0.08	0.17	0.32	0.48	0.74	1.50	1.50
≥ 70	646,000	25	4.07	0.26	0.06	0.02	0.02	0.02	0.07	0.14	0.24	0.92	0.94	1.07	1.07
Season															
Fall	1,726,000	53	3.62	0.20	0.03	0.00	0.03	0.04	0.09	0.17	0.24	0.35	0.40	1.07	1.07
Spring	255,000	28	0.55	0.30	0.07	0.00	0.02	0.04	0.07	0.15	0.32	1.09	1.20	1.53	1.53
Summer	2,672,000	94	5.87												
Winter	500,000	33	1.03												
Urbanization															
Central City	865,000	30	1.53	0.25	0.04	0.04	0.06	0.07	0.11	0.18	0.27	0.36	0.94	1.10	1.10
Non-Metropolitan	1,982,000	89	4.40	0.24	0.04	0.01	0.02	0.03	0.07	0.12	0.27	0.54	0.77	2.48	2.48
Suburban	2,246,000	87	2.59	0.25	0.03	0.00	0.03	0.04	0.09	0.16	0.29	0.49	0.97	1.50	1.53
Race															
Black	127,000	6	0.58	*	*	*	*	*	*	*	*	*	*	*	*
White	4,892,000	198	3.11	0.25	0.02	0.02	0.03	0.04	0.09	0.15	0.29	0.49	0.92	1.81	2.48
Region															
Midwest	1,790,000	74	3.86	0.23	0.04	0.01	0.02	0.03	0.06	0.15	0.26	0.39	0.85	2.48	2.48
Northeast	786,000	31	1.91												
South	1,739,000	72	2.70	0.23	0.03	0.03	0.07	0.08	0.11	0.17	0.27	0.43	0.53	1.81	1.81
West	778,000	29	2.16	0.21	0.05	0.02	0.02	0.03	0.04	0.09	0.25	0.54	0.92	1.07	1.07
Response to Questionnaire															
Households who garden	4,898,000	199	7.19	0.24	0.02	0.00	0.02	0.03	0.08	0.15	0.29	0.48	0.85	1.50	2.48
Households who farm	867,000	35	11.83	0.30	0.08	0.00	0.03	0.03	0.07	0.17	0.36	0.60	0.85	2.48	2.48

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-51. Consumer Only Intake of Home-produced Pork (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,732,000	121	0.92	1.23	0.10	0.09	0.14	0.31	0.54	0.90	1.71	2.73	3.37	4.93	7.41
Age															
1-2	38,000	5	0.67	*	*	*	*	*	*	*	*	*	*	*	*
3-5	26,000	3	0.32	*	*	*	*	*	*	*	*	*	*	*	*
6-11	129,000	11	0.77	*	*	*	*	*	*	*	*	*	*	*	*
12-19	291,000	20	1.42	1.28	0.24	0.31	0.32	0.34	0.52	0.89	1.75	3.69	3.69	4.29	4.29
20-39	511,000	32	0.83	1.21	0.18	0.11	0.28	0.41	0.55	0.79	1.43	2.90	3.08	4.93	4.93
40-69	557,000	38	0.98	1.02	0.12	0.12	0.18	0.22	0.41	0.81	1.71	1.78	2.28	3.16	3.16
≥ 70	180,000	12	1.13	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	362,000	13	0.76	*	*	*	*	*	*	*	*	*	*	*	*
Spring	547,000	59	1.19	1.13	0.13	0.11	0.14	0.22	0.35	0.90	1.50	2.68	3.68	4.29	4.29
Summer	379,000	15	0.83	*	*	*	*	*	*	*	*	*	*	*	*
Winter	444,000	34	0.91	1.40	0.24	0.13	0.26	0.38	0.50	0.88	2.21	3.08	4.93	7.41	7.41
Urbanization															
Central City	90,000	2	0.16	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	1,178,000	77	2.62	1.39	0.13	0.09	0.22	0.41	0.62	0.97	1.75	3.16	3.69	4.93	7.41
Suburban	464,000	42	0.54	0.88	0.12	0.11	0.12	0.18	0.33	0.59	1.10	2.28	2.73	2.90	2.90
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	1,732,000	121	1.10	1.23	0.10	0.09	0.14	0.31	0.54	0.90	1.71	2.73	3.37	4.93	7.41
Region															
Midwest	844,000	64	1.82	1.06	0.12	0.09	0.12	0.21	0.50	0.67	1.20	2.68	3.37	3.69	3.73
Northeast	97,000	5	0.24	*	*	*	*	*	*	*	*	*	*	*	*
South	554,000	32	0.86	1.35	0.15	0.18	0.26	0.34	0.81	1.26	1.75	2.44	3.08	4.29	4.29
West	237,000	20	0.66	1.15	0.31	0.13	0.32	0.38	0.44	0.73	1.10	1.75	2.73	7.41	7.41
Response to Questionnaire															
Households who raise animals	1,428,000	100	14.14	1.34	0.10	0.14	0.32	0.41	0.59	0.97	1.75	2.90	3.37	4.29	4.93
Households who farm	1,218,000	82	16.62	1.30	0.11	0.22	0.34	0.41	0.59	0.92	1.71	3.08	3.69	4.93	4.93

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-52. Consumer Only Intake of Home-produced Poultry (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	1,816,000	105	0.97	1.57	0.12	0.20	0.30	0.42	0.64	1.23	2.19	3.17	3.83	5.33	6.17
Age															
1-2	91,000	8	1.60	*	*	*	*	*	*	*	*	*	*	*	*
3-5	70,000	5	0.86	*	*	*	*	*	*	*	*	*	*	*	*
6-11	205,000	12	1.23	*	*	*	*	*	*	*	*	*	*	*	*
12-19	194,000	12	0.95	*	*	*	*	*	*	*	*	*	*	*	*
20-39	574,000	33	0.93	1.17	0.15	0.17	0.40	0.40	0.56	1.15	1.37	1.80	2.93	4.59	4.59
40-69	568,000	30	1.00	1.51	0.24	0.20	0.20	0.30	0.49	0.77	2.69	3.29	4.60	5.15	5.15
≥ 70	80,000	3	0.50	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	562,000	23	1.18	1.52	0.18	0.41	0.42	0.46	0.81	1.39	2.23	2.69	3.17	3.17	3.17
Spring	374,000	34	0.81	1.87	0.28	0.17	0.23	0.30	0.52	1.38	3.29	4.60	5.15	5.33	5.33
Summer	312,000	11	0.69	*	*	*	*	*	*	*	*	*	*	*	*
Winter	568,000	37	1.17	1.55	0.20	0.20	0.20	0.43	0.60	1.23	2.18	2.95	3.47	6.17	6.17
Urbanization															
Central City	230,000	8	0.41	*	*	*	*	*	*	*	*	*	*	*	*
Non-Metropolitan	997,000	56	2.21	1.48	0.13	0.20	0.28	0.41	0.67	1.19	2.10	3.17	3.29	3.86	5.33
Suburban	589,000	41	0.68	1.94	0.23	0.23	0.27	0.43	0.62	1.59	2.69	4.59	4.83	6.17	6.17
Race															
Black	44,000	2	0.20	*	*	*	*	*	*	*	*	*	*	*	*
White	1,772,000	103	1.12	1.57	0.12	0.20	0.30	0.42	0.62	1.23	2.19	3.17	3.86	5.33	6.17
Region															
Midwest	765,000	41	1.65	1.60	0.14	0.41	0.42	0.56	0.98	1.39	2.19	2.70	3.17	3.86	5.33
Northeast	64,000	4	0.16	*	*	*	*	*	*	*	*	*	*	*	*
South	654,000	38	1.02	1.67	0.25	0.17	0.20	0.30	0.46	0.91	2.11	4.59	4.83	6.17	6.17
West	333,000	22	0.92	1.24	0.18	0.27	0.27	0.43	0.56	1.02	1.89	2.45	2.93	2.93	2.93
Response to Questionnaire															
Households who raise animals	1,333,000	81	13.20	1.58	0.12	0.23	0.41	0.47	0.71	1.37	2.19	2.93	3.29	5.33	6.17
Households who farm	917,000	59	12.51	1.54	0.18	0.20	0.23	0.30	0.60	1.06	2.18	3.47	4.83	6.17	6.17

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-53. Consumer Only Intake of Homegrown Pumpkins (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	2,041,000	87	1.09	0.78	0.07	0.13	0.18	0.24	0.32	0.56	1.07	1.47	1.79	3.02	4.48
Age															
1-2	73,000	4	1.28	*	*	*	*	*	*	*	*	*	*	*	*
3-5	18,000	2	0.22	*	*	*	*	*	*	*	*	*	*	*	*
6-11	229,000	9	1.37	*	*	*	*	*	*	*	*	*	*	*	*
12-19	244,000	10	1.19	*	*	*	*	*	*	*	*	*	*	*	*
20-39	657,000	26	1.07	0.80	0.13	0.18	0.18	0.30	0.38	0.48	1.03	1.73	2.67	2.67	2.67
40-69	415,000	20	0.73	0.82	0.16	0.29	0.29	0.32	0.37	0.52	0.96	1.47	3.02	3.02	3.02
≥ 70	373,000	15	2.35	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	1,345,000	49	2.82	0.82	0.09	0.13	0.18	0.28	0.37	0.61	1.17	1.73	1.79	3.02	3.02
Spring	48,000	6	0.10	*	*	*	*	*	*	*	*	*	*	*	*
Summer	405,000	13	0.89	*	*	*	*	*	*	*	*	*	*	*	*
Winter	243,000	19	0.50	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	565,000	20	1.00	0.63	0.11	0.18	0.18	0.24	0.28	0.38	0.94	1.24	1.33	2.24	2.24
Non-Metropolitan	863,000	44	1.92	0.64	0.10	0.13	0.17	0.19	0.31	0.51	0.67	1.22	1.45	4.48	4.48
Suburban	613,000	23	0.71	1.10	0.13	0.29	0.29	0.30	0.47	1.04	1.47	1.79	2.67	2.67	2.67
Race															
Black	22,000	1	0.10	*	*	*	*	*	*	*	*	*	*	*	*
White	2,019,000	86	1.28	0.78	0.07	0.13	0.18	0.24	0.32	0.56	1.10	1.47	1.79	3.02	4.48
Region															
Midwest	1,370,000	54	2.95	0.82	0.10	0.13	0.23	0.24	0.32	0.57	1.04	1.73	2.67	3.02	4.48
Northeast	15,000	1	0.04	*	*	*	*	*	*	*	*	*	*	*	*
South	179,000	10	0.28	*	*	*	*	*	*	*	*	*	*	*	*
West	477,000	22	1.32	0.79	0.10	0.18	0.19	0.31	0.37	0.74	1.17	1.47	1.51	1.51	1.51
Response to Questionnaire															
Households who garden	1,987,000	85	2.92	0.77	0.07	0.13	0.18	0.24	0.32	0.56	1.04	1.46	1.79	3.02	4.48
Households who farm	449,000	18	6.13	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-54. Consumer Only Intake of Homegrown Snap Beans (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	12,308,000	739	6.55	0.80	0.03	0.06	0.15	0.19	0.34	0.57	1.04	1.58	2.01	3.90	9.96
Age															
1-2	246,000	17	4.32	*	*	*	*	*	*	*	*	*	*	*	*
3-5	455,000	32	5.62	1.49	0.24	0.00	0.00	0.35	0.90	1.16	1.66	3.20	4.88	6.90	6.90
6-11	862,000	62	5.16	0.90	0.12	0.00	0.20	0.22	0.32	0.64	1.21	1.79	2.75	4.81	5.66
12-19	1,151,000	69	5.62	0.64	0.06	0.00	0.16	0.22	0.32	0.50	0.81	1.34	1.79	2.72	2.72
20-39	2,677,000	160	4.35	0.61	0.04	0.07	0.13	0.16	0.26	0.50	0.79	1.24	1.64	2.05	4.26
40-69	4,987,000	292	8.79	0.72	0.03	0.10	0.16	0.23	0.36	0.56	0.86	1.45	1.77	2.70	4.23
≥ 70	1,801,000	100	11.34	0.92	0.12	0.06	0.07	0.15	0.37	0.64	1.22	1.70	2.01	9.96	9.96
Season															
Fall	3,813,000	137	8.00	0.81	0.08	0.06	0.15	0.18	0.27	0.54	1.18	1.52	2.01	4.82	9.96
Spring	2,706,000	288	5.86	0.90	0.05	0.03	0.15	0.22	0.37	0.59	1.11	1.72	2.85	5.66	6.90
Summer	2,946,000	98	6.48	0.63	0.05	0.00	0.12	0.16	0.33	0.50	0.85	1.30	1.70	2.05	2.63
Winter	2,843,000	216	5.84	0.86	0.05	0.11	0.18	0.24	0.42	0.62	1.12	1.72	2.02	3.85	7.88
Urbanization															
Central City	2,205,000	78	3.91	0.60	0.06	0.06	0.07	0.16	0.26	0.51	0.71	1.23	1.54	1.93	3.35
Non-Metropolitan	5,696,000	404	12.65	0.96	0.05	0.09	0.18	0.23	0.37	0.68	1.19	1.89	2.70	4.88	9.96
Suburban	4,347,000	255	5.02	0.70	0.04	0.10	0.14	0.19	0.34	0.52	0.93	1.36	1.77	2.98	6.08
Race															
Black	634,000	36	2.92	0.76	0.14	0.25	0.25	0.28	0.30	0.48	1.04	1.30	1.34	5.98	5.98
White	11,519,000	694	7.31	0.81	0.03	0.07	0.15	0.19	0.35	0.57	1.06	1.63	2.01	3.90	9.96
Region															
Midwest	4,651,000	307	10.02	0.86	0.06	0.07	0.15	0.19	0.34	0.55	0.99	1.70	2.47	4.88	9.96
Northeast	990,000	52	2.40	0.57	0.07	0.00	0.10	0.11	0.18	0.49	0.82	1.28	1.36	1.97	3.09
South	4,755,000	286	7.39	0.88	0.04	0.13	0.21	0.25	0.40	0.68	1.22	1.72	2.01	3.23	5.98
West	1,852,000	92	5.14	0.59	0.04	0.07	0.14	0.18	0.27	0.51	0.74	1.20	1.52	2.19	2.19
Response to Questionnaire															
Households who garden	11,843,000	700	17.38	0.79	0.03	0.06	0.15	0.19	0.33	0.56	1.02	1.60	2.01	3.85	9.96
Households who farm	2,591,000	157	35.35	0.80	0.05	0.06	0.13	0.19	0.41	0.66	1.12	1.54	1.98	2.96	4.23

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-55. Consumer Only Intake of Homegrown Strawberries (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	2,057,000	139	1.09	0.65	0.05	0.04	0.08	0.12	0.26	0.47	0.82	1.47	1.77	2.72	4.83
Age															
1-2	30,000	2	0.53	*	*	*	*	*	*	*	*	*	*	*	*
3-5	66,000	6	0.81	*	*	*	*	*	*	*	*	*	*	*	*
6-11	153,000	15	0.92	*	*	*	*	*	*	*	*	*	*	*	*
12-19	201,000	11	0.98	*	*	*	*	*	*	*	*	*	*	*	*
20-39	316,000	22	0.51	0.32	0.06	0.08	0.08	0.11	0.12	0.21	0.46	0.82	0.97	1.56	1.56
40-69	833,000	55	1.47	0.64	0.06	0.02	0.07	0.18	0.36	0.58	0.94	1.42	1.47	2.37	2.37
≥ 70	449,000	27	2.83	0.64	0.11	0.04	0.04	0.09	0.26	0.47	0.70	1.66	1.89	2.72	2.72
Season															
Fall	250,000	8	0.52	*	*	*	*	*	*	*	*	*	*	*	*
Spring	598,000	66	1.30	0.83	0.10	0.08	0.09	0.18	0.28	0.47	0.97	1.93	2.54	4.83	4.83
Summer	388,000	11	0.85	*	*	*	*	*	*	*	*	*	*	*	*
Winter	821,000	54	1.69	0.51	0.06	0.02	0.04	0.11	0.21	0.39	0.60	1.27	1.46	2.37	2.37
Urbanization															
Central City	505,000	23	0.90	0.75	0.12	0.04	0.04	0.09	0.38	0.49	1.33	1.47	1.69	2.37	2.37
Non-Metropolitan	664,000	52	1.47	0.62	0.11	0.02	0.07	0.08	0.13	0.39	0.81	1.66	2.16	4.83	4.83
Suburban	888,000	64	1.03	0.62	0.06	0.08	0.18	0.22	0.35	0.53	0.70	1.27	1.56	2.97	2.97
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	2,057,000	139	1.31	0.65	0.05	0.04	0.08	0.12	0.26	0.47	0.82	1.47	1.77	2.72	4.83
Region															
Midwest	1,123,000	76	2.42	0.69	0.08	0.02	0.07	0.08	0.18	0.42	1.00	1.66	1.93	2.97	4.83
Northeast	382,000	25	0.93	0.64	0.10	0.09	0.16	0.18	0.26	0.47	0.87	1.46	1.83	2.16	2.16
South	333,000	23	0.52	0.67	0.08	0.13	0.21	0.38	0.52	0.62	0.70	1.00	1.00	2.72	2.72
West	219,000	15	0.61	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who garden	1,843,000	123	2.70	0.64	0.05	0.04	0.08	0.12	0.23	0.45	0.82	1.46	1.77	2.54	4.83
Households who farm	87,000	9	1.19	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-56. Consumer Only Intake of Homegrown Tomatoes (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	16,737,000	743	8.90	1.18	0.05	0.08	0.15	0.23	0.39	0.74	1.46	2.50	3.54	7.26	19.30
Age															
1-2	572,000	26	10.04	3.14	0.53	0.73	0.86	0.93	1.23	1.66	4.00	7.26	10.70	10.70	10.70
3-5	516,000	26	6.37	1.61	0.27	0.50	0.51	0.51	0.75	1.25	1.65	3.00	6.25	6.25	6.25
6-11	1,093,000	51	6.54	1.63	0.27	0.22	0.31	0.39	0.53	0.76	1.66	5.20	5.70	9.14	9.14
12-19	1,411,000	61	6.89	0.72	0.09	0.00	0.00	0.18	0.27	0.52	0.85	1.67	1.94	3.39	3.39
20-39	4,169,000	175	6.77	0.85	0.10	0.07	0.13	0.15	0.25	0.52	1.00	1.83	2.10	5.52	19.30
40-69	6,758,000	305	11.92	1.05	0.05	0.11	0.17	0.28	0.40	0.75	1.41	2.40	3.05	4.50	5.00
≥ 70	1,989,000	89	12.53	1.26	0.09	0.11	0.24	0.30	0.48	1.14	1.77	2.51	2.99	3.67	3.67
Season															
Fall	5,516,000	201	11.57	1.02	0.09	0.07	0.14	0.22	0.34	0.60	1.34	2.24	2.87	6.25	10.70
Spring	1,264,000	127	2.74	0.84	0.06	0.14	0.19	0.24	0.37	0.63	1.11	1.75	2.00	3.79	5.28
Summer	8,122,000	279	17.86	1.30	0.09	0.11	0.17	0.24	0.41	0.80	1.55	3.05	4.05	7.26	10.90
Winter	1,835,000	136	3.77	1.37	0.18	0.09	0.21	0.29	0.50	0.83	1.49	2.48	3.38	8.29	19.30
Urbanization															
Central City	2,680,000	90	4.76	1.10	0.13	0.00	0.15	0.23	0.35	0.75	1.51	2.16	2.95	7.26	8.29
Non-Metropolitan	7,389,000	378	16.41	1.26	0.07	0.11	0.22	0.26	0.42	0.76	1.47	2.77	3.85	6.87	10.70
Suburban	6,668,000	275	7.70	1.13	0.09	0.08	0.14	0.18	0.37	0.67	1.38	2.35	3.32	5.52	19.30
Race															
Black	743,000	28	3.42	0.61	0.09	0.00	0.00	0.07	0.24	0.51	0.90	1.18	1.55	1.66	1.66
White	15,658,000	703	9.94	1.22	0.06	0.11	0.17	0.24	0.41	0.76	1.49	2.55	3.59	7.26	19.30
Region															
Midwest	6,747,000	322	14.54	1.18	0.09	0.06	0.15	0.21	0.36	0.68	1.41	2.51	3.69	6.87	19.30
Northeast	2,480,000	87	6.02	1.17	0.16	0.08	0.14	0.15	0.35	0.75	1.38	2.44	3.52	10.90	10.90
South	4,358,000	202	6.77	1.15	0.09	0.00	0.21	0.25	0.42	0.75	1.43	2.32	3.67	6.82	9.14
West	3,152,000	132	8.74	1.23	0.10	0.18	0.24	0.28	0.41	0.77	1.84	2.78	3.08	7.26	7.26
Response to Questionnaire															
Households who garden	14,791,000	661	21.70	1.21	0.06	0.08	0.15	0.23	0.41	0.76	1.50	2.51	3.52	7.26	19.30
Households who farm	2,269,000	112	30.96	1.42	0.16	0.00	0.18	0.23	0.42	0.77	1.86	3.55	5.20	9.14	9.14

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-57. Consumer Only Intake of Homegrown White Potatoes (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	5,895,000	281	3.14	1.66	0.11	0.00	0.19	0.31	0.55	1.27	2.07	3.11	4.76	9.52	12.80
Age															
1-2	147,000	10	2.58	*	*	*	*	*	*	*	*	*	*	*	*
3-5	119,000	6	1.47	*	*	*	*	*	*	*	*	*	*	*	*
6-11	431,000	24	2.58	2.19	0.39	0.00	0.00	0.41	0.72	1.76	3.10	5.94	6.52	6.52	6.52
12-19	751,000	31	3.67	1.26	0.19	0.07	0.19	0.26	0.38	1.22	1.80	2.95	3.11	4.14	4.14
20-39	1,501,000	66	2.44	1.24	0.12	0.16	0.16	0.20	0.48	1.00	1.62	2.54	3.08	4.29	5.09
40-69	1,855,000	95	3.27	1.86	0.23	0.13	0.26	0.35	0.70	1.31	2.04	3.43	5.29	12.80	12.80
≥ 70	1,021,000	45	6.43	1.27	0.12	0.21	0.22	0.36	0.55	1.21	1.69	2.35	2.88	3.92	3.92
Season															
Fall	2,267,000	86	4.76	1.63	0.22	0.16	0.22	0.27	0.46	1.13	1.79	3.43	4.14	12.80	12.80
Spring	527,000	58	1.14	1.23	0.13	0.07	0.11	0.20	0.41	0.86	1.91	2.86	3.08	4.28	4.28
Summer	2,403,000	81	5.28	1.63	0.18	0.00	0.19	0.32	0.62	1.32	2.09	3.08	5.29	9.43	9.43
Winter	698,000	56	1.43	2.17	0.20	0.14	0.40	0.50	0.86	2.02	2.95	4.26	5.40	6.00	6.00
Urbanization															
Central City	679,000	25	1.20	0.96	0.15	0.16	0.16	0.18	0.38	0.56	1.52	2.07	2.25	2.54	2.54
Non-Metropolitan	3,046,000	159	6.77	1.96	0.16	0.18	0.27	0.37	0.77	1.50	2.38	3.55	5.64	12.80	12.80
Suburban	2,110,000	95	2.44	1.49	0.17	0.11	0.19	0.32	0.54	0.93	1.68	3.11	4.76	9.43	9.43
Race															
Black	140,000	5	0.64	*	*	*	*	*	*	*	*	*	*	*	*
White	5,550,000	269	3.52	1.67	0.11	0.14	0.21	0.31	0.55	1.28	2.09	3.11	4.76	9.52	12.80
Region															
Midwest	2,587,000	133	5.58	1.77	0.15	0.18	0.24	0.34	0.64	1.35	2.15	3.77	5.29	9.43	9.43
Northeast	656,000	31	1.59	1.28	0.20	0.07	0.13	0.17	0.35	0.86	1.97	2.95	3.80	5.09	5.09
South	1,796,000	84	2.79	2.08	0.24	0.16	0.35	0.46	0.92	1.56	2.40	3.44	5.64	12.80	12.80
West	796,000	31	2.21	0.76	0.11	0.16	0.22	0.26	0.41	0.54	0.96	1.40	1.95	3.11	3.11
Response to Questionnaire															
Households who garden	5,291,000	250	7.76	1.65	0.11	0.00	0.21	0.31	0.56	1.28	2.09	3.10	4.28	9.52	12.80
Households who farm	1,082,000	62	14.76	1.83	0.18	0.07	0.21	0.58	0.92	1.46	2.31	3.80	5.09	6.52	6.52

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-58. Consumer Only Intake of Homegrown Exposed Fruit (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	11,770,000	679	6.26	1.49	0.08	0.04	0.14	0.26	0.45	0.83	1.70	3.16	4.78	12.00	32.50
Age															
1-2	306,000	19	5.37	*	*	*	*	*	*	*	*	*	*	*	*
3-5	470,000	30	5.80	2.60	0.78	0.00	0.00	0.37	1.00	1.82	2.64	5.41	6.07	32.50	32.50
6-11	915,000	68	5.48	2.52	0.42	0.00	0.17	0.37	0.62	1.11	2.91	6.98	11.70	15.70	15.90
12-19	896,000	50	4.37	1.33	0.21	0.08	0.12	0.26	0.40	0.61	2.27	3.41	4.78	5.90	5.90
20-39	2,521,000	139	4.09	1.09	0.14	0.08	0.13	0.17	0.30	0.62	1.07	2.00	3.58	12.90	12.90
40-69	4,272,000	247	7.53	1.25	0.11	0.06	0.16	0.25	0.44	0.72	1.40	2.61	3.25	13.00	13.00
≥ 70	2,285,000	118	14.39	1.39	0.12	0.04	0.21	0.28	0.57	0.96	1.66	3.73	4.42	5.39	7.13
Season															
Fall	2,877,000	100	6.04	1.37	0.12	0.26	0.29	0.34	0.54	1.03	1.88	2.88	4.25	5.41	5.41
Spring	2,466,000	265	5.34	1.49	0.15	0.09	0.20	0.25	0.43	0.86	1.65	2.91	4.67	8.27	32.50
Summer	3,588,000	122	7.89	1.75	0.25	0.00	0.09	0.13	0.39	0.64	1.76	4.29	6.12	13.00	15.70
Winter	2,839,000	192	5.83	1.27	0.11	0.04	0.10	0.23	0.46	0.83	1.55	2.61	4.66	8.16	11.30
Urbanization															
Central City	2,552,000	99	4.53	1.34	0.20	0.04	0.10	0.26	0.45	0.86	1.60	2.37	2.88	13.00	13.00
Non-Metropolitan	3,891,000	269	8.64	1.78	0.17	0.06	0.10	0.17	0.42	0.94	1.94	4.07	5.98	15.70	32.50
Suburban	5,267,000	309	6.08	1.36	0.09	0.09	0.21	0.29	0.47	0.77	1.65	3.16	4.67	7.29	12.90
Race															
Black	250,000	12	1.15	*	*	*	*	*	*	*	*	*	*	*	*
White	11,411,000	663	7.24	1.51	0.08	0.06	0.16	0.26	0.45	0.86	1.72	3.31	4.78	12.00	32.50
Region															
Midwest	4,429,000	293	9.55	1.60	0.14	0.04	0.13	0.22	0.42	0.88	1.88	3.58	4.78	12.00	32.50
Northeast	1,219,000	69	2.96	0.76	0.12	0.08	0.09	0.17	0.30	0.47	0.78	1.39	2.86	5.21	7.13
South	2,532,000	141	3.94	1.51	0.18	0.08	0.23	0.30	0.51	0.92	1.63	2.63	5.98	15.70	15.70
West	3,530,000	174	9.79	1.60	0.14	0.10	0.24	0.32	0.57	0.96	1.97	3.72	5.00	13.00	13.00
Response to Questionnaire															
Households who garden	10,197,000	596	14.96	1.55	0.09	0.04	0.16	0.26	0.45	0.88	1.73	3.41	5.00	12.90	32.50
Households who farm	1,917,000	112	26.16	2.32	0.25	0.07	0.28	0.37	0.68	1.30	3.14	5.00	6.12	15.70	15.70

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-59. Consumer Only Intake of Homegrown Protected Fruits (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	3,855,000	173	2.05	5.74	0.63	0.15	0.27	0.34	0.93	2.34	7.45	16.00	19.70	47.30	53.60
Age															
1-2	79,000	5	1.39	*	*	*	*	*	*	*	*	*	*	*	*
3-5	80,000	4	0.99	*	*	*	*	*	*	*	*	*	*	*	*
6-11	181,000	9	1.08	*	*	*	*	*	*	*	*	*	*	*	*
12-19	377,000	20	1.84	2.96	0.99	0.12	0.16	0.28	0.39	1.23	2.84	7.44	11.40	19.10	19.10
20-39	755,000	29	1.23	4.51	1.08	0.18	0.36	0.49	1.22	1.88	4.47	14.60	16.10	24.10	24.10
40-69	1,702,000	77	3.00	5.65	0.87	0.11	0.24	0.29	0.67	2.22	9.36	15.50	21.20	41.30	41.30
≥ 70	601,000	26	3.78	4.44	0.69	0.26	0.26	0.29	1.95	3.29	7.06	8.97	9.97	15.20	15.20
Season															
Fall	394,000	12	0.83	*	*	*	*	*	*	*	*	*	*	*	*
Spring	497,000	36	1.08	2.08	0.35	0.16	0.18	0.26	0.38	1.22	4.08	5.10	6.57	6.79	6.79
Summer	1,425,000	47	3.13	7.39	1.45	0.11	0.27	0.39	1.25	3.06	10.30	16.60	24.10	53.60	53.60
Winter	1,539,000	78	3.16	6.24	0.91	0.15	0.30	0.38	1.39	2.65	8.23	17.80	21.20	47.30	47.30
Urbanization															
Central City	1,312,000	50	2.33	3.94	0.58	0.15	0.26	0.33	0.83	3.01	5.01	9.23	9.97	18.80	18.80
Non-Metropolitan	506,000	19	1.12	*	*	*	*	*	*	*	*	*	*	*	*
Suburban	2,037,000	104	2.35	6.83	0.94	0.11	0.25	0.29	0.59	2.01	10.30	17.90	23.80	53.60	53.60
Race															
Black	200,000	8	0.92	*	*	*	*	*	*	*	*	*	*	*	*
White	3,655,000	165	2.32	5.91	0.65	0.12	0.26	0.33	1.06	2.44	7.46	16.00	21.20	47.30	53.60
Region															
Midwest	657,000	24	1.42	10.70	2.60	0.25	0.26	0.29	1.18	7.44	14.60	24.10	41.30	53.60	53.60
Northeast	105,000	5	0.26	*	*	*	*	*	*	*	*	*	*	*	*
South	1,805,000	74	2.81	4.77	0.65	0.16	0.36	0.45	1.23	2.54	5.10	15.20	16.60	23.80	24.00
West	1,288,000	70	3.57	4.85	0.93	0.11	0.18	0.27	0.49	1.84	5.34	12.30	18.80	47.30	47.30
Response to Questionnaire															
Households who garden	3,360,000	146	4.93	5.90	0.70	0.12	0.27	0.34	1.16	2.42	7.46	16.00	19.10	47.30	53.60
Households who farm	357,000	14	4.87	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-60. Consumer Only Intake of Homegrown Exposed Vegetables (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	28,762,000	1,511	15.30	1.52	0.05	0.00	0.09	0.17	0.40	0.86	1.83	3.55	5.12	10.30	20.60
Age															
1-2	815,000	43	14.30	3.48	0.51	0.02	0.24	0.83	1.20	1.89	4.23	10.70	11.90	12.10	12.10
3-5	1,069,000	62	13.19	1.74	0.22	0.00	0.01	0.05	0.58	1.16	2.53	3.47	6.29	7.36	8.86
6-11	2,454,000	134	14.68	1.39	0.18	0.00	0.04	0.09	0.31	0.64	1.60	3.22	5.47	13.30	13.30
12-19	2,611,000	143	12.74	1.07	0.09	0.00	0.03	0.14	0.30	0.66	1.46	2.35	3.78	5.67	5.67
20-39	6,969,000	348	11.31	1.05	0.08	0.01	0.07	0.12	0.26	0.56	1.26	2.33	3.32	7.57	20.60
40-69	10,993,000	579	19.38	1.60	0.08	0.00	0.14	0.24	0.48	0.98	1.92	3.59	5.22	8.99	19.00
≥ 70	3,517,000	185	22.15	1.68	0.12	0.01	0.15	0.24	0.52	1.13	2.38	4.08	4.96	6.96	10.20
Season															
Fall	8,865,000	314	18.60	1.31	0.10	0.05	0.11	0.18	0.33	0.65	1.56	3.13	4.45	8.92	12.20
Spring	4,863,000	487	10.54	1.14	0.06	0.00	0.05	0.15	0.34	0.66	1.39	2.76	4.02	7.51	10.70
Summer	10,151,000	348	22.32	2.03	0.13	0.00	0.11	0.20	0.61	1.30	2.52	4.32	6.35	12.70	19.00
Winter	4,883,000	362	10.02	1.21	0.10	0.00	0.02	0.14	0.37	0.67	1.42	2.76	3.69	8.86	20.60
Urbanization															
Central City	4,859,000	173	8.62	1.11	0.10	0.01	0.06	0.08	0.28	0.70	1.43	2.49	3.29	8.34	12.10
Non-Metropolitan	11,577,000	711	25.71	1.87	0.09	0.02	0.17	0.25	0.50	1.16	2.20	4.12	6.10	12.20	19.00
Suburban	12,266,000	625	14.17	1.35	0.07	0.00	0.10	0.16	0.36	0.74	1.58	3.22	5.22	8.61	20.60
Race															
Black	1,713,000	100	7.88	1.23	0.13	0.00	0.08	0.14	0.35	0.89	1.51	3.32	3.92	5.55	7.19
White	26,551,000	1,386	16.85	1.53	0.05	0.00	0.10	0.18	0.40	0.86	1.82	3.48	5.12	10.30	20.60
Region															
Midwest	10,402,000	570	22.42	1.48	0.09	0.01	0.07	0.16	0.39	0.81	1.69	3.55	4.67	11.90	20.60
Northeast	4,050,000	191	9.84	1.65	0.18	0.00	0.08	0.14	0.26	0.67	1.75	5.58	6.80	12.70	14.90
South	9,238,000	503	14.36	1.55	0.08	0.05	0.16	0.26	0.52	1.00	1.92	3.19	4.52	9.92	13.30
West	5,012,000	245	13.90	1.43	0.10	0.00	0.03	0.15	0.39	0.76	2.13	3.45	4.84	7.51	8.34
Response to Questionnaire															
Households who garden	25,737,000	1,361	37.76	1.57	0.06	0.00	0.09	0.17	0.41	0.89	1.97	3.63	5.45	10.30	20.60
Households who farm	3,596,000	207	49.07	2.17	0.16	0.00	0.18	0.37	0.65	1.38	2.81	6.01	6.83	10.30	13.30

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-61. Consumer Only Intake of Homegrown Protected Vegetables (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	11,428,000	656	6.08	1.01	0.05	0.10	0.15	0.19	0.32	0.63	1.20	2.24	3.05	6.49	9.42
Age															
1-2	348,000	21	6.11	2.46	0.49	0.32	0.32	0.54	1.36	1.94	2.96	3.88	9.42	9.42	9.42
3-5	440,000	32	5.43	1.30	0.21	0.23	0.23	0.32	0.48	1.04	1.48	2.51	5.10	5.31	5.31
6-11	1,052,000	63	6.30	1.10	0.13	0.19	0.21	0.32	0.39	0.79	1.31	2.14	3.12	5.40	5.40
12-19	910,000	51	4.44	0.78	0.09	0.06	0.16	0.24	0.35	0.58	0.82	1.85	2.20	2.69	2.69
20-39	3,227,000	164	5.24	0.76	0.06	0.11	0.15	0.17	0.24	0.51	0.97	1.73	2.51	3.63	4.76
40-69	3,818,000	226	6.73	0.93	0.07	0.07	0.14	0.17	0.32	0.60	1.11	1.87	3.04	6.84	7.44
≥ 70	1,442,000	89	9.08	1.05	0.16	0.12	0.21	0.24	0.36	0.57	1.21	1.86	3.05	9.23	9.23
Season															
Fall	3,907,000	143	8.20	0.85	0.07	0.12	0.16	0.20	0.32	0.57	1.10	1.73	2.51	4.78	5.31
Spring	2,086,000	236	4.52	0.70	0.04	0.06	0.14	0.17	0.27	0.49	0.91	1.44	1.86	3.74	5.73
Summer	3,559,000	118	7.82	1.40	0.16	0.10	0.18	0.23	0.38	0.78	1.69	3.05	5.40	9.23	9.42
Winter	1,876,000	159	3.85	0.93	0.08	0.12	0.14	0.18	0.31	0.60	1.20	2.32	3.06	4.76	6.39
Urbanization															
Central City	1,342,000	49	2.38	1.00	0.15	0.12	0.15	0.17	0.32	0.72	1.18	2.36	2.83	4.78	4.78
Non-Metropolitan	5,934,000	391	13.18	1.07	0.06	0.11	0.17	0.21	0.35	0.65	1.30	2.51	3.55	6.84	9.42
Suburban	4,152,000	216	4.80	0.93	0.08	0.07	0.15	0.19	0.29	0.56	1.15	1.85	2.67	6.49	9.23
Race															
Black	479,000	27	2.20	1.50	0.23	0.16	0.26	0.33	0.87	0.94	2.20	3.05	3.23	4.95	4.95
White	10,836,000	625	6.88	0.99	0.05	0.10	0.15	0.19	0.32	0.61	1.20	2.17	3.04	6.49	9.42
Region															
Midwest	4,359,000	273	9.40	1.01	0.07	0.11	0.17	0.23	0.33	0.57	1.08	2.45	3.68	6.84	7.44
Northeast	807,000	48	1.96	0.70	0.09	0.06	0.15	0.17	0.27	0.51	0.99	1.71	2.33	2.77	2.77
South	4,449,000	253	6.92	1.08	0.07	0.13	0.17	0.21	0.38	0.71	1.38	2.32	3.05	5.40	9.42
West	1,813,000	82	5.03	0.96	0.16	0.07	0.12	0.15	0.21	0.48	1.01	1.86	3.12	9.23	9.23
Response to Questionnaire															
Households who garden	10,286,000	602	15.09	1.01	0.05	0.10	0.15	0.19	0.34	0.64	1.21	2.32	3.05	6.49	9.23
Households who farm	2,325,000	142	31.72	1.30	0.15	0.09	0.17	0.21	0.34	0.60	1.40	3.55	5.40	9.23	9.23

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-62. Consumer Only Intake of Homegrown Root Vegetables (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	13,750,000	743	7.31	1.16	0.06	0.00	0.04	0.11	0.25	0.67	1.47	2.81	3.71	9.52	12.80
Age															
1-2	371,000	22	6.51	2.52	0.61	0.17	0.17	0.22	0.36	0.92	3.67	7.25	10.40	10.40	10.40
3-5	390,000	23	4.81	1.28	0.32	0.00	0.00	0.12	0.23	0.46	1.68	4.26	4.73	4.73	4.73
6-11	1,106,000	67	6.62	1.32	0.21	0.00	0.01	0.04	0.23	0.52	1.63	3.83	5.59	7.47	7.47
12-19	1,465,000	76	7.15	0.94	0.12	0.01	0.01	0.07	0.27	0.57	1.37	2.26	3.32	5.13	5.13
20-39	3,252,000	164	5.28	0.87	0.07	0.01	0.05	0.10	0.20	0.56	1.24	2.11	3.08	4.64	6.03
40-69	4,903,000	276	8.64	1.13	0.10	0.00	0.03	0.12	0.25	0.68	1.27	2.74	3.56	9.52	12.80
≥ 70	2,096,000	107	13.20	1.22	0.10	0.02	0.03	0.17	0.38	0.85	1.71	2.86	3.21	4.01	4.77
Season															
Fall	4,026,000	153	8.45	1.42	0.15	0.05	0.14	0.17	0.31	0.92	1.67	3.26	3.85	12.30	12.80
Spring	2,552,000	260	5.53	0.69	0.06	0.00	0.02	0.03	0.14	0.37	0.77	1.69	2.80	4.24	7.69
Summer	5,011,000	169	11.02	1.19	0.12	0.00	0.05	0.13	0.28	0.73	1.51	2.74	3.64	10.40	11.90
Winter	2,161,000	161	4.44	1.17	0.12	0.00	0.01	0.04	0.24	0.56	1.56	3.08	4.14	6.21	11.30
Urbanization															
Central City	2,385,000	96	4.23	0.75	0.08	0.03	0.04	0.14	0.22	0.43	0.92	1.91	2.70	3.56	3.93
Non-Metropolitan	6,094,000	366	13.54	1.43	0.10	0.01	0.07	0.13	0.28	0.76	1.85	3.32	4.24	11.30	12.80
Suburban	5,211,000	279	6.02	1.06	0.09	0.00	0.01	0.07	0.23	0.73	1.19	2.34	3.26	6.29	11.90
Race															
Black	521,000	31	2.40	0.88	0.39	0.00	0.01	0.04	0.09	0.54	0.77	1.06	1.25	12.30	12.30
White	12,861,000	697	8.16	1.18	0.06	0.01	0.05	0.13	0.26	0.68	1.50	2.82	3.72	9.52	12.80
Region															
Midwest	5,572,000	314	12.01	1.31	0.10	0.03	0.07	0.17	0.27	0.74	1.67	3.23	4.26	10.40	11.90
Northeast	1,721,000	92	4.18	0.84	0.10	0.00	0.01	0.01	0.14	0.48	1.18	2.05	2.77	4.78	6.03
South	3,842,000	205	5.97	1.38	0.14	0.01	0.05	0.13	0.28	0.69	1.70	3.32	3.83	12.30	12.80
West	2,555,000	130	7.08	0.77	0.06	0.00	0.02	0.11	0.24	0.57	0.98	1.69	2.45	3.72	3.72
Response to Questionnaire															
Households who garden	12,578,000	682	18.46	1.15	0.06	0.00	0.04	0.12	0.26	0.67	1.50	2.81	3.64	7.47	12.80
Households who farm	2,367,000	136	32.30	1.39	0.13	0.11	0.16	0.18	0.37	0.88	1.85	3.11	4.58	7.47	7.69

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-63. Consumer Only Intake of Homegrown Dark Green Vegetables (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	8,855,000	428	4.71	0.39	0.03	0.00	0.00	0.01	0.09	0.21	0.44	0.92	1.25	3.53	5.82
Age															
1-2	180,000	8	3.16	*	*	*	*	*	*	*	*	*	*	*	*
3-5	226,000	12	2.79	*	*	*	*	*	*	*	*	*	*	*	*
6-11	826,000	39	4.94	0.31	0.05	0.00	0.01	0.02	0.09	0.18	0.39	0.95	1.04	1.28	1.28
12-19	628,000	32	3.07	0.42	0.15	0.00	0.01	0.01	0.06	0.20	0.37	0.92	1.64	4.86	4.86
20-39	1,976,000	87	3.21	0.34	0.06	0.00	0.00	0.01	0.09	0.18	0.38	0.67	0.92	2.94	4.29
40-69	3,710,000	184	6.54	0.40	0.04	0.00	0.00	0.03	0.08	0.23	0.48	0.98	1.25	3.29	5.82
≥ 70	1,253,000	63	7.89	0.41	0.07	0.00	0.00	0.01	0.11	0.23	0.47	0.93	1.08	3.45	3.45
Season															
Fall	2,683,000	88	5.63	0.44	0.07	0.01	0.04	0.09	0.15	0.24	0.46	0.79	1.08	3.86	4.29
Spring	1,251,000	127	2.71	0.56	0.08	0.00	0.00	0.01	0.10	0.31	0.54	1.28	2.81	4.86	5.82
Summer	3,580,000	124	7.87	0.34	0.04	0.00	0.00	0.01	0.06	0.15	0.41	0.98	1.15	2.48	2.48
Winter	1,341,000	89	2.75	0.27	0.04	0.00	0.00	0.01	0.02	0.15	0.37	0.66	1.17	2.04	2.18
Urbanization															
Central City	1,298,000	48	2.30	0.27	0.04	0.00	0.00	0.01	0.11	0.21	0.32	0.63	0.92	1.07	1.07
Non-Metropolitan	3,218,000	167	7.15	0.33	0.04	0.00	0.00	0.02	0.07	0.17	0.45	0.75	1.00	2.48	5.82
Suburban	4,279,000	211	4.94	0.48	0.05	0.00	0.01	0.02	0.09	0.23	0.46	1.15	2.18	3.86	4.86
Race															
Black	724,000	49	3.33	1.04	0.18	0.00	0.10	0.11	0.22	0.55	1.17	3.29	3.86	4.86	4.86
White	7,963,000	373	5.05	0.32	0.02	0.00	0.00	0.01	0.08	0.20	0.38	0.78	1.07	2.37	5.82
Region															
Midwest	2,668,000	121	5.75	0.28	0.04	0.00	0.00	0.01	0.06	0.21	0.36	0.50	0.98	2.48	3.02
Northeast	1,554,000	76	3.77	0.51	0.09	0.00	0.00	0.00	0.06	0.20	0.49	1.25	1.93	3.53	5.82
South	2,945,000	148	4.58	0.48	0.05	0.04	0.07	0.09	0.15	0.29	0.64	0.92	1.28	3.86	4.29
West	1,628,000	81	4.51	0.32	0.07	0.00	0.00	0.01	0.04	0.11	0.31	0.66	0.93	4.86	4.86
Response to Questionnaire															
Households who garden	8,521,000	412	12.50	0.40	0.03	0.00	0.00	0.01	0.09	0.21	0.45	0.92	1.25	3.53	5.82
Households who farm	1,450,000	66	19.78	0.38	0.06	0.00	0.00	0.01	0.07	0.23	0.48	0.95	1.25	2.48	3.02

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-64. Consumer Only Intake of Homegrown Deep Yellow Vegetables (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	5,467,000	245	2.91	0.64	0.04	0.04	0.07	0.13	0.22	0.42	0.77	1.44	2.03	2.67	6.63
Age															
1-2	124,000	8	2.18	*	*	*	*	*	*	*	*	*	*	*	*
3-5	61,000	4	0.75	*	*	*	*	*	*	*	*	*	*	*	*
6-11	382,000	17	2.29	*	*	*	*	*	*	*	*	*	*	*	*
12-19	493,000	21	2.41	0.47	0.09	0.06	0.06	0.06	0.09	0.36	0.78	1.13	1.44	1.58	1.58
20-39	1,475,000	63	2.39	0.53	0.08	0.05	0.06	0.12	0.17	0.31	0.51	1.22	2.03	2.67	2.67
40-69	2,074,000	96	3.66	0.54	0.05	0.04	0.09	0.14	0.22	0.40	0.65	1.09	1.33	3.02	3.02
≥ 70	761,000	32	4.79	0.78	0.09	0.08	0.20	0.28	0.37	0.57	1.24	1.61	1.99	1.99	1.99
Season															
Fall	2,664,000	97	5.59	0.74	0.08	0.09	0.12	0.14	0.26	0.45	0.97	1.73	2.23	3.02	6.63
Spring	315,000	34	0.68	0.56	0.08	0.14	0.15	0.20	0.25	0.45	0.64	1.01	1.42	2.41	2.41
Summer	1,619,000	52	3.56	0.51	0.06	0.04	0.05	0.06	0.23	0.41	0.64	0.96	1.67	2.31	2.31
Winter	869,000	62	1.78	0.63	0.09	0.04	0.04	0.06	0.17	0.35	0.80	1.54	2.23	4.37	4.37
Urbanization															
Central City	1,308,000	43	2.32	0.51	0.07	0.04	0.06	0.14	0.21	0.39	0.59	0.96	1.41	2.24	2.24
Non-Metropolitan	2,100,000	118	4.66	0.67	0.08	0.04	0.06	0.09	0.22	0.37	0.87	1.39	2.12	4.37	6.63
Suburban	2,059,000	84	2.38	0.71	0.07	0.06	0.09	0.13	0.26	0.43	0.97	1.67	2.03	2.67	2.67
Race															
Black	129,000	8	0.59	*	*	*	*	*	*	*	*	*	*	*	*
White	5,093,000	229	3.23	0.65	0.04	0.05	0.09	0.14	0.24	0.43	0.80	1.50	2.03	2.67	4.37
Region															
Midwest	2,792,000	128	6.02	0.75	0.06	0.04	0.13	0.19	0.28	0.51	0.96	1.73	2.23	3.02	4.37
Northeast	735,000	29	1.79	0.40	0.08	0.04	0.06	0.06	0.09	0.15	0.64	1.09	1.37	2.21	2.21
South	557,000	30	0.87	0.54	0.21	0.05	0.05	0.08	0.22	0.31	0.44	0.77	1.22	6.63	6.63
West	1,383,000	58	3.83	0.60	0.07	0.06	0.13	0.14	0.22	0.41	0.64	1.44	1.89	2.31	2.31
Response to Questionnaire															
Households who garden	5,177,000	233	7.60	0.62	0.04	0.04	0.09	0.13	0.23	0.42	0.75	1.42	1.99	2.67	4.37
Households who farm	1,088,000	51	14.85	0.61	0.09	0.09	0.09	0.12	0.19	0.34	0.94	1.28	1.73	3.02	3.02

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-65. Consumer Only Intake of Homegrown Other Vegetables (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	25,221,000	1,437	13.41	1.38	0.05	0.01	0.11	0.18	0.36	0.78	1.65	3.09	4.52	9.95	18.40
Age															
1-2	613,000	38	10.76	3.80	0.63	0.19	0.27	0.40	1.04	2.61	4.55	7.74	11.20	18.00	18.00
3-5	887,000	59	10.95	2.15	0.27	0.00	0.23	0.37	0.72	1.37	3.16	4.47	5.96	8.41	14.00
6-11	2,149,000	134	12.86	1.30	0.14	0.00	0.12	0.19	0.35	0.80	1.61	3.04	4.57	9.95	9.95
12-19	2,379,000	141	11.61	0.98	0.09	0.00	0.06	0.12	0.32	0.64	1.33	2.05	3.17	5.41	5.41
20-39	6,020,000	328	9.77	0.93	0.06	0.03	0.09	0.15	0.24	0.56	1.12	2.19	3.04	5.10	7.00
40-69	9,649,000	547	17.01	1.40	0.09	0.01	0.11	0.19	0.40	0.84	1.58	2.92	4.65	14.10	18.40
≥ 70	3,226,000	174	20.31	1.58	0.14	0.02	0.15	0.24	0.46	0.95	1.91	3.46	5.79	9.96	11.40
Season															
Fall	6,934,000	253	14.55	1.19	0.09	0.05	0.15	0.19	0.33	0.72	1.44	2.74	4.00	6.74	9.96
Spring	5,407,000	567	11.71	1.16	0.06	0.00	0.04	0.10	0.31	0.71	1.39	2.67	4.21	7.35	14.00
Summer	8,454,000	283	18.59	1.79	0.15	0.00	0.12	0.18	0.39	0.97	1.97	4.13	6.14	14.60	18.40
Winter	4,426,000	334	9.09	1.19	0.07	0.00	0.14	0.23	0.41	0.73	1.49	2.41	3.37	7.00	11.00
Urbanization															
Central City	4,148,000	161	7.36	0.97	0.09	0.04	0.09	0.16	0.32	0.61	1.23	1.97	3.22	7.00	8.85
Non-Metropolitan	10,721,000	710	23.81	1.78	0.09	0.03	0.16	0.23	0.47	1.01	2.01	4.05	5.74	14.10	18.40
Suburban	10,292,000	564	11.89	1.14	0.06	0.00	0.09	0.15	0.31	0.65	1.44	2.69	3.77	6.81	11.40
Race															
Black	1,347,000	84	6.19	1.30	0.17	0.04	0.17	0.21	0.35	0.71	1.49	3.88	5.47	6.21	7.72
White	23,367,000	1,327	14.83	1.39	0.05	0.01	0.11	0.18	0.38	0.79	1.65	3.04	4.49	9.96	18.40
Region															
Midwest	8,296,000	522	17.88	1.43	0.09	0.03	0.12	0.19	0.37	0.73	1.65	3.05	4.65	11.20	18.40
Northeast	2,914,000	162	7.08	1.33	0.17	0.00	0.06	0.11	0.24	0.60	1.64	3.07	5.41	12.00	14.10
South	9,218,000	518	14.33	1.53	0.08	0.01	0.17	0.25	0.49	1.03	1.76	3.37	4.70	8.33	18.00
West	4,733,000	233	13.12	1.08	0.10	0.01	0.07	0.12	0.26	0.57	1.21	2.41	3.73	8.02	11.40
Response to Questionnaire															
Households who garden	22,417,000	1,291	32.89	1.44	0.05	0.01	0.11	0.18	0.38	0.82	1.70	3.22	4.65	9.95	18.40
Households who farm	3,965,000	239	54.10	1.95	0.16	0.01	0.14	0.23	0.52	1.21	2.04	5.32	7.02	14.60	15.90

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-66. Consumer Only Intake of Homegrown Citrus (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	2,530,000	125	1.35	4.76	0.61	0.08	0.16	0.29	0.76	1.99	5.10	14.10	19.70	32.20	47.90
Age															
1-2	54,000	4	0.95	*	*	*	*	*	*	*	*	*	*	*	*
3-5	51,000	3	0.63	*	*	*	*	*	*	*	*	*	*	*	*
6-11	181,000	9	1.08	*	*	*	*	*	*	*	*	*	*	*	*
12-19	194,000	14	0.95	*	*	*	*	*	*	*	*	*	*	*	*
20-39	402,000	18	0.65	*	*	*	*	*	*	*	*	*	*	*	*
40-69	1,183,000	55	2.09	4.54	0.81	0.08	0.15	0.25	0.52	1.74	5.24	15.20	19.70	23.80	23.80
≥ 70	457,000	21	2.88	4.43	0.76	0.08	0.08	0.49	1.95	3.53	6.94	8.97	8.97	15.70	15.70
Season															
Fall	280,000	8	0.59	*	*	*	*	*	*	*	*	*	*	*	*
Spring	437,000	33	0.95	2.31	0.38	0.16	0.18	0.24	0.37	1.36	4.15	5.10	6.50	7.52	7.52
Summer	334,000	11	0.73	*	*	*	*	*	*	*	*	*	*	*	*
Winter	1,479,000	73	3.04	6.47	0.95	0.15	0.33	0.49	1.64	2.93	8.59	19.10	23.80	47.90	47.90
Urbanization															
Central City	1,053,000	43	1.87	3.57	0.52	0.15	0.33	0.45	1.13	3.01	4.97	7.46	8.97	20.00	20.00
Non-Metropolitan	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Suburban	1,477,000	82	1.71	5.61	0.91	0.08	0.11	0.25	0.52	1.81	8.12	17.90	23.80	47.90	47.90
Race															
Black	200,000	8	0.92	*	*	*	*	*	*	*	*	*	*	*	*
White	2,330,000	117	1.48	4.93	0.63	0.08	0.15	0.28	0.78	2.34	5.34	14.10	19.70	32.20	47.90
Region															
Midwest	64,000	4	0.14	*	*	*	*	*	*	*	*	*	*	*	*
Northeast	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
South	1,240,000	55	1.93	5.18	0.74	0.16	0.38	0.64	1.60	3.42	6.50	14.10	19.70	23.80	23.80
West	1,226,000	66	3.40	4.56	0.98	0.08	0.11	0.24	0.37	1.42	4.53	12.40	20.00	47.90	47.90
Response to Questionnaire															
Households who garden	2,151,000	102	3.16	4.55	0.66	0.08	0.15	0.28	0.76	1.99	4.99	12.40	17.90	32.20	47.90
Households who farm	130,000	5	1.77	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.
SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-67. Consumer Only Intake of Homegrown Other Fruit (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	MAX
Total	12,615,000	706	6.71	2.20	0.19	0.05	0.15	0.26	0.46	0.91	1.91	4.59	8.12	18.40	62.60
Age															
1-2	306,000	19	5.37	*	*	*	*	*	*	*	*	*	*	*	*
3-5	499,000	31	6.16	2.66	0.76	0.00	0.00	0.38	1.02	1.87	2.71	5.54	6.30	33.20	33.20
6-11	915,000	68	5.48	2.60	0.44	0.00	0.18	0.39	0.64	1.14	2.99	7.13	12.10	16.20	16.50
12-19	1,021,000	54	4.98	1.62	0.28	0.08	0.12	0.26	0.39	0.61	2.36	3.92	6.81	8.12	8.12
20-39	2,761,000	146	4.48	1.85	0.37	0.08	0.13	0.18	0.31	0.62	1.39	3.70	6.64	37.00	37.00
40-69	4,610,000	259	8.13	2.09	0.31	0.07	0.15	0.25	0.44	0.77	1.77	3.17	9.77	18.40	53.30
≥ 70	2,326,000	119	14.65	1.66	0.18	0.04	0.21	0.36	0.57	1.07	1.65	4.06	5.21	11.70	11.70
Season															
Fall	2,923,000	102	6.13	1.39	0.11	0.26	0.30	0.38	0.57	1.07	1.88	2.89	4.06	5.39	5.54
Spring	2,526,000	268	5.47	1.47	0.15	0.09	0.20	0.25	0.43	0.83	1.65	2.89	4.59	8.26	33.20
Summer	4,327,000	144	9.51												
Winter	2,839,000	192	5.83	1.29	0.11	0.04	0.10	0.23	0.45	0.83	1.55	2.70	4.79	8.06	11.30
Urbanization															
Central City	2,681,000	102	4.76	1.79	0.29	0.04	0.17	0.29	0.52	0.89	1.60	2.61	10.40	15.40	15.40
Non-Metropolitan	4,118,000	278	9.15	2.43	0.31	0.07	0.12	0.24	0.45	1.13	2.43	4.60	8.12	24.00	53.30
Suburban	5,756,000	324	6.65	2.25	0.31	0.13	0.20	0.28	0.45	0.76	1.81	4.72	7.61	18.40	62.60
Race															
Black	250,000	12	1.15	*	*	*	*	*	*	*	*	*	*	*	*
White	12,256,000	690	7.78	2.24	0.19	0.07	0.15	0.26	0.47	0.92	1.94	4.65	8.26	18.40	62.60
Region															
Midwest	4,619,000	298	9.96	3.07	0.43	0.04	0.13	0.24	0.45	1.04	2.35	6.73	14.20	53.30	62.60
Northeast	1,279,000	72	3.11	0.93	0.22	0.08	0.09	0.16	0.31	0.48	0.81	1.29	2.16	11.70	11.70
South	3,004,000	157	4.67	1.99	0.26	0.08	0.24	0.30	0.55	1.10	1.82	4.06	6.30	16.20	24.00
West	3,653,000	177	10.13	1.76	0.16	0.10	0.22	0.29	0.54	0.97	2.04	4.35	5.75	13.00	13.00
Response to Questionnaire															
Households who garden	10,926,000	619	16.03	2.38	0.21	0.04	0.16	0.26	0.47	0.99	1.96	4.94	10.40	18.40	62.60
Households who farm	1,917,000	112	26.16	2.57	0.27	0.07	0.28	0.36	0.73	1.55	3.62	5.80	8.06	16.20	16.20

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = standard error.
P = percentile of the distribution.
Nc wgtd = weighted number of consumers.
Nc unwgtd = unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-68. Fraction of Food Intake that is Home-produced

	Total Fruits	Total Vegetables	Total Meats	Total Dairy	Total Fish	Exposed Vegetables	Protected Vegetables	Root Vegetables	Exposed Fruits	Protected Fruits
Total	0.040	0.068	0.024	0.012	0.094	0.095	0.069	0.043	0.050	0.037
Season										
Fall	0.021	0.081	0.020	0.008	0.076	0.106	0.073	0.060	0.039	0.008
Spring	0.021	0.037	0.020	0.011	0.160	0.050	0.039	0.020	0.047	0.008
Summer	0.058	0.116	0.034	0.022	0.079	0.164	0.101	0.066	0.068	0.054
Winter	0.059	0.041	0.022	0.008	0.063	0.052	0.048	0.026	0.044	0.068
Urbanization										
Central City	0.027	0.027	0.003	0.000	0.053	0.037	0.027	0.016	0.030	0.026
Non-metropolitan	0.052	0.144	0.064	0.043	0.219	0.207	0.134	0.088	0.100	0.025
Suburban	0.047	0.058	0.018	0.004	0.075	0.079	0.054	0.035	0.043	0.050
Race										
Black	0.007	0.027	0.001	0.000	0.063	0.037	0.029	0.012	0.008	0.007
White	0.049	0.081	0.031	0.014	0.110	0.109	0.081	0.050	0.059	0.045
Regions										
Northeast	0.005	0.038	0.009	0.010	0.008	0.062	0.016	0.018	0.010	0.002
Midwest	0.059	0.112	0.046	0.024	0.133	0.148	0.109	0.077	0.078	0.048
South	0.042	0.069	0.017	0.006	0.126	0.091	0.077	0.042	0.040	0.044
West	0.062	0.057	0.023	0.007	0.108	0.079	0.060	0.029	0.075	0.054
Questionnaire Response										
Households who garden	0.101	0.173	-	-	-	0.233	0.178	0.106	0.116	0.094
Households who raise animals	-	-	0.306	0.207	-	-	-	-	-	-
Households who farm	0.161	0.308	0.319	0.254	-	0.420	0.394	0.173	0.328	0.030
Households who fish	-	-	-	-	0.325	-	-	-	-	-

Table 13-68. Fraction of Food Intake that is Home-produced (continued)

	Dark Green Vegetables	Deep Yellow Vegetables	Other Vegetables	Citrus Fruits	Other Fruits	Apples	Peaches	Pears	Strawberries	Other Berries
Total	0.044	0.065	0.069	0.038	0.042	0.030	0.147	0.067	0.111	0.217
Season										
Fall	0.059	0.099	0.069	0.114	0.027	0.032	0.090	0.038	0.408	0.163
Spring	0.037	0.017	0.051	0.014	0.025	0.013	0.206	0.075	0.064	0.155
Summer	0.063	0.080	0.114	0.010	0.070	0.053	0.133	0.066	0.088	0.232
Winter	0.018	0.041	0.044	0.091	0.030	0.024	0.183	0.111	0.217	0.308
Urbanization										
Central City	0.012	0.038	0.026	0.035	0.022	0.017	0.087	0.038	0.107	0.228
Non-metropolitan	0.090	0.122	0.154	0.000	0.077	0.066	0.272	0.155	0.133	0.282
Suburban	0.054	0.058	0.053	0.056	0.042	0.024	0.121	0.068	0.101	0.175
Race										
Black	0.053	0.056	0.026	0.012	0.004	0.007	0.018	0.004	0.000	0.470
White	0.043	0.071	0.082	0.045	0.051	0.035	0.164	0.089	0.125	0.214
Regions										
Northeast	0.039	0.019	0.034	0.000	0.008	0.004	0.027	0.002	0.085	0.205
Midwest	0.054	0.174	0.102	0.001	0.083	0.052	0.164	0.112	0.209	0.231
South	0.049	0.022	0.077	0.060	0.031	0.024	0.143	0.080	0.072	0.177
West	0.034	0.063	0.055	0.103	0.046	0.043	0.238	0.093	0.044	0.233
Questionnaire Response										
Households who garden	0.120	0.140	0.180	0.087	0.107	0.070	0.316	0.169	0.232	0.306
Households who farm	0.220	0.328	0.368	0.005	0.227	0.292	0.461	0.606	0.057	0.548

Table 13-68. Fraction of food Intake that is Home-produced (continued)

	Asparagus	Beets	Broccoli	Cabbage	Carrots	Corn	Cucumbers	Lettuce	Lima Beans	Okra	Onions
Total	0.063	0.203	0.015	0.038	0.043	0.078	0.148	0.010	0.121	0.270	0.056
Season											
Fall	0.024	0.199	0.013	0.054	0.066	0.076	0.055	0.013	0.070	0.299	0.066
Spring	0.103	0.191	0.011	0.011	0.015	0.048	0.040	0.010	0.082	0.211	0.033
Summer	0	0.209	0.034	0.080	0.063	0.118	0.320	0.017	0.176	0.304	0.091
Winter	0.019	0.215	0.006	0.008	0.025	0.043	0	0.002	0.129	0.123	0.029
Urbanization											
Central City	0.058	0.212	0.004	0.004	0.018	0.025	0.029	0.009	0.037	0.068	0.017
Non-metropolitan	0.145	0.377	0.040	0.082	0.091	0.173	0.377	0.017	0.132	0.411	0.127
Suburban	0.040	0.127	0.016	0.045	0.039	0.047	0.088	0.009	0.165	0.299	0.050
Race											
Black	0.000	0.000	0.000	0.001	0.068	0.019	0.060	0.007	0.103	0.069	0.009
White	0.071	0.224	0.018	0.056	0.042	0.093	0.155	0.011	0.135	0.373	0.068
Regions											
Northeast	0.091	0.074	0.020	0.047	0.025	0.020	0.147	0.009	0.026	0.000	0.022
Midwest	0.194	0.432	0.025	0.053	0.101	0.124	0.193	0.020	0.149	0.224	0.098
South	0.015	0.145	0.013	0.029	0.020	0.088	0.140	0.006	0.140	0.291	0.047
West	0.015	0.202	0.006	0.029	0.039	0.069	0.119	0.009	0.000	0.333	0.083
Questionnaire Response											
Households who garden	0.125	0.420	0.043	0.099	0.103	0.220	0.349	0.031	0.258	0.618	0.148
Households who farm	0.432	0.316	0.159	0.219	0.185	0.524	0.524	0.063	0.103	0.821	0.361

Table 13-68. Fraction of Food Intake that is Home-produced (continued)

	Peas	Peppers	Pumpkin	Snap Beans	Tomatoes	White Potatoes	Beef	Game	Pork	Poultry	Eggs
Total	0.069	0.107	0.155	0.155	0.184	0.038	0.038	0.276	0.013	0.011	0.014
Season											
Fall	0.046	0.138	0.161	0.199	0.215	0.058	0.028	0.336	0.012	0.011	0.009
Spring	0.048	0.031	0.046	0.152	0.045	0.010	0.027	0.265	0.015	0.012	0.022
Summer	0.126	0.194	0.19	0.123	0.318	0.060	0.072	0.100	0.010	0.007	0.013
Winter	0.065	0.03	0.154	0.147	0.103	0.022	0.022	0.330	0.014	0.014	0.011
Urbanization											
Central City	0.033	0.067	0.130	0.066	0.100	0.009	0.001	0.146	0.001	0.002	0.002
Non-metropolitan	0.123	0.228	0.250	0.307	0.313	0.080	0.107	0.323	0.040	0.026	0.029
Suburban	0.064	0.086	0.127	0.118	0.156	0.029	0.026	0.316	0.006	0.011	0.014
Race											
Black	0.047	0.039	0.022	0.046	0.060	0.007	0.000	0.000	0.000	0.001	0.002
White	0.076	0.121	0.187	0.186	0.202	0.044	0.048	0.359	0.017	0.014	0.017
Regions											
Northeast	0.021	0.067	0.002	0.052	0.117	0.016	0.014	0.202	0.006	0.002	0.004
Midwest	0.058	0.188	0.357	0.243	0.291	0.065	0.076	0.513	0.021	0.021	0.019
South	0.106	0.113	0.044	0.161	0.149	0.042	0.022	0.199	0.012	0.012	0.012
West	0.051	0.082	0.181	0.108	0.182	0.013	0.041	0.207	0.011	0.008	0.021
Questionnaire Response											
Households who garden	0.193	0.246	0.230	0.384	0.398	0.090	-	-	-	-	-
Households who farm	0.308	0.564	0.824	0.623	0.616	0.134	0.485	-	0.242	0.156	0.146
Households who raise animals	-	-	-	-	-	-	0.478	-	0.239	0.151	0.214
Households who hunt	-	-	-	-	-	-	-	0.729	-	-	-

\- Indicates data are not available.

Source: Based on EPA's analyses of the 1987-88 NFCS.

Table 13-69. Percent Weight Losses from Food Preparation

Food Group	Mean Net Preparation/Cooking Loss (%)	Mean Net Post Cooking (%)
Meats[a]	29.7[b]	29.7[c]
Fish and shellfish[d]	31.5[b]	10.5[c]
Fruits	25.4[e]	30.5[f]
Vegetables[g]	12.4[h]	22[i]

[a] Averaged over various cuts and preparation methods for various meats including beef, pork, chicken, turkey, lamb, and veal.
[b] Includes dripping and volatile losses during cooking.
[c] Includes losses from cutting, shrinkage, excess fat, bones, scraps, and juices.
[d] Averaged over a variety of fish and shellfish, to include: bass, bluefish, butterfish, cod, flounder, haddock, halibut, lake trout, mackerel, perch, porgy, red snapper, rockfish, salmon, sea trout, shad, smelt, sole, spot, squid, swordfish steak, trout, whitefish, clams, crab, crayfish, lobster, oysters, and shrimp and shrimp dishes.
[e] Based on preparation losses. Averaged over apples, pears, peaches, strawberries, and oranges. Includes losses from removal of skin or peel, core or pit, stems or caps, seeds, and defects. Also, includes losses from removal of drained liquids from canned or frozen forms.
[f] Averaged over apples and peaches. Include losses from draining cooked forms.
[g] Averaged over various vegetables, to include: asparagus, beets, broccoli, cabbage, carrots, corn, cucumbers, lettuce, lima beans, okra, onions, green peas, peppers, pumpkins, snap beams, tomatoes, and potatoes.
[h] Includes losses due to paring, trimming, flowering the stalk, thawing, draining, scraping, shelling, slicing, husking, chopping, and dicing and gains from the addition of water, fat, or other ingredients. Averaged over various preparation methods.
[i] Includes losses from draining or removal of skin. Based on potatoes only.

Source: U.S. EPA, 1997 (Derived from USDA, 1975).

Table 13-70. 2008 Food Gardening by Demographic Factors

Demographic Factor	Percentage of total households that have gardens (%)
Total (~36 million)	31
Gender	
Female	54
Male	46
Age	
18 to 34	21
35 to 44	11
..45 to 54	24
55 and over	44
Education	
College Graduate	43
Some College	36
High School	21
Household income	
$75,000 and over	22
$50-$74,999	16
..$35-$49,999	24
..Under $35,000	21
..Undesignated	17
Household size	
One person	20
Two person	40
..Three-four person	32
Five or more persons	9

Source: National Gardening Association, 2009.

Table 13-71. Percentage of Gardening Households Growing Different Vegetables in 2008

Vegetable	Percent
Tomatoes	86
Cucumbers	47
Sweet peppers	46
Beans	39
Carrots	34
Summer squash	32
Onions	32
Hot peppers	31
Lettuce	28
Peas	24
Sweet Corn	23
Radish	20
Potatoes	18
Salad greens	17
Pumpkins	17
Watermelon	16
Spinach	15
Broccoli	15
Melon	15
Cabbage	14
Beets	11
Winter squash	10
Asparagus	9
Collards	9
Cauliflower	7
Celery	5
Brussels sprouts	5
Leeks	3
Kale	3
Parsnips	2
Chinese cabbage	2
Rutabaga	1

Source: National Gardening Association, 2009.

APPENDIX 13A

FOOD CODES AND DEFINITIONS OF MAJOR FOOD GROUPS USED IN ANALYSIS OF THE 1987-1988 USDA NFCS DATA TO ESTIMATE HOME-PRODUCED INTAKE RATES

Table 13A-1. Food Codes and Definitions of Major Food Groups Used in Analysis of the 1987-1988 USDA NFCS Data to Estimate Intake of Home-produced Foods

Food Product	Household Code/Definition[1]	Individual Code
MAJOR FOOD GROUPS		
Total Fruits	50- Fresh Fruits citrus other vitamin-C rich other fruits 512- Commercially Canned Fruits 522- Commercially Frozen Fruits 533- Canned Fruit Juice 534- Frozen Fruit Juice 535- Aseptically Packed Fruit Juice 536- Fresh Fruit Juice 542- Dried Fruits (includes baby foods)	6- Fruits citrus fruits and juices dried fruits other fruits fruits/juices & nectar fruit/juices baby food (includes baby foods)
Total Vegetables	48- Potatoes, Sweet potatoes 49- Fresh Vegetables dark green deep yellow tomatoes light green other 511- Commercially Canned Vegetables 521- Commercially Frozen Vegetables 531- Canned Vegetable Juice 532- Frozen Vegetable Juice 537- Fresh Vegetable Juice 538- Aseptically Packed Vegetable Juice 541- Dried Vegetables (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures/dinners)	7- Vegetables (all forms) white potatoes & PR starchy dark green vegetables deep yellow vegetables tomatoes and tom. mixtures other vegetables veg. and mixtures/baby food veg. with meat mixtures (includes baby foods; mixtures, mostly vegetables)
Total Meats	44- Meat beef pork veal lamb mutton goat game lunch meat mixtures 451- Poultry (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	20- Meat, type not specified 21- Beef 22- Pork 23- Lamb, veal, game, carcass meat 24- Poultry 25- Organ meats, sausages, lunchmeats, meat spreads (excludes meat, poultry, and fish with non-meat items; frozen plate meals; soups and gravies with meat, poultry and fish base; and gelatin-based drinks; includes baby foods)
Total Dairy	40- Milk Equivalent fresh fluid milk processed milk cream and cream substitutes frozen desserts with milk cheese dairy-based dips (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners)	1- Milk and Milk Products milk and milk drinks cream and cream substitutes milk desserts, sauces, and gravies cheeses (includes regular fluid milk, human milk, imitation milk products, yogurt, milk-based meal replacements, and infant formulas)
Total Fish	452- Fish, Shellfish various species fresh, frozen, commercial, dried (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners)	26- Fish, Shellfish various species and forms (excludes meat, poultry, and fish with non-meat items; frozen plate meals; soups and gravies with meat, poultry and fish base; and gelatin-based drinks)

[1] Food items within these categories that were identified by the household as being home-produced or home-caught (i.e., source code pertaining to home-produced foods) were included in the analysis.

APPENDIX 13B

1987-1988 NFCS FOOD CODES AND DEFINITIONS OF INDIVIDUAL FOOD ITEMS USED IN ESTIMATING FRACTION OF HOUSEHOLD FOOD INTAKE THAT IS HOME-PRODUCED

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data to Estimate Fraction of Food Intake that is Home-produced

Food Product	Household Code/Definition	Individual Code
INDIVIDUAL FOODS		
White Potatoes	4811- White Potatoes, fresh 4821- White Potatoes, commercially canned 4831- White Potatoes, commercially frozen 4841- White Potatoes, dehydrated 4851- White Potatoes, chips, sticks, salad (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners)	71- White Potatoes and PR Starchy Veg. baked, boiled, chips, sticks, creamed, scalloped, au gratin, fried, mashed, stuffed, puffs, salad, recipes, soups, Puerto Rican starchy vegetables (does not include vegetables soups; vegetable mixtures; or vegetable with meat mixtures)
Peppers	4913- Green/Red Peppers, fresh 5111201 Sweet Green Peppers, commercially canned 5111202 Hot Chili Peppers, commercially canned 5211301 Sweet Green Peppers, commercially frozen 5211302 Green Chili Peppers, commercially frozen 5211303 Red Chili Peppers, commercially frozen 5413112 Sweet Green Peppers, dry 5413113 Red Chili Peppers, dry (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners)	7512100 Pepper, hot chili, raw 7512200 Pepper, raw 7512210 Pepper, sweet green, raw 7512220 Pepper, sweet red, raw 7522600 Pepper, green, cooked, NS as to fat added 7522601 Pepper, green, cooked, fat not added 7522602 Pepper, green, cooked, fat added 7522604 Pepper, red, cooked, NS as to fat added 7522605 Pepper, red, cooked, fat not added 7522606 Pepper, red, cooked, fat added 7522609 Pepper, hot, cooked, NS as to fat added 7522610 Pepper, hot, cooked, fat not added 7522611 Pepper, hot, cooked, fat added 7551101 Peppers, hot, sauce 7551102 Peppers, pickled (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)
Onions	4953- Onions, Garlic, fresh onions chives garlic leeks 5114908 Garlic Pulp, raw 5114915 Onions, commercially canned 5213722 Onions, commercially frozen 5213723 Onions with Sauce, commercially frozen 5413103 Chives, dried 5413105 Garlic Flakes, dried 5413110 Onion Flakes, dried (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners)	7510950 Chives, raw 7511150 Garlic, raw 7511250 Leek, raw 7511701 Onions, young green, raw 7511702 Onions, mature 7521550 Chives, dried 7521740 Garlic, cooked 7522100 Onions, mature cooked, NS as to fat added 7522101 Onions, mature cooked, fat not added 7522102 Onions, mature cooked, fat added 7522103 Onions, pearl cooked 7522104 Onions, young green cooked, NS as to fat 7522105 Onions, young green cooked, fat not added 7522106 Onions, young green cooked, fat added 7522110 Onion, dehydrated 7541501 Onions, creamed 7541502 Onion rings (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data to Estimate Fraction of Food Intake that is Home-produced (continued)

Food Product	Household Code/Definition	Individual Code
Corn	4956- Corn, fresh 5114601 Yellow Corn, commercially canned 5114602 White Corn, commercially canned 5114603 Yellow Creamed Corn, commercially canned 5114604 White Creamed Corn, commercially canned 5114605 Corn on Cob, commercially canned 5114607 Hominy, canned 5115306 Low Sodium Corn, commercially canned 5115307 Low Sodium Cr. Corn, commercially canned 5213501 Yellow Corn on Cob, commercially frozen 5213502 Yellow Corn off Cob, commercially frozen 5213503 Yell. Corn with Sauce, commercially frozen 5213504 Corn with other Veg., commercially frozen 5213505 White Corn on Cob, commercially frozen 5213506 White Corn off Cob, commercially frozen 5213507 Wh. Corn with Sauce, commercially frozen 5413104 Corn, dried 5413106 Hominy, dry 5413603 Corn, instant baby food (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby food)	7510960 Corn, raw 7521600 Corn, cooked, NS as to color/fat added 7521601 Corn, cooked, NS as to color/fat not added 7521602 Corn, cooked, NS as to color/fat added 7521605 Corn, cooked, NS as to color/cream style 7521607 Corn, cooked, dried 7521610 Corn, cooked, yellow/NS as to fat added 7521611 Corn, cooked, yellow/fat not added 7521612 Corn, cooked, yellow/fat added 7521615 Corn, yellow, cream style 7521616 Corn, cooked, yell. & wh./NS as to fat 7521617 Corn, cooked, yell. & wh./fat not added 7521618 Corn, cooked, yell. & wh./fat added 7521619 Corn, yellow, cream style, fat added 7521620 Corn, cooked, white/NS as to fat added 7521621 Corn, cooked, white/fat not added 7521622 Corn, cooked, white/fat added 7521625 Corn, white, cream style 7521630 Corn, yellow, canned, low sodium, NS fat 7521631 Corn, yell., canned, low sod., fat not add 7521632 Corn, yell., canned, low sod., fat added 7521749 Hominy, cooked 752175- Hominy, cooked 7541101 Corn scalloped or pudding 7541102 Corn fritter 7541103 Corn with cream sauce 7550101 Corn relish 76405- Corn, baby (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures; includes baby food)
Apples	5031- Apples, fresh 5122101 Applesauce with sugar, commercially canned 5122102 Applesauce without sugar, comm. canned 5122103 Apple Pie Filling, commercially canned 5122104 Apples, Applesauce, baby/jr., comm. canned 5122106 Apple Pie Filling, Low Cal., comm. canned 5223101 Apple Slices, commercially frozen 5332101 Apple Juice, canned 5332102 Apple Juice, baby, Comm. canned 5342201 Apple Juice, comm. frozen 5342202 Apple Juice, home frozen 5352101 Apple Juice, aseptically packed 5362101 Apple Juice, fresh 5423101 Apples, dried (includes baby food; except mixtures)	6210110 Apples, dried, uncooked 6210115 Apples, dried, uncooked, low sodium 6210120 Apples, dried, cooked, NS as to sweetener 6210122 Apples, dried, cooked, unsweetened 6210123 Apples, dried, cooked, with sugar 6310100 Apples, raw 6310111 Applesauce, NS as to sweetener 6310112 Applesauce, unsweetened 6310113 Applesauce with sugar 6310114 Applesauce with low calorie sweetener 6310121 Apples, cooked or canned with syrup 6310131 Apple, baked NS as to sweetener 6310132 Apple, baked, unsweetened 6310133 Apple, baked with sugar 6310141 Apple rings, fried 6310142 Apple, pickled 6310150 Apple, fried 6340101 Apple, salad 6340106 Apple, candied 6410101 Apple cider 6410401 Apple juice 6410405 Apple juice with vitamin C 6710200 Applesauce baby fd., NS as to str. or jr. 6710201 Applesauce baby food, strained 6710202 Applesauce baby food, junior 6720200 Apple juice, baby food (includes baby food; except mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data to Estimate Fraction of Food Intake that is Home-produced (continued)

Food Product	Household Code/Definition	Individual Code
Tomatoes	4931- Tomatoes, fresh 5113- Tomatoes, commercially canned 5115201 Tomatoes, low sodium, commercially canned 5115202 Tomato Sauce, low sodium, comm. canned 5115203 Tomato Paste, low sodium, comm. canned 5115204 Tomato Puree, low sodium, comm. canned 5311- Canned Tomato Juice and Tomato Mixtures 5321- Frozen Tomato Juice 5371- Fresh Tomato Juice 5381102 Tomato Juice, aseptically packed 5413115 Tomatoes, dry 5614- Tomato Soup 5624- Condensed Tomato Soup 5654- Dry Tomato Soup (does not include mixtures, and ready-to-eat dinners)	74- Tomatoes and Tomato Mixtures raw, cooked, juices, sauces, mixtures, soups, sandwiches
Snap Beans	4943- Snap or Wax Beans, fresh 5114401 Green or Snap Beans, commercially canned 5114402 Wax or Yellow Beans, commercially canned 5114403 Beans, baby/jr., commercially canned 5115302 Green Beans, low sodium, comm. canned 5115303 Yell. or Wax Beans, low sod., comm. canned 5213301 Snap or Green Beans, comm. frozen 5213302 Snap or Green w/sauce, comm. frozen 5213303 Snap or Green Beans w/other veg., comm. fr. 5213304 Sp. or Gr. Beans w/other veg./sc., comm. fr. 5213305 Wax or Yell. Beans, comm. frozen (does not include soups, mixtures, and ready-to-eat dinners; includes baby foods)	7510180 Beans, string, green, raw 7520498 Beans, string, cooked, NS color/fat added 7520499 Beans, string, cooked, NS color/no fat 7520500 Beans, string, cooked, NS color & fat 7520501 Beans, string, cooked, green/NS fat 7520502 Beans, string, cooked, green/no fat 7520503 Beans, string, cooked, green/fat 7520511 Beans, str., canned, low sod.,green/NS fat 7520512 Beans, str., canned, low sod.,green/no fat 7520513 Beans, str., canned, low sod.,green/fat 7520600 Beans, string, cooked, yellow/NS fat 7520601 Beans, string, cooked, yellow/no fat 7520602 Beans, string, cooked, yellow/fat 7540301 Beans, string, green, creamed 7540302 Beans, string, green, w/mushroom sauce 7540401 Beans, string, yellow, creamed 7550011 Beans, string, green, pickled 7640100 Beans, green, string, baby 7640101 Beans, green, string, baby, str. 7640102 Beans, green, string, baby, junior 7640103 Beans, green, string, baby, creamed (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures; includes baby foods)
Beef	441- Beef (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	21- Beef beef, nfs beef steak beef oxtails, neckbones, ribs roasts, stew meat, corned, brisket, sandwich steaks ground beef, patties, meatballs other beef items beef baby food (excludes meat, poultry, and fish with non-meat items; frozen plate meals; soups and gravies with meat, poultry and fish base; and gelatin-based drinks; includes baby food)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data to Estimate Fraction of Food Intake that is Home-produced (continued)		
Food Product	**Household Code/Definition**	**Individual Code**
Pork	442- Pork (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	22- Pork pork, nfs; ground dehydrated chops steaks, cutlets ham roasts Canadian bacon bacon, salt pork other pork items pork baby food (excludes meat, poultry, and fish with non-meat items; frozen plate meals; soups and gravies with meat, poultry and fish base; and gelatin-based drinks; includes baby food)
Game	445- Variety Meat, Game (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	233- Game (excludes meat, poultry, and fish with non-meat items; frozen plate meals; soups and gravies with meat, poultry and fish base; and gelatin-based drinks)
Poultry	451- Poultry (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	24- Poultry chicken turkey duck other poultry poultry baby food (excludes meat, poultry, and fish with non-meat items; frozen plate meals; soups and gravies with meat, poultry and fish base; and gelatin-based drinks; includes baby food)
Eggs	46- Eggs (fresh equivalent) fresh processed eggs, substitutes (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	3- Eggs eggs egg mixtures egg substitutes eggs baby food froz. meals with egg as main ingred. (includes baby foods)
Broccoli	4912- Fresh Broccoli (and home canned/froz.) 5111203 Broccoli, comm. canned 52112- Comm. Frozen Broccoli (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	722- Broccoli (all forms) (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)
Carrots	4921- Fresh Carrots (and home canned/froz.) 51121- Comm. Canned Carrots 5115101 Carrots, Low Sodium, Comm. Canned 52121- Comm. Frozen Carrots 5312103 Comm. Canned Carrot Juice 5372102 Carrot Juice Fresh 5413502 Carrots, Dried Baby Food (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7310- Carrots (all forms) 7311140 Carrots in Sauce 7311200 Carrot Chips 76201- Carrots, baby (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures; includes baby foods except mixtures)
Pumpkin	4922- Fresh Pumpkin, Winter Squash (and home canned/froz.) 51122- Pumpkin/Squash, Baby or Junior, Comm. Canned 52122- Winter Squash, Comm. Frozen 5413504 Squash, Dried Baby Food (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	732- Pumpkin (all forms) 733- Winter squash (all forms) 76205- Squash, baby (does not include vegetable soups; vegetables mixtures; or vegetable with meat mixtures; includes baby foods)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data to Estimate Fraction of Food Intake that is Home-produced (continued)

Food Product	Household Code/Definition	Individual Code
Asparagus	4941- Fresh Asparagus (and home canned/froz.) 5114101 Comm. Canned Asparagus 5115301 Asparagus, Low Sodium, Comm. Canned 52131- Comm. Frozen Asparagus (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7510080 Asparagus, raw 75202- Asparagus, cooked 7540101 Asparagus, creamed or with cheese (does not include vegetable soups; vegetables mixtures, or vegetable with meat mixtures)
Lima Beans	4942- Fresh Lima and Fava Beans (and home canned/froz.) 5114204 Comm. Canned Mature Lima Beans 5114301 Comm. Canned Green Lima Beans 5115304 Comm. Canned Low Sodium Lima Beans 52132- Comm. Frozen Lima Beans 54111- Dried Lima Beans 5411306 Dried Fava Beans (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures; does not include succotash)	7510200 Lima Beans, raw 752040- Lima Beans, cooked 752041- Lima Beans, canned 75402- Lima Beans with sauce (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures; does not include succotash)
Cabbage	4944- Fresh Cabbage (and home canned/froz.) 4958601 Sauerkraut, home canned or pkgd 5114801 Sauerkraut, comm. canned 5114904 Comm. Canned Cabbage 5114905 Comm. Canned Cabbage (no sauce; incl. baby) 5115501 Sauerkraut, low sodium., comm. canned 5312102 Sauerkraut Juice, comm. canned (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7510300 Cabbage, raw 7510400 Cabbage, Chinese, raw 7510500 Cabbage, red, raw 7514100 Cabbage salad or coleslaw 7514130 Cabbage, Chinese, salad 75210- Chinese Cabbage, cooked 75211- Green Cabbage, cooked 75212- Red Cabbage, cooked 752130- Savoy Cabbage, cooked 75230- Sauerkraut, cooked 7540701 Cabbage, creamed 755025- Cabbage, pickled or in relish (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)
Lettuce	4945- Fresh Lettuce, French Endive (and home canned/froz.) (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	75113- Lettuce, raw 75143- Lettuce salad with other veg. 7514410 Lettuce, wilted, with bacon dressing 7522005 Lettuce, cooked (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)
Okra	4946- Fresh Okra (and home canned/froz.) 5114914 Comm. Canned Okra 5213720 Comm. Frozen Okra 5213721 Comm. Frozen Okra with Oth. Veg. & Sauce (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7522000 Okra, cooked, NS as to fat 7522001 Okra, cooked, fat not added 7522002 Okra, cooked, fat added 7522010 Lufta, cooked (Chinese Okra) 7541450 Okra, fried 7550700 Okra, pickled (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data to Estimate Fraction of Food Intake that is Home-produced (continued)

Food Product	**Household Code/Definition**	**Individual Code**
Peas	4947- Fresh Peas (and home canned/froz.) 51147- Comm Canned Peas (incl. baby) 5115310 Low Sodium Green or English Peas (canned) 5115314 Low Sod. Blackeye, Gr. or Imm. Peas (canned) 5114205 Blackeyed Peas, comm. canned 52134- Comm. Frozen Peas 5412- Dried Peas and Lentils (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7512000 Peas, green, raw 7512775 Snowpeas, raw 75223- Peas, cowpeas, field or blackeye, cooked 75224- Peas, green, cooked 75225- Peas, pigeon, cooked 75231- Snowpeas, cooked 7541650 Pea salad 7541660 Pea salad with cheese 75417- Peas, with sauce or creamed 76409- Peas, baby 76411- Peas, creamed, baby (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures; includes baby foods except mixtures)
Cucumbers	4952- Fresh Cucumbers (and home canned/froz.) (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7511100 Cucumbers, raw 75142- Cucumber salads 752167- Cucumbers, cooked 7550301 Cucumber pickles, dill 7550302 Cucumber pickles, relish 7550303 Cucumber pickles, sour 7550304 Cucumber pickles, sweet 7550305 Cucumber pickles, fresh 7550307 Cucumber, Kim Chee 7550311 Cucumber pickles, dill, reduced salt 7550314 Cucumber pickles, sweet, reduced salt (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)
Beets	4954- Fresh Beets (and home canned/froz.) 51145- Comm. Canned Beets (incl. baby) 5115305 Low Sodium Beets (canned) 5213714 Comm. Frozen Beets 5312104 Beet Juice (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7510250 Beets, raw 752080- Beets, cooked 752081- Beets, canned 7540501 Beets, harvard 7550021 Beets, pickled 76403- Beets, baby (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures; includes baby foods except mixtures)
Strawberries	5022- Fresh Strawberries 5122801 Comm. Canned Strawberries with sugar 5122802 Comm. Canned Strawberries without sugar 5122803 Canned Strawberry Pie Filling 5222- Comm. Frozen Strawberries (does not include ready-to-eat dinners; includes baby foods except mixtures)	6322- Strawberries 6413250 Strawberry Juice (includes baby food; except mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data to Estimate Fraction of Food Intake that is Home-produced (continued)

Food Product	Household Code/Definition	Individual Code
Other Berries	5033- Fresh Berries Other than Strawberries 5122804 Comm. Canned Blackberries with sugar 5122805 Comm. Canned Blackberries without sugar 5122806 Comm. Canned Blueberries with sugar 5122807 Comm. Canned Blueberries without sugar 5122808 Canned Blueberry Pie Filling 5122809 Comm. Canned Gooseberries with sugar 5122810 Comm. Canned Gooseberries without sugar 5122811 Comm. Canned Raspberries with sugar 5122812 Comm. Canned Raspberries without sugar 5122813 Comm. Canned Cranberry Sauce 5122815 Comm. Canned Cranberry-Orange Relish 52233- Comm. Frozen Berries (not strawberries) 5332404 Blackberry Juice (home and comm. canned) 5423114 Dried Berries (not strawberries) (does not include ready-to-eat dinners; includes baby foods except mixtures)	6320- Other Berries 6321- Other Berries 6341101 Cranberry salad 6410460 Blackberry Juice 64105- Cranberry Juice (includes baby food; except mixtures)
Peaches	5036- Fresh Peaches 51224- Comm. Canned Peaches (incl. baby) 5223601 Comm. Frozen Peaches 5332405 Home Canned Peach Juice 5423105 Dried Peaches (baby) 5423106 Dried Peaches (does not include ready-to-eat dinners; includes baby foods except mixtures)	62116- Dried Peaches 63135- Peaches 6412203 Peach Juice 6420501 Peach Nectar 67108- Peaches,baby 6711450 Peaches, dry, baby (includes baby food; except mixtures)
Pears	5037- Fresh Pears 51225- Comm. Canned Pears (incl. baby) 5332403 Comm. Canned Pear Juice, baby 5362204 Fresh Pear Juice 5423107 Dried Pears (does not include ready-to-eat dinners; includes baby foods except mixtures)	62119- Dried Pears 63137- Pears 6341201 Pear salad 6421501 Pear Nectar 67109- Pears, baby 6711455 Pears, dry, baby (includes baby food; except mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data toEstimate Fraction of Food Intake that is Home-produced (continued)

Food Product	Household Code	Household Definition	Individual Code	Individual Definition
EXPOSED/PROTECTED FRUITS/VEGETABLES, ROOT VEGETABLES				
Exposed Fruits	5022-	Strawberries, fresh	62101-	Apple, dried
	5023101	Acerola, fresh	62104-	Apricot, dried
	5023401	Currants, fresh	62108-	Currants, dried
	5031-	Apples/Applesauce, fresh	62110-	Date, dried
	5033-	Berries other than Strawberries, fresh	62116-	Peaches, dried
	5034-	Cherries, fresh	62119-	Pears, dried
	5036-	Peaches, fresh	62121-	Plum, dried
	5037-	Pears, fresh	62122-	Prune, dried
	50381-	Apricots, Nectarines, Loquats, fresh	62125-	Raisins
	5038305	Dates, fresh	63101-	Apples/applesauce
	50384-	Grapes, fresh	63102-	Wi-apple
	50386-	Plums, fresh	63103-	Apricots
	50387-	Rhubarb, fresh	63111-	Cherries, maraschino
	5038805	Persimmons, fresh	63112-	Acerola
	5038901	Sapote, fresh	63113-	Cherries, sour
	51221-	Apples/Applesauce, canned	63115-	Cherries, sweet
	51222-	Apricots, canned	63117-	Currants, raw
	51223-	Cherries, canned	63123-	Grapes
	51224-	Peaches, canned	6312601	Juneberry
	51225-	Pears, canned	63131-	Nectarine
	51228-	Berries, canned	63135-	Peach
	5122903	Grapes with sugar, canned	63137-	Pear
	5122904	Grapes without sugar, canned	63139-	Persimmons
	5122905	Plums with sugar, canned	63143-	Plum
	5122906	Plums without sugar, canned	63146-	Quince
	5122907	Plums, canned, baby	63147-	Rhubarb/Sapodillo
	5122911	Prunes, canned, baby	632-	Berries
	5122912	Prunes, with sugar, canned	64101-	Apple Cider
	5122913	Prunes, without sugar, canned	64104-	Apple Juice
	5122914	Raisin Pie Filling	64105-	Cranberry Juice
	5222-	Frozen Strawberries	64116-	Grape Juice
	52231-	Apples Slices, frozen	64122-	Peach Juice
	52233-	Berries, frozen	64132-	Prune/Strawberry Juice
	52234-	Cherries, frozen	6420101	Apricot Nectar
	52236-	Peaches, frozen	64205-	Peach Nectar
	52239-	Rhubarb, frozen	64215-	Pear Nectar
	53321-	Canned Apple Juice	67102-	Applesauce, baby
	53322-	Canned Grape Juice	67108-	Peaches, baby

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data to Estimate Fraction of Food Intake that is Home-produced (continued)

Food Product	Household Code/Definition	Individual Code
Exposed Fruits (continued)	5332402 Canned Prune Juice 5332403 Canned Pear Juice 5332404 Canned Blackberry Juice 5332405 Canned Peach Juice 53421- Frozen Grape Juice 5342201 Frozen Apple Juice, comm. fr. 5342202 Frozen Apple Juice, home fr. 5352101 Apple Juice, asep. packed 5352201 Grape Juice, asep. packed 5362101 Apple Juice, fresh 5362202 Apricot Juice, fresh 5362203 Grape Juice, fresh 5362204 Pear Juice, fresh 5362205 Prune Juice, fresh 5421- Dried Prunes 5422- Raisins, Currants, dried 5423101 Dry Apples 5423102 Dry Apricots 5423103 Dates without pits 5423104 Dates with pits 5423105 Peaches, dry, baby 5423106 Peaches, dry 5423107 Pears, dry 5423114 Berries, dry 5423115 Cherries, dry (includes baby foods)	67109- Pears, baby 6711450 Peaches, baby, dry 6711455 Pears, baby, dry 67202- Apple Juice, baby 6720380 White Grape Juice, baby 67212- Pear Juice, baby (includes baby foods/juices except mixtures; excludes fruit mixtures)
Protected Fruits	501- Citrus Fruits, fresh 5021- Cantaloupe, fresh 5023201 Mangoes, fresh 5023301 Guava, fresh 5023601 Kiwi, fresh 5023701 Papayas, fresh 5023801 Passion Fruit, fresh 5032- Bananas, Plantains, fresh 5035- Melons other than Cantaloupe, fresh 50382- Avocados, fresh 5038301 Figs, fresh 5038302 Figs, cooked 5038303 Figs, home canned 5038304 Figs, home frozen 50385- Pineapple, fresh 5038801 Pomegranates, fresh 5038902 Cherimoya, fresh 5038903 Jackfruit, fresh 5038904 Breadfruit, fresh 5038905 Tamarind, fresh 5038906 Carambola, fresh 5038907 Longan, fresh 5121- Citrus, canned 51226- Pineapple, canned 5122901 Figs with sugar, canned 5122902 Figs without sugar, canned 5122909 Bananas, canned, baby 5122910 Bananas and Pineapple, canned, baby 5122915 Litchis, canned	61- Citrus Fr., Juices (incl. cit. juice mixtures) 62107- Bananas, dried 62113- Figs, dried 62114- Lychees/Papayas, dried 62120- Pineapple, dried 62126- Tamarind, dried 63105- Avocado, raw 63107- Bananas 63109- Cantaloupe, Carambola 63110- Cassaba Melon 63119- Figs 63121- Genip 63125- Guava/Jackfruit, raw 6312650 Kiwi 6312651 Lychee, raw 6312660 Lychee, cooked 63127- Honeydew 63129- Mango 63133- Papaya 63134- Passion Fruit 63141- Pineapple 63145- Pomegranate 63148- Sweetsop, Soursop, Tamarind 63149- Watermelon 64120- Papaya Juice 64121- Passion Fruit Juice 64124- Pineapple Juice 64133- Watermelon Juice 6420150 Banana Nectar

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data to Estimate Fraction of Food Intake that is Home-produced (continued)

Food Product	Household Code/Definition	Individual Code
Protected Fruits (continued)	5122916 Mangos with sugar, canned 5122917 Mangos without sugar, canned 5122918 Mangos, canned, baby 5122920 Guava with sugar, canned 5122921 Guava without sugar, canned 5122923 Papaya with sugar, canned 5122924 Papaya without sugar, canned 52232- Bananas, frozen 52235- Melon, frozen 52237- Pineapple, frozen 5331- Canned Citrus Juices 53323- Canned Pineapple Juice 5332408 Canned Papaya Juice 5332410 Canned Mango Juice 5332501 Canned Papaya Concentrate 5341- Frozen Citrus Juice 5342203 Frozen Pineapple Juice 5351- Citrus and Citrus Blend Juices, asep. packed 5352302 Pineapple Juice, asep. packed 5361- Fresh Citrus and Citrus Blend Juices 5362206 Papaya Juice, fresh 5362207 Pineapple-Coconut Juice, fresh 5362208 Mango Juice, fresh 5362209 Pineapple Juice, fresh 5423108 Pineapple, dry 5423109 Papaya, dry 5423110 Bananas, dry 5423111 Mangos, dry 5423117 Litchis, dry 5423118 Tamarind, dry 5423119 Plantain, dry (includes baby foods)	64202- Cantaloupe Nectar 64203- Guava Nectar 64204- Mango Nectar 64210- Papaya Nectar 64213- Passion Fruit Nectar 64221- Soursop Nectar 6710503 Bananas, baby 6711500 Bananas, baby, dry 6720500 Orange Juice, baby 6721300 Pineapple Juice, baby (includes baby foods/juices except mixtures; excludes fruit mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data to Estimate Fraction of Food Intake that is Home-produced (continued)

Food Product	Household Code	Definition	Individual Code	Definition
Exposed Veg.	491-	Fresh Dark Green Vegetables	721-	Dark Green Leafy Veg.
	493-	Fresh Tomatoes	722-	Dark Green Nonleafy Veg.
	4941-	Fresh Asparagus	74-	Tomatoes and Tomato Mixtures
	4943-	Fresh Beans, Snap or Wax	7510050	Alfalfa Sprouts
	4944-	Fresh Cabbage	7510075	Artichoke, Jerusalem, raw
	4945-	Fresh Lettuce	7510080	Asparagus, raw
	4946-	Fresh Okra	75101-	Beans, sprouts and green, raw
	49481-	Fresh Artichokes	7510275	Brussel Sprouts, raw
	49483-	Fresh Brussel Sprouts	7510280	Buckwheat Sprouts, raw
	4951-	Fresh Celery	7510300	Cabbage, raw
	4952-	Fresh Cucumbers	7510400	Cabbage, Chinese, raw
	4955-	Fresh Cauliflower	7510500	Cabbage, Red, raw
	4958103	Fresh Kohlrabi	7510700	Cauliflower, raw
	4958111	Fresh Jerusalem Artichokes	7510900	Celery, raw
	4958112	Fresh Mushrooms	7510950	Chives, raw
	4958113	Mushrooms, home canned	7511100	Cucumber, raw
	4958114	Mushrooms, home frozen	7511120	Eggplant, raw
	4958118	Fresh Eggplant	7511200	Kohlrabi, raw
	4958119	Eggplant, cooked	75113-	Lettuce, raw
	4958120	Eggplant, home frozen	7511500	Mushrooms, raw
	4958200	Fresh Summer Squash	7511900	Parsley
	4958201	Summer Squash, cooked	7512100	Pepper, hot chili
	4958202	Summer Squash, home canned	75122-	Peppers, raw
	4958203	Summer Squash, home frozen	7512750	Seaweed, raw
	4958402	Fresh Bean Sprouts	7512775	Snowpeas, raw
	4958403	Fresh Alfalfa Sprouts	75128-	Summer Squash, raw
	4958504	Bamboo Shoots	7513210	Celery Juice
	4958506	Seaweed	7514100	Cabbage or cole slaw
	4958508	Tree Fern, fresh	7514130	Chinese Cabbage Salad
	4958601	Sauerkraut	7514150	Celery with cheese
	5111-	Dark Green Vegetables (all are exposed)	75142-	Cucumber salads
	5113-	Tomatoes	75143-	Lettuce salads
	5114101	Asparagus, comm. canned	7514410	Lettuce, wilted with bacon dressing
	51144-	Beans, green, snap, yellow, comm. canned	7514600	Greek salad
	5114704	Snow Peas, comm. canned	7514700	Spinach salad
	5114801	Sauerkraut, comm. canned	7520600	Algae, dried
	5114901	Artichokes, comm. canned	75201-	Artichoke, cooked
	5114902	Bamboo Shoots, comm. canned	75202-	Asparagus, cooked
	5114903	Bean Sprouts, comm. canned	75203-	Bamboo shoots, cooked
	5114904	Cabbage, comm. canned	752049-	Beans, string, cooked
	5114905	Cabbage, comm. canned, no sauce	75205-	Beans, green, cooked/canned
	5114906	Cauliflower, comm. canned, no sauce	75206-	Beans, yellow, cooked/canned
	5114907	Eggplant, comm. canned, no sauce	75207-	Bean Sprouts, cooked
	5114913	Mushrooms, comm. canned	752085-	Breadfruit
	5114914	Okra, comm. canned	752090-	Brussel Sprouts, cooked
	5114918	Seaweeds, comm. canned	75210-	Cabbage, Chinese, cooked
	5114920	Summer Squash, comm. canned	75211-	Cabbage, green, cooked

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data to Estimate Fraction of Food Intake that is Home-produced (continued)

Food Product	Household Code/Definition	Individual Code
Exposed Veg. (cont.)	5114923 Chinese or Celery Cabbage, comm. canned 51152- Tomatoes, canned, low sod. 5115301 Asparagus, canned, low sod. 5115302 Beans, Green, canned, low sod. 5115303 Beans, Yellow, canned, low sod. 5115309 Mushrooms, canned, low sod. 51154- Greens, canned, low sod. 5115501 Sauerkraut, low sodium 5211- Dark Gr. Veg., comm. frozen (all exp.) 52131- Asparagus, comm. froz. 52133- Beans, snap, green, yellow, comm. froz. 5213407 Peapods, comm froz. 5213408 Peapods, with sauce, comm froz. 5213409 Peapods, with other veg., comm froz. 5213701 Brussel Sprouts, comm. froz. 5213702 Brussel Sprouts, comm. froz. with cheese 5213703 Brussel Sprouts, comm. froz. with other veg. 5213705 Cauliflower, comm. froz. 5213706 Cauliflower, comm. froz. with sauce 5213707 Cauliflower, comm. froz. with other veg. 5213708 Caul., comm. froz. with other veg. & sauce 5213709 Summer Squash, comm. froz. 5213710 Summer Squash, comm. froz. with other veg. 5213716 Eggplant, comm. froz. 5213718 Mushrooms with sauce, comm. froz. 5213719 Mushrooms, comm. froz. 5213720 Okra, comm. froz. 5213721 Okra, comm. froz., with sauce 5311- Canned Tomato Juice and Tomato Mixtures 5312102 Canned Sauerkraut Juice 5321- Frozen Tomato Juice 5371- Fresh Tomato Juice 5381102 Aseptically Packed Tomato Juice 5413101 Dry Algae 5413102 Dry Celery 5413103 Dry Chives 5413109 Dry Mushrooms 5413111 Dry Parsley 5413112 Dry Green Peppers 5413113 Dry Red Peppers 5413114 Dry Seaweed 5413115 Dry Tomatoes (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	75212- Cabbage, red, cooked 752130- Cabbage, savoy, cooked 75214- Cauliflower 75215- Celery, Chives, Christophine (chayote) 752167- Cucumber, cooked 752170- Eggplant, cooked 752171- Fern shoots 752172- Fern shoots 752173- Flowers of sesbania, squash or lily 7521801 Kohlrabi, cooked 75219- Mushrooms, cooked 75220- Okra/lettuce, cooked 7522116 Palm Hearts, cooked 7522121 Parsley, cooked 75226- Peppers, pimento, cooked 75230- Sauerkraut, cooked/canned 75231- Snowpeas, cooked 75232- Seaweed 75233- Summer Squash 7540050 Artichokes, stuffed 7540101 Asparagus, creamed or with cheese 75403- Beans, green with sauce 75404- Beans, yellow with sauce 7540601 Brussel Sprouts, creamed 7540701 Cabbage, creamed 75409- Cauliflower, creamed 75410- Celery/Chiles, creamed 75412- Eggplant, fried, with sauce, etc. 75413- Kohlrabi, creamed 75414- Mushrooms, Okra, fried, stuffed, creamed 754180- Squash, baked, fried, creamed, etc. 7541822 Christophine, creamed 7550011 Beans, pickled 7550051 Celery, pickled 7550201 Cauliflower, pickled 755025- Cabbage, pickled 7550301 Cucumber pickles, dill 7550302 Cucumber pickles, relish 7550303 Cucumber pickles, sour 7550304 Cucumber pickles, sweet 7550305 Cucumber pickles, fresh 7550307 Cucumber, Kim Chee 7550308 Eggplant, pickled 7550311 Cucumber pickles, dill, reduced salt 7550314 Cucumber pickles, sweet, reduced salt 7550500 Mushrooms, pickled 7550700 Okra, pickled 75510- Olives 7551101 Peppers, hot 7551102 Peppers,pickled 7551301 Seaweed, pickled 7553500 Zucchini, pickled 76102- Dark Green Veg., baby 76401- Beans, baby (excl. most soups & mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data to Estimate Fraction of Food Intake that is Home-produced (continued)

Food Product	Household Code/Definition	Individual Code
Protected Veg.	4922- Fresh Pumpkin, Winter Squash 4942- Fresh Lima Beans 4947- Fresh Peas 49482- Fresh Soy Beans 4956- Fresh Corn 4958303 Succotash, home canned 4958304 Succotash, home frozen 4958401 Fresh Cactus (prickly pear) 4958503 Burdock 4958505 Bitter Melon 4958507 Horseradish Tree Pods 51122- Comm. Canned Pumpkin and Squash (baby) 51142- Beans, comm. canned 51143- Beans, lima and soy, comm. canned 51146- Corn, comm. canned 5114701 Peas, green, comm. canned 5114702 Peas, baby, comm. canned 5114703 Peas, blackeye, comm. canned 5114705 Pigeon Peas, comm. canned 5114919 Succotash, comm. canned 5115304 Lima Beans, canned, low sod. 5115306 Corn, canned, low sod. 5115307 Creamed Corn, canned, low sod. 511531- Peas and Beans, canned, low sod. 52122- Winter Squash, comm. froz. 52132- Lima Beans, comm. froz. 5213401 Peas, gr., comm. froz. 5213402 Peas, gr., with sauce, comm. froz. 5213403 Peas, gr., with other veg., comm. froz. 5213404 Peas, gr., with other veg., comm. froz. 5213405 Peas, blackeye, comm froz. 5213406 Peas, blackeye, with sauce, comm froz. 52135- Corn, comm. froz. 5213712 Artichoke Hearts, comm. froz. 5213713 Baked Beans, comm. froz. 5213717 Kidney Beans, comm. froz. 5213724 Succotash, comm. froz. 5411- Dried Beans 5412- Dried Peas and Lentils 5413104 Dry Corn 5413106 Dry Hominy 5413504 Dry Squash, baby 5413603 Dry Creamed Corn, baby (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	732- Pumpkin 733- Winter Squash 7510200 Lima Beans, raw 7510550 Cactus, raw 7510960 Corn, raw 7512000 Peas, raw 7520070 Aloe vera juice 752040- Lima Beans, cooked 752041- Lima Beans, canned 7520829 Bitter Melon 752083- Bitter Melon, cooked 7520950 Burdock 752131- Cactus 752160- Corn, cooked 752161- Corn, yellow, cooked 752162- Corn, white, cooked 752163- Corn, canned 7521749 Hominy 752175- Hominy 75223- Peas, cowpeas, field or blackeye, cooked 75224- Peas, green, cooked 75225- Peas, pigeon, cooked 75301- Succotash 75402- Lima Beans with sauce 75411- Corn, scalloped, fritter, with cream 7541650 Pea salad 7541660 Pea salad with cheese 75417- Peas, with sauce or creamed 7550101 Corn relish 76205- Squash, yellow, baby 76405- Corn, baby 76409- Peas, baby 76411- Peas, creamed, baby (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data to Estimate Fraction of Food Intake that is Home-produced (continued)

Food Product	Household Code/Definition	Individual Code
Root Vegetables	48- Potatoes, Sweetpotatoes 4921- Fresh Carrots 4953- Fresh Onions, Garlic 4954- Fresh Beets 4957- Fresh Turnips 4958101 Fresh Celeriac 4958102 Fresh Horseradish 4958104 Fresh Radishes, no greens 4958105 Radishes, home canned 4958106 Radishes, home frozen 4958107 Fresh Radishes, with greens 4958108 Fresh Salsify 4958109 Fresh Rutabagas 4958110 Rutabagas, home frozen 4958115 Fresh Parsnips 4958116 Parsnips, home canned 4958117 Parsnips, home frozen 4958502 Fresh Lotus Root 4958509 Ginger Root 4958510 Jicama, including yambean 51121- Carrots, comm. canned 51145- Beets, comm. canned 5114908 Garlic Pulp, comm. canned 5114910 Horseradish, comm. prep. 5114915 Onions, comm. canned 5114916 Rutabagas, comm. canned 5114917 Salsify, comm. canned 5114921 Turnips, comm. canned 5114922 Water Chestnuts, comm. canned 51151- Carrots, canned, low sod. 5115305 Beets, canned, low sod. 5115502 Turnips, low sod. 52121- Carrots, comm. froz. 5213714 Beets, comm. froz. 5213722 Onions, comm. froz. 5213723 Onions, comm. froz., with sauce 5213725 Turnips, comm. froz. 5312103 Canned Carrot Juice 5312104 Canned Beet Juice 5372102 Fresh Carrot Juice 5413105 Dry Garlic 5413110 Dry Onion 5413502 Dry Carrots, baby 5413503 Dry Sweet Potatoes, baby (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	71- White Potatoes and Puerto Rican St. Veg. 7310- Carrots 7311140 Carrots in sauce 7311200 Carrot chips 734- Sweetpotatoes 7510250 Beets, raw 7511150 Garlic, raw 7511180 Jicama (yambean), raw 7511250 Leeks, raw 75117- Onions, raw 7512500 Radish, raw 7512700 Rutabaga, raw 7512900 Turnip, raw 752080- Beets, cooked 752081- Beets, canned 7521362 Cassava 7521740 Garlic, cooked 7521771 Horseradish 7521850 Lotus root 752210- Onions, cooked 7522110 Onions, dehydrated 752220- Parsnips, cooked 75227- Radishes, cooked 75228- Rutabaga, cooked 75229- Salsify, cooked 75234- Turnip, cooked 75235- Water Chestnut 7540501 Beets, harvard 75415- Onions, creamed, fried 7541601 Parsnips, creamed 7541810 Turnips, creamed 7550021 Beets, pickled 7550309 Horseradish 7551201 Radishes, pickled 7553403 Turnip, pickled 76201- Carrots, baby 76209- Sweetpotatoes, baby 76403- Beets, baby (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)
USDA SUBCATEGORIES		
Dark Green Vegetables	491- Fresh Dark Green Vegetables 5111- Comm. Canned Dark Green Veg. 51154- Low Sodium Dark Green Veg. 5211- Comm. Frozen Dark Green Veg. 5413111 Dry Parsley 5413112 Dry Green Peppers 5413113 Dry Red Peppers (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures/dinners; excludes vegetable juices and dried vegetables)	72- Dark Green Vegetables all forms leafy, nonleafy, dk. gr. veg. soups

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987-1988 USDA NFCS Household Data to Estimate Fraction of Food Intake that is Home-produced (continued)

Food Product	Household Code/Definition	Individual Code
Deep Yellow Vegetables	492- Fresh Deep Yellow Vegetables 5112- Comm. Canned Deep Yellow Veg. 51151- Low Sodium Carrots 5212- Comm. Frozen Deep Yellow Veg. 5312103 Carrot Juice 54135- Dry Carrots, Squash, Sw. Potatoes (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures/dinners; excludes vegetable juices and dried vegetables)	73- Deep Yellow Vegetables all forms carrots, pumpkin, squash, sweetpotatoes, dp. yell. veg. soups
Other Vegetables	494- Fresh Light Green Vegetables 495- Fresh Other Vegetables 5114- Comm. Canned Other Veg. 51153- Low Sodium Other Veg. 51155- Low Sodium Other Veg. 5213- Comm. Frozen Other Veg. 5312102 Sauerkraut Juice 5312104 Beet Juice 5411- Dreid Beans 5412- Dried Peas, Lentils 541310- Dried Other Veg. 5413114 Dry Seaweed 5413603 Dry Cr. Corn, baby (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures/dinners; excludes vegetable juices and dried vegetables)	75- Other Vegetables all forms
Citrus Fruits	501- Fresh Citrus Fruits 5121- Comm. Canned Citrus Fruits 5331- Canned Citrus and Citrus Blend Juice 5341- Frozen Citrus and Citrus Blend Juice 5351- Aseptically Packed Citrus and Citr. Blend Juice 5361- Fresh Citrus and Citrus Blend Juice (includes baby foods; excludes dried fruits)	61- Citrus Fruits and Juices 6720500 Orange Juice, baby food 6720600 Orange-Apricot Juice, baby food 6720700 Orange-Pineapple Juice, baby food 6721100 Orange-Apple-Banana Juice, baby food (excludes dried fruits)
Other Fruits	502- Fresh Other Vitamin C-Rich Fruits 503- Fresh Other Fruits 5122- Comm. Canned Fruits Other than Citrus 5222- Frozen Strawberries 5223- Frozen Other than Citr. or Vitamin C-Rich Fr. 5332- Canned Fruit Juice Other than Citrus 5342- Frozen Juices Other than Citrus 5352- Aseptically Packed Fruit Juice Other than Citr. 5362- Fresh Fruit Juice Other than Citrus 542- Dry Fruits (includes baby foods; excludes dried fruits)	62- Dried Fruits 63- Other Fruits 64- Fruit Juices and Nectars Excluding Citrus 671- Fruits, baby 67202- Apple Juice, baby 67203- Baby Juices 67204- Baby Juices 67212- Baby Juices 67213- Baby Juices 673- Baby Fruits 674- Baby Fruits

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14 TOTAL FOOD INTAKE

14.1 INTRODUCTION

The U.S. food supply is generally considered to be one of the safest in the world. Nevertheless, contamination of foods may occur as a result of environmental pollution of the air, water, or soil, or the intentional use of chemicals such as pesticides or other agrochemicals. Ingestion of contaminated foods is a potential pathway of exposure to such contaminants. To assess chemical exposure through this pathway, information on food ingestion rates is needed. Per capita and consumers only data on food consumption rates for various food items and food categories are reported in Chapters 9 through 13 of this handbook. These intake rates were estimated by U.S. EPA using databases developed by the U.S. Department of Agriculture (USDA). U.S. EPA (2007) expanded the analysis of food intake in order to examine individuals' food consumption habits in greater detail. Using data from the USDA's Continuing Survey of Food Intake by Individuals (CSFII) conducted in 1994-1996, 1998, U.S. EPA (2007) derived distributions to characterize (1) total food intake among various groups in the U.S. population, subdivided by age, race, geographic region, and urbanization; (2) the contribution of various food categories (e.g., meats, grains, vegetables, etc.) to total food intake among these populations; and (3) the contribution of various food categories to total food intake among individuals exhibiting low- or high-end consumption patterns of a specific food category (e.g., individuals below the 10th percentile or above the 90th percentile for fish consumption). These data may be useful for assessing exposure among populations exhibiting lower or higher than usual intake of certain types of foods (e.g., people who eat little or no meat, or people who eat large quantities of fish).

The recommendations for total food intake rates are provided in the next section, along with a summary of the confidence ratings for these recommendations. Following the recommendations, the key study on total food intake is summarized.

14.2 RECOMMENDATIONS

A summary of recommended values for total food intake, on an as-consumed basis, is presented in Table 14-1. The confidence ratings for these recommendations are presented in Table 14-2. The recommended intake rates are based on data from the U.S. EPA (2007) analysis of CSFII data. The analysis presented in U.S. EPA (2007) was conducted before U.S. EPA published the guidance entitled *Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). As a result, the age groups used for children in U.S. EPA (2007) were not entirely consistent with the age groups recommended in the 2005 guidance. Therefore, a re-analysis of the data was conducted to conform to U.S. EPA's recommended age groups for children.

Because these recommendations are based on 1994-96 and 1998 CSFII data, they may not reflect recent changes that may have occurred in consumption patterns. In addition, these distributions are based on data collected over a 2-day period and may not necessarily reflect the long-term distribution of average daily intake rates. However, because the broad categories of foods used in this analysis (e.g., total foods, total fruits, total vegetables, etc.) are typically eaten on a daily basis throughout the year with minimal seasonality, the short-term distribution may be a reasonable approximation of the long-term distribution, although it will display somewhat increased variability. This implies that the upper percentiles shown here will tend to overestimate the corresponding percentiles of the true long-term distribution.

Table 14-1. Recommended Values for Per Capita Total Food Intake, As Consumed				
Age Group	Mean	95th Percentile	Multiple Percentiles	Source
	g/kg-day			
Children				
Birth to <1 month	20	61	See Table 14-3	U.S. EPA re-analysis of CSFII 1994-96, 98 data (Based on U.S. EPA, 2007)
1 to <3 months	16	40		
3 to <6 months	28	65		
6 to <12 months	56	134		
1 to <2 years	90	161		
2 to <3 years	74	126		
3 to <6 years	61	102		
6 to <11 years	40	70		
11 to <16 years	24	45		
16 to <21 years	18	35		
Adults				
20 to <40 years	16	30	See Table 14-3	U.S. EPA, 2007
40 to <70 years	14	26		
70 years and older	15	27		

Note: Total food intake was defined as intake of the sum of all foods in the following major food categories: dairy, meats, fish, eggs, grains, vegetables, fruits, and fats. Beverages, sugar, candy, and sweets, and nuts and nut products were not included because they could not be categorized into the major food groups. Also, human milk intake was not included.

Table 14-2. Confidence in Recommendations for Total Food Intake		
General Assessment Factors	Rationale	Rating
Soundness		High
Adequacy of Approach	The survey methodology was adequate and the analytical approach was competently executed. The study size was very large; sample size varied with age. The response rate was good. The key study analyzed primary data on recall of ingestion.	
Minimal (or Defined) Bias	No direct measurements were taken. The study relied on survey data.	
Applicability and Utility		Medium
Exposure Factor of Interest	The analysis was specifically designed to address food intake.	
Representativeness	The population studied was representative of the U.S. population.	
Currency	The data used were the most current data publicly available at the time the analysis was conducted for the handbook. However, these data are now 11-15 years old. The national trends in bodyweight,(increasing obesity prevalence) may in part be due to changes in food intake patterns.	
Data Collection Period	Ingestion rates were estimated based on short-term data collected in the CSFII 1994-96, 1998.	
Clarity and Completeness		Medium
Accessibility	The CSFII data are publicly available. The U.S. EPA (2007) report is available online.	
Reproducibility	The methodology was clearly presented; enough information was included to reproduce results.	
Quality Assurance	Quality assurance methods were not described in the study report.	
Variability and Uncertainty		Medium
Variability in Population	Short term distributions were provided. The survey was not designed to capture long term day-to-day variability.	
Uncertainty	The survey data were based on recall over a 2-day period. Other sources of uncertainty were minimal.	
Evaluation and Review		Medium
Peer Review	The USDA CSFII survey received a high level of peer review. U.S. EPA (2007) analysis was also peer-reviewed; however, the re-analysis of these data using the new age categories for children was not peer reviewed outside the Agency.	
Number and Agreement of Studies	Only one key study was available for this factor	
Overall Rating		**Medium**

14.3 KEY STUDY OF TOTAL FOOD INTAKE

14.3.1 U.S. EPA Re-analysis of 1994-96, 1998 CSFII, Based on U.S. EPA (2007) - Analysis of Total Food Intake and Composition of Individual's Diet Based on USDA's 1994–96, 1998 Continuing Survey of Food Intakes by Individuals (CSFII)

U.S. EPA's National Center for Environmental Assessment (NCEA) conducted an analysis to evaluate the total food intake of individuals in the United States using data from the USDA's 1994–1996, 1998 CSFII (USDA, 2000) and U.S. EPA's *Food Commodity Intake Database* (FCID) (U.S. EPA, 2000). The 1994–96 CSFII and its 1998 Supplemental Children's Survey were designed to obtain data from a statistically representative sample of noninstitutionalized persons living in the United States. Survey participants were selected using a multistage process. The respondents were interviewed twice to collect information on food consumption during two non-consecutive days. For both survey days, data were collected by an in-home interviewer. The day two interview was conducted 3 to 10 days later and on a different day of the week. Of the more than 20,000 individuals surveyed, approximately 10,000 were under 21 years of age, and approximately 9,000 were under the age of 11. The 1994-96 survey and 1998 supplement are referred to collectively as CSFII 1994-96, 1998. Each individual in the survey was assigned a sample weight based on his or her demographic data; these weights were taken into account when calculating mean and percentile values of food consumption for the various demographic categories that were analyzed in the study. The sample weighting process used in the CSFII 1994-96, 1998 are discussed in detail in USDA (2000).

For the analysis of total food intake, food commodity codes provided in U.S. EPA's Food Commodity Intake Database (FCID) (U.S. EPA, 2000) were used to translate as-eaten foods (e.g., beef stew) identified by USDA food codes in the CSFII data set into food commodities (e.g., beef, potatoes, carrots, etc.). The method used to translate USDA food codes into U.S. EPA commodity codes is discussed in detail in USDA (2000). The U.S. EPA commodity codes were assigned to broad food categories (e.g., total meats, total vegetables, etc.) for use in the analysis. Total food intake was defined as intake of the sum of all foods in the following major food categories: dairy, meats, fish, eggs, grains, vegetables, fruits, and fats. Beverages, sugar, candy, and sweets, and nuts and nut products were not included because they could not be categorized into the major food groups. Also, human milk intake was not included. Percent consuming, mean, standard error, and a range of percentile values were calculated on the basis of grams of food per kilogram of body weight per day (g/kg-day) and on the basis of grams per day (g/day). In addition to total food intake, intake of the various major food groups for the various age groups in units of g/day and g/kg-day were also estimated for comparison to total intake.

To evaluate variability in the contributions of the major food groups to total food intake, individuals were ranked from lowest to highest, based on total food intake. Three subsets of individuals were defined, as follows: a group at the low end of the distribution of total intake (i.e., below the 10^{th} percentile of total intake), a central group (i.e., the 45^{th} to 55^{th} percentile of total intake), and a group at the high end of the distribution of total intake (i.e., above the 90^{th} percentile of total intake). Mean total food intake (in g/day and g/kg-day), mean intake of each of the major food groups (in g/day and g/kg-day), and the percent of total food intake that each of these food groups represents were calculated for each of the three populations (i.e., individuals with low-end, central, and high-end total food intake). A similar analysis was conducted to estimate the contribution of the major food groups to total food intake for individuals at the low-end, central, and high-end of the distribution of total meat intake, total dairy intake, total meat and dairy intake, total fish intake, and total fruit and vegetable intake. For example, to evaluate the variability in the diets of individuals at the low-end, central range, and high-end of the distribution of total meat intake, survey individuals were ranked according to their reported total meat intake. Three subsets of individuals were formed as described above. Mean total food intake, intake of the major food groups, and the percent of total food intake represented by each of the major food groups were tabulated. U.S. EPA (2007) presented the results of the analysis for the following age groups: <1 year, 1 to 2 years, 3 to 5 years, 6 to 11 years, 12 to 19 years, 20 to 39 years, 40 to 69 years, and 70 years and older. The data were tabulated in units of g/kg-day and g/day.

In order to conform to the standard age categories for children recommended in *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005), each of the tables from U.S. EPA (2007) was modified by re-analyzing the source data and applying the new childhood age categories (i.e., <1 month, 1 to <3 months, 3 to <6 months, 6 to <12 months, 1 to <2 years, 2 to <3 years, 3 to <6 years, 6 to <11 years, 11 to <16 years, and 16 to <21 years).

Distributions of total food intake are presented in Table 14-3 in units of g/day and g/kg-day. Tables 14-4 and 14-5 compare total food intake to intake of the various major food groups for the various age groups in units of g/day and g/kg-day, respectively. It should be noted that some U.S. EPA commodity codes are listed under more than one food category. For this reason, in the tables, the intake rates for the individual food categories do not necessarily add up to the figure given for total food intake (U.S. EPA, 2007). Also, data are not reported for food groups for which there were less than 20 consumers in a particular age group. Tables 14-6 through 14-11 present the contributions of the major food groups to total food intake for individuals (in the various age groups) at the low-end, central, and high-end of the distribution of total food intake (Table 14-6), total meat intake (Table 14-7), total meat and dairy intake (Table 14-8), total fish intake (Table 14-9), total fruit and vegetable intake (Table 14-10), and total dairy intake (Table 14-11) in units of g/day and g/kg-day. For each of the three classes of consumers, consumption of nine different food categories is presented (i.e., total foods, dairy, meats, fish, eggs, grains, vegetables, fruits, and fats). For example, in Table 14-9 one will find the mean consumption of meats, eggs, vegetables, etc. for individuals with an unusually high (or low or average) consumption of fish.

As discussed in previous chapters, the 1994-96, 98 CSFII data have both advantages and limitations with regard to estimating food intake rates. The large sample size (more than 20,000 persons) is sufficient to allow categorization within narrowly defined age categories. In addition, the survey was designed to obtain a statistically valid sample of the entire United States population that included children and low income groups. However, the survey design is of limited utility for assessing small and potentially at-risk subpopulations based on ethnicity, medical status, geography, or other factors such as activity level. Another limitation is that data are based on a two-day survey period and, as such, may not accurately reflect long-term eating patterns. This is particularly true for the extremes of the distribution of food intake.

14.4 REFERENCES FOR CHAPTER 14

USDA (2000) 1994–96, 1998 Continuing survey of food intakes by individuals (CSFII). CD-ROM. Agricultural Research Service, Beltsville Human Nutrition Research Center, Beltsville, MD. Available from the National Technical Information Service, Springfield, VA; PB-2000-500027.

U.S. EPA (2000) Food commodity intake database [FCID raw data file]. Office of Pesticide Programs, Washington, DC. Available from the National Technical Information Service, Springfield, VA; PB2000-5000101.

U.S. EPA (2005) Guidance on selecting age groups for monitoring and assessing childhood exposures to environmental contaminants. U.S. Environmental Protection Agency, Washington, D.C., EPA/630/P-03/003F. Available from the National Technical Information Service, Springfield, VA, and online at www.epa.gov/ncea.

U.S. EPA (2007) Analysis of total food intake and composition of individual's diet based on USDA's 1994–96, 1998 continuing survey of food intakes by individuals (CSFII). National Center for Environmental Assessment, Washington, DC; EPA/600/R-05/062F. Available from the National Technical Information Service, Springfield, VA, and online at www.epa.gov/ncea.

Table 14-3. Per Capita Total Food Intake

Age Group	N cons.[a]	N total[b]	PC	Mean	SE	Percentile 1	5	10	25	50	75	90	95	99	Max
Total Food Intake (g/day, as consumed)															
Birth to <1 month	59	88	67.0%	67	59	0	0	0	0	67	108	142	221	222	222
1 to <3 month	183	245	74.7%	80	70	0	0	0	0	94	120	168	188	273	404
3 to <6 month	385	411	93.7%	197	150	0	0	12	100	167	286	385	476	705	1,151
6 to <12 month	676	678	99.7%	507	344	34	141	191	283	413	600	925	1,220	1,823	2,465
1 to <2 years	1,002	1,002	100%	1,039	407	216	414	570	770	998	1,244	1,556	1,756	2,215	3,605
2 to <3 years	994	994	100%	1,024	377	312	491	575	752	994	1,257	1,517	1,649	2,071	2,737
3 to <6 years	4,112	4,112	100%	1,066	380	416	548	629	805	1,020	1,276	1,548	1,746	2,168	4,886
6 to <11 years	1,553	1,553	100%	1,118	372	438	586	680	846	1,052	1,344	1,642	1,825	2,218	3,602
11 to <16 years	975	975	100%	1,209	499	343	536	657	851	1,124	1,491	1,860	2,179	2,668	4,548
16 to <21 years	743	743	100%	1,184	634	308	467	556	750	1,061	1,447	1,883	2,283	3,281	8,840
20 to <40 years	2,950	2,950	100%	1,100	518	-	493	579	778	1,040	1,390	1,780	2,110	3,120	5,640
40 to <70 years	4,818	4,818	100%	1,100	468	-	472	567	766	1,030	1,350	1,710	1,930	2,480	4,320
70 years and older	1,393	1,393	100%	1,000	430	-	449	549	741	982	1,280	1,560	1,820	2,260	3,090
Total Food Intake (g/kg-day, as consumed)															
Birth to <1 month	59	88	67.0%	20	18	0	0	0	0	19	33	43	61	69	69
1 to <3 month	183	245	74.7%	16	14	0	0	0	0	18	25	36	40	55	76
3 to <6 month	385	411	93.7%	28	21	0	0	2	15	24	38	53	65	107	169
6 to <12 month	676	678	99.7%	56	36	3	17	22	33	47	66	99	134	211	233
1 to <2 years	1,002	1,002	100%	90	37	17	38	48	65	85	109	137	161	207	265
2 to <3 years	994	994	100%	74	29	23	34	39	52	72	92	113	126	146	194
3 to <6 years	4,112	4,112	100%	61	24	21	30	34	44	57	73	91	102	132	239
6 to <11 years	1,553	1,553	100%	40	17	10	17	21	28	38	49	61	70	88	122
11 to <16 years	975	975	100%	24	11	5	9	11	16	22	30	38	45	55	82
16 to <21 years	743	743	100%	18	9	5	6	8	12	16	22	30	35	47	115
20 to <40 years	2,950	2,950	100%	16	7	-	6	8	11	15	20	25	30	38	70
40 to <70 years	4,818	4,818	100%	14	6	-	6	7	10	14	18	23	26	34	75
70 years and older	1,393	1,393	100%	15	6	-	6	8	10	14	19	24	27	35	47

[a] Number of consumers. The number of consumers of total food may be less than the number of individuals in the study sample for the youngest age groups, because human milk was not included in the total food intake estimates presented here.
[b] Sample size.
PC = Percent consuming.
SE = Standard error.
\- = Value not available.

Source: Based on U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 14-4. Per Capita Intake of Total Food and Intake of Major Food Groups (g/day, As Consumed)															
Food Group	N cons.[a]	N total[b]	PC	Mean	SE	Percentile									
						1	5	10	25	50	75	90	95	99	Max
Age Birth to <1month															
Total Food Intake	59	88	67.0%	67	59	0	0	0	0	67	108	142	221	222	222
Total Dairy Intake	51	88	58.0%	41	38	0	0	0	0	40	72	81	156	156	156
Total Meat Intake	0	88	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Total Egg Intake	0	88	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Total Fish Intake	0	88	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Total Grain Intake	5	88	5.7%	-	-	-	-	-	-	-	-	-	-	-	-
Total Vegetable Intake	27	88	30.7%	5	23	0	0	0	0	0	0.29	16	32	108	125
Total Fruit Intake	2	88	2.3%	-	-	-	-	-	-	-	-	-	-	-	-
Total Fat Intake	58	88	65.9%	19	16	0	0	0	0	20	32	38	64	64	64
Age 1 to <3 months															
Total Food Intake	183	245	74.7%	80	70	0	0	0	0	94	120	168	188	273	404
Total Dairy Intake	147	245	60.0%	37	40	0	0	0	0	19	72	89	103	129	155
Total Meat Intake	1	245	0.4%	-	-	-	-	-	-	-	-	-	-	-	-
Total Egg Intake	0	245	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Total Fish Intake	0	245	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Total Grain Intake	44	245	18.0%	1	5	0	0	0	0	0	0	3	9	20	45
Total Vegetable Intake	88	245	35.9%	15	33	0	0	0	0	0	0.92	74	94	119	211
Total Fruit Intake	23	245	9.4%	4	21	0	0	0	0	0	0	0	31	114	171
Total Fat Intake	176	245	71.8%	21	17	0	0	0	0	27	34	42	49	65	72
Age 3 to <6 months															
Total Food Intake	385	411	93.7%	197	150	0	0	12	100	167	286	385	476	705	1,151
Total Dairy Intake	308	411	74.9%	56	56	0	0	0	0	60	85	109	124	260	496
Total Meat Intake	44	411	10.7%	2	7	0	0	0	0	0	0	1	13	29	92
Total Egg Intake	28	411	6.8%	0.23	3	0	0	0	0	0	0	0	0.49	4	50
Total Fish Intake	1	411	0.2%	-	-	-	-	-	-	-	-	-	-	-	-
Total Grain Intake	284	411	69.1%	8	11	0	0	0	0	4	11	21	27	44	68
Total Vegetable Intake	263	411	64.0%	34	46	0	0	0	0	13	58	102	120	184	226
Total Fruit Intake	218	411	53.0%	68	102	0	0	0	0	15	99	196	282	522	750
Total Fat Intake	357	411	86.9%	28	17	0	0	0	20	30	38	45	53	81	106

Food Group	N cons.[a]	N total[b]	PC	Mean	SE	Percentile 1	5	10	25	50	75	90	95	99	Max
Table 14-4. Per Capita Intake of Total Food and Intake of Major Food Groups (g/day, As Consumed) (continued)															
Age 6 to <12 months															
Total Food Intake	676	678	99.7%	507	344	34	141	191	283	413	600	925	1,220	1,823	2,465
Total Dairy Intake	628	678	92.6%	151	246	0	0	1.0	26	71	124	401	722	1,297	1,873
Total Meat Intake	500	678	73.7%	22	27	0	0	0	0	14	32	59	78	117	269
Total Egg Intake	352	678	51.9%	6	13	0	0	0	0	0	2	22	42	73	103
Total Fish Intake	34	678	5.0%	0.62	3	0	0	0	0	0	0	0	0	21	42
Total Grain Intake	653	678	96.3%	33	28	0	0.83	6	14	28	45	66	84	125	260
Total Vegetable Intake	662	678	97.6%	91	67	0	2	14	41	81	127	180	231	285	452
Total Fruit Intake	639	678	94.2%	169	142	0	0	17	70	147	232	335	425	670	1,254
Total Fat Intake	661	678	97.5%	31	16	0	2	7	23	31	40	51	58	81	90
Age 1 to <2 years															
Total Food Intake	1,002	1,002	100%	1,039	407	216	414	570	770	998	1,244	1,556	1,756	2,215	3,605
Total Dairy Intake	999	1,002	99.7%	489	332	1	38	94	241	451	681	917	1,090	1,474	2,935
Total Meat Intake	965	1,002	96.3%	47	37	0	0	6	20	39	66	100	120	181	221
Total Egg Intake	906	1,002	90.4%	14	21	0	0	0	1	4	23	45	57	86	212
Total Fish Intake	188	1,002	18.8%	3	10	0	0	0	0	0	0	11	21	45	135
Total Grain Intake	997	1,002	99.5%	66	34	8	19	27	42	60	83	111	126	172	209
Total Vegetable Intake	1,000	1,002	99.8%	120	75	9	25	37	68	107	155	220	255	402	739
Total Fruit Intake	986	1,002	98.4%	254	204	0	4	30	99	209	349	532	664	828	1,762
Total Fat Intake	1,002	1,002	100%	39	17	8	15	20	28	37	48	62	69	87	146
Age 2 to <3 years															
Total Food Intake	994	994	100%	1,024	377	312	491	575	752	994	1,257	1,517	1,649	2,071	2,737
Total Dairy Intake	994	994	100%	383	243	6	54	104	201	346	510	709	838	1,079	1,378
Total Meat Intake	981	994	98.7%	60	41	0	8	14	31	51	80	115	139	199	280
Total Egg Intake	943	994	94.9%	18	24	0	0	0	1	7	27	50	60	93	169
Total Fish Intake	190	994	19.1%	4	12	0	0	0	0	0	0	13	26	53	127
Total Grain Intake	993	994	99.9%	81	35	16	32	41	58	78	99	126	147	195	263
Total Vegetable Intake	994	994	100%	145	89	18	45	57	86	128	178	249	302	431	846
Total Fruit Intake	970	994	97.6%	279	230	0	2	25	117	231	382	594	750	992	2,042
Total Fat Intake	994	994	100%	42	18	11	17	22	30	40	51	65	73	101	129

Table 14-4. Per Capita Intake of Total Food and Intake of Major Food Groups (g/day, As Consumed) (continued)

Food Group	N cons.[a]	N total[b]	PC	Mean	SE	Percentile									
						1	5	10	25	50	75	90	95	99	Max
Age 3 to <6 years															
Total Food Intake	4,112	4,112	100%	1066	380	416	548	629	805	1,020	1,276	1,548	1,746	2,168	4,886
Total Dairy Intake	4,112	4,112	100%	392	249	14	68	121	224	356	522	706	805	1,151	3,978
Total Meat Intake	4,062	4,112	98.8%	73	49	0	11	20	38	65	97	133	163	230	433
Total Egg Intake	3,910	4,112	95.1%	16	23	0	0	0	1	6	24	47	59	99	290
Total Fish Intake	801	4,112	19.5%	5	16	0	0	0	0	0	0	19	36	71	192
Total Grain Intake	4,111	4,112	100%	101	41	29	44	54	72	95	122	155	175	230	410
Total Vegetable Intake	4,111	4,112	100%	170	89	30	56	75	109	156	213	280	329	454	915
Total Fruit Intake	4,021	4,112	97.8%	243	220	0	2	16	85	196	344	516	642	1,000	2,252
Total Fat Intake	4,112	4,112	100%	50	19	14	23	27	36	47	60	74	85	113	167
Age 6 to <11 years															
Total Food Intake	1,553	1,553	100%	1118	372	438	586	680	846	1,052	1,344	1,642	1,825	2,218	3,602
Total Dairy Intake	1,553	1,553	100%	408	243	10	63	126	229	371	557	741	837	1,130	2,680
Total Meat Intake	1,533	1,553	98.7%	87	56	0	12	24	48	79	116	156	195	268	435
Total Egg Intake	1,490	1,553	95.9%	16	22	0	0	0	2	6	22	46	58	107	163
Total Fish Intake	258	1,553	16.6%	6	17	0	0	0	0	0	0	23	38	102	169
Total Grain Intake	1,553	1,553	100%	119	48	31	54	67	87	114	143	179	201	262	513
Total Vegetable Intake	1,553	1,553	100%	210	103	42	76	96	136	193	264	342	410	560	896
Total Fruit Intake	1,515	1,553	97.6%	193	184	0	1	8	60	141	280	440	545	880	1,406
Total Fat Intake	1,553	1,553	100%	58	22	16	27	33	42	56	70	86	95	121	168
Age 11 to <16 years															
Total Food Intake	975	975	100%	1209	499	343	536	657	851	1,124	1,491	1,860	2,179	2,668	4,548
Total Dairy Intake	975	975	100%	368	291	1	25	43	152	307	507	740	948	1,401	1,972
Total Meat Intake	970	975	99.5%	114	75	1	18	32	63	101	154	208	244	355	578
Total Egg Intake	930	975	95.4%	19	27	0	0	0	2	7	25	53	72	123	244
Total Fish Intake	167	975	17.1%	9	24	0	0	0	0	0	0	30	62	125	227
Total Grain Intake	975	975	100%	136	63	33	56	70	93	127	168	212	249	333	645
Total Vegetable Intake	975	975	100%	280	146	65	105	124	176	246	352	472	552	713	1,333
Total Fruit Intake	923	975	94.7%	195	202	0	0	0.68	31	135	273	483	635	930	1,535
Total Fat Intake	975	975	100%	69	33	18	28	34	47	64	83	110	131	176	321

Table 14-4. Per Capita Intake of Total Food and Intake of Major Food Groups (g/day, As Consumed) (continued)

Food Group	N cons.[a]	N total[b]	PC	Mean	SE	Percentile									
						1	5	10	25	50	75	90	95	99	Max
Age 16 to <21 years															
Total Food Intake	743	743	100%	1184	634	308	467	556	750	1,061	1,447	1,883	2,283	3,281	8,840
Total Dairy Intake	742	743	99.9%	283	279	0	8	19	63	196	410	649	934	1,235	1,866
Total Meat Intake	730	743	98.3%	139	127	0	12	28	64	116	185	266	310	458	2,343
Total Egg Intake	703	743	94.6%	21	30	0	0		1	7	29	59	89	126	223
Total Fish Intake	143	743	19.2%	10	33	0	0	0	0	0	0	34	76	146	399
Total Grain Intake	743	743	100%	150	93	13	48	58	88	132	190	256	307	543	730
Total Vegetable Intake	743	743	100%	325	204	43	86	128	194	280	400	562	683	1,160	2,495
Total Fruit Intake	671	743	90.3%	168	237	0	0	0	3	74	242	432	665	1,023	2,270
Total Fat Intake	743	743	100%	74	42	13	22	30	46	67	94	129	148	213	391
Age 20 years and older															
Total Food Intake	9,161	9,161	100%	1,110	481	-	477	570	769	1,030	1,360	1,730	2,010	2,650	5,640
Total Dairy Intake	9,161	9,143	99.8%	221	228	-	9	20	60	153	312	509	643	1,020	3,720
Total Meat Intake	9,161	9,005	98.3%	130	90	-	15	35	65	111	171	246	299	457	1,010
Total Egg Intake	9,161	8,621	94.1%	24	32	-	0	0.13	2	10	36	63	87	129	445
Total Fish Intake	9,161	2,648	28.9%	15	36	-	0	0	0	0	12	56	86	162	434
Total Grain Intake	9,161	9,152	99.9%	136	84	-	42	53	79	116	167	238	297	462	1,110
Total Vegetable Intake	9,161	9,161	100%	309	171	-	91	124	191	281	394	525	626	850	1,810
Total Fruit Intake	9,161	8,566	93.5%	191	224	-	0	0	18	125	280	473	625	996	2,690
Total Fat Intake	9,161	9,161	100%	64	34	-	20	26	39	57	81	109	127	178	359

a Number of consumers. The number of consumers of total food may be less than the number of individuals in the study sample for the youngest age groups, because human milk was not included in the total food intake estimates presented here.
b Sample size.
PC = Percent consuming.
SE = Standard error.
- = Value not available or data not reported where the number of consumers was less than 20.

Source: Based on U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 14-5. Per Capita Intake of Total Food and Intake of Major Food Groups (g/kg-day, As Consumed)															
Food Group	N cons.[a]	N total[b]	PC	Mean	SE	Percentile									
						1	5	10	25	50	75	90	95	99	Max
Age Birth to <1month															
Total Food Intake	59	88	67.0%	20	18	0	0	0	0	19	33	43	61	69	69
Total Dairy Intake	51	88	58.0%	12	12	0	0	0	0	13	21	25	43	49	49
Total Meat Intake	0	88	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Total Egg Intake	0	88	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Total Fish Intake	0	88	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Total Grain Intake	5	88	5.7%	-	-	-	-	-	-	-	-	-	-	-	-
Total Vegetable Intake	27	88	30.7%	2	6	0	0	0	0	0	0	4	12	30	35
Total Fruit Intake	2	88	2.3%	-	-	-	-	-	-	-	-	-	-	-	-
Total Fat Intake	58	88	65.9%	6	5	0	0	0	0	6	9	11	18	20	20
Age 1 to <3 months															
Total Food Intake	183	245	74.7%	16	14	0	0	0	0	18	25	36	40	55	76
Total Dairy Intake	147	245	60.0%	8	9	0	0	0	0	4	15	20	26	34	43
Total Meat Intake	1	245	0.4%	-	-	-	-	-	-	-	-	-	-	-	-
Total Egg Intake	0	245	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Total Fish Intake	0	245	0.0%	-	-	-	-	-	-	-	-	-	-	-	-
Total Grain Intake	44	245	18.0%	0	1	0	0	0	0	0	0	1	2	3	9
Total Vegetable Intake	88	245	35.9%	3	6	0	0	0	0	0	0	13	17	26	34
Total Fruit Intake	23	245	9.4%	1	5	0	0	0	0	0	0	0	7	19	43
Total Fat Intake	176	245	71.8%	4	4	0	0	0	0	5	7	9	11	14	18
Age 3 to <6 months															
Total Food Intake	385	411	93.7%	28	21	0	0	2	15	24	38	53	65	107	169
Total Dairy Intake	308	411	74.9%	8	8	0	0	0	0	8	12	16	20	38	73
Total Meat Intake	44	411	10.7%	0	1	0	0	0	0	0	0	0	1	4	13
Total Egg Intake	28	411	6.8%	0	0	0	0	0	0	0	0	0	0	1	4
Total Fish Intake	1	411	0.2%	-	-	-	-	-	-	-	-	-	-	-	-
Total Grain Intake	284	411	69.1%	1	2	0	0	0	0	1	1	3	4	6	10
Total Vegetable Intake	263	411	64.0%	5	7	0	0	0	0	2	8	14	18	25	52
Total Fruit Intake	218	411	53.0%	9	15	0	0	0	0	2	13	29	37	72	110
Total Fat Intake	357	411	86.9%	4	3	0	0	0	2	4	6	7	8	12	17

Table 14-5. Per Capita Intake of Total Food and Intake of Major Food Groups (g/kg-day, As Consumed) (continued)

Food Group	N cons.[a]	N total[b]	PC	Mean	SE	Percentile									
						1	5	10	25	50	75	90	95	99	Max
Age 6 to <12 months															
Total Food Intake	676	678	99.7%	56	36	3	17	22	33	47	66	99	134	211	233
Total Dairy Intake	628	678	92.6%	16	26	0	0	0	3	8	14	38	72	165	180
Total Meat Intake	500	678	73.7%	2	3	0	0	0	0	1	4	6	8	12	30
Total Egg Intake	352	678	51.9%	1	1	0	0	0	0	0	0	2	4	7	11
Total Fish Intake	34	678	5.0%	0	0	0	0	0	0	0	0	0	0	2	4
Total Grain Intake	653	678	96.3%	4	3	0	0	1	2	3	5	7	9	14	26
Total Vegetable Intake	662	678	97.6%	10	8	0	0	2	5	9	14	20	25	34	67
Total Fruit Intake	639	678	94.2%	19	16	0	0	2	8	16	26	36	46	84	138
Total Fat Intake	661	678	97.5%	3	2	0	0	1	2	3	4	6	7	8	10
Age 1 to <2 years															
Total Food Intake	1,002	1,002	100%	90	37	17	38	48	65	85	109	137	161	207	265
Total Dairy Intake	999	1,002	99.7%	43	30	0	3	8	20	38	59	83	100	137	216
Total Meat Intake	965	1,002	96.3%	4	3	0	0	1	2	3	6	8	10	14	21
Total Egg Intake	906	1,002	90.4%	1	2	0	0	0	0	0	2	4	5	7	15
Total Fish Intake	188	1,002	18.8%	0	1	0	0	0	0	0	0	1	2	3	12
Total Grain Intake	997	1,002	99.5%	6	3	1	2	2	4	5	7	9	11	15	19
Total Vegetable Intake	1,000	1,002	99.8%	10	7	1	2	3	6	9	14	19	22	33	61
Total Fruit Intake	986	1,002	98.4%	22	18	0	0	3	9	18	31	44	58	81	144
Total Fat Intake	1,002	1,002	100%	3	2	0.73	1	2	2	3	4	5	6	8	11
Age 2 to <3 years															
Total Food Intake	994	994	100%	74	29	23	34	39	52	72	92	113	126	146	194
Total Dairy Intake	994	994	100%	28	18	0	4	7	14	24	37	52	63	84	108
Total Meat Intake	981	994	98.7%	4	3	0	1	1	2	4	6	8	9	14	20
Total Egg Intake	943	994	94.9%	1	2	0	0	0	0	0	2	4	4	6	13
Total Fish Intake	190	994	19.1%	0	1	0	0	0	0	0	0	1	2	4	11
Total Grain Intake	993	994	99.9%	6	3	1	2	3	4	5	7	9	10	14	28
Total Vegetable Intake	994	994	100%	10	6	1	3	4	6	9	13	18	22	34	64
Total Fruit Intake	970	994	97.6%	20	17	0	0	2	8	16	27	44	56	71	114
Total Fat Intake	994	994	100%	3	1	1	1	1	2	3	4	5	5	7	9

Table 14-5. Per Capita Intake of Total Food and Intake of Major Food Groups (g/kg-day, As Consumed) (continued)

Food Group	N cons.[a]	N total[b]	PC	Mean	SE	Percentile									
						1	5	10	25	50	75	90	95	99	Max
Age 3 to <6 years															
Total Food Intake	4,112	4,112	100%	61	24	21	30	34	44	57	73	91	102	132	239
Total Dairy Intake	4,112	4,112	100%	22	15	1	4	7	12	20	30	41	48	66	195
Total Meat Intake	4,062	4,112	98.8%	4	3	0	1	1	2	4	5	8	9	13	23
Total Egg Intake	3,910	4,112	95.1%	1	1	0	0	0	0	0	1	3	3	5	13
Total Fish Intake	801	4,112	19.5%	0	1	0	0	0	0	0	0	1	2	4	12
Total Grain Intake	4,111	4,112	100%	6	3	2	2	3	4	5	7	9	10	14	27
Total Vegetable Intake	4,111	4,112	100%	10	5	2	3	4	6	9	12	16	19	26	60
Total Fruit Intake	4,021	4,112	97.8%	14	13	0	0	1	5	11	20	30	39	57	124
Total Fat Intake	4,112	4,112	100%	3	1	1	1	2	2	3	3	4	5	6	10
Age 6 to <11 years															
Total Food Intake	1,553	1,553	100%	40	17	10	17	21	28	38	49	61	70	88	122
Total Dairy Intake	1,553	1,553	100%	15	10	0	2	4	7	13	20	27	33	42	79
Total Meat Intake	1,533	1,553	98.7%	3	2	0	0	1	2	3	4	6	7	10	18
Total Egg Intake	1,490	1,553	95.9%	1	1	0	0	0	0	0	1	2	2	4	8
Total Fish Intake	258	1,553	16.6%	0	1	0	0	0	0	0	0	1	1	3	7
Total Grain Intake	1,553	1,553	100%	4	2	1	2	2	3	4	5	7	8	11	16
Total Vegetable Intake	1,553	1,553	100%	7	4	1	2	3	5	7	9	12	15	20	50
Total Fruit Intake	1,515	1,553	97.6%	7	7	0	0	0	2	5	10	16	21	32	55
Total Fat Intake	1,553	1,553	100%	2	1	1	1	1	1	2	3	3	4	5	9
Age 11 to <16 years															
Total Food Intake	975	975	100%	24	11	5	9	11	16	22	30	38	45	55	82
Total Dairy Intake	975	975	100%	7	6	0	0	1	3	6	10	15	20	29	38
Total Meat Intake	970	975	99.5%	2	1	0	0	1	1	2	3	4	5	7	10
Total Egg Intake	930	975	95.4%	0	1	0	0	0	0	0	0	1	1	3	7
Total Fish Intake	167	975	17.1%	0	0	0	0	0	0	0	0	1	1	2	7
Total Grain Intake	975	975	100%	3	1	1	1	1	2	2	3	5	5	7	9
Total Vegetable Intake	975	975	100%	5	3	1	2	2	3	5	7	9	11	14	31
Total Fruit Intake	923	975	94.7%	4	4	0	0	0	1	3	6	10	14	18	32
Total Fat Intake	975	975	100%	1	1	0	0	1	1	1	2	2	3	4	5

Table 14-5. Per Capita Intake of Total Food and Intake of Major Food Groups (g/kg-day, As Consumed) (continued)

Food Group	N cons.[a]	N total[b]	PC	Mean	SE	Percentile									
						1	5	10	25	50	75	90	95	99	Max
Age 16 to <21 years															
Total Food Intake	743	743	100%	18	9	5	6	8	12	16	22	30	35	47	115
Total Dairy Intake	742	743	99.9%	4	4	0	0	0	1	3	6	10	12	19	25
Total Meat Intake	730	743	98.3%	2	2	0	0	0	1	2	3	4	5	7	30
Total Egg Intake	703	743	94.6%	0	0	0	0	0	0	0	0	1	1	2	3
Total Fish Intake	143	743	19.2%	0	1	0	0	0	0	0	0	1	1	2	7
Total Grain Intake	743	743	100%	2	1	0	1	1	1	2	3	4	5	7	12
Total Vegetable Intake	743	743	100%	5	3	1	1	2	3	4	6	8	10	15	32
Total Fruit Intake	671	743	90.3%	3	4	0	0	0	0	1	4	7	10	16	29
Total Fat Intake	743	743	100%	1	1	0	0	0	1	1	1	2	2	3	5
Age 20 years and older															
Total Food Intake	9,161	9,161	100%	15	7	-	6	8	10	14	19	24	28	37	75
Total Dairy Intake	9,161	9,143	99.8%	3	3	-	0	0	1	2	4	7	9	14	41
Total Meat Intake	9,161	9,005	98.3%	2	1	-	0	0	1	2	2	3	4	6	13
Total Egg Intake	9,161	8,621	94.1%	0	0	-	0	0	0	0	0	1	1	2	8
Total Fish Intake	9,161	2,648	28.9%	0	0	-	0	0	0	0	0	1	1	2	8
Total Grain Intake	9,161	9,152	100%	2	1	-	1	1	1	2	2	3	4	6	16
Total Vegetable Intake	9,161	9,161	100%	4	2	-	1	2	3	4	5	7	9	12	28
Total Fruit Intake	9,161	8,566	93.5%	3	3	-	0	0	0	2	4	7	9	15	52
Total Fat Intake	9,161	9,161	100%	1	0	-	0	0	1	1	1	1	2	2	4

[a] Number of consumers. The number of consumers of total food may be less than the number of individuals in the study sample for the youngest age groups, because human milk was not included in the total food intake estimates presented here.
[b] Sample size.
PC = Percent consuming.
SE = Standard error.
\- = Data not reported where the number of consumers was less than 20.
x = Value not available.

Source: Based on U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 14-6. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Food Intake

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age Birth to <1 month (g/day, as consumed)						
Total Foods	0	0.0%	64	100.0%	196	100.0%
Total Dairy	0	0.0%	39	61.2%	109	55.4%
Total Meats	0	0.0%	0	0.0%	0	0.0%
Total Fish	0	0.0%	0	0.0%	0	0.0%
Total Eggs	0	0.0%	0	0.0%	0	0.0%
Total Grains	0	0.0%	0	0.0%	4	2.1%
Total Vegetables	0	0.0%	5	7.4%	24	12.1%
Total Fruits	0	0.0%	0	0.0%	8	4.1%
Total Fats[a]	0	0.0%	19	29.4%	52	26.2%
Age 1 to <3 months (g/day, as consumed)						
Total Foods	0	0.0%	94	100.0%	206	100.0%
Total Dairy	0	0.0%	53	56.9%	63	30.8%
Total Meats	0	0.0%	0	0.0%	0	0.0%
Total Fish	0	0.0%	0	0.0%	0	0.0%
Total Eggs	0	0.0%	0	0.0%	0	0.0%
Total Grains	0	0.0%	1	1.1%	3	1.3%
Total Vegetables	0	0.0%	11	12.0%	58	28.4%
Total Fruits	0	0.0%	0	0.0%	27	13.0%
Total Fats[a]	0	0.0%	27	28.4%	49	23.6%
Age 3 to <6 months (g/day, as consumed)						
Total Foods	1	100.0%	166	100.0%	507	100.0%
Total Dairy	0	3.0%	69	41.9%	90	17.8%
Total Meats	0	0.0%	0	0.2%	4	0.8%
Total Fish	0	0.0%	0	0.0%	0	0.1%
Total Eggs	0	0.0%	1	0.3%	1	0.1%
Total Grains	1	74.5%	8	4.9%	14	2.8%
Total Vegetables	0	10.9%	27	16.3%	73	14.4%
Total Fruits	0	9.9%	24	14.6%	284	56.0%
Total Fats[a]	0	1.3%	34	20.4%	36	7.2%

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age Birth to <1 month (g/kg-day, as consumed)						
Total Foods	0	0.0%	20	100.0%	58	100.0%
Total Dairy	0	0.0%	14	70.5%	35	60.1%
Total Meats	0	0.0%	0	0.0%	0	0.0%
Total Fish	0	0.0%	0	0.0%	0	0.0%
Total Eggs	0	0.0%	0	0.0%	0	0.0%
Total Grains	0	0.0%	0	0.0%	1	2.1%
Total Vegetables	0	0.0%	0	0.1%	6	10.0%
Total Fruits	0	0.0%	0	0.0%	0	0.0%
Total Fats[a]	0	0.0%	6	29.4%	16	27.8%
Age 1 to <3 months (g/kg-day, as consumed)						
Total Foods	0	0.0%	18	100.0%	44	100.0%
Total Dairy	0	0.0%	9	51.9%	20	45.4%
Total Meats	0	0.0%	0	0.0%	0	0.0%
Total Fish	0	0.0%	0	0.0%	0	0.0%
Total Eggs	0	0.0%	0	0.0%	0	0.0%
Total Grains	0	0.0%	0	1.1%	0	0.5%
Total Vegetables	0	0.0%	3	18.9%	7	16.4%
Total Fruits	0	0.0%	0	0.0%	5	12.3%
Total Fats[a]	0	0.0%	5	27.7%	11	24.4%
Age 3 to <6 months (g/kg-day, as consumed)						
Total Foods	0	100.0%	24	100.0%	73	100.0%
Total Dairy	0	0.5%	9	37.3%	13	17.9%
Total Meats	0	0.0%	0	0.5%	1	0.8%
Total Fish	0	0.0%	0	0.0%	0	0.1%
Total Eggs	0	0.0%	0	0.0%	0	0.0%
Total Grains	0	85.0%	1	4.0%	2	3.4%
Total Vegetables	0	7.4%	5	20.8%	11	14.5%
Total Fruits	0	6.7%	4	15.0%	40	55.0%
Total Fats[a]	0	0.2%	5	21.3%	5	7.5%

Table 14-6. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Food Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age 6 to <12 months (g/day, as consumed)							Age 6 to <12 months (g/kg-day, as consumed)						
Total Foods	124	100.0%	414	100.0%	1,358	100.0%	Total Foods	15	100.0%	47	100.0%	144	100.0%
Total Dairy	33	26.4%	72	17.5%	770	56.7%	Total Dairy	4	25.4%	6	13.8%	77	53.1%
Total Meats	3	2.4%	19	4.6%	47	3.5%	Total Meats	0	2.3%	2	4.9%	5	3.4%
Total Fish	0	0.2%	1	0.3%	0	0.0%	Total Fish	0	0.2%	0	0.2%	0	0.0%
Total Eggs	1	0.5%	7	1.6%	8	0.6%	Total Eggs	0	0.9%	1	1.5%	1	0.8%
Total Grains	11	9.1%	37	8.9%	50	3.7%	Total Grains	2	10.7%	4	9.1%	5	3.6%
Total Vegetables	30	24.2%	90	21.9%	121	8.9%	Total Vegetables	3	21.9%	10	22.4%	14	9.8%
Total Fruits	30	24.4%	151	36.5%	314	23.1%	Total Fruits	4	25.9%	19	40.0%	37	25.8%
Total Fats[a]	14	11.6%	35	8.4%	44	3.2%	Total Fats[a]	2	11.4%	4	7.5%	5	3.2%
Age 1 to <2 years (g/day, as consumed)							Age 1 to <2 years (g/kg-day, as consumed)						
Total Foods	407	100.0%	998	100.0%	1,859	100.0%	Total Foods	35	100.0%	85	100.0%	167	100.0%
Total Dairy	113	27.8%	487	48.8%	1,008	54.2%	Total Dairy	10	29.5%	41	48.1%	94	56.1%
Total Meats	28	6.9%	46	4.6%	66	3.5%	Total Meats	3	7.5%	4	4.7%	5	3.2%
Total Fish	1	0.3%	3	0.3%	4	0.2%	Total Fish	0	0.4%	1	0.5%	0	0.2%
Total Eggs	9	2.2%	16	1.6%	22	1.2%	Total Eggs	1	2.1%	1	1.4%	2	0.9%
Total Grains	44	10.8%	63	6.3%	81	4.3%	Total Grains	4	10.9%	5	6.0%	7	4.3%
Total Vegetables	82	20.1%	101	10.2%	165	8.9%	Total Vegetables	7	18.6%	10	11.9%	13	7.8%
Total Fruits	100	24.6%	238	23.8%	446	24.0%	Total Fruits	8	23.0%	19	22.8%	40	24.0%
Total Fats[a]	24	5.8%	38	3.8%	61	3.3%	Total Fats[a]	2	6.4%	3	3.8%	5	3.2%
Age 2 to <3 years (g/day, as consumed)							Age 2 to <3 years (g/kg-day, as consumed)						
Total Foods	448	100.0%	989	100.0%	1,760	100.0%	Total Foods	32	100.0%	72	100.0%	129	100.0%
Total Dairy	118	26.3%	370	37.4%	698	39.7%	Total Dairy	8	24.8%	26	36.3%	54	42.2%
Total Meats	50	11.1%	60	6.1%	72	4.1%	Total Meats	4	11.2%	4	5.3%	5	3.8%
Total Fish	1	0.3%	4	0.4%	7	0.4%	Total Fish	0	0.4%	0	0.2%	0	0.3%
Total Eggs	12	2.7%	14	1.4%	24	1.4%	Total Eggs	1	3.6%	1	1.7%	2	1.3%
Total Grains	62	13.7%	86	8.7%	98	5.6%	Total Grains	4	13.8%	6	8.0%	7	5.6%
Total Vegetables	98	21.9%	145	14.6%	185	10.5%	Total Vegetables	7	22.0%	10	13.3%	13	10.0%
Total Fruits	70	15.6%	255	25.8%	609	34.6%	Total Fruits	5	16.2%	21	29.8%	42	32.9%
Total Fats[a]	31	6.8%	44	4.4%	56	3.2%	Total Fats[a]	2	7.1%	3	3.9%	4	3.2%

Table 14-6. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Food Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age3 to <6 years (g/day, as consumed)						
Total Foods	527	100.0%	1,020	100.0%	1,817	100.0%
Total Dairy	144	27.3%	378	37.0%	728	40.1%
Total Meats	53	10.0%	72	7.0%	94	5.2%
Total Fish	3	0.6%	5	0.5%	9	0.5%
Total Eggs	11	2.0%	15	1.5%	24	1.3%
Total Grains	76	14.4%	103	10.1%	132	7.3%
Total Vegetables	117	22.3%	163	16.0%	233	12.8%
Total Fruits	76	14.4%	216	21.2%	509	28.0%
Total Fats[a]	34	6.5%	50	4.9%	68	3.7%
Age 6 to <11 years (g/day, as consumed)						
Total Foods	565	100.0%	1,060	100.0%	1,886	100.0%
Total Dairy	147	26.1%	370	34.9%	766	40.6%
Total Meats	65	11.4%	95	9.0%	104	5.5%
Total Fish	2	0.3%	6	0.6%	10	0.5%
Total Eggs	10	1.7%	16	1.5%	22	1.2%
Total Grains	89	15.8%	116	10.9%	157	8.3%
Total Vegetables	136	24.1%	203	19.2%	294	15.6%
Total Fruits	66	11.6%	178	16.8%	426	22.6%
Total Fats[a]	39	6.8%	58	5.5%	76	4.0%
Age 11 to <16 years (g/day, as consumed)						
Total Foods	513	100.0%	1,127	100.0%	2,256	100.0%
Total Dairy	92	17.9%	308	27.3%	808	35.8%
Total Meats	71	13.9%	116	10.3%	172	7.6%
Total Fish	4	0.8%	7	0.6%	16	0.7%
Total Eggs	10	1.9%	20	1.8%	28	1.2%
Total Grains	84	16.3%	133	11.8%	207	9.2%
Total Vegetables	162	31.6%	258	22.9%	459	20.3%
Total Fruits	42	8.2%	203	18.0%	420	18.6%
Total Fats[a]	40	7.8%	64	5.7%	114	5.0%

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age 3 to <6 years (g/kg-day, as consumed)						
Total Foods	28	100.0%	57	100.0%	108	100.0%
Total Dairy	8	27.3%	21	36.3%	43	40.3%
Total Meats	3	10.4%	4	7.1%	5	4.8%
Total Fish	0	0.5%	0	0.5%	0	0.4%
Total Eggs	1	2.1%	1	1.6%	1	1.1%
Total Grains	4	14.0%	6	9.9%	8	7.1%
Total Vegetables	6	22.0%	9	16.0%	14	12.5%
Total Fruits	4	15.2%	13	22.1%	31	29.0%
Total Fats[a]	2	6.4%	3	4.8%	4	3.7%
Age 6 to <11 years (g/kg-day, as consumed)						
Total Foods	16	100.0%	38	100.0%	73	100.0%
Total Dairy	4	26.2%	15	38.6%	30	40.8%
Total Meats	2	11.9%	3	8.1%	4	5.9%
Total Fish	0	0.5%	0	0.5%	0	0.4%
Total Eggs	0	1.8%	1	1.6%	1	1.3%
Total Grains	2	14.7%	4	10.8%	7	9.0%
Total Vegetables	4	24.7%	7	18.0%	11	15.5%
Total Fruits	2	11.2%	6	14.9%	15	21.2%
Total Fats[a]	1	7.3%	2	5.3%	3	4.3%
Age 11 to <16 years (g/kg-day, as consumed)						
Total Foods	8	100.0%	22	100.0%	46	100.0%
Total Dairy	1	17.3%	6	26.9%	18	38.4%
Total Meats	1	14.7%	2	10.3%	3	7.0%
Total Fish	0	0.9%	0	0.8%	0	0.8%
Total Eggs	0	1.8%	0	2.2%	1	1.3%
Total Grains	1	16.6%	3	11.7%	4	9.3%
Total Vegetables	3	31.7%	5	23.4%	9	18.4%
Total Fruits	1	7.2%	4	17.4%	8	18.2%
Total Fats[a]	1	8.3%	1	5.9%	2	4.8%

Table 14-6. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Food Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age 16 to <21 years (g/day, as consumed)							Age 16 to <21 years (g/kg-day, as consumed)						
Total Foods	438	100.0%	1,060	100.0%	2,590	100.0%	Total Foods	6	100.0%	16	100.0%	38	100.0%
Total Dairy	56	12.8%	219	20.7%	759	29.3%	Total Dairy	1	12.2%	4	23.8%	10	27.4%
Total Meats	61	14.0%	141	13.3%	272	10.5%	Total Meats	1	15.6%	2	11.5%	4	10.0%
Total Fish	7	1.5%	11	1.1%	14	0.5%	Total Fish	0	1.7%	0	1.0%	0	0.5%
Total Eggs	8	1.9%	17	1.6%	29	1.1%	Total Eggs	0	1.8%	0	1.6%	0	1.1%
Total Grains	67	15.2%	138	13.0%	241	9.3%	Total Grains	1	14.8%	2	13.1%	4	9.9%
Total Vegetables	148	33.8%	312	29.4%	620	23.9%	Total Vegetables	2	34.0%	5	30.0%	10	25.3%
Total Fruits	48	11.0%	138	13.1%	487	18.8%	Total Fruits	1	10.2%	2	10.9%	8	19.7%
Total Fats[a]	33	7.6%	72	6.8%	136	5.3%	Total Fats[a]	1	8.1%	1	7.1%	2	5.0%
Age 20 years and older (g/day, as consumed)							Age 20 years and older (g/kg-day, as consumed)						
Total Foods	451	100.0%	1,030	100.0%	2,140	100.0%	Total Foods	6	100.0%	14	100.0%	30	100.0%
Total Dairy	55	12.1%	188	18.3%	520	24.3%	Total Dairy	1	12.5%	3	19.4%	7	24.9%
Total Meats	74	16.5%	128	12.5%	210	9.8%	Total Meats	1	17.3%	2	12.2%	2	8.2%
Total Fish	7	1.6%	13	1.2%	25	1.2%	Total Fish	0	1.6%	0	1.4%	0	0.9%
Total Eggs	15	3.2%	23	2.3%	34	1.6%	Total Eggs	0	3.5%	0	2.3%	0	1.5%
Total Grains	69	15.3%	130	12.7%	230	10.8%	Total Grains	1	15.6%	2	13.1%	3	10.1%
Total Vegetables	147	32.6%	291	28.4%	516	24.2%	Total Vegetables	2	32.1%	4	28.9%	7	23.5%
Total Fruits	40	8.9%	174	17.0%	466	21.8%	Total Fruits	0	7.9%	2	14.9%	7	23.6%
Total Fats[a]	34	7.6%	60	5.9%	105	4.9%	Total Fats[a]	0	7.7%	1	6.1%	1	4.6%

[a] Includes added fats such as butter, margarine, dressings and sauces, vegetable oil, etc; does not include fats eaten as components of other foods such as meats.

Source: Based on U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 14-7. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Meat Intake

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age Birth to <1 month (g/day, as consumed)[b]							Age Birth to <1 month (g/kg-day, as consumed)[b]						
Total Foods	67	100.0%	-	-	-	-	Total Foods	20	100.0%	-	-	-	-
Total Dairy	41	61.5%	-	-	-	-	Total Dairy	12	61.6%	-	-	-	-
Total Meats	0	0.0%	-	-	-	-	Total Meats	0	0.0%	-	-	-	-
Total Fish	0	0.0%	-	-	-	-	Total Fish	0	0.0%	-	-	-	-
Total Eggs	0	0.0%	-	-	-	-	Total Eggs	0	0.0%	-	-	-	-
Total Grains	0	0.7%	-	-	-	-	Total Grains	0	0.7%	-	-	-	-
Total Vegetables	5	7.7%	-	-	-	-	Total Vegetables	2	7.7%	-	-	-	-
Total Fruits	1	1.3%	-	-	-	-	Total Fruits	0	1.1%	-	-	-	-
Total Fats[a]	19	28.3%	-	-	-	-	Total Fats[a]	6	28.4%	-	-	-	-
Age 1 to <3 months (g/day, as consumed)[c]							Age 1 to <3 months (g/kg-day, as consumed)[c]						
Total Foods	79	100.0%	-	-	149	100.0%	Total Foods	16	100.0%	-	-	47	100.0%
Total Dairy	37	46.4%	-	-	103	68.9%	Total Dairy	8	47.9%	-	-	32	68.9%
Total Meats	0	0.0%	-	-	1	0.7%	Total Meats	0	0.0%	-	-	0	0.7%
Total Fish	0	0.0%	-	-	0	0.0%	Total Fish	0	0.0%	-	-	0	0.0%
Total Eggs	0	0.0%	-	-	0	0.0%	Total Eggs	0	0.0%	-	-	0	0.0%
Total Grains	1	1.5%	-	-	0	0.1%	Total Grains	0	1.4%	-	-	0	0.1%
Total Vegetables	15	18.6%	-	-	3	2.1%	Total Vegetables	3	16.8%	-	-	1	2.1%
Total Fruits	4	5.2%	-	-	0	0.0%	Total Fruits	1	5.6%	-	-	0	0.0%
Total Fats[a]	21	26.4%	-	-	42	28.2%	Total Fats[a]	4	26.5%	-	-	13	28.2%
Age 3 to <6 months (g/day, as consumed)[d]							Age 3 to <6 months (g/kg-day, as consumed)[d]						
Total Foods	181	100.0%	-	-	316	100.0%	Total Foods	26	100.0%	-	-	41	100.0%
Total Dairy	55	30.1%	-	-	62	19.7%	Total Dairy	8	30.6%	-	-	8	20.5%
Total Meats	0	0.0%	-	-	16	4.9%	Total Meats	0	0.0%	-	-	2	4.9%
Total Fish	0	0.0%	-	-	0	0.1%	Total Fish	0	0.0%	-	-	0	0.1%
Total Eggs	0	0.1%	-	-	1	0.5%	Total Eggs	0	0.0%	-	-	0	0.3%
Total Grains	7	3.7%	-	-	16	5.0%	Total Grains	1	3.7%	-	-	2	4.8%
Total Vegetables	31	17.0%	-	-	56	17.9%	Total Vegetables	4	16.9%	-	-	7	17.6%
Total Fruits	59	32.9%	-	-	133	42.3%	Total Fruits	8	32.2%	-	-	17	41.7%
Total Fats[a]	28	15.3%	-	-	28	8.9%	Total Fats[a]	4	15.6%	-	-	4	9.2%

Table 14-7. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Meat Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age 6 to <12 months (g/day, as consumed)							Age 6 to <12 months (g/kg-day, as consumed)						
Total Foods	347	100.0%	466	100.0%	922	100.0%	Total Foods	40	100.0%	48	100.0%	99	100.0%
Total Dairy	80	23.0%	108	23.2%	384	41.6%	Total Dairy	9	22.6%	11	23.9%	41	41.1%
Total Meats	0	0.0%	14	2.9%	85	9.3%	Total Meats	0	0.0%	1	3.0%	9	9.3%
Total Fish	0	0.0%	0	0.1%	0	0.0%	Total Fish	0	0.0%	0	0.1%	0	0.0%
Total Eggs	2	0.5%	3	0.6%	11	1.2%	Total Eggs	0	0..5%	0	1.0%	1	0.9%
Total Grains	24	6.8%	29	6.2%	51	5.6%	Total Grains	3	6.6%	3	6.0%	6	5.8%
Total Vegetables	69	19.8%	116	24.8%	135	14.7%	Total Vegetables	8	19.7%	10	21.9%	15	15.4%
Total Fruits	143	41.3%	162	34.8%	216	23.4%	Total Fruits	17	41.9%	17	36.5%	23	23.1%
Total Fats[a]	27	7.7%	31	6.7%	43	4.6%	Total Fats[a]	2	7.8%	3	7.1%	5	4.6%
Age 1 to <2 years (g/day, as consumed)							Age 1 to <2 years (g/kg-day, as consumed)						
Total Foods	921	100.0%	992	100.0%	1,229	100.0%	Total Foods	82	100.0%	90	100.0%	108	100.0%
Total Dairy	464	50.4%	483	48.7%	460	37.4%	Total Dairy	41	49.9%	46	50.5%	43	40.1%
Total Meats	2	0.2%	39	4.0%	128	10.4%	Total Meats	0	0.2%	3	3.8%	11	10.0%
Total Fish	3	0.3%	2	0.2%	6	0.5%	Total Fish	0	0.3%	0	0.3%	0	0.5%
Total Eggs	8	0.9%	14	1.5%	24	1.9%	Total Eggs	1	0.8%	1	1.4%	2	1.9%
Total Grains	56	6.1%	64	6.5%	78	6.4%	Total Grains	5	6.1%	6	6.1%	7	6.9%
Total Vegetables	97	10.5%	113	11.3%	189	15.4%	Total Vegetables	9	11.1%	10	10.8%	16	15.1%
Total Fruits	250	27.2%	228	23.0%	290	23.6%	Total Fruits	22	27.3%	21	22.7%	22	20.8%
Total Fats[a]	30	3.3%	38	3.8%	57	4.6%	Total Fats[a]	3	3.3%	3	3.8%	5	4.7%
Age 2 to <3 years (g/day, as consumed)							Age 2 to <3 years (g/kg-day, as consumed)						
Total Foods	950	100.0%	947	100.0%	1,131	100.0%	Total Foods	71	100.0%	68	100.0%	83	100.0%
Total Dairy	426	44.9%	373	39.3%	374	33.0%	Total Dairy	31	44.2%	26	37.7%	27	32.3%
Total Meats	7	0.7%	52	5.4%	148	13.1%	Total Meats	1	0.7%	4	5.5%	10	12.4%
Total Fish	4	0.5%	4	0.5%	2	0.2%	Total Fish	0	0.5%	0	0.3%	0	0.2%
Total Eggs	12	1.3%	18	1.9%	21	1.9%	Total Eggs	1	1.3%	1	1.3%	2	1.8%
Total Grains	73	7.7%	76	8.1%	90	8.0%	Total Grains	6	7.8%	6	8.3%	7	8.1%
Total Vegetables	104	10.9%	146	15.4%	202	17.9%	Total Vegetables	8	11.1%	10	15.1%	14	16.8%
Total Fruits	279	29.4%	226	23.8%	232	20.5%	Total Fruits	21	29.6%	18	26.7%	19	23.1%
Total Fats[a]	29	3.0%	40	4.2%	62	5.5%	Total Fats[a]	2	3.1%	3	4.0%	4	5.2%

Table 14-7. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Meat Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age3 to <6 years (g/day, as consumed)						
Total Foods	991	100.0%	1,037	100.0%	1,246	100.0%
Total Dairy	419	42.3%	376	36.3%	389	31.2%
Total Meats	10	1.0%	65	6.3%	176	14.1%
Total Fish	7	0.7%	6	0.5%	4	0.3%
Total Eggs	10	1.0%	16	1.5%	24	1.9%
Total Grains	98	9.9%	101	9.8%	117	9.4%
Total Vegetables	128	13.0%	170	16.4%	217	17.4%
Total Fruits	257	25.9%	238	22.9%	243	19.5%
Total Fats[a]	35	3.6%	48	4.7%	73	5.9%
Age 6 to <11 years (g/day, as consumed)						
Total Foods	1,028	100.0%	1,087	100.0%	1,300	100.0%
Total Dairy	424	41.3%	386	35.5%	382	29.4%
Total Meats	11	1.1%	79	7.3%	206	15.8%
Total Fish	6	0.6%	5	0.5%	4	0.3%
Total Eggs	13	1.3%	15	1.4%	17	1.3%
Total Grains	121	11.8%	117	10.7%	136	10.4%
Total Vegetables	164	16.0%	212	19.5%	270	20.7%
Total Fruits	214	20.8%	191	17.6%	198	15.2%
Total Fats[a]	40	3.9%	59	5.4%	81	6.2%
Age 11 to <16 years (g/day, as consumed)						
Total Foods	1,043	100.0%	1,194	100.0%	1,606	100.0%
Total Dairy	342	32.8%	377	31.6%	435	27.1%
Total Meats	17	1.6%	101	8.5%	268	16.7%
Total Fish	13	1.3%	7	0.6%	7	0.4%
Total Eggs	17	1.6%	13	1.1%	21	1.3%
Total Grains	116	11.1%	144	12.1%	159	9.9%
Total Vegetables	227	21.7%	260	21.8%	404	25.2%
Total Fruits	238	22.8%	202	16.9%	204	12.7%
Total Fats[a]	44	4.2%	67	5.6%	106	6.6%

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age 3 to <6 years (g/kg-day, as consumed)						
Total Foods	57	100.0%	59	100.0%	74	100.0%
Total Dairy	24	42.1%	23	38.2%	23	31.3%
Total Meats	1	1.0%	4	6.0%	10	13.4%
Total Fish	0	0.6%	0	0.5%	0	0.3%
Total Eggs	1	1.0%	1	1.4%	1	2.0%
Total Grains	6	9.9%	6	9.5%	7	9.4%
Total Vegetables	7	13.0%	9	15.8%	13	17.5%
Total Fruits	15	26.1%	13	22.0%	15	20.1%
Total Fats[a]	2	3.6%	3	4.8%	4	5.7%
Age 6 to <11 years (g/kg-day, as consumed)						
Total Foods	36	100.0%	39	100.0%	51	100.0%
Total Dairy	15	41.5%	15	38.7%	15	29.7%
Total Meats	0	1.0%	3	7.0%	8	14.8%
Total Fish	0	0.9%	0.32	0.8%	0	0.3%
Total Eggs	0	1.2%	0.42	1.1%	1	1.5%
Total Grains	4	11.5%	4	10.7%	5	10.4%
Total Vegetables	5	15.1%	7	19.1%	10	20.2%
Total Fruits	8	21.7%	6	15.6%	8	16.5%
Total Fats[a]	1	3.8%	2	5.1%	3	6.0%
Age 11 to <16 years (g/kg-day, as consumed)						
Total Foods	19	100.0%	22	100.0%	33	100.0%
Total Dairy	6	31.5%	6	27.0%	10	29.7%
Total Meats	0	1.6%	2	8.8%	5	16.3%
Total Fish	0	1.5%	0	0.5%	0	0.5%
Total Eggs	0	1.5%	0	1.3%	0	1.4%
Total Grains	2	11.6%	3	11.7%	3	10.0%
Total Vegetables	4	22.2%	5	24.1%	8	23.3%
Total Fruits	4	23.1%	4	18.9%	4	11.7%
Total Fats[a]	1	4.4%	1	5.7%	2	6.7%

Table 14-7. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Meat Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age 16 to <21 years (g/day, as consumed)							Age 16 to <21 years (g/kg-day, as consumed)						
Total Foods	922	100.0%	1,084	100.0%	1,957	100.0%	Total Foods	15	100.0%	18	100.0%	28	100.0%
Total Dairy	307	33.3%	280	25.8%	403	20.6%	Total Dairy	4	30.3%	4	24.0%	5	18.1%
Total Meats	12	1.3%	115	10.6%	385	19.7%	Total Meats	0	1.3%	2	9.6%	5	19.8%
Total Fish	20	2.1%	9	0.9%	12	0.6%	Total Fish	0	2.2%	0	1.0%	0	0.4%
Total Eggs	14	1.5%	15	1.4%	31	1.6%	Total Eggs	0	1.4%	0	1.9%	0	1.6%
Total Grains	131	14.2%	147	13.6%	231	11.8%	Total Grains	2	14.5%	2	12.8%	3	12.3%
Total Vegetables	215	23.3%	287	26.5%	532	27.2%	Total Vegetables	4	24.6%	5	27.5%	8	28.9%
Total Fruits	151	16.4%	147	13.5%	226	11.6%	Total Fruits	3	17.8%	3	15.7%	3	12.4%
Total Fats[a]	42	4.5%	73	6.7%	139	7.1%	Total Fats[a]	1	4.6%	1	6.2%	2	6.5%
Age 20 years and older (g/day, as consumed)							Age 20 years and older (g/kg-day, as consumed)						
Total Foods	943	100.0%	1,030	100.0%	1,560	100.0%	Total Foods	14	100.0%	15	100.0%	21	100.0%
Total Dairy	213	22.6%	211	20.4%	254	16.3%	Total Dairy	3	22.6%	3	20.7%	3	15.9%
Total Meats	15	1.6%	111	10.8%	338	21.7%	Total Meats	0	1.6%	2	10.3%	4	21.3%
Total Fish	25	2.6%	12	1.2%	13	0.8%	Total Fish	0	2.6%	0	1.3%	0	0.9%
Total Eggs	17	1.8%	21	2.0%	33	2.1%	Total Eggs	0	1.8%	0	2.1%	0	2.0%
Total Grains	113	12.0%	124	12.0%	196	12.5%	Total Grains	2	11.9%	2	12.2%	3	12.2%
Total Vegetables	259	27.4%	282	27.2%	446	28.5%	Total Vegetables	4	27.3%	4	27.6%	6	28.2%
Total Fruits	234	24.9%	192	18.6%	165	10.5%	Total Fruits	3	25.3%	3	18.2%	3	12.3%
Total Fats[a]	38	4.1%	59	5.7%	115	7.4%	Total Fats[a]	1	4.0%	1	5.5%	1	7.0%

[a] Includes added fats such as butter, margarine, dressings and sauces, vegetable oil, etc; does not include fats eaten as components of other foods such as meats.
[b] All individuals in this sample group consumed 0 grams/day of meat. Therefore, results are reported in the low-end decile.
[c] Only one individual in this sample group consumed more than 0 grams/day of meat. This result is reported in the high-end decile. All other samples are reported in the low-end decile.
[d] All individuals in this sample group below the 89th percentile consumed 0 grams/day of meat. Therefore, only high-end and low-end consumer groups are reported.

Source: Based on U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 14-8. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Meat and Dairy Intake

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age Birth to <1 month (g/day, as consumed)						
Total Foods	12	100.0%	60	100.0%	185	100.0%
Total Dairy	0	0.0%	40	67.3%	127	69.0%
Total Meats	0	0.0%	0	0.0%	0	0.0%
Total Fish	0	0.0%	0	0.0%	0	0.0%
Total Eggs	0	0.0%	0	0.0%	0	0.0%
Total Grains	0	0.3%	0	0.0%	4	2.2%
Total Vegetables	8	66.1%	2	3.4%	1	0.4%
Total Fruits	0	0.0%	0	0.0%	0	0.0%
Total Fats[a]	3	27.1%	18	29.2%	52	28.4%
Age 1 to <3 months (g/day, as consumed)						
Total Foods	36	100.0%	84	100.0%	166	100.0%
Total Dairy	0	0.0%	19	22.4%	109	65.6%
Total Meats	0	0.0%	0	0.0%	0	0.0%
Total Fish	0	0.0%	0	0.0%	0	0.0%
Total Eggs	0	0.0%	0	0.0%	0	0.0%
Total Grains	0	0.9%	1	1.2%	1	0.8%
Total Vegetables	21	58.8%	42	50.7%	4	2.7%
Total Fruits	2	4.3%	0	0.0%	6	3.7%
Total Fats[a]	10	26.7%	21	25.4%	45	27.2%
Age 3 to <6 months (g/day, as consumed)						
Total Foods	121	100.0%	204	100.0%	334	100.0%
Total Dairy	0	0.0%	60	29.7%	159	47.7%
Total Meats	0	0.0%	0	0.3%	5	1.4%
Total Fish	0	0.0%	0	0.0%	0	0.1%
Total Eggs	0	0.0%	0	0.1%	1	0.2%
Total Grains	5	4.5%	7	3.2%	12	3.7%
Total Vegetables	44	36.4%	29	14.5%	27	8.0%
Total Fruits	52	42.9%	80	39.0%	74	22.3%
Total Fats[a]	15	12.3%	27	13.2%	54	16.3%

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age Birth to <1 month (g/kg-day, as consumed)						
Total Foods	4	100.0%	18	100.0%	56	100.0%
Total Dairy	0	0.0%	12	67.1%	39	69.0%
Total Meats	0	0.0%	0	0.0%	0	0.0%
Total Fish	0	0.0%	0	0.0%	0	0.0%
Total Eggs	0	0.0%	0	0.0%	0	0.0%
Total Grains	0	0.2%	0	0.0%	1	2.1%
Total Vegetables	2	64.4%	1	3.7%	0	0.5%
Total Fruits	0	0.0%	0	0.0%	0	0.0%
Total Fats[a]	1	27.5%	5	29.2%	16	28.4%
Age 1 to <3 months (g/kg-day, as consumed)						
Total Foods	7	100.0%	14	100.0%	41	100.0%
Total Dairy	0	0.0%	3	24.0%	26	64.1%
Total Meats	0	0.0%	0	0.0%	0	0.0%
Total Fish	0	0.0%	0	0.0%	0	0.0%
Total Eggs	0	0.0%	0	0.0%	0	0.0%
Total Grains	0	0.8%	0	2.0%	0	0.6%
Total Vegetables	4	57.8%	7	48.7%	0	1.1%
Total Fruits	0	5.4%	0	0.0%	3	7.7%
Total Fats[a]	2	26.4%	4	25.0%	11	26.5%
Age 3 to <6 months (g/kg-day, as consumed)						
Total Foods	17	100.0%	30	100.0%	45	100.0%
Total Dairy	0	0.0%	8	26.5%	24	53.4%
Total Meats	0	0.0%	0	0.6%	1	1.3%
Total Fish	0	0.0%	0	0.0%	0	0.1%
Total Eggs	0	0.0%	0	0.3%	0	0.1%
Total Grains	1	4.5%	1	3.7%	2	3.6%
Total Vegetables	6	37.1%	3	11.2%	2	5.3%
Total Fruits	7	41.7%	14	46.0%	8	17.3%
Total Fats[a]	2	12.6%	3	11.4%	8	18.7%

Table 14-8. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Meat and Dairy Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age 6 to <12 months (g/day, as consumed)							Age 6 to <12 months (g/kg-day, as consumed)						
Total Foods	253	100.0%	403	100.0%	1,284	100.0%	Total Foods	29	100.0%	43	100.0%	135	100.0%
Total Dairy	1	0.5%	71	17.6%	827	64.5%	Total Dairy	0	0.4%	8	18.0%	87	64.2%
Total Meats	1	0.3%	17	4.1%	45	3.5%	Total Meats	0	0.3%	2	4.7%	5	3.3%
Total Fish	0	0.0%	1	0.4%	0	0.0%	Total Fish	0	0.0%	0	0.3%	0	0.0%
Total Eggs	3	1.0%	3	0.7%	7	0.5%	Total Eggs	0	1.1%	0	0.9%	1	0.5%
Total Grains	22	8.5%	32	8.0%	45	3.5%	Total Grains	2	8.0%	3	7.1%	5	3.5%
Total Vegetables	95	37.7%	82	20.3%	108	8.4%	Total Vegetables	11	38.2%	9	20.0%	12	8.6%
Total Fruits	110	43.4%	166	41.1%	209	16.3%	Total Fruits	13	43.4%	17	40.4%	22	16.6%
Total Fats[a]	17	6.7%	32	8.0%	41	3.2%	Total Fats[a]	2	6.7%	4	8.3%	4	3.2%
Age 1 to <2 years (g/day, as consumed)							Age 1 to <2 years (g/kg-day, as consumed)						
Total Foods	569	100.0%	1,014	100.0%	1,687	100.0%	Total Foods	51	100.0%	82	100.0%	155	100.0%
Total Dairy	46	8.0%	456	45.0%	1,165	69.0%	Total Dairy	4	7.7%	38	45.6%	106	68.2%
Total Meats	30	5.2%	43	4.2%	52	3.1%	Total Meats	3	5.5%	4	5.3%	4	2.8%
Total Fish	2	0.4%	2	0.2%	3	0.2%	Total Fish	0	0.2%	0	0.3%	0	0.1%
Total Eggs	12	2.0%	13	1.3%	19	1.1%	Total Eggs	1	2.1%	1	1.6%	1	0.9%
Total Grains	54	9.5%	64	6.3%	65	3.8%	Total Grains	5	9.5%	6	7.2%	6	3.7%
Total Vegetables	128	22.5%	114	11.3%	111	6.6%	Total Vegetables	11	22.2%	11	13.0%	11	6.9%
Total Fruits	264	46.4%	278	27.4%	209	12.4%	Total Fruits	24	46.6%	19	22.7%	21	13.7%
Total Fats[a]	25	4.5%	36	3.6%	59	3.5%	Total Fats[a]	2	4.5%	3	3.8%	5	3.4%
Age 2 to <3 years (g/day, as consumed)							Age 2 to <3 years (g/kg-day, as consumed)						
Total Foods	641	100.0%	981	100.0%	1,546	100.0%	Total Foods	46	100.0%	73	100.0%	114	100.0%
Total Dairy	57	9.0%	348	35.5%	883	57.1%	Total Dairy	4	8.2%	24	32.6%	67	58.3%
Total Meats	45	6.9%	59	6.0%	60	3.9%	Total Meats	3	7.4%	5	6.5%	4	3.8%
Total Fish	4	0.6%	3	0.3%	4	0.3%	Total Fish	0	0.4%	0	0.3%	0	0.2%
Total Eggs	21	3.2%	18	1.9%	20	1.3%	Total Eggs	1	3.2%	1	1.6%	2	1.3%
Total Grains	75	11.8%	86	8.7%	86	5.6%	Total Grains	5	11.6%	6	8.7%	7	5.7%
Total Vegetables	155	24.1%	148	15.1%	143	9.2%	Total Vegetables	11	23.6%	11	14.9%	11	9.5%
Total Fruits	240	37.5%	264	26.9%	286	18.5%	Total Fruits	18	38.7%	22	29.9%	19	16.6%
Total Fats[a]	32	5.0%	42	4.3%	55	3.6%	Total Fats[a]	2	5.2%	3	4.3%	4	3.7%

Table 14-8. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Meat and Dairy Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age 3 to <6 years (g/day, as consumed)							Age 3 to <6 years (g/kg-day, as consumed)						
Total Foods	702	100.0%	1,043	100.0%	1,646	100.0%	Total Foods	39	100.0%	59	100.0%	97	100.0%
Total Dairy	75	10.7%	352	33.8%	878	53.3%	Total Dairy	4	10.8%	20	33.6%	52	53.1%
Total Meats	52	7.5%	79	7.6%	88	5.4%	Total Meats	3	7.6%	4	7.1%	5	5.2%
Total Fish	5	0.7%	5	0.5%	5	0.3%	Total Fish	0	0.8%	0	0.4%	0	0.3%
Total Eggs	15	2.2%	16	1.5%	19	1.2%	Total Eggs	1	2.2%	1	1.6%	1	1.0%
Total Grains	85	12.0%	107	10.2%	121	7.3%	Total Grains	5	12.0%	6	10.0%	7	7.2%
Total Vegetables	159	22.6%	167	16.0%	191	11.6%	Total Vegetables	9	22.7%	10	16.1%	11	11.7%
Total Fruits	258	36.7%	251	24.1%	259	15.8%	Total Fruits	14	36.1%	15	25.0%	16	16.2%
Total Fats[a]	35	5.0%	51	4.9%	67	4.1%	Total Fats[a]	2	5.1%	3	4.7%	4	4.1%
Age 6 to <11 years (g/day, as consumed)							Age 6 to <11 years (g/kg-day, as consumed)						
Total Foods	725	100.0%	1,061	100.0%	1,727	100.0%	Total Foods	21	100.0%	38	100.0%	68	100.0%
Total Dairy	76	10.5%	366	34.5%	883	51.1%	Total Dairy	2	11.6%	13	34.8%	35	51.0%
Total Meats	66	9.2%	91	8.6%	105	6.1%	Total Meats	2	9.9%	3	8.2%	4	5.9%
Total Fish	6	0.8%	7	0.7%	6	0.3%	Total Fish	0	0.8%	0	0.6%	0	0.4%
Total Eggs	16	2.3%	17	1.6%	18	1.1%	Total Eggs	1	2.4%	1	1.4%	1	1.0%
Total Grains	101	13.9%	116	10.9%	151	8.7%	Total Grains	3	14.1%	4	10.9%	6	9.2%
Total Vegetables	202	27.9%	205	19.4%	245	14.2%	Total Vegetables	6	27.0%	7	18.7%	10	14.1%
Total Fruits	198	27.3%	178	16.7%	221	12.8%	Total Fruits	6	25.9%	7	17.8%	8	12.4%
Total Fats[a]	43	6.0%	56	5.3%	73	4.2%	Total Fats[a]	1	6.2%	2	5.4%	3	4.4%
Age 11 to <16 years (g/day, as consumed)							Age 11 to <16 years (g/kg-day, as consumed)						
Total Foods	727	100.0%	1,111	100.0%	2,045	100.0%	Total Foods	12	100.0%	23	100.0%	43	100.0%
Total Dairy	38	5.2%	299	26.9%	1,004	49.1%	Total Dairy	1	4.9%	6	26.0%	21	47.9%
Total Meats	58	8.0%	118	10.6%	161	7.9%	Total Meats	1	9.3%	2	10.9%	3	7.5%
Total Fish	10	1.4%	11	1.0%	12	0.6%	Total Fish	0	1.3%	0	0.6%	0	0.8%
Total Eggs	16	2.2%	22	2.0%	26	1.3%	Total Eggs	0	2.5%	0	1.5%	1	1.2%
Total Grains	103	14.2%	137	12.4%	181	8.9%	Total Grains	2	14.2%	3	11.5%	4	9.1%
Total Vegetables	234	32.2%	265	23.9%	332	16.2%	Total Vegetables	4	32.4%	6	24.5%	7	15.5%
Total Fruits	213	29.3%	176	15.8%	204	10.0%	Total Fruits	3	27.0%	4	17.1%	5	11.8%
Total Fats[a]	42	5.8%	66	6.0%	104	5.1%	Total Fats[a]	1	6.3%	1	6.1%	2	4.9%

Table 14-8. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Meat and Dairy Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age 16 to <21 years (g/day, as consumed)							Age 16 to <21 years (g/kg-day, as consumed)						
Total Foods	610	100.0%	1,017	100.0%	2,379	100.0%	Total Foods	9	100.0%	15	100.0%	34	100.0%
Total Dairy	22	3.5%	204	20.1%	923	38.8%	Total Dairy	0	3.8%	3	19.1%	13	39.1%
Total Meats	42	6.8%	128	12.6%	256	10.8%	Total Meats	1	6.8%	2	13.4%	4	10.8%
Total Fish	12	1.9%	12	1.2%	8	0.3%	Total Fish	0	1.8%	0	0.9%	0	0.3%
Total Eggs	13	2.2%	19	1.8%	28	1.2%	Total Eggs	0	2.0%	0	1.8%	0	1.1%
Total Grains	87	14.3%	140	13.8%	233	9.8%	Total Grains	1	14.6%	2	14.3%	3	10.1%
Total Vegetables	202	33.1%	305	29.9%	492	20.7%	Total Vegetables	3	34.0%	5	30.4%	7	20.8%
Total Fruits	177	29.1%	133	13.1%	282	11.9%	Total Fruits	3	28.1%	2	12.2%	4	11.2%
Total Fats[a]	34	5.6%	68	6.6%	127	5.3%	Total Fats[a]	1	5.5%	1	6.8%	2	5.4%
Age 20 years and older (g/day, as consumed)							Age 20 years and older (g/kg-day, as consumed)						
Total Foods	679	100.0%	1,050	100.0%	1,860	100.0%	Total Foods	9	100.0%	14	100.0%	26	100.0%
Total Dairy	28	4.1%	157	14.9%	696	37.5%	Total Dairy	0	3.9%	2	15.2%	10	37.6%
Total Meats	45	6.6%	136	12.9%	208	11.2%	Total Meats	1	6.8%	2	12.7%	3	10.4%
Total Fish	21	3.1%	14	1.3%	17	0.9%	Total Fish	0	3.1%	0	1.4%	0	1.0%
Total Eggs	19	2.8%	22	2.1%	29	1.5%	Total Eggs	0	2.8%	0	2.1%	0	1.5%
Total Grains	99	14.6%	131	12.5%	185	10.0%	Total Grains	1	14.5%	2	12.9%	3	9.8%
Total Vegetables	236	34.7%	319	30.3%	385	20.7%	Total Vegetables	3	35.0%	4	29.9%	5	20.3%
Total Fruits	179	26.3%	190	18.1%	215	11.6%	Total Fruits	2	26.1%	3	18.1%	3	13.1%
Total Fats[a]	34	5.0%	65	6.1%	100	5.4%	Total Fats[a]	0	5.1%	1	6.0%	1	5.1%

[a] Includes added fats such as butter, margarine, dressings and sauces, vegetable oil, etc.; does not include fats eaten as components of other foods such as meats.

Source: Based on U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 14-9. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Fish Intake

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age Birth to <1 month (g/day, as consumed)[b]							Age Birth to <1 month (g/kg-day, as consumed)[b]						
Total Foods	67	100.0%	-	-	-	-	Total Foods	20	100.0%	-	-	-	-
Total Dairy	41	61.5%	-	-	-	-	Total Dairy	12	61.6%	-	-	-	-
Total Meats	0	0.0%	-	-	-	-	Total Meats	0	0.0%	-	-	-	-
Total Fish	0	0.0%	-	-	-	-	Total Fish	0	0.0%	-	-	-	-
Total Eggs	0	0.0%	-	-	-	-	Total Eggs	0	0.0%	-	-	-	-
Total Grains	0	0.7%	-	-	-	-	Total Grains	0	0.7%	-	-	-	-
Total Vegetables	5	7.7%	-	-	-	-	Total Vegetables	2	7.7%	-	-	-	-
Total Fruits	1	1.3%	-	-	-	-	Total Fruits	0	1.1%	-	-	-	-
Total Fats[a]	19	28.3%	-	-	-	-	Total Fats[a]	6	28.4%	-	-	-	-
Age 1 to <3 months (g/day, as consumed)[b]							Age 1 to <3 months (g/kg-day, as consumed)[b]						
Total Foods	80	100.0%	-	-	-	-	Total Foods	16	100.0%	-	-	-	-
Total Dairy	37	46.5%	-	-	-	-	Total Dairy	8	48.2%	-	-	-	-
Total Meats	0	0.0%	-	-	-	-	Total Meats	0	0.0%	-	-	-	-
Total Fish	0	0.0%	-	-	-	-	Total Fish	0	0.0%	-	-	-	-
Total Eggs	0	0.0%	-	-	-	-	Total Eggs	0	0.0%	-	-	-	-
Total Grains	1	1.5%	-	-	-	-	Total Grains	0	1.4%	-	-	-	-
Total Vegetables	15	18.5%	-	-	-	-	Total Vegetables	3	16.6%	-	-	-	-
Total Fruits	4	5.2%	-	-	-	-	Total Fruits	1	5.5%	-	-	-	-
Total Fats[a]	21	26.4%	-	-	-	-	Total Fats[a]	4	26.5%	-	-	-	-
Age 3 to <6 months (g/day, as consumed)[c]							Age 3 to <6 months (g/kg-day, as consumed)[c]						
Total Foods	196	100.0%	-	-	410	100.0%	Total Foods	28	100.0%	-	-	53	100.0%
Total Dairy	55	28.3%	-	-	159	38.8%	Total Dairy	8	28.9%	-	-	21	38.8%
Total Meats	2	0.8%	-	-	28	6.8%	Total Meats	0	0.7%	-	-	4	6.8%
Total Fish	0	0.0%	-	-	17	4.1%	Total Fish	0	0.0%	-	-	2	4.1%
Total Eggs	0	0.1%	-	-	4	1.0%	Total Eggs	0	0.1%	-	-	1	1.0%
Total Grains	8	3.9%	-	-	47	11.5%	Total Grains	1	3.8%	-	-	6	11.5%
Total Vegetables	34	17.2%	-	-	34	8.3%	Total Vegetables	5	17.1%	-	-	4	8.3%
Total Fruits	68	34.7%	-	-	30	7.2%	Total Fruits	9	33.9%	-	-	4	7.2%
Total Fats[a]	28	14.1%	-	-	81	19.8%	Total Fats[a]	4	14.5%	-	-	11	19.8%

Table 14-9. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Fish Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age 6 to <12 months (g/day, as consumed)[d]						
Total Foods	799	100.0%	-	-	770	100.0%
Total Dairy	334	41.8%	-	-	287	37.3%
Total Meats	38	4.7%	-	-	46	6.0%
Total Fish	0	0.0%	-	-	7	0.9%
Total Eggs	11	1.4%	-	-	14	1.9%
Total Grains	47	5.9%	-	-	66	8.6%
Total Vegetables	101	12.6%	-	-	117	15.3%
Total Fruits	227	28.4%	-	-	194	25.2%
Total Fats[a]	37	4.7%	-	-	36	4.7%
Age 1 to <2 years (g/day, as consumed)[d]						
Total Foods	1,032	100.0%	-	-	1,139	100.0%
Total Dairy	496	48.1%	-	-	461	40.5%
Total Meats	46	4.5%	-	-	56	4.9%
Total Fish	0	0.0%	-	-	26	2.3%
Total Eggs	14	1.4%	-	-	19	1.7%
Total Grains	65	6.3%	-	-	76	6.7%
Total Vegetables	118	11.4%	-	-	151	13.2%
Total Fruits	247	24.0%	-	-	300	26.3%
Total Fats[a]	39	3.8%	-	-	43	3.8%
Age 2 to <3 years (g/day, as consumed)[d]						
Total Foods	1,015	100.0%	-	-	1,107	100.0%
Total Dairy	381	37.6%	-	-	424	38.3%
Total Meats	62	6.1%	-	-	53	4.8%
Total Fish	0	0.0%	-	-	31	2.8%
Total Eggs	18	1.8%	-	-	17	1.6%
Total Grains	81	7.9%	-	-	84	7.6%
Total Vegetables	144	14.2%	-	-	142	12.8%
Total Fruits	276	27.2%	-	-	304	27.4%
Total Fats[a]	42	4.2%	-	-	43	3.9%

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age 6 to <12 months (g/kg-day, as consumed)[d]						
Total Foods	81	100.0%	-	-	74	100.0%
Total Dairy	34	41.8%	-	-	27	37.1%
Total Meats	4	4.7%	-	-	4	6.0%
Total Fish	0	0.0%	-	-	1	0.9%
Total Eggs	1	1.4%	-	-	1	2.0%
Total Grains	5	5.9%	-	-	6	8.4%
Total Vegetables	10	12.6%	-	-	12	15.6%
Total Fruits	23	28.4%	-	-	19	25.2%
Total Fats[a]	4	4.7%	-	-	3	4.7%
Age 1 to <2 years (g/kg-day, as consumed)[d]						
Total Foods	90	100.0%	-	-	98	100.0%
Total Dairy	43	48.2%	-	-	41	42.4%
Total Meats	4	4.4%	-	-	5	4.8%
Total Fish	0	0.0%	-	-	2	2.2%
Total Eggs	1	1.3%	-	-	2	1.6%
Total Grains	6	6.2%	-	-	7	6.7%
Total Vegetables	10	11.4%	-	-	12	12.3%
Total Fruits	22	24.0%	-	-	25	25.5%
Total Fats[a]	3	3.8%	-	-	4	3.8%
Age 2 to <3 years (g/kg-day, as consumed)[d]						
Total Foods	73	100.0%	-	-	82	100.0%
Total Dairy	28	37.9%	-	-	31	37.6%
Total Meats	4	6.0%	-	-	4	4.6%
Total Fish	0	0.0%	-	-	2	2.9%
Total Eggs	1	1.7%	-	-	1	1.5%
Total Grains	6	7.9%	-	-	6	7.5%
Total Vegetables	10	14.1%	-	-	10	12.7%
Total Fruits	20	27.0%	-	-	23	28.5%
Total Fats[a]	3	4.2%	-	-	3	3.9%

Table 14-9. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Fish Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age 3 to <6 years (g/day, as consumed)[d]						
Total Foods	1,053	100.0%	-	-	1,156	100.0%
Total Dairy	390	37.1%	-	-	399	34.5%
Total Meats	76	7.2%	-	-	62	5.3%
Total Fish	0	0.0%	-	-	43	3.7%
Total Eggs	16	1.5%	-	-	17	1.4%
Total Grains	101	9.6%	-	-	103	8.9%
Total Vegetables	168	15.9%	-	-	193	16.7%
Total Fruits	237	22.5%	-	-	273	23.6%
Total Fats[a]	50	4.8%	-	-	50	4.3%
Age 6 to <11 years (g/day, as consumed)[d]						
Total Foods	1,109	100.0%	-	-	1,234	100.0%
Total Dairy	408	36.8%	-	-	430	34.8%
Total Meats	89	8.0%	-	-	76	6.2%
Total Fish	0	0.0%	-	-	51	4.1%
Total Eggs	15	1.3%	-	-	22	1.8%
Total Grains	119	10.7%	-	-	126	10.2%
Total Vegetables	208	18.8%	-	-	233	18.9%
Total Fruits	190	17.1%	-	-	218	17.7%
Total Fats[a]	58	5.2%	-	-	61	4.9%
Age 11 to <16 years (g/day, as consumed)[d]						
Total Foods	1,197	100.0%	-	-	1,378	100.0%
Total Dairy	372	31.1%	-	-	397	28.8%
Total Meats	117	9.8%	-	-	104	7.5%
Total Fish	0	0.0%	-	-	72	5.2%
Total Eggs	17	1.4%	-	-	28	2.0%
Total Grains	135	11.3%	-	-	146	10.6%
Total Vegetables	277	23.1%	-	-	310	22.5%
Total Fruits	190	15.8%	-	-	226	16.4%
Total Fats[a]	69	5.8%	-	-	76	5.5%

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age 3 to <6 years (g/kg-day, as consumed)[d]						
Total Foods	60	100.0%	-	-	66	100.0%
Total Dairy	22	37.1%	-	-	22	33.9%
Total Meats	4	7.1%	-	-	3	5.3%
Total Fish	0	0.0%	-	-	2	3.7%
Total Eggs	1	1.5%	-	-	1	1.6%
Total Grains	6	9.5%	-	-	6	9.0%
Total Vegetables	9	15.8%	-	-	11	16.9%
Total Fruits	14	22.7%	-	-	16	23.8%
Total Fats[a]	3	4.7%	-	-	3	4.3%
Age 6 to <11 years (g/kg-day, as consumed)[d]						
Total Foods	40	100.0%	-	-	44	100.0%
Total Dairy	15	37.0%	-	-	16	35.6%
Total Meats	3	7.9%	-	-	3	6.1%
Total Fish	0	0.0%	-	-	2	4.1%
Total Eggs	1	1.3%	-	-	1	1.6%
Total Grains	4	10.7%	-	-	4	10.1%
Total Vegetables	7	18.5%	-	-	8	18.4%
Total Fruits	7	17.3%	-	-	8	17.5%
Total Fats[a]	2	5.2%	-	-	2	4.9%
Age 11 to <16 years (g/kg-day, as consumed)[d]						
Total Foods	24	100.0%	-	-	28	100.0%
Total Dairy	7	31.1%	-	-	9	30.9%
Total Meats	2	9.7%	-	-	2	6.9%
Total Fish	0	0.0%	-	-	1	4.9%
Total Eggs	0	1.4%	-	-	1	1.9%
Total Grains	3	11.3%	-	-	3	10.5%
Total Vegetables	5	22.9%	-	-	6	21.1%
Total Fruits	4	16.2%	-	-	5	17.1%
Total Fats[a]	1	5.7%	-	-	1	5.2%

Table 14-9. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Fish Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age 16 to <21 years (g/day, as consumed)[d]							Age 16 to <21 years (g/kg-day, as consumed)[d]						
Total Foods	1,171	100.0%	-	-	1,339	100.0%	Total Foods	18	100.0%	-	-	19	100.0%
Total Dairy	288	24.6%	-	-	261	19.5%	Total Dairy	4	24.5%	-	-	4	20.3%
Total Meats	143	12.2%	-	-	139	10.4%	Total Meats	2	11.9%	-	-	2	9.4%
Total Fish	0	0.0%	-	-	86	6.5%	Total Fish	0	0.0%	-	-	1	6.7%
Total Eggs	20	1.7%	-	-	21	1.6%	Total Eggs	0	1.7%	-	-	0	1.6%
Total Grains	146	12.5%	-	-	162	12.1%	Total Grains	2	12.5%	-	-	2	12.0%
Total Vegetables	325	27.8%	-	-	357	26.6%	Total Vegetables	5	27.9%	-	-	5	26.0%
Total Fruits	160	13.7%	-	-	219	16.3%	Total Fruits	2	13.9%	-	-	3	16.9%
Total Fats[a]	75	6.4%	-	-	80	6.0%	Total Fats[a]	1	6.4%	-	-	1	5.9%
Age 20 years and older (g/day, as consumed)							Age 20 years and older (g/kg-day, as consumed)						
Total Foods	1,040	100.0%	1,060	100.0%	1,340	100.0%	Total Foods	14	100.0%	15	100.0%	19	100.0%
Total Dairy	207	20.0%	205	19.3%	250	18.7%	Total Dairy	3	20.2%	3	19.1%	4	19.0%
Total Meats	126	12.1%	143	13.4%	121	9.1%	Total Meats	2	11.9%	2	12.7%	2	8.5%
Total Fish	0	0.0%	0	0.0%	102	7.7%	Total Fish	0	0.0%	0	0.0%	1	7.6%
Total Eggs	22	2.1%	24	2.2%	27	2.0%	Total Eggs	0	2.0%	0	2.0%	0	1.9%
Total Grains	134	12.9%	133	12.5%	152	11.4%	Total Grains	2	13.0%	2	12.3%	2	11.2%
Total Vegetables	303	29.2%	300	28.3%	348	26.0%	Total Vegetables	4	29.1%	4	28.3%	5	26.0%
Total Fruits	165	15.9%	180	16.9%	238	17.8%	Total Fruits	2	16.1%	3	18.2%	4	18.7%
Total Fats[a]	62	6.0%	64	6.0%	74	5.5%	Total Fats[a]	1	5.9%	1	5.8%	1	5.2%

[a] Includes added fats such as butter, margarine, dressings and sauces, vegetable oil, etc.; does not include fats eaten as components of other foods such as meats.
[b] All individuals in this sample group consumed 0 grams/day of fish. Therefore, only low-end consumers are reported.
[c] Only one individual in this sample group consumed more than 0 grams/day of fish. Therefore, this sample is reported in the high-end consumer group and all other samples are placed in the low-end consumer group.
[d] All individuals in this sample group below the 80th percentile consumed 0 grams/day of fish. Therefore, only high-end and low-end consumer groups are reported.

Source: Based on U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 14-10. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Fruit and Vegetable Intake

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age Birth to <1 month (g/day, as consumed)[b]							Age Birth to <1 month (g/kg-day, as consumed)[b]						
Total Foods	49	100.0%	-	-	101	100.0%	Total Foods	14	100.0%	-	-	29	100.0%
Total Dairy	34	69.7%	-	-	21	21.1%	Total Dairy	10	69.6%	-	-	6	19.4%
Total Meats	0	0.0%	-	-	0	0.0%	Total Meats	0	0.0%	-	-	0	0.0%
Total Fish	0	0.0%	-	-	0	0.0%	Total Fish	0	0.0%	-	-	0	0.0%
Total Eggs	0	0.0%	-	-	0	0.0%	Total Eggs	0	0.0%	-	-	0	0.0%
Total Grains	1	1.2%	-	-	0.21	0.2%	Total Grains	0	1.3%	-	-	0	0.2%
Total Vegetables	0	0.0%	-	-	44	43.3%	Total Vegetables	0	0.0%	-	-	13	44.8%
Total Fruits	0	0.0%	-	-	8	7.6%	Total Fruits	0	0.0%	-	-	2	6.4%
Total Fats[a]	14	29.1%	-	-	25	24.8%	Total Fats[a]	4	29.1%	-	-	7	25.4%
Age 1 to <3 months (g/day, as consumed)[b]							Age 1 to <3 months (g/kg-day, as consumed)[b]						
Total Foods	49	100.0%	-	-	171	100.0%	Total Foods	11	100.0%	-	-	35	100.0%
Total Dairy	34	69.2%	-	-	16	9.5%	Total Dairy	7	69.4%	-	-	4	11.5%
Total Meats	0	0.0%	-	-	0	0.0%	Total Meats	0	0.0%	-	-	0	0.0%
Total Fish	0	0.0%	-	-	0	0.0%	Total Fish	0	0.0%	-	-	0	0.0%
Total Eggs	0	0.0%	-	-	0	0.0%	Total Eggs	0	0.0%	-	-	0	0.0%
Total Grains	1	1.9%	-	-	2	1.0%	Total Grains	0	1.7%	-	-	0	1.1%
Total Vegetables	0	0.0%	-	-	89	52.0%	Total Vegetables	0	0.0%	-	-	16	46.8%
Total Fruits	0	0.0%	-	-	18	10.2%	Total Fruits	0	0.0%	-	-	5	13.9%
Total Fats[a]	14	28.9%	-	-	40	23.4%	Total Fats[a]	3	29.0%	-	-	8	22.7%
Age 3 to <6 months (g/day, as consumed)							Age 3 to <6 months (g/kg-day, as consumed)						
Total Foods	69	100.0%	144	100.0%	495	100.0%	Total Foods	11	100.0%	21	100.0%	70	100.0%
Total Dairy	47	68.0%	51	35.6%	49	9.9%	Total Dairy	7	68.1%	8	37.2%	7	10.1%
Total Meats	0	0.0%	2	1.3%	4	0.8%	Total Meats	0	0.0%	0	1.5%	1	0.7%
Total Fish	0	0.0%	0	0.3%	0	0.0%	Total Fish	0	0.0%	0	0.3%	0	0.0%
Total Eggs	0	0.0%	1	0.4%	0	0.0%	Total Eggs	0	0.0%	0	0.5%	0	0.0%
Total Grains	2	3.3%	10	6.7%	12	2.4%	Total Grains	0	3.2%	1	6.6%	2	2.6%
Total Vegetables	0	0.0%	24	16.6%	88	17.7%	Total Vegetables	0	0.0%	3	15.1%	12	17.7%
Total Fruits	0	0.0%	29	19.9%	311	62.8%	Total Fruits	0	0.0%	4	20.8%	44	62.4%
Total Fats[a]	20	28.4%	25	17.7%	27	5.4%	Total Fats[a]	3	28.5%	4	16.9%	4	5.5%

Table 14-10. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Fruit and Vegetable Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age 6 to <12 months (g/day, as consumed)							Age 6 to <12 months (g/kg-day, as consumed)						
Total Foods	189	100.0%	461	100.0%	951	100.0%	Total Foods	21	100.0%	57	100.0%	100	100.0%
Total Dairy	91	48.3%	129	28.0%	207	21.8%	Total Dairy	10	48.1%	19	33.2%	18	17.9%
Total Meats	8	4.0%	17	3.6%	37	3.9%	Total Meats	1	3.6%	2	4.3%	4	3.8%
Total Fish	1	0.4%	1	0.2%	0	0.0%	Total Fish	0	0.4%	0	0.1%	0	0.0%
Total Eggs	4	1.9%	9	1.9%	8	0.8%	Total Eggs	0	1.7%	1	1.0%	1	0.7%
Total Grains	23	12.1%	31	6.8%	41	4.3%	Total Grains	2	11.4%	4	6.5%	5	4.6%
Total Vegetables	18	9.4%	83	18.1%	160	16.8%	Total Vegetables	2	9.3%	10	16.9%	19	19.0%
Total Fruits	15	7.7%	158	34.3%	459	48.2%	Total Fruits	2	8.4%	18	30.8%	50	49.5%
Total Fats[a]	31	16.3%	31	6.8%	35	3.6%	Total Fats[a]	3	16.8%	4	6.6%	4	3.9%
Age 1 to <2 years (g/day, as consumed)							Age 1 to <2 years (g/kg-day, as consumed)						
Total Foods	796	100.0%	1,048	100.0%	1,499	100.0%	Total Foods	68	100.0%	88	100.0%	133	100.0%
Total Dairy	578	72.7%	535	51.0%	425	28.4%	Total Dairy	49	71.8%	44	49.6%	39	29.5%
Total Meats	35	4.5%	46	4.4%	62	4.2%	Total Meats	3	4.7%	4	4.5%	5	3.6%
Total Fish	1	0.1%	3	0.3%	5	0.4%	Total Fish	0	0.2%	0	0.3%	0	0.2%
Total Eggs	8	1.0%	16	1.5%	17	1.1%	Total Eggs	1	1.1%	1	1.2%	2	1.2%
Total Grains	49	6.2%	65	6.2%	77	5.1%	Total Grains	4	6.2%	6	6.9%	7	5.2%
Total Vegetables	56	7.1%	123	11.7%	179	11.9%	Total Vegetables	5	7.1%	11	12.6%	15	11.6%
Total Fruits	26	3.2%	210	20.1%	687	45.8%	Total Fruits	2	3.4%	18	20.5%	60	45.4%
Total Fats[a]	36	4.6%	41	3.9%	39	2.6%	Total Fats[a]	3	4.7%	3	3.7%	4	2.7%
Age 2 to <3 years (g/day, as consumed)							Age 2 to <3 years (g/kg-day, as consumed)						
Total Foods	601	100.0%	942	100.0%	1,589	100.0%	Total Foods	43	100.0%	69	100.0%	114	100.0%
Total Dairy	308	51.2%	352	37.4%	384	24.1%	Total Dairy	22	51.3%	27	39.3%	27	23.6%
Total Meats	53	8.8%	59	6.3%	64	4.0%	Total Meats	4	8.8%	4	6.0%	4	3.8%
Total Fish	2	0.3%	4	0.5%	5	0.3%	Total Fish	0	0.3%	0	0.4%	0	0.4%
Total Eggs	14	2.3%	18	2.0%	20	1.3%	Total Eggs	1	2.3%	1	1.9%	2	1.4%
Total Grains	72	12.0%	80	8.5%	91	5.7%	Total Grains	5	12.0%	6	8.6%	7	5.7%
Total Vegetables	81	13.4%	141	15.0%	202	12.7%	Total Vegetables	6	13.8%	10	14.0%	14	12.4%
Total Fruits	24	4.0%	237	25.1%	765	48.1%	Total Fruits	2	3.7%	17	24.6%	56	49.1%
Total Fats[a]	38	6.3%	40	4.2%	46	2.9%	Total Fats[a]	3	6.3%	3	4.1%	3	2.9%

Table 14-10. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Fruit and Vegetable Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age3 to <6 years (g/day, as consumed)							Age 3 to <6 years (g/kg-day, as consumed)						
Total Foods	731	100.0%	1,014	100.0%	1,594	100.0%	Total Foods	40	100.0%	58	100.0%	95	100.0%
Total Dairy	388	53.1%	385	38.0%	401	25.1%	Total Dairy	21	52.7%	22	38.2%	25	25.8%
Total Meats	60	8.2%	74	7.3%	81	5.1%	Total Meats	3	8.6%	4	7.0%	5	4.8%
Total Fish	4	0.5%	7	0.7%	9	0.6%	Total Fish	0	0.4%	0	0.6%	0	0.5%
Total Eggs	13	1.7%	14	1.4%	21	1.3%	Total Eggs	1	1.6%	1	1.4%	1	1.1%
Total Grains	92	12.5%	96	9.4%	113	7.1%	Total Grains	5	12.4%	6	10.3%	7	6.8%
Total Vegetables	92	12.5%	174	17.1%	231	14.5%	Total Vegetables	5	13.0%	10	16.5%	13	13.9%
Total Fruits	27	3.6%	199	19.6%	668	41.9%	Total Fruits	1	3.4%	11	19.5%	41	42.5%
Total Fats[a]	45	6.1%	49	4.9%	53	3.3%	Total Fats[a]	2	6.1%	3	4.9%	3	3.3%
Age 6 to <11 years (g/day, as consumed)							Age 6 to <11 years (g/kg-day, as consumed)						
Total Foods	784	100.0%	1,068	100.0%	1,664	100.0%	Total Foods	23	100.0%	38	100.0%	64	100.0%
Total Dairy	385	49.2%	406	38.0%	448	26.9%	Total Dairy	11	47.0%	14	37.6%	18	27.5%
Total Meats	76	9.7%	88	8.3%	98	5.9%	Total Meats	2	10.1%	3	8.9%	4	5.7%
Total Fish	5	0.6%	6	0.6%	8	0.5%	Total Fish	0	0.8%	0	0.4%	0	0.5%
Total Eggs	16	2.1%	16	1.5%	17	1.0%	Total Eggs	1	2.3%	1	1.5%	1	1.2%
Total Grains	105	13.3%	117	11.0%	127	7.6%	Total Grains	3	13.8%	5	11.8%	5	8.1%
Total Vegetables	103	13.2%	213	19.9%	313	18.8%	Total Vegetables	3	13.8%	7	19.1%	11	17.7%
Total Fruits	26	3.4%	144	13.5%	559	33.6%	Total Fruits	1	3.6%	5	13.3%	22	33.6%
Total Fats[a]	48	6.2%	59	5.5%	64	3.9%	Total Fats[a]	1	6.4%	2	5.4%	3	3.9%
Age 11 to <16 years (g/day, as consumed)							Age 11 to <16 years (g/kg-day, as consumed)						
Total Foods	709	100.0%	1,149	100.0%	1,911	100.0%	Total Foods	12	100.0%	23	100.0%	39	100.0%
Total Dairy	301	42.4%	362	31.5%	395	20.7%	Total Dairy	5	42.0%	8	33.1%	9	22.3%
Total Meats	91	12.8%	112	9.7%	146	7.7%	Total Meats	1	12.4%	2	9.8%	3	6.4%
Total Fish	3	0.4%	10	0.8%	14	0.7%	Total Fish	0	0.5%	0	0.5%	0	0.5%
Total Eggs	13	1.8%	20	1.7%	24	1.3%	Total Eggs	0	1.9%	0	1.7%	1	1.5%
Total Grains	106	15.0%	136	11.8%	165	8.6%	Total Grains	2	14.8%	3	12.1%	3	8.8%
Total Vegetables	125	17.7%	286	24.9%	458	24.0%	Total Vegetables	2	18.2%	5	23.0%	9	22.4%
Total Fruits	13	1.9%	136	11.8%	597	31.2%	Total Fruits	0	2.2%	3	12.3%	13	32.3%
Total Fats[a]	49	6.9%	66	5.8%	87	4.5%	Total Fats[a]	1	7.0%	1	5.9%	2	4.2%

Table 14-10. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Fruit and Vegetable Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age 16 to <21 years (g/day, as consumed)						
Total Foods	624	100.0%	970	100.0%	2,353	100.0%
Total Dairy	238	38.1%	203	21.0%	449	19.1%
Total Meats	76	12.2%	112	11.5%	245	10.4%
Total Fish	8	1.2%	15	1.6%	17	0.7%
Total Eggs	21	3.3%	16	1.6%	30	1.3%
Total Grains	100	16.1%	138	14.2%	211	9.0%
Total Vegetables	109	17.5%	283	29.2%	615	26.1%
Total Fruits	18	2.9%	121	12.5%	644	27.4%
Total Fats[a]	46	7.3%	66	6.8%	116	4.9%
Age 20 years and older (g/day, as consumed)						
Total Foods	602	100.0%	1,040	100.0%	1,920	100.0%
Total Dairy	178	29.6%	215	20.6%	282	14.7%
Total Meats	99	16.4%	129	12.4%	168	8.7%
Total Fish	11	1.8%	15	1.4%	23	1.2%
Total Eggs	21	3.5%	23	2.2%	28	1.5%
Total Grains	105	17.5%	131	12.6%	177	9.2%
Total Vegetables	115	19.1%	306	29.4%	527	27.4%
Total Fruits	16	2.6%	138	13.3%	610	31.7%
Total Fats[a]	45	7.5%	64	6.2%	83	4.3%

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age 16 to <21 years (g/kg-day, as consumed)						
Total Foods	9	100.0%	16	100.0%	34	100.0%
Total Dairy	4	39.0%	3	21.0%	6	17.8%
Total Meats	1	11.7%	2	12.7%	3	9.6%
Total Fish	0	1.4%	0	0.8%	0	0.6%
Total Eggs	0	3.4%	0	2.5%	0	1.0%
Total Grains	1	16.2%	2	14.6%	3	10.0%
Total Vegetables	2	17.9%	5	30.7%	9	25.8%
Total Fruits	0	1.8%	1	9.1%	10	30.0%
Total Fats[a]	1	7.2%	1	7.5%	2	4.4%
Age 20 years and older (g/kg-day, as consumed)						
Total Foods	8	100.0%	14	100.0%	27	100.0%
Total Dairy	2	28.6%	3	20.3%	4	14.7%
Total Meats	1	16.9%	2	13.0%	2	7.5%
Total Fish	0	1.8%	0	1.2%	0	1.3%
Total Eggs	0	3.4%	0	2.1%	0	1.3%
Total Grains	1	17.8%	2	13.2%	2	9.0%
Total Vegetables	2	19.6%	4	29.7%	7	27.2%
Total Fruits	0	2.5%	2	12.5%	9	33.9%
Total Fats[a]	1	7.7%	1	6.3%	1	3.8%

[a] Includes added fats such as butter, margarine, dressings and sauces, vegetable oil, etc; does not include fats eaten as components of other foods such as meats.
[b] All individuals in this sample group below the 75th percentile consumed 0 grams/day of fruits and vegetables. Therefore, only high-end and low-end consumer groups are reported.

Source: Based on U.S. EPA analysis of 1994-96, 1998 CSFII.

Table 14-11. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Dairy Intake

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age Birth to <1 month (g/day, as consumed)							Age Birth to <1 month (g/kg-day, as consumed)						
Total Foods	12	100.0%	60	100.0%	185	100.0%	Total Foods	4	100.0%	18	100.0%	56	100.0%
Total Dairy	0	0.0%	40	67.3%	127	69.0%	Total Dairy	0	0.0%	12	67.1%	39	69.0%
Total Meats	0	0.0%	0	0.0%	0	0.0%	Total Meats	0	0.0%	0	0.0%	0	0.0%
Total Fish	0	0.0%	0	0.0%	0	0.0%	Total Fish	0	0.0%	0	0.0%	0	0.0%
Total Eggs	0	0.0%	0	0.0%	0	0.0%	Total Eggs	0	0.0%	0	0.0%	0	0.0%
Total Grains	0	0.3%	0	0.0%	4	2.2%	Total Grains	0	0.2%	0	0.0%	1	2.1%
Total Vegetables	8	66.1%	2	3.4%	1	0.4%	Total Vegetables	2	64.4%	1	3.7%	0	0.5%
Total Fruits	0	0.0%	0	0.0%	0	0.0%	Total Fruits	0	0.0%	0	0.0%	0	0.0%
Total Fats[a]	3	27.1%	18	29.2%	52	28.4%	Total Fats[a]	1	27.5%	5	29.2%	16	28.4%
Age 1 to <3 months (g/day, as consumed)							Age 1 to <3 months (g/kg-day, as consumed)						
Total Foods	36	100.0%	84	100.0%	166	100.0%	Total Foods	7	100.0%	14	100.0%	41	100.0%
Total Dairy	0	0.0%	19	22.4%	109	65.6%	Total Dairy	0	0.0%	3	24.0%	26	64.1%
Total Meats	0	0.0%	0	0.0%	0	0.0%	Total Meats	0	0.0%	0	0.0%	0	0.0%
Total Fish	0	0.0%	0	0.0%	0	0.0%	Total Fish	0	0.0%	0	0.0%	0	0.0%
Total Eggs	0	0.0%	0	0.0%	0	0.0%	Total Eggs	0	0.0%	0	0.0%	0	0.0%
Total Grains	0	0.9%	1	1.2%	0	0.8%	Total Grains	0	0.8%	0	2.0%	0	0.6%
Total Vegetables	21	58.8%	42	50.7%	4	2.7%	Total Vegetables	4	57.8%	7	48.7%	0	1.1%
Total Fruits	2	4.3%	0	0.0%	6	3.7%	Total Fruits	0	5.4%	0	0.0%	3	7.7%
Total Fats[a]	10	26.7%	21	25.4%	45	27.2%	Total Fats[a]	2	26.4%	4	25.0%	11	26.5%
Age 3 to <6 months (g/day, as consumed)							Age 3 to <6 months (g/kg-day, as consumed)						
Total Foods	132	100.0%	217	100.0%	346	100.0%	Total Foods	19	100.0%	32	100.0%	44	100.0%
Total Dairy	0	0.0%	59	27.0%	160	46.3%	Total Dairy	0	0.0%	8	24.8%	24	54.9%
Total Meats	1	0.4%	2	1.0%	4	1.1%	Total Meats	0	0.5%	0	0.7%	0	1.0%
Total Fish	0	0.0%	0	0.0%	0	0.1%	Total Fish	0	0.0%	0	0.0%	0	0.1%
Total Eggs	0	0.0%	0	0.2%	1	0.2%	Total Eggs	0	0.0%	0	0.3%	0	0.1%
Total Grains	6	4.5%	8	3.8%	12	3.4%	Total Grains	1	4.5%	1	3.8%	2	3.4%
Total Vegetables	46	34.9%	37	17.0%	26	7.6%	Total Vegetables	7	35.6%	4	13.7%	2	5.0%
Total Fruits	58	44.1%	84	38.8%	87	25.1%	Total Fruits	8	43.0%	14	45.8%	7	15.9%
Total Fats[a]	16	11.9%	26	12.1%	55	15.8%	Total Fats[a]	2	12.2%	3	10.7%	8	19.2%

Table 14-11. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Dairy Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age 6 to <12 months (g/day, as consumed)						
Total Foods	317	100.0%	368	100.0%	1,285	100.0%
Total Dairy	0	0.0%	71	19.2%	833	64.8%
Total Meats	11	3.4%	16	4.4%	41	3.2%
Total Fish	0	0.0%	1	0.3%	0	0.0%
Total Eggs	3	0.9%	5	1.4%	6	0.5%
Total Grains	27	8.6%	23	6.3%	46	3.6%
Total Vegetables	114	35.9%	75	20.4%	106	8.2%
Total Fruits	137	43.3%	147	39.9%	211	16.4%
Total Fats[a]	20	6.4%	30	8.2%	40	3.1%
Age 1 to <2 years (g/day, as consumed)						
Total Foods	601	100.0%	989	100.0%	1,700	100.0%
Total Dairy	40	6.7%	451	45.6%	1,170	68.8%
Total Meats	43	7.1%	51	5.2%	45	2.6%
Total Fish	3	0.5%	4	0.4%	3	0.2%
Total Eggs	14	2.3%	15	1.5%	18	1.1%
Total Grains	57	9.5%	65	6.5%	63	3.7%
Total Vegetables	139	23.1%	120	12.1%	112	6.6%
Total Fruits	268	44.7%	240	24.3%	226	13.3%
Total Fats[a]	29	4.8%	38	3.8%	58	3.4%
Age 2 to <3 years (g/day, as consumed)						
Total Foods	661	100.0%	996	100.0%	1,528	100.0%
Total Dairy	48	7.3%	348	34.9%	885	57.9%
Total Meats	61	9.3%	63	6.3%	55	3.6%
Total Fish	2	0.3%	6	0.6%	5	0.3%
Total Eggs	25	3.8%	20	2.1%	19	1.3%
Total Grains	78	11.9%	82	8.2%	86	5.6%
Total Vegetables	163	24.7%	144	14.5%	137	9.0%
Total Fruits	237	35.8%	279	28.0%	277	18.1%
Total Fats[a]	37	5.5%	41	4.1%	55	3.6%

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age 6 to <12 months (g/kg-day, as consumed)						
Total Foods	36	100.0%	43	100.0%	135	100.0%
Total Dairy	0	0.0%	8	18.2%	87	64.8%
Total Meats	1	3.5%	2	4.8%	4	3.0%
Total Fish	0	0.0%	0	0.3%	0	0.0%
Total Eggs	0	1.0%	1	2.1%	1	0.5%
Total Grains	3	7.9%	3	7.7%	5	3.5%
Total Vegetables	13	35.3%	8	17.9%	11	8.2%
Total Fruits	16	44.6%	18	40.7%	22	16.6%
Total Fats[a]	2	6.3%	4	8.1%	4	3.1%
Age 1 to <2 years (g/kg-day, as consumed)						
Total Foods	55	100.0%	86	100.0%	154	100.0%
Total Dairy	3	6.1%	38	44.0%	106	68.5%
Total Meats	4	7.2%	4	4.8%	4	2.6%
Total Fish	0	0.5%	1	0.6%	0	0.1%
Total Eggs	1	2.3%	2	1.8%	1	0.8%
Total Grains	5	9.5%	6	6.9%	6	3.7%
Total Vegetables	12	21.8%	11	13.0%	10	6.7%
Total Fruits	25	46.3%	21	24.5%	21	13.8%
Total Fats[a]	3	4.7%	3	3.7%	5	3.4%
Age 2 to <3 years (g/kg-day, as consumed)						
Total Foods	47	100.0%	72	100.0%	114	100.0%
Total Dairy	3	7.2%	24	33.7%	67	58.4%
Total Meats	4	9.4%	4	6.2%	4	3.6%
Total Fish	0	0.3%	0	0.4%	0	0.2%
Total Eggs	2	3.7%	1	1.5%	1	1.3%
Total Grains	5	11.6%	6	8.5%	6	5.7%
Total Vegetables	12	24.6%	10	14.0%	11	9.3%
Total Fruits	17	36.4%	22	30.2%	20	17.3%
Total Fats[a]	3	5.5%	3	4.2%	4	3.6%

Table 14-11. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Dairy Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers		Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent		Intake	Percent	Intake	Percent	Intake	Percent
Age3 to <6 years (g/day, as consumed)							Age 3 to <6 years (g/kg-day, as consumed)						
Total Foods	725	100.0%	1,047	100.0%	1,612	100.0%	Total Foods	41	100.0%	58	100.0%	97	100.0%
Total Dairy	64	8.9%	355	33.9%	886	55.0%	Total Dairy	4	8.8%	20	34.2%	52	54.0%
Total Meats	75	10.4%	72	6.9%	70	4.3%	Total Meats	4	10.6%	4	6.6%	4	4.4%
Total Fish	4	0.6%	6	0.5%	6	0.4%	Total Fish	0	0.5%	0	0.5%	0	0.3%
Total Eggs	19	2.6%	15	1.4%	18	1.1%	Total Eggs	1	2.6%	1	1.5%	1	1.0%
Total Grains	87	12.1%	104	9.9%	116	7.2%	Total Grains	5	12.1%	6	9.9%	7	7.2%
Total Vegetables	168	23.2%	173	16.5%	183	11.3%	Total Vegetables	10	23.8%	9	16.3%	11	11.6%
Total Fruits	253	34.9%	257	24.5%	251	15.6%	Total Fruits	14	34.0%	14	24.7%	16	16.5%
Total Fats[a]	40	5.6%	49	4.7%	63	3.9%	Total Fats[a]	2	5.7%	3	4.7%	4	4.0%
Age 6 to <11 years (g/day, as consumed)							Age 6 to <11 years (g/kg-day, as consumed)						
Total Foods	766	100.0%	1,053	100.0%	1,722	100.0%	Total Foods	25	100.0%	38	100.0%	67	100.0%
Total Dairy	63	8.2%	372	35.4%	892	51.8%	Total Dairy	2	8.1%	13	34.2%	35	51.9%
Total Meats	99	12.9%	80	7.6%	87	5.1%	Total Meats	3	13.2%	2	8.0%	3	4.9%
Total Fish	6	0.8%	5	0.5%	6	0.4%	Total Fish	0	0.8%	0	0.5%	0	0.4%
Total Eggs	17	2.2%	14	1.3%	17	1.0%	Total Eggs	1	2.3%	1	1.8%	1	0.9%
Total Grains	105	13.7%	113	10.7%	152	8.8%	Total Grains	3	13.6%	4	10.7%	6	9.0%
Total Vegetables	221	28.9%	214	20.3%	242	14.0%	Total Vegetables	7	29.5%	8	19.7%	9	13.7%
Total Fruits	194	25.3%	175	16.6%	227	13.2%	Total Fruits	6	24.4%	7	17.8%	9	13.5%
Total Fats[a]	49	6.4%	56	5.3%	70	4.1%	Total Fats[a]	2	6.6%	2	5.2%	3	4.2%
Age 11 to <16 years (g/day, as consumed)							Age 11 to <16 years (g/kg-day, as consumed)						
Total Foods	747	100.0%	1,094	100.0%	2,020	100.0%	Total Foods	13	100.0%	22	100.0%	42	100.0%
Total Dairy	22	3.0%	307	28.0%	1,017	50.3%	Total Dairy	0	2.9%	6	27.3%	21	49.4%
Total Meats	102	13.6%	101	9.2%	134	6.7%	Total Meats	2	13.8%	2	9.6%	3	6.4%
Total Fish	8	1.1%	9	0.8%	12	0.6%	Total Fish	0	1.0%	0	0.6%	0	0.8%
Total Eggs	20	2.7%	18	1.6%	25	1.2%	Total Eggs	0	2.6%	0	1.7%	1	1.2%
Total Grains	104	13.9%	133	12.2%	181	9.0%	Total Grains	2	13.7%	3	12.2%	4	9.1%
Total Vegetables	239	32.0%	265	24.2%	322	16.0%	Total Vegetables	4	33.0%	5	23.3%	6	15.1%
Total Fruits	197	26.4%	180	16.4%	204	10.1%	Total Fruits	3	25.7%	4	17.8%	5	11.9%
Total Fats[a]	47	6.2%	62	5.6%	100	5.0%	Total Fats[a]	1	6.2%	1	5.9%	2	4.8%

Table 14-11. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-end, Mid-range, and High-end Total Dairy Intake (continued)

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age 16 to <21 years (g/day, as consumed)						
Total Foods	647	100.0%	1,095	100.0%	2,233	100.0%
Total Dairy	8	1.2%	197	18.0%	950	42.5%
Total Meats	101	15.7%	125	11.4%	197	8.8%
Total Fish	8	1.2%	16	1.5%	8	0.4%
Total Eggs	12	1.8%	28	2.5%	27	1.2%
Total Grains	90	13.9%	162	14.8%	217	9.7%
Total Vegetables	228	35.2%	324	29.6%	438	19.6%
Total Fruits	152	23.5%	154	14.1%	249	11.2%
Total Fats[a]	37	5.8%	73	6.7%	114	5.1%
Age 20 years and older (g/day, as consumed)						
Total Foods	741	100.0%	1,030	100.0%	1,810	100.0%
Total Dairy	9	1.2%	155	15.1%	725	40.1%
Total Meats	117	15.8%	129	12.6%	156	8.6%
Total Fish	16	2.2%	16	1.6%	19	1.1%
Total Eggs	20	2.7%	23	2.3%	26	1.4%
Total Grains	113	15.2%	130	12.6%	176	9.7%
Total Vegetables	258	34.8%	304	29.6%	361	20.0%
Total Fruits	159	21.4%	189	18.4%	226	12.5%
Total Fats[a]	42	5.6%	62	6.0%	89	4.9%

Food Group	Low-end Consumers		Mid-range Consumers		High-end Consumers	
	Intake	Percent	Intake	Percent	Intake	Percent
Age 16 to <21 years (g/kg-day, as consumed)						
Total Foods	10	100.0%	17	100.0%	33	100.0%
Total Dairy	0	1.2%	3	16.6%	14	42.8%
Total Meats	2	15.1%	2	13.6%	3	8.9%
Total Fish	0	1.1%	0	0.9%	0	0.3%
Total Eggs	0	1.7%	0	2.2%	0	1.2%
Total Grains	1	14.1%	2	14.0%	3	9.6%
Total Vegetables	4	35.8%	5	28.6%	7	20.0%
Total Fruits	2	23.9%	3	16.1%	3	10.6%
Total Fats[a]	1	5.6%	1	6.5%	2	5.1%
Age 20 years and older (g/kg-day, as consumed)						
Total Foods	10	100.0%	14	100.0%	25	100.0%
Total Dairy	0	1.2%	2	14.8%	10	41.0%
Total Meats	2	15.8%	2	12.3%	2	7.3%
Total Fish	0	2.1%	0	1.6%	0	1.0%
Total Eggs	0	2.7%	0	2.3%	0	1.4%
Total Grains	2	15.0%	2	12.5%	2	9.5%
Total Vegetables	4	34.5%	4	29.5%	5	19.4%
Total Fruits	2	21.9%	3	19.4%	3	14.2%
Total Fats[a]	1	5.5%	1	5.9%	1	4.5%

[a] Includes added fats such as butter, margarine, dressings and sauces, vegetable oil, etc; does not include fats eaten as components of other foods such as meats.

Source: Based on U.S. EPA analysis of 1994-96, 1998 CSFII.

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15 HUMAN MILK INTAKE

15.1 INTRODUCTION

Human lactation is known to impart a wide range of benefits to nursing infants, including protection against infection, increases in cognitive development, and avoidance of allergies due to intolerance to cow's milk (AAP, 2005). Ingestion of human milk has also been associated with a reduction in risk of postneonatal death in the U.S. (Chen and Rogan, 2004). The American Academy of Pediatrics recommends exclusive breastfeeding for approximately the first six months and supports the continuation of breastfeeding for the first year and beyond if desired by the mother and child (AAP, 2005). However, contaminants may find their way into human milk of lactating mothers because mothers are themselves exposed, thus, making human milk a potential source of exposure to toxic substances for nursing infants. Lipid soluble chemical compounds accumulate in body fat and may be transferred to breast-fed infants in the lipid portion of human milk. Water soluble chemicals may also partition into the aqueous phase and be excreted via human milk. Because nursing infants obtain most (if not all) of their dietary intake from human milk, they are especially vulnerable to exposures to these compounds. Estimating the magnitude of the potential dose to infants from human milk requires information on the milk intake rate (quantity of human milk consumed per day) and the duration (months) over which breast-feeding occurs. Information on the fat content of human milk is also needed for estimating dose from human milk residue concentrations that have been indexed to lipid content.

Several studies have generated data on human milk intake. Typically, human milk intake has been measured over a 24-hour period by weighing the infant before and after each feeding without changing its clothing (test weighing). The sum of the difference between the measured weights over the 24-hour period is assumed to be equivalent to the amount of human milk consumed daily. Intakes measured using this procedure are often corrected for evaporative water losses (insensible water losses) between infant weighings (NAS, 1991). Neville et al. (1988) evaluated the validity of the test weight approach among bottle-fed infants by comparing the weights of milk taken from bottles with the differences between the infants' weights before and after feeding. When test weight data were corrected for insensible weight loss, they were not significantly different from bottle weights. Conversions between weight and volume of human milk consumed are made using the density of human milk (approximately 1.03 g/mL) (NAS, 1991). Techniques for measuring human milk intake using stable isotopes such as deuterium have been developed. The advantages of these techniques over test weighing procedures are that they are less burdensome for the mother and do not interfere with normal behavior (Albernaz et al., 2002). However, few data based on this technique were found in the literature.

Among infants born in 2004, 73.8% were breastfed postpartum, 41.5% at 6 months, and 20.9% at 12 months. Studies among nursing mothers in industrialized countries have shown that average intakes among infants ranged from approximately 500 to 800 mL/day, with the highest intake reported for infants 3 to <6 months old (see Table 15-1).

The recommendations for human milk intake rates and lipid intake rates are provided in the next section along with a summary of the confidence ratings for these recommendations. The recommended values are based on key studies identified by U.S. EPA for this factor. Following the recommendations, key studies on human milk intake are summarized. Relevant data on lipid content and fat intake, breast-feeding duration, and the estimated percentage of the U.S. population that breast-feeds are also presented.

A number of other studies exist in the literature, but they focus on other aspects of lactation such as growth patterns of nursing infants, supplementary food and energy intake, and nutrition of lactating mothers (Dewey et al., 1992; Drewett et al., 1993; Gonzalez-Cossio et al., 1998). These studies are not included in this chapter because they do no focus on the exposure factor of interest. Other studies in the literature focus on formula intake. Since some baby formula is prepared by adding water, these data are presented in Chapter 3 – Ingestion of Water and Other Select Liquids.

15.2 RECOMMENDATIONS

The studies described in Section 15.3 were used in selecting recommended values for human milk intake and lipid intake. Although different survey designs, testing periods, and populations were utilized by the studies to estimate intake, the mean and standard deviation estimates reported in these studies are relatively consistent. There are, however, limitations with the data. With the exception of Butte et al. (1984) and Arcus-Arth et al. (2005), data were not presented on a body weight basis. This is particularly important since intake rates may be higher on a body weight basis for younger infants. Also, the data used to derive the recommendations are over 15 years old and the sample size of the studies was small. Other populations of concern such as mothers highly committed to breastfeeding, sometimes for periods longer than 1 year, may not be captured by the studies presented in this chapter.

15.2.1 Human Milk Intake

A summary of recommended values for human milk and lipid intake rates is presented in Table 15-1 and the confidence ratings for these recommendations are presented in Table 15-2. The human milk intake rates for nursing infants that have been reported in the studies described in this section are summarized in Table 15-3 in units of mL/day and in Table 15-4 in units of mL/kg-day (i.e., indexed to body weight). It should be noted that the decrease in human milk with age is likely a result of complementary foods being introduced as the child grows and not necessarily a decrease in total energy intake. In order to conform to the new standardized age groupings used in this handbook (see Chapter 1), data from Pao et al. (1980), Dewey and Lönnerdal (1983), Butte et al. (1984), Neville et al. (1988), Dewey et al. (1991a), Dewey et al. (1991b), Butte et al. (2000) and Arcus-Arth et al. (2005) were compiled for each month of the first year of life. Recommendations were converted to mL/day using a density of human milk of 1.03 g/mL rounded up to two significant figures. Only two studies (i.e., Butte et al., 1984 and Arcus-Arth et al., 2005) provided data on a body weight basis. For some months multiple studies were available; for others only one study was available. Weighted means were calculated for each age in months. When upper percentiles were not available from a study, these were estimated by adding two standard deviations to the mean value. Recommendations for upper percentiles, when multiple studies were available, were calculated as the midpoint of the range of upper percentile values of the studies available for each age in months. These month-by-month intakes were composited to yield intake rates for the standardized age groups by calculating a weighted average. Recommendations are provided for the population of exclusively breastfed infants since this population may have higher exposures than partially breastfed infants. Exclusively breastfed in this chapter refers to infants whose sole source of milk comes from human milk, with no other milk substitutes. Partially breastfed refers to infants whose source of milk comes from both human milk and other milk substitutes (i.e., formula). Note that some studies define partially breastfed as infants whose dietary intake comes from not only human milk and formula, but also from other solid foods (e.g., strained fruits, vegetables, meats).

15.2.2 Lipid Content and Lipid Intake

Recommended lipid intake rates are presented in Table 15-5. The table parallels the human milk intake tables (Table 15-3). With the exception of the data from Butte et al. (1984), the rates were calculated assuming a lipid content of 4% (Butte et al., 1984; NAS, 1991; Maxwell and Burmaster, 1993). In the case of the Butte et al. (1984) study, lipid intake rates were provided, and were used in place of the estimated lipid intakes. Lipid intake rates on a body weight basis are presented in Table 15-6. These were calculated from the values presented in Table 15-4 multiplied by 4% lipid content.

Table 15-1. Recommended Values for Human Milk And Lipid Intake Rates for Exclusively Breastfed Infants					
Age Group	Mean		Upper Percentile[a]		Source
	mL/day	mL/kg-day	mL/day	mL/kg-day	
Human Milk Intake					
Birth to <1 month	510	150	950	220	b, i
1 to <3 months	690	140	980	190	b, c, d, e
3 to <6 months	770	110	1,000	150	b, c, d, e, f, g, h
6 to <12 months	620	83	1,000	130	b, c, e, f, g, h
Lipid Intake [i]					
Birth to <1 month	20	6.0	38	8.7	h
1 to <3 months	27	5.5	40	8.0	d, h
3 to <6 months	30	4.2	42	6.1	d, h
6 to <12 months	25	3.3	42	5.2	h

a Upper percentile is reported as mean plus 2 standard deviations.
b Neville et al., 1988.
c Pao et al., 1980.
d Butte et al., 1984.
e Dewey and Lönnerdal, 1983.
f Butte et al., 2000.
g Dewey et al., 1991b.
h Arcus- Arth et al., 2005.
i The recommended value for the lipid content of human milk is 4.0 percent. See Section 15.4.

Table 15-2. Confidence in Recommendations for Human Milk Intake		
General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	Methodology uses changes in body weight as a surrogate for total ingestion. More sophisticated techniques measuring stable isotopes have been developed, but data with this technique were not available. Sample sizes were relatively small (7-108). Mothers selected for the studies were volunteers. The studies analyzed primary data.	
Minimal (or defined) Bias	Mothers were instructed in the use of infant scales to minimize measurement errors. Three out of the 8 studies indicated correcting data for insensible water loss. Some biases may be introduced by including partially-breastfed infants.	
Applicability and Utility		Medium
Exposure Factor of Interest	The studies focused on estimating human milk intake.	
Representativeness	Most studies focused on the U.S. population, but were not national samples. Populations studied were mainly from high socioeconomic status. One study included populations from Sweden and Finland. However, this may not affect the amount of intake, but rather the prevalence and initiation of lactation.	
Currency	Studies were conducted between 1980 and 2000. However, this may not affect the amount of intake, but rather the prevalence and initiation of lactation.	
Data Collection Period	Infants were not studied long enough to fully characterize day to day variability.	
Clarity and Completeness		Medium
Accessibility	All key studies are available from the peer reviewed literature.	
Reproducibility	The methodology was clearly presented, but some studies did not discuss adjustments due to insensible weight loss.	
Quality Assurance	Some steps were taken to ensure data quality. For example, mothers were trained to use the scales. However, this element could not be fully evaluated from the information presented in the published studies.	
Variability and Uncertainty		Low
Variability in Population	Variability was not very well characterized. Mothers committed to breastfeeding over 1 year were not captured.	
Uncertainty	Not correcting for insensible water loss may underestimate intake.	
Evaluation and Review		High
Peer Review	The studies appeared in peer review journals.	
Number and Agreement of Studies	There are 8 key studies. The results of studies from different researchers are in agreement.	
Overall Rating		**Medium**

Table 15-3. Human Milk Intake Rates Derived from Key Studies for Exclusively Breast-fed Infants (mL/day)

Age (months)	Number of Children	Mean Intake (mL/day)	Upper Percentile Consumption (mL/day)[a]	Source	Weighted Mean Intake and Upper Percentile Consumption (across all Key Studies) (mL/day): Individual Age Mean[b]	Individual Age Upper[c]	Composite Age Groups Mean[b]	Composite Age Groups Upper[c]
0 <1	6 to 13	511	951	Neville et al., 1988	511	951	511	951
1	11	600	918	Pao et al., 1980	670	973	692	983
	37	729	981	Butte et al., 1984				
	10 to 12	679 [d]	889	Neville et al., 1988				
	16	673	1,057	Dewey and Lönnerdal, 1983				
2	10 to 12	679 [d]	889	Neville et al., 1988	713	992		
	19	756	1,096	Dewey and Lönnerdal, 1983				
	40	704	958	Butte et al., 1984				
3	2	833	-[e]	Pao et al., 1980	758	1,025	769	1,024
	37	702	924	Butte et al., 1984				
	10	713	935	Neville et al., 1988				
	16	782	1,126	Dewey and Lönnerdal, 1983				
	73	788	1,047	Dewey et al., 1991b				
	40	728	988	Butte et al., 2000				
4	12	690	888	Neville et al., 1988	739	991		
	13	810	1,094	Dewey and Lönnerdal, 1983				
	41	718	996	Butte et al., 1984				
5	12	814	1,074	Neville et al., 1988	810	1,057		
	11	805	1,039	Dewey and Lönnerdal, 1983				
6	1	682	-[ed]	Pao et al., 1980	741	1,059	622	1,024
	13	744	978	Neville et al., 1988				
	11	896	1,140	Dewey and Lönnerdal, 1983				
	60	747	1,079	Dewey et al., 1991b				
	30	637	1,050	Butte et al., 2000				
7	12	700	1,000	Neville et al., 1988	700	1,000		
8	9	604	1,012	Neville et al., 1988	604	1,012		
9	12	600	1,028	Neville et al., 1988	614	1,039		
	50	627	1,049	Dewey et al., 1991b				
10	11	535	989	Neville et al., 1988	535	989		
11	8	538	1,004	Neville et al., 1988	538	1,004		
12	8	391	877	Neville et al., 1988	410	904	410	904
	42	435	922	Dewey et al., 1991a; 1991b				
	13	403	931	Butte et al., 2000				

[a] Upper percentile is reported as mean plus 2 standard deviations.
[b] Calculated as the mean of the means.
[c] Middle of the range of upper percentiles.
[d] Calculated for infants 1 to < 2 months old.
[e] Standard deviations and upper percentiles not calculated for small sample sizes.

Table 15-4. Human Milk Intake Rates Derived from Key Studies for Exclusively Breast-fed Infants (mL/kg/day)

Age (months)	Number of Children	Mean Intake (mL/kg-day)	Upper Percentile Consumption (mL/kg-day)[a]	Source	Weighted Mean Intake and Upper Percentile Consumption (across all Key Studies) (mL/kg-day): Individual Age Mean[b]	Individual Age Upper[c]	Composite Age Groups Mean	Composite Age Groups Upper[c]
0 <1	9 to 25	150	217	Arcus-Arth et al, 2005	150	217	150	217
1	37 25	154 150	200 198	Butte et al., 1984 Arcus-Arth et al, 2005	152	199	144	187
2	40 25	125 144	161 188	Butte et al., 1984 Arcus-Arth et al, 2005	135	175		
3	37 108	114 127	152 163	Butte et al., 1984 Arcus-Arth et al, 2005	121	158	110	149
4	41 57	108 112	142 148	Butte et al., 1984 Arcus-Arth et al, 2005	110	145		
5	26	100	140	Arcus-Arth et al, 2005	100	140		
6	39	101	141	Arcus-Arth et al, 2005	101	141	83	130
7	8	75	125	Arcus-Arth et al, 2005	75	125		
9	57	72	118	Arcus-Arth et al, 2005	72	118		
12	42	47	101	Arcus-Arth et al, 2005	47	101	47	101

[a] Upper percentile is reported as mean plus 2 standard deviations.
[b] Calculated as the mean of the means.
[c] Middle of the range of upper percentiles.

Table 15-5. Lipid Intake Rates Derived from Key Studies for Exclusively Breastfed Infants (mL/day)[a]

Age (months)	Number of Children	Mean Intake (mL/day)	Upper Percentile Consumption (mL/day)[b]	Source	Weighted Mean Intake and Upper Percentile Consumption (across all Key Studies) (mL/day): Individual Age Mean[c]	Individual Age Upper[d]	Composite Age Groups Mean[c]	Composite Age Groups Upper[d]
0 <1	6 to 13	20	38	Neville et al., 1988	20	38	20	38
1	11	24	37	Pao et al., 1980	26	39	27	40
	37	27	43	Butte et al., 1984				
	10 to 12	27	36	Neville et al., 1988				
	16	27	42	Dewey and Lönnerdal, 1983				
2	10 to 12	27	36	Neville et al., 1988	27	40		
	19	30	44	Dewey and Lönnerdal, 1983				
	40	24	38	Butte et al., 1984				
3	2	33	-[e]	Pao et al., 1980	30	41	30	42
	37	23	37	Butte et al., 1984				
	10	29	37	Neville et al., 1988				
	16	31	45	Dewey and Lönnerdal, 1983				
	73	32	42	Dewey et al., 1991b				
	40	29	40	Butte et al. 2000				
4	12	28	36	Neville et al., 1988	28	40		
	13	32	44	Dewey and Lönnerdal, 1983				
	41	25	41	Butte et al., 1984				
5	12	33	43	Neville et al., 1988	33	43		
	11	32	42	Dewey and Lönnerdal, 1983				
6	1	27	-[e]	Pao et al., 1980	30	40	25	42
	13	30	39	Neville et al., 1988				
	11	36	46	Dewey and Lönnerdal, 1983				
	60	30	43	Dewey et al., 1991b				
	30	25	42	Butte et al., 2000				
7	12	28	40	Neville et al., 1988	28	40		
8	9	24	40	Neville et al., 1988	24	40		
9	12	24	41	Neville et al., 1988	24	41		
	50	25	42	Dewey et al., 1991b				
10	11	21	40	Neville et al., 1988	21	40		
11	9	22	40	Neville et al., 1988	22	40		
12	9	16	35	Neville et al., 1988	16	36	16	36
	42	17	37	Dewey et al., 1991a; 1991b				
	13	16	37	Butte et al., 2000				

[a] Except for Butte et al. 1984, values were calculated from Table 15-3 using 4% lipid content.
[b] Upper percentile is reported as mean plus 2 standard deviations.
[c] Calculated as the mean of the means.
[d] Middle of the range of upper percentiles.
[e] Standard deviations and upper percentiles not calculated for small sample sizes.

Table 15-6. Lipid Intake Rates Derived from Key Studies for Exclusively Breast-fed Infants (mL/kg/day)[a]								
Age (months)	Number of Children	Mean Intake (mL/kg-day)	Upper Percentile Consumption (mL/kg-day)[b]	Source	Weighted Mean Intake and Upper Percentile Consumption[b] (across a2ll Key Studies) (mL/kg-day)			
					Individual Age		Composite Ages Groups	
					Mean[c]	Upper[d]	Mean[e]	Upper[d]
0 <1	9 to 25	6.0	8.7	Arcus-Arth et al, 2005	6.0	8.7	6.0	8.7
1	37 25	5.7 6.0	9.1 8.7	Butte et al., 1984 Arcus-Arth et al, 2005	5.9	8.9	5.5	8.0
2	40 25	4.3 5.8	6.7 7.5	Butte et al., 1984 Arcus-Arth et al, 2005	5.1	7.1		
3	37 108	3.7 5.1	6.1 6.5	Butte et al., 1984 Arcus-Arth et al, 2005	4.4	6.3	4.2	6.1
4	41 57	3.7 4.5	6.3 5.9	Butte et al., 1984 Arcus-Arth et al, 2005	4.1	6.1		
5	26	4.0	5.6	Arcus-Arth et al, 2005	4.0	5.8		
6	39	4.0	5.6	Arcus-Arth et al, 2005	4.0	5.6	3.3	5.2
7	8	3.0	5.0	Arcus-Arth et al, 2005	3.0	5.0		
9	57	2.9	4.7	Arcus-Arth et al, 2005	2.9	4.7		
12	42	1.9	4.0	Arcus-Arth et al, 2005	1.9	4.0	1.9	4.0

[a] Except for Butte et al. 1984, values were calculated from Table 15-4 using 4% lipid content.
[b] Upper percentile is reported as mean plus 2 standard deviations.
[c] Calculated as the mean of the means.
[d] Middle of the range of upper percentiles.

15.3 KEY STUDIES ON HUMAN MILK INTAKE

15.3.1 Pao et al., 1980 - Milk Intakes and Feeding Patterns of Breast-fed Infants

Pao et al. (1980) conducted a study of 22 healthy nursing infants to estimate human milk intake rates. Infants were categorized as completely breast-fed or partially breast-fed. Breastfeeding mothers were recruited through LaLeche League groups. Except for one black infant, all other infants were from white middle-class families in southwestern Ohio. The goal of the study was to enroll infants as close to one month of age as possible and to obtain records near one, three, six, and nine months of age (Pao et al., 1980). However, not all mother/infant pairs participated at each time interval. Data were collected for these 22 infants using the test weighing method. Records were collected for three consecutive 24-hour periods at each test interval. The weight of human milk was converted to volume by assuming a density of 1.03 g/mL. Daily intake rates were calculated for each infant based on the mean of the three 24-hour periods. Mean daily human milk intake rates for the infants surveyed at each time interval are presented in Table 15-7. These data (Table 15-7) are presented as they are reported in Pao et al. (1980). For completely breast-fed infants, the mean intake rates were 600 mL/day at 1 month of age, 833 mL/day at 3 months of age, and 682 mL/day at 6 months of age. Partially breast-fed infants had mean intake rates of 485 mL/day, 467 mL/day, 395 mL/day, and <554 mL/day at 1, 3, 6, and 9 months of age, respectively. Pao et al. (1980) also noted that intake rates for boys in both groups were slightly higher than for girls.

The advantage of this study is that data for both exclusively and partially breast-fed infants were collected for multiple time periods. Also, data for individual infants were collected over 3 consecutive days which would account for some individual variability. However, the number of infants in the study was relatively small. In addition, this study did not account for insensible weight loss which may underestimate the amount of human milk ingested.

15.3.2 Dewey and Lönnerdal, 1983 - Milk and Nutrient Intake of Breast-fed Infants from 1 to 6 Months: Relation to Growth and Fatness

Dewey and Lönnerdal (1983) monitored the dietary intake of 20 nursing infants between the ages of 1 and 6 months. The number of study participants dropped to 13 by the end of the sixth month. Most of the infants in the study were exclusively breast-fed. One infant's intake was supplemented by formula during the first and second month of life. During the third, fourth, and fifth months, three, four, and five infants, respectively, were given some formula to supplement their intake. Two infants were given only formula (no human milk) during the sixth month. According to Dewey and Lönnerdal (1983), the mothers were all well educated and recruited through Lamaze childbirth classes in the Davis area of California. Human milk intake volume was estimated based on two 24-hour test weighings per month. Human milk intake rates for the various age groups are presented in Table 15-8. Human milk intake averaged 673, 782, and 896 mL/day at 1, 3, and 6 months of age, respectively.

The advantage of this study is that it evaluated nursing infants for a period of 6 months based on two 24-hour observations per infant per month. However, corrections for insensible weight loss apparently were not made. Also, the number of infants in the study was relatively small and the study participants were not representative of the general population. Some infants during the study period were given some formula (i.e., up to 5 infants during the fifth month). Without the raw data, these subjects could not be excluded from the study results. Thus, these subjects may affect the results when deriving recommendations for exclusively breastfed infants.

15.3.3 Butte et al., 1984 - Human Milk Intake and Growth in Exclusively Breast-fed Infants

Human milk intake was studied in exclusively breast-fed infants during the first 4 months of life (Butte et al., 1984). Nursing mothers were recruited through the Baylor Milk Bank Program in Texas. Forty-five mother/infant pairs participated in the study. However, data for some time periods (i.e., 1, 2, 3, or 4 months) were missing for some mothers as a result of illness or other factors. The mothers were from the middle- to upper-socioeconomic stratum and had a mean age of 28.0 ± 3.1 years. A total of 41 mothers were white, 2 were Hispanic, 1 was Asian, and 1 was West Indian. Infant growth progressed satisfactorily over the course of the study.

The amount of milk ingested over a 24-hour period was determined by weighing the infant before and after feeding. The study did not indicate whether the data were corrected for insensible water or weight loss. The mean and standard deviation milk intake difference based on weighing the bottle before and after nine successive feedings, was estimated to be 3.2 ± 3.1 g. Test weighing occurred over a 24-hour period for most study participants, but intake among several infants was studied over longer periods (48 to 96 hours) to assess individual variation in intake. It was reported that eight of the infants received some food supplementation during the study period. Six of them received less than 60 kcal/day of formula, oatmeal, glucose water, or rice water for 1 or 2 days. One infant received an additional 90 kcal/day of infant formula and rice water for 6 days during the fourth month because of inadequate milk production. Converting values reported as g/day to mL/day, using a conversion factor of 1.03 g/mL, mean human milk intake ranged from 702 mL/day at 3 months to 729 mL/day at 1 month, with an overall mean of 712 mL/day for the entire study period (Table 15-9). Intakes were also calculated on the basis of body weight (Table 15-9). Based on the results of test weighings conducted over 48 to 96 hours, the overall mean variation in individual daily intake was estimated to be 7.9 ± 3.6 percent.

The advantage of this study is that data for a larger number of exclusively breast-fed infants were collected than in previous studies. However, data were collected for infants up to 4 months and day-to-day variability was not characterized for all infants. It was reported that eighteen percent (i.e., 8 out of 45) of the infants received some formula supplementation during the study period. Without the raw data, these subjects could not be excluded from the study results. Therefore, values derived from this study for exclusively breastfed infants may be somewhat underestimated.

15.3.4 Neville et al., 1988 - Studies in Human Lactation: Milk Volumes in Lactating Women During the Onset of Lactation and Full Lactation

Neville et al. (1988) studied human milk intake among 13 infants during the first year of life. The mothers were all multiparous, nonsmoking, Caucasian women of middle- to upper-socioeconomic status living in Denver, CO. All women in the study practiced exclusive breast-feeding for at least 5 months. Solid foods were introduced at mean age of 7 months. Daily milk intake was estimated by the test weighing method with corrections for insensible weight loss. Data were collected daily from birth to 14 days, weekly from weeks 3 through 8, and monthly until the study period ended at 1 year after inception. One infant was weaned at 8 months, while all others were weaned on or after the 12 months. Formula was used occasionally ($\leq$ 240 mL/wk) after 4 months in three infants. The estimated human milk intakes for this study are listed in Table 15-10. Converting values reported as g/day to mL/day, using a conversion factor of 1.03 g/mL, mean human milk intakes were 748 mL/day, 713 mL/day, 744 mL/day, and 391 mL/day at 1, 3, 6, and 12 months of age, respectively.

In comparison to the previously described studies, Neville et al. (1988) collected data on numerous days over a relatively long time period (12 months) and they were corrected for insensible weight loss. However, the intake rates presented in Table 15-10 are estimated based on intake during only a 24-hour period. Consequently, these intake rates are based on short-term data that do not account for day-to-day variability among individual infants. Also, a smaller number of subjects was included than in the previous studies. Three infants were given some formula after 4 months. Without the raw data, these subjects could not be excluded from the study results. Thus, data presented for infants between 5 and 12 months may be an underestimate for the intake of exclusively breastfed infants.

15.3.5 Dewey et al., 1991a, b - (a) Maternal Versus Infant Factors Related to Human Milk Intake and Residual Volume: The DARLING Study; (b) Adequacy of Energy Intake among Breast-fed Infants in the DARLING Study: Relationships to Growth, Velocity, Morbidity, and Activity Levels

The Davis Area Research on Lactation, Infant Nutrition and Growth (DARLING) study was conducted in 1986 to evaluate growth patterns, nutrient intake, morbidity, and activity levels in infants who were breast-fed for at least the first 12 months of life (Dewey et al., 1991a, b). Subjects were non-randomly selected through letters to new parents using birth listing. One of the criteria used for selection was that mothers did not plan to feed their infants more than 120 mL/day of other milk or formula for the first 12 months of life. Seventy-three infants aged 3 months were included in the study. At subsequent time intervals, the number of infants included in the study was somewhat lower as a result of attrition. All infants in the study were healthy and of normal gestational age and weight at birth, and did not consume solid foods until after the first 4 months of age. The mothers were highly educated and of "relatively high socioeconomic status."

Human milk intake was estimated by weighing the infants before and after each feeding and correcting for insensible water loss. Test weighings were conducted over a 4-day period every 3 months. The results of the study indicate that human milk intake declines over the first 12 months of life. This decline is associated with the intake of solid food. Converting values reported as g/day to mL/day, using a conversion factor of 1.03 g/mL, mean human milk intake was estimated to be 788 mL/day at 3 months and 435 mL/day at 12 months (Table 15-11). Based on the estimated intakes at 3 months of age, variability between individuals (coefficient of variation ([CV] = 16.3%) was higher than the average day-to-day variability ([CV] = 8.9 ± 5.4%) for the infants in the study (Dewey et al., 1991a).

The advantages of this study are that data were collected over a relatively long-time (4 days) period at each test interval, which would account for some day-to-day infant variability, and corrections for insensible water loss were made. Data from this study are assumed to represent exclusively breastfed infants, since mothers were specifically recruited for that purpose. It is, however, unclear from the Dewey et al. (1991a) study if this criterion was met throughout the length of the study period.

15.3.6 Butte, et al., 2000 - Infant Feeding Mode Affects Early Growth and Body Composition

Butte et al. (2000) conducted a study to assess the impact of infant feeding mode on growth and body composition during the first two years of life. The study was conducted in the Houston, Texas area, recruited through the Children's Nutrition Research Center (CNRC) referral system. The study was approved by the Baylor Affiliates Review Boards for Human Subject Research. The overall sample was 76 healthy term infants at 0.5, 3, 6, 9, 12, 18, and 24 months of age. The sample size varied between 71 to 76 infants for each age group. Repeated measurements for body composition and anthropometric were performed. The mothers agreed to either exclusively breast feed or formula feed the infants for the first 4 months of life.

At 3-month or 6-month study intervals, the feeding history was taken. The mothers or caretakers were questioned about breastfeeding frequency, and the use of formula, milk, juice, solids, water and vitamin or mineral supplements. Also, infant food intake was quantified at 3, 6, 12, and 24 months with a 3-day weighted intake record completed by the mother or caretaker (Butte et al., 2000). The intake of human milk was assessed by test weighing; the infant weights were measured before and after each feeding. Using a pre-weighing and post-weighing method, the intake of formula and other foods and beverages was determined for 3 days by the mothers using a digital scale and recorded on predetermined forms.

The average duration of breastfeeding was 11.4 months (SD = 5.8). Butte et al. (2000) reported that infants were exclusively breastfed for at least the first four months except for the following: one was weaned at 109 days, another received formula at 102 days and another given cereal at 106 days. The infant feeding characteristics are shown in Table 15-12. The intakes of human milk for the infants are shown in Table 15-13. Converting values reported as g/day to mL/day, using a conversion factor of 1.03 g/mL, mean human milk intake was estimated to be 728 mL/day at 3 months (weighted average of boys and girls), 637 mL/day at 6 months (weighted average of boys and girls), and 403 mL/day at 12 months (weighted average of boys and girls) (Table 15-13). Feeding practices by percent for infants are shown in Table 15-14. The mean weights are provided in Table 15-15.

Advantages of this study are that it provides intake data for breastfed infants for the first four months of life. The study also provides the mean weights for the infants by feeding type and by gender. The limitations of the study are that the sample size is small and it is limited to one geographical location. The authors did not indicate if results were corrected for insensible weight loss. Since mothers could introduce formula after 4 months, only the data for the 3-month old infants can be considered exclusively breastfed.

15.3.7 Arcus-Arth et al., 2005 - Human Milk and Lipid Intake Distributions for Assessing Cumulative Exposure and Risk

Arcus-Arth et al. (2005) derived population distributions for average daily milk and lipid intakes in g/kg day for infants 0 to 6 months and 0 to 12 months of age for infants fed according to the American Academy of Pediatrics (AAP) recommendations. The AAP recommends exclusively breastfeeding for the first 6 months of life, and human milk as the only source of milk until age 1 year, with the introduction of solid foods after 6 months. The distributions were derived based on data in the peer reviewed literature and datasets supplied by the publication authors for infants 7 days and older (Arcus-Arth et al., 2005). As cited in Arcus-Arth et al. (2005), data sources included Dewey et al. (1991a, 199b), Hofvander et al. (1982), Neubauer et al. (1993), Ferris et al. (1993), Salmenpera et al. (1985), and Stuff and Nichols (1989). The authors also evaluated intake rates for infants breastfed exclusively over the first year and provides a regression line of intake versus age for estimating short-term exposures. Arcus-Arth et al. (2005) derived human milk intake rates for the entire infant population (nursing and non-nursing) from U.S. data on consumption, prevalence and duration. Arcus-Arth et al. (2005) defined exclusive breastfeeding (EBF) as "breast milk is the sole source of calories, with no or insignificant calories from other liquid or solid food sources." Predominant breastfeeding was described by Arcus-Arth et al. (2005) as "breast milk is the sole milk source with significant calories from other foods." The data that were consistent with AAP advice were used to construct the AAP dataset (Arcus-Arth et al., 2005). The 0 to 12 months EBF dataset was created using 0 to 6 month AAP data and data from the EBF infants older than 6 months of age. Because there are no data in the AAP dataset for any individual infant followed at regular, frequent intervals over the 12 month period, population distributions were derived with assumptions regarding individual intake variability over time (Arcus-Arth et al., 2005). Two methods were used. In Method 1, the average population daily intake at each age is described by a regression line, assuming normality. Arcus-Arth et al. (2005) noted that age specific intake data were consistent with the assumption of normality. In Method 2, intake over time is simulated for 2500 hypothetical infants and the distribution intakes derived from 2,500 individual intakes (Arcus-Arth et al., 2005). The population intake distribution was derived following Method 1. Table 15-16 presents the means, and standard deviations for intake data at different ages; the variability was greatest for the 2 youngest and 3 oldest age groups. The values in Table 15-16 using Method 1 were used to derive recommendations presented in Table 15-1 since it provides data for the fine age categories. Converting values reported as g/day to mL/day, using a conversion factor of 1.03 g/mL, mean human milk intake was estimated to be 150 mL/kg-day at 1 month, 127 mL/kg-day at 3 months, 101 mL/kg-day at 6 months, and 47 mL/kg-day at 12 months (Table 15-16). Time weighted average intakes for larger age groups (i.e., 0 to 6 months, 0 to 12 months) are presented in Table 15-17.

An advantage of this study is that it was designed to represent the infant population whose mothers follow the AAP recommendations. Intake was calculated on a body weight basis. In addition, the data used to derive the distributions were from peer reviewed literature and datasets supplied by the publication authors. The distributions were derived from data for infants fed in accordance to AAP recommendations, and they most likely represent daily average milk intake for a significant portion of breastfed infants today (Arcus-Arth et al., 2005). The limitations of the study are that the data used were from mothers that were predominantly white, well nourished and from mid or high socioeconomic status. Arcus-Arth et al. (2005) also included data from Sweden and Finland. However, human milk volume in mL/day is similar among all women except for severely malnourished women (Arcus-Arth et al., 2005). According to Arcus-Arth et al. (2005), "Although few infants are exclusively breastfed for 12 months, the EBF distributions may represent a more highly exposed subpopulation of infants exclusively breastfed in excess of 6 months."

15.4 KEY STUDIES ON LIPID CONTENT AND LIPID INTAKE FROM HUMAN MILK

Human milk contains over 200 constituents including lipids, various proteins, carbohydrates, vitamins, minerals, and trace elements as well as enzymes and hormones. The lipid content of human milk varies according to the length of time that an infant nurses, and increases from the beginning to the end of a single nursing session (NAS, 1991). The lipid portion accounts for approximately 4% of human milk (3.9% ± 0.4%) (NAS, 1991). This value is supported by various studies that evaluated lipid content from human milk. Several studies also estimated the quantity of lipid consumed by breast-feeding infants. These values are appropriate for performing exposure assessments for nursing infants when the contaminant(s) have residue concentrations that are indexed to the fat portion of human milk.

15.4.1 Butte et al., 1984 - Human Milk Intake and Growth in Exclusively Breast-fed Infants

Butte et al. (1984) analyzed the lipid content of human milk samples taken from women who participated in a study of human milk intake among exclusively breast-fed infants. The study was conducted with over 40 women during a 4-month period. The mean lipid content of human milk at various infants' ages is presented in Table 15-18. The overall lipid content for the 4-month study period was 3.43 ± 0.69 % (3.4%). Butte et al. (1984) also calculated lipid intakes from 24-hour human milk intakes and the lipid content of the human milk samples. Lipid intake was estimated to range from 22.9 mL/day (3.7 mL/kg-day) to 27.2 mL/day (5.7 mL/kg-day).

The number of women included in this study was small, and these women were selected primarily from middle to upper socioeconomic classes. Thus, data on human milk lipid content from this study may not be entirely representative of human milk lipid content among the U.S. population. Also, these estimates are based on short-term data, and day-to-day variability was not characterized.

15.4.2 Mitoulas et al., 2002 - Variation in Fat, Lactose, and Protein in Human Milk Over 24 h and Throughout the First Year of Lactation

Mitoulas et al. (2002) conducted a study of healthy nursing women to determine the volume and composition of human milk during the first year of lactation. Nursing mothers were recruited through the Nursing Mothers' Association of Australia. All infants were completely breastfed on demand for at least 4 months. Complementary solid food was introduced between 4 and 6 months of age. Mothers consumed their own *ad libitum* diets throughout the study. Seventeen mothers initially provided data for milk production and fat content, whereas lactose, protein, and energy were initially obtained from nine mothers. The number of mothers participating in the study decreased at 6 months due to the cessation of sample collection from 11 mothers, the maximum period of exclusive breast-feeding.

Milk samples were collected before and after each feed from each breast over a 24-28 hour period. Milk yield was determined by weighing the mother before and after each feed from each breast. Insensible water loss was accounted for by weighing the mother 20 minutes after the end of each feeding. The rate of water loss during this 20 minute period was used to calculate insensible water loss during the feeding. Samples of milk produced at the beginning of the feeding (foremilk) and at the end of the feeding (hindmilk) were averaged to provide the fat, protein, lactose, and energy content for each feed. In all cases the left and right breasts were treated separately, therefore, 'n' represents the number of individual breasts sampled.

Mean human milk production and composition at each age interval are presented in Table 15-19. The mean 24 hour milk production from both breasts was 798 (SD= 232) mL. The mean fat, lactose, and protein contents (g/L) were 37.4 (SE= 0.6), 61.4 (SE =0.6), and 9.16 (SE= 0.19), respectively. Composition did not vary between left and right breasts or preferred and non-preferred breasts. Milk production was constant for the first 6 months and thereafter steadily declined. The fat content of milk decreased between 1 and 4 months, before increasing to 12 months of lactation. The concentration of protein decreased to 6 months and then remained steady. Lactose remained constant throughout the 12 months of lactation. The decrease of energy at 2 months and subsequent increase by 9 months can be attributed to the changes in fat content. Milk production, as well as concentrations of fat, lactose, protein, and energy, differed significantly between women.

The focus of this study was on human milk composition and production, not on infant's human milk intake. The advantage of this study is that it evaluated nursing mothers for a period of 12 months. However, the number of mother-infant pairs in the study was small (17 mothers with infants) and may not be entirely representative of the U.S. population. This study accounted for insensible water loss which increases the accuracy of the amount of human milk produced.

15.4.3 Mitoulas et al., 2003 - Infant Intake of Fatty Acids from Human Milk Over the First Year of Lactation

Mitoulas et al. (2003) conducted a study of 5 healthy nursing women to determine the content of fat in human milk and fat intake by infants during the first year of lactation. Nursing mothers were recruited through the Australian Breastfeeding Association or from private healthcare facilities. All infants were completely breastfed on demand for at least 4 months. Complementary solid food was introduced between 4 and 6 months of age. Mothers consumed their own *ad libitum* diets throughout the study.

Milk samples were collected before and after each feed from each breast over a 24-28 hour period. Fore- and hind-milk samples were averaged to provide the fat content for each feed. Milk yield was determined by weighing the mother before and after each feed from each breast. Insensible water loss was accounted for by weighing the mother 20 minutes after the end of each feeding. The rate of water loss during this 20 minutes was used to calculate insensible water loss during the feeding.

Changes in volume of human milk produced and milk fat content over the first year of lactation is presented in Table 15-20. The mean volumes of milk produced for both breasts combined were 812, 790, 911, 810, 677, and 505 mL/day at 1, 2, 4, 6, 9, and 12 months, respectively. The average daily intake over the 12 months was 751 mL/day with a mean fat content of 35.5 g/L. There was a significant difference in the proportional composition of fatty acids over the course of lactation. Table 15-21 provides average fatty acid composition over the first 12 months of lactation. Additionally, fatty acid composition varied over the course of the day.

The focus of this study was on human milk composition and production, not on infant's human milk intake. The advantage of this study is that it evaluated the human milk composition for a period of 12 months. However, the number of mother-infant pairs in the study was small (5 mothers with infants) and may not be entirely representative of the entire U.S. population. This study accounted for insensible water loss which increases the accuracy of the amount of human milk produced.

15.4.4 Arcus-Arth et al., 2005 - Human Milk and Lipid Intake Distributions for Assessing Cumulative Exposure and Risk

Arcus-Arth et al. (2005) derived population distributions for average daily milk and lipid intakes in g/kg day for infants 0 to 6 months and 0 to 12 months of age for infants fed according to the American Academy of Pediatrics (AAP) recommendations. Lipid intakes were calculated from lipid content and milk intakes measured on the same infant (Arcus-Arth et al., 2005). Table 15-22 provides lipid intakes based on data from Dewey et al. 1991a and Table 15-23 provides lipid intakes calculated assuming 4% lipid content and milk intake in the AAP dataset. Arcus-Arth et al. (2005) noted that the distributions presented are intended to represent the U.S. infant population.

An advantage of this study is that it was designed to represent the population of infants who are breastfed according to the AAP recommendations. In addition, the data used to derive the distributions were from peer review literature and datasets supplied by the publication authors. The limitation of the study are that the data used were from mothers that were predominantly white, well nourished and from mid- or upper-socioeconomic status, however human milk volume in mL/day is similar among all women except for severely malnourished women (Arcus-Arth et al., 2005). The authors noted that "although few infants are exclusively breastfed for 12 months, the exclusively breastfed distributions may represent a more highly exposed subpopulation of infants exclusively breastfed in excess of 6 months." The distributions were derived from data for infants fed in accordance to AAP recommendations, and they most likely represent daily average milk intake for a significant portion of breastfed infants today (Arcus-Arth et al., 2005).

15.4.5 Kent et al., 2006 - Volume and Frequency of Breastfeeding and Fat Content of Breast Milk Throughout the Day

Kent et al. (2006) collected data from 71 Australian mothers who were exclusively nursing their 1 to 6 months old infants. The study focused on examining the variation of milk consumed from each breast, the degree of fullness of each breast before and after feeding, and the fat content of milk consumed from each breast during daytime and nighttime feedings. The volume of milk was measured using test-weighing procedures with no correction for infant insensible water loss. On average, infants had 11 ± 3 breastfeedings per day (range= 6 to18). The intervals between feedings was 2 hours and 18 minutes ± 43 minutes (range = 4 minutes to 10 hours and 58 minutes). The 24-hour average human milk intake was 765 ± 164 mL/day (range = 464 to 1,317 mL/day). The fat content of milk ranged from 22.3 g/L to 61.6 g/L (2.2% - 6.0 %) with an average of 41.1 g/L (4.0%).

This study examined breastfeeding practices of volunteer mothers in Australia. Although amounts of milk consumed by Australian infants may be similar to infants in the U.S. population, results could not be broken out by smaller age groups to examine variability with age. The study provides estimates of fat content from a large number of samples.

15.5 RELEVANT STUDY ON LIPID INTAKE FROM HUMAN MILK

15.5.1 Maxwell and Burmaster, 1993 - A Simulation Model to Estimate a Distribution of Lipid Intake from Human Milk During the First Year of Life

Maxwell and Burmaster (1993) used a hypothetical population of 5,000 infants between birth and 1 year of age to simulate a distribution of daily lipid intake from human milk. The hypothetical population represented both bottle-fed and breast-fed infants aged 1 to 365 days. A distribution of daily lipid intake was developed, based on data in Dewey et al. (1991b) on human milk intake for infants at 3, 6, 9, and 12 months and human milk lipid content, and survey data in Ryan et al. (1991) on the percentage of breast-fed infants under the age of 12 months (i.e., approximately 22%). A model was used to simulate intake among 1,113 of the 5,000 infants that were expected to be breast-fed. The results of the model indicated that lipid intake among nursing infants under 12 months of age can be characterized by a normal distribution with a mean of 26.0 mL/day and a standard deviation of 7.2 mL/day (Table 15-24). The model assumes that nursing infants are completely breast-fed and does not account for infants who are breast-fed longer than 1 year. Based on data collected by Dewey et al. (1991b), Maxwell and Burmaster (1993) estimated the lipid content of human milk to be 36.7 g/L at 3 months (35.6 mg/g or 3.6%), 39.2 g/L at 6 months (38.1 mg/g or 3.8%), 41.6 g/L at 9 months (40.4 mg/g or 4.0%), and 40.2 g/L at 12 months (39.0 mg/g or 3.9%).

The limitation of this study is that it

provides a "snapshot" of daily lipid intake from human milk for breast-fed infants. These results are also based on a simulation model and there are uncertainties associated with the assumptions made. Another limitation is that lipid intake was not derived for the U.S. EPA recommended age categories. The estimated mean lipid intake rate represents the average daily intake for nursing infants under 12 months of age. The study did not generate "new" data. A reanalysis of previously reported data on human milk intake and human milk lipid intake were provided.

15.6 OTHER FACTORS

There are many factors that influence the initiation, continuation, and amount of human milk intake. These factors are complex and may include considerations such as: maternal nutritional status, parity, parental involvement, support from lactation consultants, mother's working status, infant's age, weight, gender, food supplementation, the frequency of breast-feeding sessions per day, the duration of breast-feeding per event, the duration of breast-feeding during childhood, ethnicity, geographic area, and other socioeconomic factors. For example, a study conducted in the United Kingdom found that social and educational factors most influenced the initiation and continuation of lactation (Wright et al. 2006). Prenatal and postnatal lactation consultant intervention was found to be effective in increasing lactation duration and intensity (Bonuck et al. 2005).

15.6.1 Population of Nursing Infants

Breastfeeding rates in the United States have consistently increased since 1993. McDowell et al. (2008) reported that the percentage of infants who were ever breastfed increased from 60% in 1993-1994 to 77% among infants born in 2005-2006 according to the data from the National Health and Nutrition Examination Surveys (NHANES). This exceeded the goal of 75% set in the Healthy People 2010. Rates among non-Hispanic black women increased significantly from 36% in 1993-1994 to 65% in 2005-2006. Income and age had a significant impact on breastfeeding rates. Breastfeeding rate among higher income women was 74% compared to 57% among lower income women (McDowell et al., 2008).

In another study to monitor progress towards achieving the CDC *Healthy People 2010* breastfeeding objectives (initiation and duration), Scanlon et al. (2007) analyzed data from the National Immunization Survey (NIS). NIS uses random-digit dialing to survey households to survey age eligible children, followed by a mail survey to eligible children's vaccination providers to validate the vaccination information. NIS is conducted annually by the CDC to obtain national, state, and selected urban area estimation on vaccinations rates among U.S. children age 19 to 35 months. The interview response rate for years 2001-2006 ranged between 64.5% and 76.1%. Questions regarding breastfeeding were added to the NIS survey in 2001. The sample population was infants born during 2000-2004. Scanlon et al. (2007), noted that because data in their analysis are for children aged 19 to 35 months at the time of the NIS interview, each cross-sectional survey includes children from birth cohorts that span 3 calendar years; the breastfeeding data were analyzed by year of birth during 2000-2004 (birth year cohort instead if survey year).

Among infants born in 2000, breastfeeding rates were 70.9% (CI= 69.0-72.8) for the postpartum period (in hospital before discharge), 34.2% (CI= 32.2-36.2) at 6 months, and 15.7 (CI= 14.2-17.2) at 12 months. For infants born in 2004, these rates had increased to 73.8% (CI= 72.8-74.8) for the postpartum period, 41.5% (CI= 40.4-42.6) at 6 months, and 20.9 (CI= 20.0-21.8) at 12 months. Rates of breastfeeding through 3 months were lowest among black infants (19.8%), infants whose mothers were <20 years of age (16.8%), those whose mothers had a high school education or less (22.9% and 23.9%), those whose mothers were unmarried (18.8%), those who resided in rural areas (23.9%), and those whose families had an income-to-poverty ratio of <100% (23.9%). Table 15-25 provides data for exclusive breastfeeding through 3 and 6 months by socioeconomic characteristics for infants born in 2004.

Scanlon et al. (2007) noted the following limitations that could affect the utility of these data: (1) breastfeeding behavior was based on retrospective self-report by mothers or other caregivers, whose responses might be subject to recall bias, (2) the NIS question that defines early postpartum breastfeeding or initiation, "Was [child's name] ever breastfed or fed breast milk?" collects information that might differ from the HP2010 objective for initiation, and (3) although survey data were weighted to make them representative of all U.S. children aged 19 to 35 months, some bias might remain. The advantage of the study is that is representative of the U.S. infant population.

CDC (2008) developed the breastfeeding report card. The CDC National Immunization Program in partnership with the CDC National Center for Health Statistics conducts the NIS within all 50 states, District of Columbia, and selected geographic areas within the states. Five breastfeeding goals are in the Healthy People 2010 report. The Breastfeeding Report Card presents data for each state for the following categories of infants: ever breastfed, breastfed at 6 months, breastfed at 12 months, exclusive breastfeeding through 3 month, and exclusive breastfeeding through 6 months. These indicators are used to measure a state's ability to promote, protect, and support breastfeeding. These data for the estimated percentage of infants born in 2004 are presented in Table 15-26. The advantage of this report is that it provides data for each state and is representative of the U.S. infant population.

Analysis of breastfeeding practices in other developing countries was also found in the literature. Marriott et al. (2007) researched feeding practices in developing countries in the first year of life, based on 24-hour recall data. Marriott et al. (2007), used secondary data from the Demographic and Health Surveys (DHS) for more than 35,000 infants in twenty countries. This survey has conducted since 1986 and was expanded to provide a standardized survey instrument that can be used by developing countries to collect data on maternal/infant health, intake and household variables and to build national health statistics (Marriott et al., 2007). The analysis was based on the responses of the survey mothers for questions on whether they were currently breasfeeding and had fed other liquids and solid foods to their infants in the previous 24 hours. The data incorporated were from between 1999 and 2003. Marriott et al. (2007) selected the youngest child less than 1 year old in each of the families; multiples were included such as twins or triplets. Separate analyses were conducted for infants less than 6 months old and infants 6 months and older, but less than 12 months old. Food and liquid variables other than water and infant formulas were collapsed into broader food categories for cross-country comparisons (Marriott et al., 2007). Tinned, powdered, and any other specified animal milks were collapsed. In addition, all other liquids such as herbal teas, fruit juices, and sugar water (excluding unique country-specific liquids) were collapsed into other liquids and the 10 types of solid food groups into an any-solid-foods category (Marriott et al., 2007). Data were pooled from the 20 countries to provide a large sample size and increase statistical power. Tables 15-27 and 15-28 present the percentage of mothers that were currently breastfeeding and separately had fed their infants other liquids or solid food by age groups. Table 15-29 presents the pooled data summary for the study period. The current breastfeeding was consistent across countries for both age groups; the countries that reported the highest percentages of current breastfeeding for the 0 to 6 months old infants also reported the highest percentages in the 6 to12 month old infants. Pooled data show that 96.6% of the 0 to 6 months old infants and 87.9% of the 6 to 12 month old infants were breastfeeding. Feeding of other fluids was lowest in the 0 to 6 months infants, with the percentage feeding water the highest of this category. The percentage of mothers feeding commercial infant formulas was the lowest in most countries.

There are other older studies that analyze ethnic and racial differences in breastfeeding practices. Li and Grummer-Strawn (2002) investigated ethnic and racial disparities in lactation in the United States using data from the Third National Health and Nutrition Examinations Survey (NHANES III) that was conducted between 1988 and 1994. NHANES II participants were ages 2 months and older. The data were collected during a home interview from a parent or a proxy respondent for the child (Li and Grummer-Strawn, 2002). The sample population consisted of children 12 to 71 months of age at time of interview. The NHANES III response rate for children participating was approximately 94 percent (Li and Grummer-Strawn, 2002). Data for a total of 2,863 exclusively breastfed, 6,140 ever breastfed, and 6,123 continued breastfed children were included in the analysis (Li and Grummer-Strawn, 2002). The proportion of children ever-breastfed was 60% among non-Hispanic whites, 26% among non-Hispanic blacks, and 54% among Mexican Americans. This number decreased to 27, 9, and 23 respectively by 6 months. The percentage of children fed exclusively human milk at 4 months was also significantly lower for blacks at 8.5%, compared to 22.6% for whites and 14.1% for Mexican-Americans. The racial and ethnic differences in proportion of children ever breastfed is presented in Table 15-30, the proportion of children who received any breast milk at 6 months are presented in Table 15-31, and the proportion of children exclusively breastfed at 4 months is presented in Table 15-32.

Li and Grummer-Strawn (2002) noted that there may have been some lag time between birth and the time of the interview. This may have caused misclassification if the predicator variables changed considerably between birth and the time of interview. Also, NHANES III did not collect information on maternal education. Instead, the educational level of household head was used as a proxy. The advantage of this study is that it is representative of the U.S. children's population.

Data from some older studies provide historical information on breastfeeding practices in the U.S. These data are provided here to show trends in the U.S. population. In 1991, the National

Academy of Sciences (NAS) reported that the percentage of breast-feeding women has changed dramatically over the years (NAS, 1991). The Ross Products Division of Abbott Laboratories conducted a large national mail survey in 1995 to determine patterns of breastfeeding during the first 6 months of life. The Ross Laboratory Mothers's Survey was first developed in 1955 and has been expanded to include many more infants. Before 1991, the survey was conducted on a quarterly basis, and approximately 40,000 to 50,000 questionnaires were mailed each quarter (Ryan, 1997). Beginning in 1991, the survey was conducted monthly; 35,000 questionnaires were mailed each month. Over time, the response rate has been consistently in the range of 50 ± 5%. In 1989 and 1995, 196,000 and 720,000 questionnaires were mailed, respectively. Ryan (1997) reported rates of breast-feeding through 1995 and compared them with those in 1989.

The survey demonstrates increases in both the initiation of breast-feeding and continued breast-feeding at 6 months of age between 1989 and 1991. Table 15-33 presents the percent of breast-feeding in hospitals and at 6 months of age by selected demographic characteristics. In 1995, the incidence of breast-feeding at birth and at 6 months for all infants was approximately 59.7% and 21.6 %, respectively. The largest increases in the initiation of breast-feeding between 1989 and 1995 occurred among women who were Black, were less than 20 years of age, earned less than $10,000 per year, had no more than a grade school education, were living in the South Atlantic region of the U.S., had infants of low birth weight, were employed full time outside the home at the time they received the survey, and participated in the Women, Infants, and Children program (WIC). In 1995, as in 1989, the initiation of breast-feeding was highest among women who were greater than 35 years of age, earned more than $25,000 per year, and were college educated, did not participate in the WIC program, and were living in the Mountain and Pacific regions of the U.S.

Data on the actual length of time that infants continue to breast-feed beyond 5 or 6 months were limited (NAS, 1991). However, Maxwell and Burmaster (1993) estimated that approximately 22 percent of infants under 1 year of age are breast-fed. This estimate was based on a reanalysis of survey data in Ryan et al. (1991) collected by Ross Laboratories (Maxwell and Burmaster, 1993). Studies have also indicated that breast-feeding practices may differ among ethnic and socioeconomic groups and among regions of the United States. More recently, the Ross Products Division of Abbott Laboratories reported the results of their ongoing "Ross Mothers Survey" in 2003 (Abbott 2003). The percentages of mothers who breast feed, based on ethnic background and demographic variables, are presented in Table 15-34. These data update the values presented in the NAS 1991 report.

15.6.2 Intake Rates Based on Nutritional Status

Information on differences in the quality and quantity of human milk on the basis of ethnic or socioeconomic characteristics of the population is limited. Lönnerdal et al. (1976) studied human milk volume and composition (nitrogen, lactose, proteins) among underprivileged and privileged Ethiopian mothers. No significant differences were observed between the data for these two groups. Similar data were observed for well-nourished Swedish mothers. Lönnerdal et al. (1976) stated that these results indicate that human milk quality and quantity are not affected by maternal malnutrition. However, Brown et al. (1986a, b) noted that the lactational capacity and energy concentration of marginally-nourished women in Bangladesh were "modestly less than in better nourished mothers." Human milk intake rates for infants of marginally-nourished women in this study were 690 ± 122 g/day at 3 months, 722 ± 105 g/day at 6 months, and 719 ± 119 g/day at 9 months of age (Brown et al., 1986a). Brown et al. (1986a) observed that human milk from women with larger measurements of arm circumference and triceps skinfold thickness had higher concentrations of fat and energy than mothers with less body fat. Positive correlations between maternal weight and milk fat concentrations were also observed. These results suggest that milk composition may be affected by maternal nutritional status.

15.6.3 Frequency and Duration of Feeding

Hofvander et al. (1982) reported on the frequency of feeding among 25 bottle-fed and 25 breast-fed infants at ages 1, 2, and 3 months. The mean number of meals for these age groups was approximately 5 meals/day (Table 15-35). Neville et al. (1988) reported slightly higher mean feeding frequencies. The mean number of meals per day for exclusively breast-fed infants was 7.3 at ages 2 to 5 months and 8.2 at ages 2 weeks to 1 month. Neville et al. (1988) reported that, for infants between the ages of 1 week and 5 months, the average duration of a breastfeeding session is 16-18 minutes.

Buckley (2001) studied the breastfeeding patterns, dietary intake, and growth measurement of children who continued to breastfeed beyond 1 year of age. The sample was 38 mother-child pairs living in the Washington, DC area. The criteria for inclusion in the study were that infants or their mothers had no hospitalization of either subject 3 months prior to the study and that the mother was currently breastfeeding a 1-year old or older child (Buckley, 2001). The participants were recruited through local medical consultants and the La Leche League members. The children selected as the final study subjects consisted of 22 boys and 16 girls with ages ranging from 12 to 43 month old. The data were collected using a 7-day breastfeeding diary. The frequency and length of breastfeeding varied with the age of the child (Buckley, 2001). The author noted a statistically significant difference in the mean number of breastfeeding episodes per day and the average total minutes of breastfeeding between the 1, 2, and 3 year old groups. Table 15-36 provides the comparison of breastfeeding patterns between age groups. An advantage of this study is that the frequency and duration data are based primarily on a 7-day diary and some dietary recall. Limitations of the study are the small sample size and that it is limited to one geographical area.

15.7 REFERENCES FOR CHAPTER 15

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Table 15-7. Daily Intakes of Human Milk

Age	Number of Infants	Intake	
		Mean ± SD (mL/day) [a]	Intake Range (mL/day)
Completely Breast-fed			
1 month	11	600 ± 159	426 - 989
3 months	2	833	645 - 1,000
6 months	1	682	616 - 786
Partially Breast-fed			
1 month	4	485 ± 79	398 - 655
3 months	11	467 ± 100	242 - 698
6 months	6	395 ± 175	147 - 684
9 months	3	<554	451 - 732

[a] Data expressed as mean ± standard deviation.

Source: Pao et al., 1980.

Table 15-8. Human Milk Intakes for Infants Aged 1 to 6 Months

Age	Number of Infants	Intake	
		Mean ± SD (mL/day)	Intake Range (mL/day)
1 month	16	673 ± 192	341-1,003
2 months	19	756 ± 170	449-1,055
3 months	16	782 ± 172	492-1,053
4 months	13	810 ± 142	593-1,045
5 months	11	805 ± 117	554-1,045
6 months	11	896 ± 122	675-1,096

Source: Dewey and Lönnerdal, 1983.

Table 15-9. Human Milk Intake Among Exclusively Breast-fed Infants During the First 4 Months of Life

Age	Number of Infants	Intake (mL/day)[a] Mean ± SD	Intake (mL/kg-day)[a] Mean ± SD	Feedings/Day	Body Weight[b] (kg)
1 month	37	729 ± 126	154 ± 23	8.3 ± 1.9	4.7
2 months	40	704 ± 127	125 ± 18	7.2 ±1.9	5.6
3 months	37	702 ± 111	114 ± 19	6.8 ± 1.9	6.2
4 months	41	718 ± 124	108 ± 17	6.7 ± 1.8	6.7

[a] Values reported by the author in units of g/day and g/kg-day were converted to units of mL/day and mL/kg-day by dividing by 1.03 g/mL (density of human milk).
[b] Calculated by dividing human milk intake (g/day) by human milk intake (g/kg-day).
SD = Standard deviation.

Source: Butte et al., 1984.

Table 15-10. Human Milk Intake During a 24-hour Period

Age (days)	Number of Infants	Intake (mL/day)[a] Mean ± SD	Intake (mL/day)[a] Range	Intake by Age Category (mL/day)[a,c]
1	6	43 ± 68	-30-145 [b]	511 ± 220
2	9	177 ± 83	43-345	
3	10	360 ± 149	203-668	
4	10	438 ± 171	159-674	
5	11	483 ± 125	314-715	
6	9	493 ± 162	306-836	
7	7	556 ± 162	394-817	
8	8	564 ± 154	398-896	
9	9	563 ± 74	456-699	
10	9	569 ± 128	355-841	
11	8	597 ± 163	386-907	
14	9	634 ± 150	404-895	
21	10	632 ± 82	538-763	
28	13	748 ± 174	481-1,111	
35	12	649 ± 114	451-903	679 ± 105
42	12	690 ± 108	538-870	
49	10	688 ± 112	543-895	
56	12	674 ± 95	540-834	
90	10	713 ± 111	595-915	713 ± 111
120	12	690 ± 97	553-822	690 ± 97
150	12	814 ± 130	668-1,139	814 ± 130
180	13	744 ± 117	493-909	744 ± 117
210	12	700 ± 150	472-935	700 ± 150
240	9	604 ± 204	280-973	604 ± 204
270	12	600 ± 214	217-846	600 ± 214
300	11	535 ± 227	125-868	535 ± 227
330	8	538 ± 233	117-835	538 ± 233
360	8	391 ± 243	63-748	391 ± 243

[a] Values reported by the author in units of g/day were converted to units of mL/day by dividing by 1.03 g/mL (density of human milk).
[b] Negative value due to insensible weight loss correction.
[c] Multiple data sets were combined by producing simulated data sets fitting the known mean and SD for each age, compositing the data sets to correspond to age groups of 0 to <1 month and 1 to <2 months, and calculating new means and SD's on the composited data.
SD = Standard deviation.

Source: Neville et al., 1988.

Table 15-11. Human Milk Intake Estimated by the Darling Study

Age	Number of Infants	Intake (mL/day) Mean ± SD
3 months	73	788 ± 129
6 months	60	747 ± 166
9 months	50	627 ± 211
12 months	42	435 ± 244

[a] Values reported by the author in units of g/day were converted to units of mL/day by dividing by 1.03 g/mL (density of human milk).
SD = Standard deviation.

Source: Dewey et al., 1991b.

Table 15-12. Mean Breastfed Infants Characteristics [a]

	Boys (N=14)	Girls (N=26)
Ethnicity (White, Black, Hispanic, Asian) (N)	10/1/2/1	21/1/3/1
Duration of Breastfeeding (days)	315 ± 152	362 ± 190
Duration of Formula Feeding (days)	184 ± 153	105 ± 121
Age at Introduction of Formula (months)	6.2 ± 2.9	5.2 ± 2.3
Age at Introduction of Solids (months)	5.0 ± 1.5	5.0 ± 0.09
Age at Introduction of Cow's Milk (months)	13.1 ± 3.1	12.5 ± 3.8

[a] Mean ± standard deviation.
N = Number of infants.

Source: Butte et al., 2000.

Table 15-13. Mean Human Milk Intake of Breastfed Infants (mL/day)[a]

Age Group	Boys	Girls
3 months	790 ± 172 (N=14)	694 ± 108 (N=26)
6 months	576 ± 266 (N=12)	678 ±250 (N=18)
12 months	586 ±286 (N=2)	370± 260 (N=11)
24 months	-	-

[a] 3-day average; values reported by the author in units of g/day were converted to units of mL/day by dividing by 1.03 g/mL (density of human milk); mean ± standard deviation.
N = Number of infants.

Source: Butte et al., 2000.

Table 15-14. Feeding Practices by Percent of Infants						
Infants	Age					
	3 months	6 months	9 months	12 months	18 months	24 months
	Percentage					
Infants Still Breastfed	100	80	58	38	25	5
Breastfed Infants Given Formula	0	40	48	30	10	2
Formula-fed Infants Given Breast Milk	100	100	94	47	6	0
Use of Cow's Milk for Breastfed Infants	-	-	8	65	82	88
Use of Cow's Milk for Formula-fed Infants	-	-	28	67	89	92

Source: Butte et al., 2000.

Table 15-15. Body Weight of Breastfed Infants[a]		
	Weight (kg)	
Age	Boys	Girls
0.5 months	3.9 ± 0.4 (n=14)	3.7 ± 0.5 (n=19)
3 months	6.4 ± 0.6 (n=14)	6.0 ± 0.6 (n=19)
6 months	8.1 ± 0.8 (n=14)	7.5 ± 0.6 (n=18)
9 months	9.3 ± 1.0 (n=14)	8.4 ± 0.6 (n=19)
12 months	10.1 ± 1.1 (n=14)	9.2 ± 0.7 (n=19)
18 months	11.6 ± 1.2 (n=14)	10.7 ± 1.0 (n=19)
24 months	12.7 ± 1.3 (n=12)	11.8 ± 1.1 (n=19)

[a] Mean ± standard deviation.
N = Number of infants.

Source: Butte et al., 2000.

Table 15-16. AAP Dataset Milk Intake Rates at Different Ages

Age	Mean (mL/kg day)[a]	SD (mL/kg day)[a]	CV	Skewness Statistic[b]	N
7 days	143	37	0.26	0.598	10
14 days	156	40	0.26	-1.39	9
30 days	150	24	0.16	0.905	25
60 days	144	22	0.15	0.433	25
90 days	127	18	0.14	-0.168	108
120 days	112	18	0.16	0.696	57
150 days	100	21	0.21	-1.077	26
180 days	101	20	0.20	-1.860	39
210 days	75	25	0.33	-0.844	8
270 days	72	23	0.32	-0.184	57
360 days	47	27	0.57	0.874	42

[a] Values reported by the author in units of g/kg-day were converted to units of mL/kg-day by dividing by 1.03 g/mL (density of human milk).
[b] Statistic/SE: -2 < Statistic/SE < +2 suggests a normal distribution
SD = Standard deviation.
CV = Coefficient of variation.
N = Number of infants.

Source: Arcus-Arth et al., 2005.

Table 15-17. Average Daily Human Milk Intake (mL/kg day) [a]

Averaging Period	Mean (SD)	Population Percentile							
		5	10	25	50	75	90	95	99
AAP 0 to 6 months									
Method 1	126 (21)	92	99	112	126	140	152	160	174
Method 2	123 (7)	112	114	118	123	127	131	133	138
AAP 0 to 12 months									
Method 1	98 (22)	61	69	83	98	113	127	135	150
Method 2	99 (5)	90	92	95	99	102	105	107	110
EBF 0 to 12 months	110 (21)	75	83	95	110	124	137	144	159
General Pop.									
0 to 6 months	79	0	0	24	92	123	141	152	170
0 to 12 months	51	0	0	12	49	85	108	119	138

[a] Values reported by the author in units of g/kg-day were converted to units of mL/kg-day by dividing by 1.03 g/mL (density of human milk).

Source: Arcus-Arth et al., 2005.

Table 15-18. Lipid Content of Human Milk and Estimated Lipid Intake Among Exclusively Breast-fed Infants

Age (months)	Number of Observations	Lipid Content (mg/g) Mean ± SD	Lipid Content % [a]	Lipid Intake (mL/day)[b] Mean ± SD	Lipid Intake (mL/kg-day)[b] Mean ± SD
1	37	36.2 ± 7.5	3.6	27 ± 8	5.7 ± 1.7
2	40	34.4 ± 6.8	3.4	24 ± 7	4.3 ± 1.2
3	37	32.2 ± 7.8	3.2	23 ± 7	3.7 ± 1.2
4	41	34.8 ± 10.8	3.5	25 ± 8	3.7 ± 1.3

[a] Percents calculated from lipid content reported in mg/g.
[b] Values reported by the author in units of g/day and g/kg-day were converted to units of mL/day and mL/kg-day by dividing by 1.03 g/mL (density of human milk).

Source: Butte et al., 1984.

Table 15-19. Human Milk Production and Composition Over the First 12 Months of Lactation [a]

Age Group (months)	Volume, per Breast (mL/24h)			Fat (g/L)			Lactose (g/L)			Protein (g/L)			Energy (kJ/mL)		
	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N
1	416	24	34	39.9	1.4	34	59.7	0.8	18	10.5	0.4	18	2.7	0.06	18
2	408	23	34	35.2	1.4	34	60.4	1.1	18	9.6	0.4	18	2.5	0.06	18
4	421	20	34	35.4	1.4	32	62.6	1.3	16	9.3	0.4	18	2.6	0.09	16
6	413	25	30	37.3	1.4	28	62.5	1.7	16	8.0	0.4	16	2.6	0.09	16
9	354	47	12	40.7	1.7	12	62.8	1.5	12	8.3	0.5	12	2.8	0.09	12
12	252	51	10	40.9	3.3	10	61.4	2.9	10	8.3	0.6	10	2.8	0.14	10
1 to 12	399	11	154	37.4	0.6	150	61.4	0.6	90	9.2	0.2	92	2.7	0.04	90

[a] Infants were completely breast-fed to 4 months and complementary solid food was introduced between 4-6 months.
SE = Standard error.
N = Number of infants.

Source: Mitoulas et al., 2002.

Table 15-20. Changes in Volume of Human Milk Produced and Milk Fat Content Over the First Year of Lactation [a]									
Age Group (months)		Volume, Left Breast (mL/day)		Volume, Right Breast (mL/day)		Fat, Left Breast (g/L)		Fat, Right Breast (g/L)	
	N	Mean	SE	Mean	SE	Mean	SE	Mean	SE
1	5	338	52	475	69	38	1.5	38	2.6
2	5	364	52	427	42	31	2.2	30	2.9
4	5	430	51	482	58	32	3.3	29	2.6
6	5	373	75	437	56	33	2.5	33	2.5
9	5	312	65	365	94	43	2.2	38	3.3
12	5	203	69	302	85	40	4.8	42	5.0
1 to 12	30	337	26	414	28	36	1.4	35	1.5
Statistical significance: P		NS		NS		0.004		0.008	

[a] Infants were completely breast-fed to 4 months, and complementary solid food was introduced between 4-6 months.
SE = Standard error.
NS = No statistical difference.
P = Probability.

Source: Mitoulas et al., 2003.

Table 15-21. Changes in Fatty Acid Composition of Human Milk Over the First Year of Lactation (g/100 g total fatty acids)												
Fatty Acid	1 month		2 months		4 months		6 months		9 months		12 months	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Medium-chain Saturated	14.2	0.4	13.9	0.6	12.0	0.5	11.5	0.2	14.1	0.3	17.0	0.4
Odd-chain Saturated	0.9	0.01	0.9	0.02	0.8	0.02	0.8	0.03	0.8	0.02	0.8	0.02
Long-chain Saturated	34.1	0.3	33.7	0.3	32.8	0.3	31.8	0.6	31.4	0.6	33.9	0.6
Mono-unsaturated	37.5	0.2	33.7	0.4	38.6	0.5	37.5	0.5	37.3	0.5	33.0	0.5
Trans-	2.0	0.08	2.2	0.1	2.2	0.09	4.6	0.02	1.7	0.2	1.8	0.09
Poly-unsaturated	12.7	0.2	9.5	0.2	11.8	0.4	13.4	0.6	8.0	0.1	6.7	0.03

SE = Standard error.

Source: Mitoulas et al., 2003.

Table 15-22. Comparison Daily Lipid Intake Based on Lipid Content Assumptions (mL/kg-day)[a,b]

Lipid Content Used in Calculation	Mean	Population Percentile							
		5	10	25	50	75	90	95	99
Measured Lipid Content[c]	3.6	2.0	2.3	2.9	3.6	4.3	4.9	5.2	5.9
4% Lipid Content[d]	3.9	2.5	2.8	3.3	3.8	4.4	4.9	5.2	5.8

[a] Values reported by the author in units of g/kg-day were converted to units of mL/kg-day by dividing by 1.03 g/mL (density of human milk).
[b] Estimates based on data from Dewey et al. 1991a.
[c] Lipid intake derived from lipid content and milk intake measurements.
[d] Lipid intake derived using 4% lipid content value and milk intake.

Source: Arcus-Arth et al., 2005.

Table 15-23. Distribution of Average Daily Lipid Intake (mL/kg day) assuming 4% Milk Lipid Content

	Mean	Population Percentile							
		5	10	25	50	75	90	95	99
AAP Infants 0 to 12 months	3.9	2.4	2.8	3.3	3.9	4.5	5.1	5.4	6.0

[a] Values reported by the author in units of g/kg-day were converted to units of mL/kg-day by dividing by 1.03 g/mL (density of human milk).

Source: Arcus-Arth et al., 2005.

Table 15-24. Predicted Lipid Intakes for Breast-fed Infants Under 12 Months of Age

Statistic	Value
Number of Observations in Simulation	1,113
Minimum Lipid Intake	1.0 mL/day[a]
Maximum Lipid Intake	51.0 mL/day[a]
Arithmetic Mean Lipid Intake	26.0 mL/day[a]
Standard Deviation Lipid Intake	7.2 mL/day[a]

[a] Values reported by the author in units of g/day were converted to units of mL/day by dividing by 1.03 g/mL (density of human milk).

Source: Maxwell and Burmaster, 1993.

Table 15-25. Socio-economic Characteristics of Exclusively Breastfed Infants Born in 2004				
	Percent of Exclusive Breastfeeding Infants Through 3 and 6 Months			
	3 months		6 months	
Characteristic	%	95% CI	%	95% CI
U.S. Overall (N=17,654)	30.5	29.4-31.6	11.3	10.5-12.1
Infant Sex				
Male	30.7	29.1-32.3	10.8	9.8-11.8
Female[a]	30.3	28.7-31.9	11.7	10.5-12.9
Race/Ethnicity (child)				
Hispanic	30.8	28.3-33.3	11.5	9.7-13.3
White, non-Hispanic[a]	33.0	31.6-34.4	11.8	10.9-12.7
Black, non-Hispanic	19.8 [b]	17.0-22.6	7.3 [b]	5.5-9.1
Asian, non-Hispanic	30.6	25.0-36.2	14.5	10.0-19.0
Other	29.3	24.9-33.7	12.2	9.2-15.2
Maternal Age (years)				
<20	16.8 [b]	10.3-23.3	6.1 [b]	1.5-10.7
20 to 29	26.2 [b]	24.4-28.0	8.4 [b]	7.3-9.5
≥30[a]	34.6	33.2-36.0	13.8	12.7-14.9
Household Head Education				
<High school	23.9 [b]	21.0-26.8	9.1 [b]	7.1-11.1
High school	22.9 [b]	20.9-24.9	8.2 [b]	7.0-9.4
Some college	32.8 [b]	30.3-35.3	12.3 [b]	10.2-14.4
College graduate[a]	41.5	39.7-43.3	15.4	14.1-16.7
Marital Status				
Married[a]	35.4	34.0-36.8	13.4	12.4-14.4
Unmarried	18.8 [b]	16.9-20.7	6.1 [b]	5.0-7.2
Residence				
MSA, center city[a]	30.7	29.0-32.4	11.7	10.5-12.9
MSA, non-center city	32.8	30.9-34.7	12.1	10.8-13.4
Non-MSA	23.9 [b]	21.8-26.0	8.2 [b]	6.9-9.5
Poverty income ratio (%)				
<100	23.9 [b]	21.6-26.2	8.3 [b]	6.9-9.7
100 to <184	26.6 [b]	23.8-29.4	8.9 [b]	7.2-10.6
185 to <349	33.2 [b]	30.9-35.5	11.8 [b]	10.3-13.3
≥350[a]	37.7	35.7-39.7	14.0	12.6-15.4

[a] Referent group.
[b] $p<0.05$ by chi-square test, compared with referent group.
N = Number of infants.
MSA = Metropolitan statistical area.
Source: Scanlon et al., 2007.

Table 15-26. Geographic-specific Breastfeeding Percent Rates Among Children Born in 2005 [a]					
State	Ever Breastfed	Breastfed at 6 Months	Breastfed at 12 Months	Exclusive Breastfeeding Through 3 Months	Exclusive Breastfeeding Through 6 Months
U.S. National	74.2	43.1	21.4	31.5	11.9
Alabama	53.2	25.6	9.5	17.3	6.6
Alaska	81.3	53..0	25.8	42.3	20.7
Arizona	88.5	51.7	22.0	33.0	10.2
Arkansas	60.3	30.6	14.0	22.5	7.4
California	85.1	62.0	32.1	41.1	17.6
Colorado	81.4	48.2	25.8	42.9	13.1
Connecticut	74.5	42.9	18.8	36.4	12.3
Delaware	63.4	30.6	13.8	23.4	8.3
Dist of Columbia	70.5	46.7	25.8	27.8	9.3
Florida	70.6	36.8	21.0	28.0	11.4
Georgia	72.0	43.5	18.2	23.9	11.7
Hawaii	85.3	54.5	37.1	34.5	15.6
Idaho	85.2	59.0	28.2	54.4	21.9
Illinois	71.2	37.5	15.8	33.2	10.2
Indiana	65.3	35.7	17.8	24.9	6.6
Iowa	74.8	40.4	21.9	37.7	11.5
Kansas	79.4	43.4	21.2	32.6	13.6
Kentucky	48.2	23.2	9.8	21.5	5.9
Louisiana	47.9	21.8	9.5	20.1	7.2
Maine	71.7	41.2	22.5	39.0	12.3
Maryland	73.0	43.0	20.7	28.9	11.6
Massachusetts	78.1	43.3	21.7	35.5	14.0
Michigan	69.1	35.5	19.8	31.5	12.1
Minnesota	79.4	45.9	20.5	41.7	17.1
Mississippi	50.2	21.8	7.5	18.5	5.6
Missouri	67.5	30.5	14.4	29.2	7.8
Montana	77.6	48.0	26.8	38.3	15.1
Nebraska	78.8	54.9	23.3	32.1	12.5
Nevada	78.3	45.3	18.3	30.2	11.0
New Hampshire	75.3	46.8	23.9	35.5	9.8
New Jersey	75.0	37.3	15.2	24.5	10.8
New Mexico	77.0	41.8	26.1	37.2	15.0
New York	76.3	43.5	24.6	25.5	8.4
North Carolina	66.2	37.5	18.2	26.3	9.5
North Dakota	68.2	36.8	18.4	36.0	11.9
Ohio	65.0	31.5	14.0	22.9	9.0
Oklahoma	69.1	28.1	13.4	24.0	8.1
Oregon	89.2	62.1	38.9	51.8	23.8

Table 15-26. Geographic-specific Breastfeeding Percent Rates Among Children Born in 2005 [a] (continued)

State	Ever Breastfed	Breastfed at 6 Months	Breastfed at 12 Months	Exclusive Breastfeeding Through 3 Months	Exclusive Breastfeeding Through 6 Months
Pennsylvania	70.7	36.3	16.2	27.4	7.5
Rhode Island	70.9	49.3	21.9	35.6	15.3
South Carolina	66.8	33.7	15.6	27.1	11.8
South Dakota	70.1	38.1	12.2	34.0	12.5
Tennessee	56.9	24.1	12.6	19.0	6.0
Texas	77.9	43.8	23.7	30.5	10.0
Utah	90.3	60.4	25.7	42.6	17.4
Vermont	77.6	53.8	32.6	49.0	23.9
Virginia	75.8	42.7	18.7	33.8	14.3
Washington	90.1	57.3	33.4	44.9	21.3
West Virginia	57.7	22.5	12.0	14.7	4.4
Wisconsin	67.9	39.2	16.4	35.9	9.0
Wyoming	81.8	46.6	20.6	40.5	12.3

[a] Exclusive breastfeeding information is from the 2006 NIS survey data only and is defined as ONLY breast milk-No solids, no water, no other liquids.

Source: CDC, 2008.

Table 15-27. Percentage of Mothers in Developing Countries by Feeding Practices for Infants 0 to 6 Months Old [a]

Country	Breastfeeding	Water	Milk	Formula	Other Liquids	Solid Foods
Ethiopia	98.8	26.3	19	0	10.8	5.3
Ghana	99.6	41.9	6.7	3.5	4.3	15.6
Kenya	99.7	60	35.1	4.8	35.9	46.3
Malarwi	100	46	1.4	1.7	5.2	42.3
Nambia	95.3	65.4	0	0	17.9	33.4
Nigeria	99.1	78.2	9.2	12.7	17.9	18.5
Uganda	98.7	15.1	20.3	1.5	10.3	11.4
Zamibia	99.6	52.6	2.1	2.7	6.7	31.2
Zimbabwe	100	63.9	1.6	3.2	9	43.7
Armenia	86.1	62.7	22.9	13.1	48.1	23.9
Egypt	95.5	22.9	11.1	4.3	27.6	13.2
Jordan	92.4	58.5	3	25.1	13.8	20.2
Bangladesh	99.6	30.2	13.6	5.3	19.7	20.3
Cambodia	98.9	87.9	2.1	3.3	6.7	16.6
India	98.1	40.2	21.2	0	7.1	6.5
Indonesia	92.8	37	0.7	24.2	8.7	43
Nepal	100	23.3	12.3	0	2.8	9.3
Philippines	80.5	53.4	4.4	30	12.4	16.8
Vietnam	98.7	45.9	16.9	0.8	8.9	18.7
Kazakhstan	94.4	53.7	21.4	8.2	37.4	15.4
Pooled	96.6	45.9	11.9	9	15.1	21.9

[a] Percentage of mothers who stated that they currently breast-feed and separately had fed their infants 4 categories of liquid or solid food in the past 24 hours by country for infants age 0 to 6 months old.

Source: Marriott et al., 2007.

Table 15-28. Percentage of Mothers in Developing Countries by Feeding Practices for Infants 6 to 12 Months Old[a]

Country	Breastfeeding	Water	Milk	Formula	Other Liquids	Solid Foods
Ethiopia	99.4	69.2	37.6	0	23.9	54.7
Ghana	99.3	88.8	14.6	9.6	23.9	71.1
Kenya	96.5	77.7	58.7	6	56.4	89.6
Malarwi	99.4	93.5	5.9	3.2	31.2	94.9
Nambia	78.7	91.9	0	0	42.7	79.5
Nigeria	97.8	91.6	14.4	13.4	27.4	70.4
Uganda	97.4	65.9	32.1	1.6	56.2	82.1
Zamibia	99.5	91.7	8.2	5	25.9	90.2
Zimbabwe	96.7	92.5	8.7	2.4	49.9	94.8
Armenia	53.4	91.1	56.9	11.6	85.3	88.1
Egypt	89.1	85.9	36.8	16.7	48.5	75.7
Jordan	65.7	99.3	24.3	28.8	57.7	94.9
Bangladesh	96.2	87.7	29.8	10.1	21.9	65.2
Cambodia	94.4	97.5	3.7	6.7	29	81
India	94.9	81.4	45	0	25.2	44.1
Indonesia	84.8	85.4	4.9	38.8	35.4	87.9
Nepal	98.8	84.3	32	0	15.8	71.5
Philippines	64.4	95.1	12.2	47.1	31	88
Vietnam	93.2	95	36.1	5.3	37.9	85.8
Kazakhstan	81.2	74.3	85.4	11.4	91.8	85.9
Pooled	87.9	87.4	29.6	15.1	41.6	80.1

[a] Percentage of mothers who stated that they currently breast-feed and separately had fed their infants 4 categories of liquid or solid food in the past 24 hours by country for infants age 6 to 12 months old.

Source: Marriott et al., 2007.

Table 15-29. Population Weighted Averages of Mothers Who Reported Selected Feeding Practices During the Previous 24-hours

Feeding Practices	Infant Age	
	0 to 6 months	6 to 12 months
	Percentage (weighted N)	
Current Breast-feeding	96.6 (22,781)	87.9 (18,944)
Gave Infant:		
Water	45.9 (10,767)	87.4 (18,6663)
Tinned, Powdered, or Other Milk	11.9 (2,769)	29.6 (6,283)
Commercial Formula	9.0 (1,261)	15.1 (1,911)
Other Liquids	15.1 (3,531)	41.6 (8,902)
Any Solid Food	21.9 (5,131)	80.1 (17,119)

N = Number of infants.

Source: Marriott et al., 2007.

Table 15-30. Racial and Ethnic Differences in Proportion of Children Ever Breastfed, NHANES III (1988-1994)													
										Absolute Difference (%,SE)[a]			
	Non-Hispanic White			Non-Hispanic Black			Mexican American			White vs Black		White vs Mexican American	
Characteristic	N	%	(SE)	N	%	(SE)	N	%	(SE)	%	(SE)	%	(SE)
All infants	1,869	60.3	2.0	1,845	25.5	1.4	2,118	54.4	1.9	34.8	(2.0)[b]	6.0	(2.3)[a]
Infant sex													
Male	901	60.4	2.6	913	24.4	1.6	1,033	53.8	1.8	35.9	(2.9)[b]	6.6	(2.8)[a]
Female	968	60.3	2.3	932	26.7	1.9	1,085	54.9	2.9	33.7	(2.6)[b]	5.4	(3.4)[c]
Infant birth weight (g)													
<2,500	118	40.1	5.3	221	14.9	2.6	165	34.1	3.9	25.1	(5.8)[b]	5.9	(6.4)[c]
≥2,500	1,738	62.1	2.1	1,584	26.8	1.6	1,838	55.7	2.0	35.3	(2.1)[b]	6.4	(2.5)[a]
Maternal age (years)													
<20	175	33.7	4.4	380	13.1	2.1	381	43.7	3.0	20.6	(4.8)[b]	-10	(5.1)[c]
20 to 24	464	48.3	3.0	559	22.0	2.0	649	54.8	2.6	26.4	(3.7)[b]	-6.4	(4.2)[c]
25 to 29	651	65.4	2.2	504	30.6	2.5	624	56.9	3.3	34.8	(3.1)[b]	8.6	(4.0)[a]
≥30	575	71.9	2.7	391	36.1	2.3	454	59.6	2.8	35.8	(3.4)[b]	12.3	(3.4)[b]
Household head education													
<High school	313	32.3	4.0	583	14.7	2.5	1,262	51.0	2.6	17.6	(5.0)[b]	-18.8	(4.8)[b]
High school	623	52.6	2.8	773	21.9	2.0	479	51.4	3.4	30.7	(3.2)[b]	1.2	(4.1)[c]
Some college	397	63.8	2.3	317	37.2	3.5	226	68.0	5.2	26.6	(3.7)[b]	-4.1	(5.6)[c]
College graduate	505	83.0	2.4	139	54.4	4.9	74	78.3	7.4	28.6	(5.3)[b]	4.6	(7.6)[c]
Smoking during pregnancy													
Yes	526	39.8	3.0	403	18.0	2.1	198	31.2	3.9	21.8	(3.7)[b]	8.6	(4.7)[c]
No	1,334	68.2	2.0	1,429	27.8	1.7	1,917	56.7	1.9	40.4	(2.1)[b]	11.5	(2.5)[b]
Maternal body mass index													
<25.0	1,331	64.9	2.0	872	26.8	2.0	961	54.1	2.5	38.0	(2.5)[b]	10.8	(2.7)[b]
25.0 to 29.9	283	50.9	3.4	484	24.1	3.2	534	57.8	2.1	26.8	(4.5)[b]	-6.8	(4.1)[c]
≥30	204	48.6	4.8	415	24.3	2.7	359	47.1	4.4	24.3	(5.3)[b]	1.5	(6.1)[c]
Residence													
Metropolitan	762	67.2	3.0	943	32.0	1.9	1,384	56.1	2.0	35.3	(2.6)[b]	11.2	(2.9)[b]
Rural	1,107	54.9	3.1	902	18.3	1.9	734	51.3	3.1	36.6	(2.7)[b]	3.6	(4.0)[c]
Region													
Northeast	317	51.6	4.6	258	34.2	4.4	12	74.1	10.4	17.3	(3.6)[b]	-22.5	(14.5)[c]
Midwest	556	61.7	2.3	346	26.5	2.4	170	51.5	3.7	35.2	(3.3)[b]	10.2	(5.0)[a]
South	748	52.7	2.7	1,074	19.4	2.0	694	42.7	3.5	33.3	(2.7)[b]	10	(4.6)[a]
West	248	82.4	3.9	167	45.1	5.1	1,242	59.1	2.2	37.3	(7.1)[b]	23.4	(3.3)[b]

Table 15-30. Racial and Ethnic Differences in Proportion of Children Ever Breastfed, NHANES III (1988-1994) (continued)													
	Non-Hispanic White			Non-Hispanic Black			Mexican American			Absolute Difference (%,SE)[a]			
										White vs Black		White vs Mexican American	
Poverty income ratio (%)													
<100	257	38.5	4.2	905	18.2	1.9	986	48.2	2.8	20.3	(4.4)[b]	-9.6	(4.7)[a]
100 to <185	388	55.7	2.6	391	26.8	2.1	490	54.1	3.4	28.9	(3.5)[b]	1.5	(4.2)[c]
185 to <350	672	61.9	2.5	294	32.0	3.0	288	64.7	4.7	30.0	(3.7)[b]	2.8	(5.3)[c]
≥350	444	77.0	2.5	105	58.1	5.1	74	71.9	9.0	19.0	(5.6)[b]	5.2	(9.0)[c]
Unknown	108	44.7	7.1	150	25.5	3.9	280	59.5	2.8	19.2	(7.9)[a]	-14.8	(7.9)[c]

[a] $p < 0.05$.
[b] $p < 0.01$.
[c] No statistical difference.
N = Number of infants.
SE = Standard error.

Source: Li and Grummer-Strawn, 2002.

Table 15-31. Racial and Ethnic Differences in Proportion of Children Who Received Any Human Milk at 6 Months (NHANES III, 1988-1994)

	Non-Hispanic White			Non-Hispanic Black			Mexican American			Absolute Difference (%,SE)			
										White vs Black		White vs Mexican American	
Characteristic	N	%	(SE)	No.	%	(SE)	N	%	(SE)	%	(SE)	%	(SE)
All infants	1863	26.8	1.6	1,842	8.5	0.9	2,112	23.1	1.4	18.3	(1.7)[b]	3.7	(2.1)[c]
Infant sex													
Male	900	27.6	2.3	912	8.5	1.1	1,029	22.3	1.6	19.1	(2.6)[b]	5.2	(2.6)[a]
Female	963	26.1	1.8	930	8.6	1.1	1,083	24.0	2.0	17.5	(2.1)[a]	2.1	(2.7)[c]
Infant birth weight (g)													
<2,500	118	10.9	3.1	221	4.2	1.8	165	15.2	4.7	6.7	(3.3)[a]	-4.3	(5.7)[c]
≥2,500	1,733	28.3	1.8	1,581	9.0	0.9	1,832	23.1	1.7	19.3	(1.8)[b]	5.2	(2.3)[a]
Maternal age (years)													
<20	174	10.2	2.9	380	4.7	1.4	380	11.6	1.7	5.5	(3.0)[c]	-1.3	(3.8)[c]
20 to 24	461	13.4	2.4	559	7.5	1.1	646	23.8	2.4	5.9	(2.5)[a]	-10.4	(3.3)[b]
25 to 29	651	29.3	2.6	503	10.9	2.0	624	24.6	2.6	18.4	(3.5)[b]	4.8	(3.6)[c]
≥30	573	39.0	2.6	389	10.7	1.7	452	30.0	2.8	28.4	(3.3)[b]	9.0	(3.6)[a]
Household head education													
<High school	312	14.6	3.8	582	4.4	1.2	1,258	20.7	1.4	10.2	(4.5)[a]	-6.2	(4.1)[c]
High school	622	19.9	1.7	771	5.0	1.0	478	22.4	2.5	14.9	(2.0)[b]	2.5	(3.1)[c]
Some college	396	26.8	2.4	317	16.6	2.5	225	28.4	5.3	10.2	(3.5)[b]	-1.6	(6.1)[c]
College graduate	502	42.2	2.9	139	21.1	3.2	74	45.5	7.3	21.1	(5.2)[b]	3.4	(7.6)[c]
Smoking during pregnancy													
Yes	524	11.3	1.5	402	4.3	1.1	198	9.3	2.2	7.0	(1.9)[b]	2.1	(2.7)[c]
No	1,331	32.7	2.1	1,427	9.8	1.1	1,911	24.5	1.5	22.9	(2.3)[b]	8.1	(2.6)[b]
Maternal body mass index													
<25.0	1,326	29.6	1.8	871	8.9	1.2	959	21.9	2.1	20.7	(2.1)[b]	7.8	(2.7)[b]
25.0 to 29.9	282	19.0	2.4	482	8.2	1.9	534	26.4	1.9	10.8	(3.2)[b]	7.4	(3.0)[a]
≥30	204	20.4	4.1	415	7.3	1.6	357	17.2	3.0	13.1	(4.4)[b]	3.3	(5.2)[c]
Residence													
Metropolitan	760	29.7	2.5	941	11.8	1.3	1,378	23.5	1.7	17.9	(2.4)[b]	6.1	(3.1)[c]
Rural	1,103	24.6	2.4	901	4.9	0.9	734	22.5	2.8	19.7	(2.2)[b]	2.2	(3.4)[c]
Region													
Northeast	316	21.0	2.2	258	9.7	1.8	12	43.6	16.0	11.3	(1.8)[b]	-22.6	(16.5)[c]
Midwest	553	28.8	2.1	344	9.8	2.4	170	18.2	4.7	19.0	(3.7)[b]	10.6	(6.2)[c]
South	746	20.1	2.8	1,073	5.9	1.0	693	17.2	2.8	14.3	(2.8)[b]	2.9	(4.2)[c]
West	248	42.7	4.7	167	19.3	3.3	1,237	25.9	1.4	23.4	(5.3)[b]	16.8	(5.1)[b]

Table 15-31. Racial and Ethnic Differences in Proportion of Children Who Received Any Human Milk at 6 Months (NHANES III, 1988-1994) (continued)

	Non-Hispanic White			Non-Hispanic Black			Mexican American			Absolute Difference (%,SE)			
										White vs Black		White vs Mexican American	
Poverty income ratio (%)													
100 to <185	387	23.5	2.9	390	9.9	1.8	486	23.4	2.7	13.6	(3.9)[b]	0	(4.1)[c]
185 to <350	670	30.4	2.7	293	10.0	2.4	287	27.6	4.4	20.4	(4.0)[b]	2.9	(4.8)[c]
≥350	443	33.0	3.0	105	15.2	2.8	74	32.3	9.0	17.8	(4.2)[b]	0.7	(9.5)[c]
Unknown	108	13.3	3.8	149	6.4	2.9	280	26.7	4.5	7.0	(5.3)[c]	-13.4	(6.6)[a]

[a] p <0.05.
[b] p <0.01.
[c] No statistical difference.
N = Number of individuals.
SE = Standard error.

Source: Li and Grummer-Strawn, 2002.

Table 15-32. Racial and Ethnic Differences in Proportion of Children Exclusively Breastfed at 4 Months (NHANES III, 1991-1994)

	Non-Hispanic White			Non-Hispanic Black			Mexican American			Absolute Difference (%,SE) White vs Black		Absolute Difference (%,SE) White vs Mexican American	
Characteristic	N	%	(SE)	N	%	(SE)	N	%	(SE)	%	(SE)	%	(SE)
All infants	824	22.6	1.7	906	8.5	1.5	957	20.4	1.4	14.1	(2.2)[b]	2.3	(1.6)[c]
Infant sex													
Male	394	22.3	1.9	454	7.0	1.6	498	20.7	1.5	15.3	(2.6)[b]	1.5	(1.8)[c]
Female	430	23.0	2.2	452	10.0	2.2	459	20.0	1.8	12.9	(3.0)[b]	3.0	(2.1)[c]
Infant birth weight (g)													
<2500	50	15.2	7.1	118	7.0	2.3	66	5.6	1.8	8.2	(8.1)[c]	9.5	(6.9)[c]
≥2500	774	23.1	1.8	786	8.8	1.6	880	21.6	1.4	14.4	(2.2)[b]	1.5	(1.6)[c]
Maternal age (years)													
<20	76	6.6	3.2	172	6.4	2.1	170	12.1	2.5	0.2	(3.7)[c]	-5.6	(3.8)[c]
20 to 24	205	11.4	2.2	273	7.4	2.4	319	21.0	2.3	4.0	(2.7)[c]	-9.6	(3.2)[b]
25 to 29	271	21.6	2.3	254	8.6	2.5	256	22.1	2.5	13.0	(3.2)[b]	-0.5	(3.2)[c]
≥30	270	34.8	2.7	201	11.9	2.6	210	23.6	3.1	22.9	(4.2)[b]	11.1	(3.7)[b]
Household head education													
<High school	146	9.5	3.5	256	2.0	0.7	563	19.7	1.8	7.5	(3.6)[a]	-10.2	(4.0)[a]
High school	277	14.5	2.7	406	7.1	2.1	222	18.8	3.6	7.4	(3.2)[a]	-4.3	(4.7)[c]
Some college	175	30.8	3.8	141	17.4	3.0	120	21.0	3.9	13.4	(4.7)[b]	9.8	(6.1)[c]
College graduate	219	34.1	3.9	92	17.4	4.7	37	31.5	4.5	16.7	(6.9)[a]	2.6	(6.3)[c]
Smoking during pregnancy													
Yes	224	10.0	2.8	168	5.4	2.2	64	3.2	1.8	4.6	(3.7)[c]	6.8	(3.4)[c]
No	596	27.2	2.1	730	9.4	1.9	892	21.7	1.5	17.8	(2.8)[b]	5.6	(2.0)[a]
Maternal body mass index													
<25.0	597	24.8	2.1	407	8.0	1.9	417	19.4	1.9	16.8	(3.0)[b]	5.4	(2.3)[a]
25.0 to 29.9	117	19.7	4.3	230	8.6	1.9	261	23.1	3.4	11.1	(4.6)[a]	-3.4	(4.9)[c]
≥30	91	15.4	3.8	230	9.0	2.9	184	15.9	2.3	6.4	(5.2)[c]	-0.5	(4.6)[c]
Residence													
Metropolitan	312	24.4	3	535	11.0	2.0	608	19.6	1.6	13.4	(3.5)[b]	4.8	(2.8)[c]
Rural	512	21.3	1.8	371	4.2	1.3	349	22.3	3.3	17.1	(1.8)[b]	-1.1	(3.0)[c]
Region													
Northeast	138	20.0	1.4	131	11.1	2.9	10	9.4	9.5	8.8	(2.2)[b]	10.6	(8.7)[c]
Midwest	231	26.5	3.2	143	12.6	5.6	98	19.2	4.1	13.9	(7.6)[c]	7.4	(3.7)[c]
South	378	14.1	2.8	574	5.9	1.4	383	15.9	3.1	8.2	(1.9)[b]	-1.8	(3.7)[c]
West	77	34.7	2.7	58	12.5	5.0	466	23.0	1.3	22.2	(5.4)[b]	11.7	(2.5)

Table 15-32. Racial and Ethnic Differences in Proportion of Children Exclusively Breastfed at 4 Months (NHANES III, 1991-1994) (continued)

	Non-Hispanic White			Non-Hispanic Black			Mexican American			Absolute Difference (%,SE)			
										White vs Black		White vs Mexican American	
Poverty income ratio (%)													
<100	116	13.1	3.3	448	5.7	1.6	471	18.4	1.8	7.4	(3.5)[a]	-5.3	(3.1)[c]
100 to <185	166	18.9	3.2	197	10.6	2.8	234	21.9	4.1	8.3	(3.3)[a]	-3	(6.1)[c]
185 to <350	274	25.1	3.2	145	12.9	4.3	132	26.4	4.2	12.2	(5.0)[a]	-1.3	(4.1)[c]
≥350	235	27.4	4.1	57	12.8	3.5	37	17.0	5.0	14.6	(5.0)[b]	10.4	(5.2)[c]
Unknown	33	16.5	7.6	59	7.3	3.7	83	16.1	5.1	9.2	(8.6)[c]	0.4	(9.5)[c]

[a] p <0.05.
[b] p <0.01.
[c] No statistical difference.
N = Number of individuals.
SE = Standard error.

Source: Li and Grummer-Strawn, 2002.

Table 15-33. Percentage of Mothers Breast-feeding Newborn Infants in the Hospital and Infants at 5 or 6 Months of Age in the United States in 1989 and 1995, by Ethnic Background and Selected Demographic Variables

Characteristic	Percentage of Mothers Breast-Feeding					
	In Hospital			At 6 Months		
	1989	1995	Change[a]	1989	1995	Change[a]
All Infants	52.2	59.7	14.4	18.1	21.6	19.3
White	58.5	64.3	9.9	21.0	24.1	14.8
Black	23.0	37.0	60.9	6.4	11.2	75.0
Hispanic	48.4	61.0	26.0	13.9	19.6	41.0
Maternal Age (years)						
<20	30.2	42.8	41.7	5.6	9.1	62.5
20 to 24	45.2	52.6	16.4	11.5	14.6	27.0
25 to 29	58.8	63.1	7.3	21.1	22.9	8.5
30 to 34	65.5	68.1	4.0	29.3	29.0	(1.0)[b]
35+	66.5	70.0	5.3	34.0	33.8	(0.6)[b]
Total Family Income						
<$10,000	31.8	41.8	31.4	8.2	11.4	39.0
$10,000 to $14,999	47.1	51.7	9.8	13.9	15.4	10.8
$15,000 to $24,999	54.7	58.8	7.5	18.9	19.8	4.8
≥25,000	66.3	70.7	6.6	25.5	28.5	11.8
Maternal Education						
Grade School	31.7	43.8	38.2	11.5	17.1	48.7
High School	42.5	49.7	16.9	12.4	15.0	21.0
College	70.7	74.4	5.2	28.8	31.2	8.3
Maternal Employment						
Employed Full Time	50.8	60.7	19.5	8.9	14.3	60.7
Employed Part Time	59.4	63.5	6.9	21.1	23.4	10.9
Not Employed	51.0	58.0	13.7	21.6	25.0	15.7
Birth Weight						
Low (≤2,500 g)	36.2	47.7	31.8	9.8	12.6	28.6
Normal	53.5	60.5	13.1	18.8	22.3	18.6
Parity						
Primiparous	52.6	61.6	17.1	15.1	19.5	29.1
Multiparous	51.7	57.8	11.8	21.1	23.6	11.8
WIC Participation[c]						
Participant	34.2	46.6	36.3	8.4	12.7	51.2
Nonparticipant	62.9	71.0	12.9	23.8	29.2	22.7
U.S. Census Region						
New England	52.2	61.2	17.2	18.6	22.2	19.4
Middle Atlantic	47.4	53.8	13.5	16.8	19.6	16.7
East North Central	47.6	54.6	14.7	16.7	18.9	13.2
West North Central	55.9	61.9	10.7	18.4	21.4	16.3
South Atlantic	43.8	54.8	25.1	13.7	18.6	35.8
East South Central	37.9	44.1	16.4	11.5	13.0	13.0
West South Central	46.0	54.4	18.3	13.6	17.0	25.0
Mountain	70.2	75.1	7.0	28.3	30.3	7.1
Pacific	70.3	75.1	6.8	26.6	30.9	16.2

[a] The percent change was calculated using the following formula: % breastfed in 1984 - % breastfed in 1989 / % breastfed in 1984.
[b] Figures in parentheses indicate a decrease in the rate of breastfeeding from 1989 to 1995.
[c] WIC indicates Women, Infants, and Children supplemental food program.

Source: Ryan, 1997.

Table 15-34. Percentage of Mothers Breast-feeding Newborn Infants in the Hospital and Infants at 6 and 12 Months of Age in the United States in 2003, by Ethnic Background and Selected Demographic Variables

Characteristic	Percentage of Mothers Breast-Feeding		
	In Hospital	At 6 Months	At 12 Months
All Infants	44	18	10
White	53	20	12
Black	26	10	5
Hispanic	33	15	12
Asian	39	23	12
Maternal Age (years)			
<20	28	9	4
20 to 24	40	13	8
25 to 29	48	20	10
30 to 34	50	23	14
35+	47	23	14
Maternal Education			
Any Grade School	26	13	17
Any High School	35	12	8
No College	35	12	8
College	55	24	14
Maternal Employment			
Employed Full Time	44	11	6
Employed Part Time	49	19	11
Total Employed	45	14	8
Not Employed	43	21	13
Low Birth Weight <5 lbs 9oz	27	10	6
Parity			
Primiparous	48	17	10
Multiparous	43	19	11
WIC Participation [a]			
Participant	32	11	7
Nonparticipant	55	25	14
U.S. Census Region			
New England	52	22	11
Middle Atlantic	36	17	9
East North Central	44	17	9
West North Central	55	18	9
South Atlantic	42	16	10
East South Central	37	11	7
West South Central	37	15	8
Mountain	53	23	16
Pacific	50	24	15

[a] WIC indicates Women, Infants, and Children supplemental food program.

Source: Abbott, 2003.

Table 15-35. Number of Meals Per Day		
Age (months)	Bottle-fed Infants (meals/day) [a]	Breast-fed (meals/day) [a]
1	5.4 (4-7)	5.8 (5-7)
2	4.8 (4-6)	5.3 (5-7)
3	4.7 (3-6)	5.1 (4-8)

[a] Data expressed as mean with range in parentheses.

Source: Hofvander et al., 1982.

Table 15-36. Comparison of Breastfeeding Patterns Between Age and Groups (Mean ±SD)			
Breastfeeding Episodes per Day	5.8 ± 2.6	6.8 ± 2.4	2.5 ± 2.0
Total Time Breastfeeding (min/day)	65.2 ± 44.0	102.2 ± 51.4	31.2 ± 24.6
Length of Breastfeeding (min/episode)	10.8 ± 6.1	14.2 ± 6.1	11.6 ± 5.6

SD = Standard deviation

Source: Buckley, 2001.

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16 ACTIVITY FACTORS

16.1 INTRODUCTION

Individual or group activities are important determinants of potential exposure, because toxic chemicals introduced into the environment may not cause harm to an individual until an activity is performed that subjects the individual to contact with those contaminants. An activity or time spent in a given activity will vary among individuals on the basis of, for example, culture, ethnicity, hobbies, location, gender, age, socioeconomic characteristics, and personal preferences. However, limited information is available regarding ethnic, cultural and socioeconomic differences in individuals' choice of activities or time spent in a given activity. Children are of special concern because certain activities and behaviors specific to children place them at higher risk of exposure to certain environmental agents (Chance and Harmsen, 1998).

In calculating exposure, a person's average daily dose is determined from a combination of variables including the pollutant concentration, exposure duration, and frequency of exposure (see Chapter 1). These variables can be dependent on human activity patterns and time spent at each activity and/or location.

Time activity data are generally obtained using recall questionnaires and diaries to record the person's activities and microenvironments. Other methods include the use of global positioning system (GPS) technology to provide information on individuals' locations (Phillips et al., 2001; Elgethun et al., 2003).

Obtaining accurate information on time and activities can be challenging. This is especially true for children (Hubal et al., 2000). Children engage in more contact activities than adults; therefore, a much wider distribution of activities need to be considered when assessing children's exposure (Hubal et al., 2000). Other factors that may affect children's activity patterns include: social status, economics, and the cultural practices of their families.

This chapter summarizes data on how much time individuals spend participating in various activities in various microenvironments and on the frequency of performing various. Information is also provided on occupational mobility and population mobility. The data in this chapter cover a wide range of activities and populations, arranged by age group when such data are available. One of the objectives of this handbook is to provide recommended exposure factor values using a consistent set of age groups. In this chapter, several studies are used as sources for activity pattern data. In some cases, the source data could be retrieved and analyzed using the standard age groupings recommended in *Guidance for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). In other cases, the original source data were not available, and the study results are presented here using the same age groups as the original study, whether or not they conform to the standard age groupings.

The recommendations for activity factors are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values are based on key studies identified by U.S. EPA for this factor. Following the recommendations, key studies on activity patterns are summarized. Relevant data on activity patterns are also presented to provide the reader with added perspective on the current state-of-knowledge pertaining to activity patterns in adults and children.

16.2 RECOMMENDATIONS

16.2.1 ACTIVITY PATTERNS

Assessors are commonly interested in quantitative information describing several types of time use data for adults and children including: time spent indoors and outdoors; time spent bathing, showering, and swimming; and time spent playing on various types of surfaces. The recommended values for these factors are summarized in Table 16-1. Note that, except for swimming, all activity factors are reported in units of minutes/day. Time spent swimming is reported in units of minutes/month. These data are based on two key studies presented in this chapter: a study of children's activity patterns in California (Wiley et al., 1991) and the National Human Activity Pattern Survey (NHAPS) (U.S. EPA, 1996). Both mean and 95th percentile recommended values are provided. However, because these recommendations are based on short-term survey data, 95th percentile values may be misleading for estimating chronic (i.e., long term) exposures and should be used with caution. Also, the upper percentile values for some activities are truncated as a result of the maximum response included in the survey (e.g., durations of more than 120 minutes/day were reported as 121 minutes/day), and could not be further refined). The confidence ratings for the recommendations are presented in Table 16-2.

The recommendations for total time spent indoors and the total time spent outdoors are based on U.S. EPA re-analysis of the source data from Wiley et al. (1991) for children < 1 year of age and U.S. EPA (1996) for childhood age groups > 1 year of age. Although Wiley et al. (1991) is a study of California children and the sample size was very small for infants, it provides data for children's activities for the younger age groups. Data from U.S. EPA (1996) are representative of the U.S. general population. In some cases, however, the time spent indoors or outdoors would be better addressed on a site-specific basis since the times are likely to vary depending on the climate, residential setting (i.e., rural versus urban), personal traits (e.g., health status) and personal habits. For children > 1 year of age, the recommended values for time spent indoors at a residence, duration of showering and bathing, time spent swimming, and time spent playing on sand, gravel, grass or dirt are based on a U.S. EPA re-analysis of the source data from U.S. EPA (1996). For adults 18 years and older, the recommended values are taken directly from the source document (U.S. EPA, 1996).

16.2.2 Occupational Mobility

The median occupational tenure of the working population (109.1 million people) ages 16 years of age and older in January 1987 was 7.9 years for men and 5.4 years for women (Carey, 1988). Since the occupational tenure varies significantly according to age and gender, the recommended values are given by 5 year age groups separately for males and females in Table 16-3. Table 16-82 presents occupational tenure for males and females combined. Part-time employment, race and the position held are important to consider in determining occupational tenure. These data are presented in Tables 16-83 through 16-86. Table 16-3 also presents recommendations for occupational mobility rate, by age. This rate is the percentage of persons employed in an occupation who had voluntarily entered it from another occupation. The overall percent was 5.3 (Carey, 1990). The ratings indicating confidence in the occupational mobility recommendations are presented in Table 16-4It should be noted that the recommended values are not for use in evaluating job tenure. These data can be used for determining time spent in an occupation and not for time spent at a specific job site.

16.2.3 Population Mobility

An assessment of population mobility can assist in determining the length of time a household is exposed in a particular location. For example, the duration of exposure to site-specific contamination, such as a polluted stream from which a family fishes or contaminated soil on which children play or vegetables are grown, will be directly related to the period of time residents live near the contaminated site.

There are two key studies from which the population mobility recommendations were derived, the U.S. Bureau of the Census American Housing Survey, (U.S. Bureau of the Census, 2008a) and Johnson and Capel, 1992. The U.S. Buraeu of Census (2008a) provides data on current residence time and Johnson and Capel (1992) provide data on residential occupancy period. Table 16-5 presents the recommendations for population mobility. The confidence ratings for these recommendations are presented in Table 16-6.

The 50th and 90th percentiles for current residence time from the U.S. Bureau of the Census (2008a) are 8 years and 32 years, respectively. The mean and 90th percentile for residential occupancy period from Johnson and Capel (1992) are 12 years and 26 years, respectively.

Table 16-1. Recommended Values for Activity Patterns

Age Group	Mean	95th Percentile	Source
Time Indoors (total) minutes/day			
Birth to <1 month	1,440	-	U.S. EPA analysis of source data from Wiley et al., 1991 for age groups from birth to < 12 months. Average for boys and girls, whole population. See Table 16-14.
1 to <3 months	1,432	-	
3 to <6 months	1,414	-	
6 to <12 months	1,301	-	
1 to <2 years	1,353	-	U.S. EPA re-analysis of source data from U.S. EPA, 1996 for age groups from 1 to < 21 years, whole population. See Table 16-21.
2 to <3 years	1,316	-	
3 to <6 years	1,278	-	
6 to <11 years	1,244	-	
11 to <16 years	1,260	-	Adults, ≥ 18 years: U.S. EPA, 1996. Total minutes per 24 hours (1,440) minus time outdoors, doers only. See Table 16-22.
16 to <21 years	1,248	-	
18 to <65 years	1,159	-	
≥ 65 years	1,142	-	
Time Outdoors (total) minutes/day			
Birth to <1 month	0	-	Children, Birth to < 12 months: U.S. EPA analysis of source data from Wiley et al., 1991. Average for boys and girls, whole population. See Table 16-14.
1 to <3 months	8	-	
3 to <6 months	26	-	
6 to <12 months	139	-	
1 to <2 years	36	-	Children, 1 to <21 years: U.S. EPA re-analysis of source data from U.S. EPA, 1996, whole population. See Table 16-21.
2 to <3 years	76	-	
3 to <6 years	107	-	
6 to <11 years	132	-	
11 to <16 years	100	-	Adults, ≥ 18 years: U.S. EPA, 1996. Sum of minutes spent outdoors away from the residence and minutes spent outdoors at the residence. Doers only. See Table 16-22.
16 to <21 years	102	-	
18 to <65 years	281	-	
≥ 65 years	298	-	
Time Indoors (at residence) minutes/day			
Birth to <1year	1,108	1,440	Children, Birth to <21 years: U.S. EPA re-analysis of source data from U.S. EPA, 1996. Doers only. See Table 16-15.
1 to <2 years	1,065	1,440	
2 to <3 years	979	1,296	
3 to <6 years	957	1,355	
6 to <11 years	893	1,275	
11 to <16 years	889	1,315	Adults ≥ 18 years: U.S. EPA, 1996. Doers only. See Table 16-16
16 to <21 years	833	1,288	
18 to < 65 years	948	1,428	
≥ 65 years	1,175	1,440	
Showering minutes/day			
Birth to <1year	15	-	U.S. EPA re-analysis of source data from U.S. EPA, 1996. Doers only. See Table 16-28.
1 to <2 years	20	-	
2 to <3 years	22	44	
3 to <6 years	17	34	
6 to <11 years	18	41	
11 to <16 years	18	40	
16 to <21 years	20	45	

Table 16-1. Recommended Values for Activity Patterns (continued)			
Age Group	Mean	95th Percentile	Source
Bathing minutes/day			
Birth to <1 year	19	30	U.S. EPA re-analysis of source data from U.S. EPA, 1996. Doers only. See Table 16-28.
1 to <2 years	23	32	
2 to <3 years	23	45	
3 to <6 years	24	60	
6 to <11 years	24	46	
11 to <16 years	25	43	
16 to <21 years	33	60	
Bathing/Showering minutes/day			
18 to <65 years	17	-	U.S. EPA, 1996. Doers only. See Table 16-29.
≥65 years	17	-	
Swimming minutes/month			
Birth to <1 year	96	-	Children, Birth to < 21 years: U.S. EPA re-analysis of source data from U.S. EPA, 1996. Doers only. See Table 16-35. Adults, ≥18 years: U.S. EPA, 1996. Doers only. See Table 16-37.
1 to < 2 years	105	-	
2 to <3 years	116	181	
3 to <6 years	137	181	
6 to <11 years	151	181	
11 to <16 years	139	181	
16 to <21 years	145	181	
18 to <65 years	45[a]	181	
≥65 years	40[a]	181	
Playing on Sand/Gravel minutes/day			
Birth to <1 year	18	-	Children, <21 years: U.S. EPA re-analysis of source data from U.S. EPA, 1996. Doers only. See Table 16-38. Adults, ≥18 years: U.S. EPA, 1996. Doers only. See Table 16-39.
1 to < 2 years	43	121	
2 to <3 years	53	121	
3 to <6 years	60	121	
6 to <11 years	67	121	
11 to <16 years	67	121	
16 to <21 years	83	-	
18 to < 64 years	0[a]	121	
≥ 65 years	0[a]	-	
Playing on Grass minutes/day			
Birth to <1 year	52	-	Children, <21 years: U.S. EPA re-analysis of source data from U.S. EPA, 1996. Doers only. See Table 16-38. Adults, ≥18 years: U.S. EPA, 1996. Doers only. See Tables 16-39.
1 to < 2 years	68	121	
2 to <3 years	62	121	
3 to <6 years	79	121	
6 to <11 years	73	121	
11 to <16 years	75	121	
16 to <21 years	60	-	
18 to <65 years	60[a]	121	
≥65 years	121[a]	-	

Table 16-1. Recommended Values for Activity Patterns (continued)			
Age Group	Mean	95th Percentile	Source
Playing on Dirt minutes/day			
Birth to <1 year	33	-	Children, <21 years: U.S. EPA re-analysis of source data from U.S. EPA, 1996. Doers only. See Table 16-38. Adults, ≥18 years: U.S. EPA, 1996. Doers only. See Table 16-39.
1 to < 2 years	56	121	
2 to <3 years	47	121	
3 to <6 years	63	121	
6 to <11 years	63	121	
11 to <16 years	49	120	
16 to <21 years	30	-	
18 to <65 years	0[a]	120	
≥65 years	0[a]	-	

- Percentiles were not calculated for sample sizes less than 10 or in cases where the mean was calculated by summing the means from multiple locations or activities.

a Median value, mean not available in U.S. EPA, 1996.

Note: All activities are reported in units of minutes/day, except swimming, which is reported in units of minutes/month. There are 1,440 minutes in a day. Time indoors and outdoors may not add up to 1,440 minutes due to activities that could not be classified as either indoors or outdoors.

Table 16-2. Confidence in Recommendations for Activity Patterns		
General Assessment Factors	Rationale	Rating
Soundness		High
Adequacy of Approach	The survey methodologies and data analyses were adequate. For the reanalysis of U.S. EPA (1996) study data, responses were weighted; however, adult data were not reanalyzed. The California children's activity pattern survey design (Wiley et al., 1991) and NHAPS (U.S. EPA, 1996) consisted of large overall sample sizes that varied with age. Data were collected via questionnaires and interviews.	
Minimal (or Defined) Bias	Measurement or recording error may have occurred since the diaries were based on 24 hour recall. The sample sizes for some age groups were small for some activity factors. The upper ends of the distributions were truncated for some factors. The data were based on short-term data.	
Applicability and Utility		Medium
Exposure Factor of Interest	The key studies focused on activities of children and adults.	
Representativeness	U.S. EPA (1996) was a nationally representative survey of the U.S. population and the reanalysis was weighted; the Wiley et al. (1991) survey was conducted in California and it was not representative of the U.S. population.	
Currency	The Wiley et al. (1991) study was conducted between April 1989 and February 1990; the U.S. EPA (1996) study was conducted between October 1992 and September 1994.	
Data Collection Period	Data were collected for a 24-hour period.	
Clarity and Completeness		Medium
Accessibility	The original studies are widely available to the public; U.S. EPA analysis of the original raw data from U.S. EPA (1996) is available upon request.	
Reproducibility	The methodologies were clearly presented; enough information was included to reproduce the results.	
Quality Assurance	Quality assurance methods were not well described in study reports.	
Variability and Uncertainty		Medium
Variability in Population	Variability was characterized across various age categories of children and adults.	
Uncertainty	The studies were based on short term recall data, and the upper ends of the distributions were truncated.	
Evaluation and Review		Medium
Peer Review	The original studies received a high level of peer review. The re-analysis of the U.S. EPA (1996) data to conform to the standardized age categories was not peer-reviewed.	
Number and Agreement of Studies	There were 2 key studies.	
Overall Rating		**Medium for the mean; low for upper percentile**

Table 16-3. Recommended Values for Occupational Mobility

Age Group	Median Tenure (years) Men	Median Tenure (years) Women	Source
All ages, ≥16 years	7.9	5.4	Carey, 1988. See Table 16-82
16-24 years	2.0	1.9	
25-29 years	4.6	4.1	
30-34 years	7.6	6.0	
35-39 years	10.4	7.0	
40-44 years	13.8	8.0	
45-49 years	17.5	10.0	
50-54 years	20.0	10.8	
55-59 years	21.9	12.4	
60-64 years	23.9	14.5	
65-69 years	26.9	15.6	
≥70 years	30.5	18.8	
Age Group	**Occupational Mobility Rate[a] (percent)**		**Source**
16-24 years	12.7		Carey, 1990. See Table 16-86
25-34 years	6.6		
35-44 years	4.0		
45-54 years	1.9		
55-64 years	1.0		
≥64 years	0.3		
Total, ≥16 years	5.3		

[a] Occupational mobility rate = percentage of persons employed in an occupation who had voluntarily entered it from another occupation..

Table 16-4. Confidence in Recommendations for Occupational Mobility		
General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	Both studies are based on the U.S. Bureau of the Census' Current Population Survey which uses valid methodologies and approaches and is representative of the U.S. population with sample sizes of approximately 50,000 a month. Both studies are secondary analyses based on supplemental data to the January, 1987, Current Population Survey (a U.S. Census publication).	
Minimal (or Defined) Bias	Much of the original study data is not available. Only median values are reported. There is minimal concern about sampling and nonsampling error and nonresponse bias as in all surveys based on statistical samples.	
Applicability and Utility		Medium
Exposure Factor of Interest	Occupational tenure was the focus of both key studies.	
Representativeness	The data are statistically representative of the U.S. population.	
Currency	The data were collected over 20 years ago in 1986 and 1987. It is questionable whether the results would be the same if current data was analyzed based on changes in the economy that have occurred since the study was conducted.	
Data Collection Period	Data were collected in 1986-1987.	
Clarity and Completeness		Medium
Accessibility	The studies are widely available to the public. The Current Population Survey January, 1987: Occupational Mobility and Job Tenure data are available from the U.S. Bureau of the Census.	
Reproducibility	Results can be reproduced and methodology can be followed and evaluated.	
Quality Assurance	Quality assurance methods were not well described.	
Variability and Uncertainty		High
Variability in Population	The study provided averages according to gender, race, and education; age averages and percentiles were provided.	
Uncertainty	The studies are based on recall data.	
Evaluation and Review		Medium
Peer Review	The studies received a high level of peer review.	
Number and Agreement of Studies	There are two key studies based on the same data source.	
Overall Rating		**Medium**

Table 16-5. Recommended Values for Population Mobility						
	Mean	50th Percentile	90th Percentile	95th Percentile	99th Percentile	Source
Residential Occupancy Period	12 yrs	9 yrs	26 yrs	33 yrs	47 yrs	Johnson and Capel, 1992. See Table 16-87.
Current Residence Time	13 yrs	8 yrs	32 yrs	46 yrs	62 yrs	U.S. Bureau of the Census, 2008a See Table 16-90.

Table 16-6. Confidence in Recommendations for Population Mobility		
General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	Both key studies are based on U.S. Bureau of the Census, data which uses valid data collection methodologies and approaches and is representative of the U.S. population.	
Minimal (or Defined) Bias	Data do not account for each member of the household; values are more realistic estimates for the individual's total residence time than the average time a household has been living at its current residence. The moving process was modeled in Johnson and Capel (1992). For the mean and percentile calculations of U.S. Bureau of the Census (2008a) data, an even distribution was assumed within different ranges which may bias the statistics.	
Applicability and Utility		Medium
Exposure Factor of Interest	The Census data provided length of time at current residence. The other study used modeling to estimate total time.	
Representativeness	The sample surveyed was statistically representative of the U.S. population.	
Currency	The data were collected in 2007 and 1985-1987, and reported in 2008 and 1992, respectively.	
Data Collection Period	Data were collected throughout the calendar year..	
Clarity and Completeness		High
Accessibility	The studies are widely available to the public.	
Reproducibility	Results can be reproduced or methodology can be followed and evaluated.	
Quality Assurance	Quality assurance is discussed in the documentation on the U.S. Bureau of the Census studies.	
Variability and Uncertainty		Medium
Variability in Population	The study provided data by age and gender. Variability across several geographic regions was noted. Type of ownership was also addressed.	
Uncertainty	The U.S. Bureau of the Census data was truncated at 65 years..	
Evaluation and Review		High
Peer Review	The studies received high levels of peer review and appear in publications.	
Number and Agreement of Studies	The two studies produced similar results.	
Overall Rating		**Medium**

16.3 ACTIVITY PATTERNS
16.3.1 KEY STUDIES
16.3.1.1 *Wiley et al., 1991 - Study of Children's Activity Patterns*

The California Study of Children's Activity Patterns survey (Wiley et al., 1991) provided estimates of the time children spent in various activities and locations (microenvironments) on a typical day. The sample population consisted of 1,200 children, under 12 years of age, selected from English-speaking households using Random Digit Dial (RDD) methods. This represented a survey response rate of 77.9 percent. One child was selected from each household. If the selected child was 8 years old or less, the adult in the household who spent the most time with the child responded. However, if the selected child was between 9 and 11 years old, that child responded. The population was also stratified to provide representative estimates for major regions of the state. The survey questionnaire included a time diary which provided information on the children's activity and location patterns based on a 24-hour recall period. In addition, the survey questionnaire included questions about potential exposure to sources of indoor air pollution (e.g., presence of smokers) on the diary day, and the socio-demographic characteristics of children and adult respondents. The questionnaires and the time diaries were administered via a computer-assisted telephone interviewing (CATI) technology (Wiley et al., 1991). The telephone interviews were conducted during April 1989 to February 1990 over four seasons: spring (April to June 1989), summer (July to September 1989), fall (October to December 1989), and winter (January to February 1990).

The data obtained from the survey interviews resulted in ten major activity categories, 113 detailed activity codes, 6 major categories of locations, and 63 detailed location codes. The time respondents under 12 years of age spent in the 10 activity categories (plus a "don't know" or non-coded activity category) are presented in Table 6-7. For each of the 10 activity categories, this table presents the mean duration for all survey participants, the percentage of respondents who reported participating in the activity (i.e., percent doers), and the mean, median, and maximum duration for only those survey respondents who engaged in the activity (i.e., doers). It also includes the detailed activity with the highest mean duration of time for each activity category. The activity category with the highest time expenditure was personal needs and care, with a mean of 794 minutes/day (13.2 hours/day). Night sleep was the detailed activity that had the highest mean duration in that activity category. The activity category "don't know" had a mean duration of about 2 minutes/day and only 4 percent of the respondents reported missing activity time.

Table 16-8 presents the mean time spent in the 10 activity categories by age and gender. Because the original source data were available, U.S. EPA re-analyzed the data according to the standardized age categories used in this handbook. Differences between activity patterns in boys and girls tended to be small. Table 16-9 presents the mean time spent in the 10 activity categories grouped by season and geographic region in the state of California. There were seasonal differences for 5 activity categories: personal needs and care, education, entertainment/social, recreation, and communication/passive leisure. Time expenditure differences in various regions of the state were minimal for childcare, work-related, goods/services, personal needs and care, education, entertainment/social, and recreation.

Table 16-10 presents the distribution of time across six location categories. The mean duration for all survey participants, the percent of respondents engaging in the activity (i.e., percent doers); the mean, median, and maximum duration for doers only; and the detailed locations with the highest average time expenditure are shown. For all survey respondents, the largest mean amount of time spent was at home (1,078 minutes/day); 99 percent of respondents spent time at home (mean of 1,086 minutes/day for these individuals only). Tables 16-11 and 16-12 show the average time spent in the six locations grouped by age and gender, and season and region, respectively. Again, because the original source data were available, the age categories used by Wiley et al. (1991) have been replaced in Table 16-11 by the standardized age categories used in this handbook. There were relatively large differences among the age groups in time expenditure for educational settings (Table 16-11). There were small differences in time expenditure at the six locations by region, but time spent in school decreased in the summer months compared to other seasons (Table 16-12).

Table 16-13 shows the average time children spent in proximity to gasoline fumes and gas oven fumes. In general, the sampled children spent more time closer to gasoline fumes than to gas oven fumes. The age categories in Table 16-13 have been modified to conform to the standardized categories used in this handbook.

The U.S. EPA estimated the total time indoors and outdoors using the data from the Wiley et al. (1991) study. Activities performed indoors were assumed to include household work, child care, personal needs and care, education, and communication/passive leisure. The average times spent in these indoor activities and half the time spent in each activity which could have occurred either indoors or outdoors (i.e., work-related, goods/services, organizational activities, entertainment/social, don't know/not coded) were summed. Table 16-14 summarizes the results of this analysis using the standard age groups.

A limitation of this study is that the sampling population was restricted to only English-speaking households; therefore, the data obtained do not represent the diverse population group present in California. Another limitation is that time use values obtained from this survey were based on short-term recall (24-hr) data; therefore, the data set obtained may be biased. Other limitations are: the survey was conducted in California and is not representative of the national population, and the significance of the observed differences in the data obtained (i.e., gender, age, seasons, and regions) were not tested statistically. An advantage of this study is that time expenditure in various activities and locations were presented for children grouped by age, gender, and season. Also, potential exposures of respondents to pollutants were explored in the survey. Another advantage is the use of the CATI program in obtaining time diaries, which allows automatic coding of activities and locations onto a computer tape, and allows activities forgotten by respondents to be inserted into their appropriate position during interviewing.

16.3.1.2 *U.S. EPA, 1996 - National Human Activity Pattern Survey (NHAPS)*

U.S. EPA (1996) analyzed data collected by the National Human Activity Pattern Survey (NHAPS). This survey was conducted by U.S. EPA and is the largest and most current human activity pattern survey available (U.S. EPA, 1996). Data for 9,386 respondents in the 48 contiguous United States were collected via minute-by-minute 24-hour diaries. NHAPS was conducted from October 1992 through September 1994 by the University of Maryland's Survey Research Center using CATI technology to collect 24-hour retrospective diaries and answers to a number of personal and exposure related questions from each respondent. Detailed data were collected for a maximum of 82 different possible locations, and a maximum of 91 different activities. Participants were selected using a RDD method. The response rate was 63 percent, overall. If the chosen respondent was a child too young to interview, an adult in the household gave a proxy interview. Each participant was asked to recount their entire daily routine from midnight to midnight immediately previous to the day that they were interviewed. The survey collected information on duration and frequency of selected activities and of the time spent in selected microenvironments. In addition, demographic information was collected for each respondent to allow for statistical summaries to be generated according to specific subgroups of the U.S. population (i.e., by gender, age, race, employment status, census region, season, etc.). Saturdays and Sundays were over sampled to ensure an adequate weekend sample.

For children, the source data from U.S. EPA have been reviewed and re-analyzed by U.S. EPA to conform to the age categories recommended in *Guidance for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). This analysis was weighted according to geographic, socioeconomic, time/season, and other demographic factors to ensure that results were representative of the U.S. population. The weighted sample matched the 1990 U.S. census population for each gender, age group, census region, and the day-of-week and seasonal responses were equally distributed.

Tables 16-15 through 16-44 provide data from the NHAPS study. Because no data were available on subjects' age in months, age groups less than 1 year old were consolidated into a single group. These tables provide statistics for 24-hour cumulative time spent (mean, minimum, percentiles, and maximum) in selected locations or engaging in selected activities. The original analysis generated statistics for the subset of the survey population that reported being in the location or doing the activity in questions (i.e., doers only). For the reanalysis, statistics were calculated for the entire survey population (i.e., whole population) and for doers only. When the sample size was 10 persons or fewer, percentile values were not calculated. Also note that some of these activities were not necessarily mutually exclusive (e.g. time spent in active sports likely overlaps with exercise time).

Data is presented for the time children, aged birth to less than 21 years, spent in various locations and doing various activities. Each children only table is followed by a table for the whole population which presents data for sub-populations (i.e., by gender, age, race, ethnicity, employment, education, Census region, day of the week, season, asthma status, and bronchitis/emphysema status) and includes the time adults, aged 18 years and older, spent in various locations and doing various activities. Tables 16-15 and 16-16 present data for time spent in rooms of the house (*e.g.*, kitchen, bathroom, bedroom, and garage), and all rooms combined, for children and by demographic characteristics (including adulthood) respectively. Tables 16-17 and 16-18 present data for time spent in other indoor locations (*e.g.*, restaurants, indoors at school, and grocery/convenience stores). Tables 16-19 and 16-20 present data for the time survey participants spent outdoors on school grounds/playgrounds, parks or golf courses, or pool rivers, or lakes.

Table 16-21 provides data on time spent in indoor and outdoor environments for children birth to <21 years of age. The U.S. EPA estimated the time spent indoors by adding the average times spent indoors at the respondents' home (kitchen, living room, bathroom, etc.), at other houses, and inside other locations such as school, restaurants, etc. Time outdoors was estimated by adding the average time spent outdoors at the respondents' pool and yard, others' pool and yard, and outside other locations such as sidewalk, street, neighborhood, parking lot, service station/gas station, school grounds, park/golf course, pool, river, lake, farm, etc. Table 16-22 provides data on time spent in outdoor and indoor environments for adults aged 18 years and older. The average time spent outdoors was estimated by summing the average time spent outdoors away from the residence and the average time spent outdoors at the residence. Note that these averages are for doers only and thus over-estimate the total time spent in the environments for the population.

Tables 16-23 and 16-24 present data for the time spent in various types of vehicles (i.e., car, truck/van, bus), and in all vehicles combined. Tables 16-25 and 16-26 present data for the time children and adults spent in various major activity categories (i.e., sleeping, napping, eating, attending school, outdoor recreation, active sports, exercise, and walking).

Tables 16-27 through 16-31 provide data related to showering and bathing. Data on handwashing activities are in Tables 16-32 and 16-33. Tables 16-34 and 16-35 provide data for children on monthly swimming (in a freshwater pool) frequency by the number of respondents and swimming duration, respectively. Tables 16-36 and 16-37 provide data by demographic characteristics (including adulthood) on monthly swimming (in a freshwater pool) frequency by the number of respondents and swimming duration, respectively. Table 16-38 provides data on the time children spent playing on dirt, sand/gravel, or grass, and Table 16-39 displays these data by demographic characteristics (including adulthood). Tables 16-40 and 16-41 provide data on the number of minutes spent near excessive dust. Tables 16-42 and 16-43 provide information on time spent in the presence of smokers. For this data set, the authors' original age categories for children were used because the methodology used to generate these data could not be reproduced.

The advantages of the NHAPS data set are that it is representative of the U.S. population. The reanalysis done by EPA to get estimates for childhood age groups that correspond to the *Guidance for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005) was weighted and thus the results presented are balanced geographically, seasonally, and for day/time. Also, the NHAPS is inclusive of all ages, genders, and races. A disadvantage of the study is that for the standard age categories, the number of respondents is small for the "doers" of many activities. In addition, the durations exceeding 60, 120, and 181 minutes were not collected for some activities. Therefore, the actual time spent at the high end of the distribution for these activities could not be accurately estimated.

16.3.2 RELEVANT STUDIES

16.3.2.1 *Hill, 1985 - Patterns of Time Use*

Hill (1985) investigated the total amount of time American adults spend in one year performing various activities and the variation in time use across three different dimensions: demographic characteristics, geographical location, and seasonal characteristics. In this study, time estimates were based on data collected from time diaries in four waves (1 per season) of a survey conducted in the fall of 1975 through the fall of 1976 for the 1975-1976 Time Allocation Study. The sampling periods included two weekdays, one Saturday and one Sunday. The information gathered were responses to the survey question "What were you doing?" The survey also provided information on secondary activities (i.e., respondents performing more than one activity at the same time). Hill (1985) analyzed time estimates for 10 broad categories of activities based on data collected from 87 activities. These estimates included seasonal variation in time use patterns and comparisons of time use patterns for different days of the week.

Analysis of the 1975-76 survey data revealed very small regional differences in time use among the broad activity patterns (Hill, 1985). The weighted mean hours per week spent performing the 10 major activity categories presented by region are shown in Table 16-44. Table 16-45 presents the time spent per day, by the day of the week for the 10 major activity categories. Adult time use was dominated in descending order by personal care (including sleep), market work, passive leisure, and house work. Collectively, these activities represent about 80 percent of available time (Hill, 1985).

According to Hill (1985), sleep (included in personal care) was the single most dominant activity averaging about 56.3 hours per week. Television watching (included in passive leisure) averaged about 21.8 hours per week, and housework activities averaged about 14.7 hours per week. Weekdays were predominantly market-work oriented. Weekends (Saturday and Sunday) were predominantly devoted to household tasks ("sleeping in," socializing, and active leisure) (Hill, 1985). Table 16-46 presents the mean time spent performing these 10 groups of activities during each wave of interview (fall, winter, spring, and summer). Adjustments were made to the data to assure equal distributions of weekdays, Saturdays, and Sundays (Hill, 1985). The data indicates that the time periods adults spent performing market work, child care, shopping, organizational activities, and active leisure were fairly constant throughout the year (Hill, 1985). The mean hours spent per week in performing the 10 major activity patterns are presented by gender in Table 16-47. These data indicate that time use patterns determined by data collected for the mid-1970's survey show gender differences. Men spent more time on activities related to labor market work and education, and women spent more time on household work activities.

A limitation associated with this study is that the time data were obtained from an old survey conducted in the mid-1970s. Because of fairly rapid changes in American society, applying these data to current exposure assessments may result in some biases. Another limitation is that time use data were not presented for children. An advantage of this study is that time diaries were kept and data were not based on recall. The former approach may result in a more accurate data set. Another advantage of this study is that the survey is seasonally balanced since it was conducted throughout the year and the data are from a large survey sample.

16.3.2.2 *Timmer et al., 1985 - How Children Use Time*

Timmer et al. (1985) conducted a study using the data obtained on children's time use from a 1981-1982 panel study. Data were obtained for 389 children between 3 and 17 years of age. Data were collected using a time diary and a standardized interview. The time diary involved children reporting their activities beginning at 12:00 a.m. the previous night, the duration and location of each activity, the presence of another individual, and whether they were performing other activities at the same time. The standardized interview was administered to the children to gather information about their psychological, intellectual (using reading comprehension tests), and emotional well-being; their hopes and goals; their family environment; and their attitudes and beliefs.

For preschool children, parents provided information about the child's previous day's activities. Children in first through third grades completed the time diary with their parents assistance and, in addition, completed reading tests. Children in fourth grade and above provided their own diary information and participated in the interview. Parents were asked to assess their children's socioemotional and intellectual development, and a survey form was sent to a teacher of each school-age child to evaluate their socioemotional and intellectual development. The activity descriptor codes used in this study were developed by Juster et al. (1983).

The mean time spent performing major activities on weekdays and weekends by age, sex, and type of day is presented in Table 16-48. On weekdays, children spend about 40 percent of their time sleeping, 20 percent in school, and 10 percent eating, and performing personal care activities (Timmer et al., 1985). The data in Table 16-48 indicate that girls spent more time than boys performing household work and personal care activities and less time playing sports. Also, the children spent most of their free time watching television.

Table 16-49 presents the mean time children spent during weekdays and weekends performing major activities by five different age groups. The significant effects of each variable (i.e., age and sex) are also shown. Older children spent more time performing household and market work, studying, and watching television and less time eating, sleeping, and playing. The authors estimated that, on average, boys spent 19.4 hours a week and girls spent 17.8 hours per week watching television.

U.S. EPA estimated the total time indoors and outdoors using the Timmer et al. (1985) data. Activities performed indoors were assumed to include household work, personal care, eating, sleeping, attending school, studying, attending church, watching television, and engaging in household conversations. The average times spent in these indoor activities and half the time spent in each activity which could have occurred indoors or outdoors (e.g., market work, sports, hobbies, art activities, playing, reading, and other passive leisure) were summed. Table 16-50 summarizes the results of this analysis by age group and day of the week.

A limitation associated with this study is that it was conducted in 1981. It is likely that activity patterns of children have changed from 1981 to the present. Thus, the application of these data to current exposure assessments may bias their results. Another limitation is that the data do not provide overall annual estimates of children's time use since data were collected only during the time of the year when children attended school and not during school vacations. An advantage of this survey is that diary recordings of activity patterns were kept and the data obtained were not based entirely on recall. Another advantage is that because parents assisted younger children with keeping their diaries and with interviews, any bias that may have been created by having younger children record their data should have been minimized.

16.3.2.3 *Robinson and Thomas, 1991 - Time Spent in Activities, Locations, and Microenvironments: A California-National Comparison*

Robinson and Thomas (1991) reviewed and compared data from the 1987-88 California Air Resources Board (CARB) time-activity study for California residents and from a similar 1985 national study, *Americans' Use of Time*, conducted at the University of Maryland. Both studies used the diary approach to collect data. Time- use patterns were collected for individuals aged 12 years and older. Telephone interviews based on the RDD procedure were conducted for 1,762 and 2,762 respondents for the CARB study and the national study, respectively. Robinson and Thomas (1991) defined a set of 16 microenvironments based on the activity and location codes employed in the two studies. The mean durations of time spent in the 16 microenvironments by age, are presented in Table 16-51. In both studies, children and adults spent the majority of their time sleeping, and engaging in leisure and work/study-related activities.

Table 16-52 shows the mean time spent in the 10 major activities by gender and for all respondents between the ages of 18-64 years. Table 16-53 presents the mean time spent at 3 major locations for the CARB and national study grouped by total sample and gender, ages 18-64 years. The mean duration of time spent in locations for total sample population, 12 years and older, across three types of locations is presented in Table 16-54 for both studies.

The limitations associated with the Robinson and Thomas (1991) study are that the CARB survey was performed in California only and may not be representative of the U.S. population as a whole, and the studies were conducted in the 1980s and activity patterns may have changed over time. Another limitation is that the data are based on short-term studies. Finally, the available data could not be re-analyzed to conform to the standardized age categories used in this handbook.

16.3.2.4 *Funk et al., 1998 - Quantifying the Distribution of Inhalation Exposure in Human Populations: Distribution of Time Spent by Adults, Adolescents, and Children at Home, at Work, and at School*

Funk et al. (1998) used the data from the CARB study to determine distributions of exposure time by tracking the time spent participating in daily activities for male and female children, adolescents, and adults. CARB performed two studies from 1987 to 1990; the first was focused on adults (18 years and older) and adolescents (12-17 years old), and the second focused on children (6-11 years old). The targeted groups were noninstitutionalized English speaking Californians with telephones in their residences. Individuals were contacted by telephone and asked to account for every minute within the previous 24 hours, including the amount of time spent on an activity and the location of the activity. The surveys were conducted on different days of the week as well as different seasons of the year.

Using the location descriptors provided in the CARB study, Funk et al. (1998) categorized the activities into two groups, "at home" (any activity at principal residence) and "away." Each activity was assigned to one of three inhalation rate levels (low, moderate, or high) based on the level of exertion expected from the activity. Ambiguous activities were assigned to moderate inhalation rate levels. Among the adolescents and children studied, means were determined for the aggregate age groups. Sample sizes are shown in Table 16-55.

Funk et al. (1998) used several statistical methods, such as Chi-square, Kolmogorov-Smirnov, and Anderson-Darling, to determine whether the time spent in an activity group had a known distribution. Most of the activities performed by all individuals were assigned a low or moderate inhalation rate (Table 16-56).

The aggregate time periods spent at home in each activity are shown in Table 16-57. Aggregate time spent at home performing different activities was compared between genders. There were no significant differences between adolescent males and females in any of the activity groups (Table 16-58). There were significant differences between males and females among adults in all activity groups except for the low activity group (Table 16-58). In children, ages 6-11 years, differences between gender and age were observed at the low inhalation rate levels. There were significant differences ($p<0.05$) between two age groups (6-8 years, and 9-11 years) and gender at the moderate inhalation rate level (Table 16-59).

A limitation of this study was that large proportions of the respondents in the study did not participate in high-inhalation rate-level activities. The Funk et al. (1998) study was based on data from one geographic location, collected more that a decade ago. Thus, it may not be representative of current activities among the general population of the U.S.

16.3.2.5 *Hubal et al., 2000 - Children's Exposure Assessment: A Review of Factors Influencing Children's Exposure and the Date Available to Characterize and Assess that Exposure*

Hubal et al. (2000) reviewed available data from the Consolidated Human Activity Database (CHAD), including activity pattern data, to characterize and assess environmental exposures to children. CHAD was developed by the U.S. EPA's National Exposure Research Laboratory (NERL) to provide access to existing human activity pattern data for use in exposure and risk assessment efforts. It is available online at http://www.epa.gov/chadnet1/. Data from twelve activity pattern studies conducted at the city, state, and national levels are included in CHAD. CHAD contains both the original raw data from each study and data modified based on predefined format requirements. Modifications made to data included: recoding of variables to fit into them a common activity/location code system, and standardization of time diaries to an exact 24-hour length. Detailed information on the coding system and the studies included in CHAD is available in the CHAD User Manual, available at http://oaspub.epa.gov/chad/CHAD_Datafiles$.startup#Manual, and in McCurdy et al. (2000).

A total of 144 activity codes and 115 location codes were used in CHAD (McCurdy et al., 2000). Although some participants in a study conducted multiple activities, many activities were only conducted within a few studies. The same is true for activity locations. The selection of exposure estimates for a particular activity or particular location should be based on study parameters that closely relate to the exposure scenario being assessed. The maximum amount of time, on average, within a majority of the studies was sleeping or taking a nap, while the maximum amount of time spent at a particular location was at home or at work, depending on the study.

Many of the limitations of CHAD data arise from the incorporation of multiple studies into the time diary functions specified in CHAD. Activities and locations were coded similarly to the NHAPS study; studies with differing coding systems were modified to fit the NHAPS codes. In some cases start times and end times from a study had to be adjusted to fit a 24-hour period. Respondents were not randomly distributed in CHAD. For example, some cities or states were over sampled because entire studies were carried out in those places. Other studies excluded large groups of people such as smokers, or non-English speakers, or people without telephones. Many surveys were age-restricted, or they preferentially sampled certain target groups. As a result, users are cautioned against using random individuals in CHAD to represent the U.S. population as a whole (Glenn et al., 2000).

CHAD contains 3,009 person-days of macroactivity data for 2,640 children less than 12 years of age (Hubal et al., 2000) (Table 16-60). The number of hours these children spent in various microenvironments are shown in Table 16-61 and the time they spent in various activities indoors at home is shown in Table 16-62.

Hubal et al. (2000) noted that CHAD contains approximately "140 activity codes and 110 location codes, but the data generally are not available for all activity locations for any single respondent. In fact, not all of the codes were used for most of the studies. Even though many codes are used in macroactivity studies, many of the activity codes do not adequately capture the richness of what children actually do. They are much too broadly defined and ignore many child-oriented behaviors. Thus, there is a need for more and better-focused research into children's activities."

U.S. EPA updated the analysis performed by Hubal et al. (2000) using CHAD data downloaded in 2000, sorted according to the age groups recommended in *Guidance for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). The results are shown in Tables 16-63 and 16-64. In this analysis, individual study participants within CHAD whose behavior patterns were measured over multiple days were treated as multiple one-day activity patterns. This is a potential source of error or bias in the results because a single individual may contribute multiple data sets to the aggregate population being studied.

16.3.2.6 ***Wong et al., 2000 - Adult Proxy Responses to a Survey of Children's Dermal Soil Contact Activities***

Wong et al. (2000) conducted telephone surveys to gather information on children's activity patterns as related to dermal contact with soil during outdoor play on bare dirt or mixed grass and dirt surfaces. This study, the second Soil Contact Survey (SCS-II), was a follow-up to the initial Soil Contact Survey (SCS-I), conducted in 1996, that primarily focused on assessing adult behavior related to dermal contact with soil and dust (Garlock et al., 1999). As part of SCS-I, information was gathered on the behavior of children under the age of 18 years, however, the questions were limited to clothing choices and the length of time between soil contact and hand washing. Questions were posed for SCS-II to further define children's outdoor activities and hand washing and bathing frequency. For both soil contact surveys households were randomly phoned in order to obtain nationally representative results. The adult respondents were questioned as surrogates for one randomly chosen child under the age of 18 residing within the household.

In the SCS-II, of 680 total adult respondents with a child in their household, 500 (73.5 percent) reported that their child played outdoors on bare dirt or mixed grass and dirt surfaces (identified as "players"). Those children that reportedly did not play outdoors ("non-players") were typically very young (≤1 year) or relatively older (≥14 years). Of the 500 children that played outdoors, 497 played outdoors in warm weather months (April through October) and 390 were reported to play outdoors during cold weather months (November through March). These results are presented in Table 16-65. The frequency (days/week), duration (hours/day), and total hours per week spent playing outdoors was determined for those children identified as "players" (Table 16-66). The responses indicated that children spent a relatively high percentage of time outdoors during the warmer months, and a lesser amount of time outdoors in cold weather. The median play frequency reported was 7 days/week in warm weather and 3 days/week in cold weather. Median play duration was 3 hours/day in warm weather and 1 hour/day during cold weather months.

Adult respondents were then questioned as to how many times per day their child washed his/her hands and how many times the child bathed or showered per week, during both warm and cold weather months. This information provided an estimate of the time between skin contact with soil and removal of soil by washing (i.e., exposure time). Hand washing and bathing frequencies for child players are reported in Table 16-67. Based on these results, hand washing occurred a median of 4 times per day during both warm and cold weather months. The median frequency for baths and showers was estimated to be 7 times per week for both warm and cold weather.

Based on reported household incomes, the respondents sampled in SCS-II tended to have higher incomes than that of the general population. This may be explained by the fact that phone surveys cannot sample households without telephones. Additional uncertainty or error in the study results may have occurred as a result of the use of surrogate respondents. Adult respondents were questioned regarding child activities that may have occurred in prior seasons, introducing the chance of recall error. In some instances, a respondent did not know the answer to a question or refused to answer. Table 16-68 compares mean play duration data from SCS-II to similar activities identified in NHAPS (U.S. EPA, 1996). Table 16-69 compares the number of times per day a child washed his or her hands, based on data from SCS-II and NHAPS. As indicated in Tables 16-68 and 16-69, where comparison is possible, NHAPS and SCS-II results showed similarities in observed behaviors.

16.3.2.7 ***Graham and McCurdy, 2004 - Developing Meaningful Cohorts for Human Exposure Models***

Graham and McCurdy (2004) used a statistical model [general linear model and analysis of variance (GLM/ANOVA)] to assess the significance of various factors in explaining variation in time spent outdoors, indoors and in motor vehicles. These factors, which are commonly used in developing cohorts for exposure modeling, included age, gender, weather, ethnicity, day type, and precipitation. Activity pattern data from CHAD, containing 30 or more records per day, were used in the analysis (Graham and McCurdy, 2004).

Data on time spent outdoors for people who spent >0 time outdoors (i.e., doers) are presented in Table 16-70. Graham and McCurdy (2004) found that all the factors evaluated were significant ($p<0.001$) in explaining differences in time spent outdoors (Graham and McCurdy, 2004). An evaluation of gender differences in time spent outdoors by age cohorts was also conducted. Table 16-71 presents descriptive statistics and the results of the two-sample Kolmogorov-Smirnov (KS) test for this evaluation. As shown in Table 16-71, there were statistically significant gender differences in time spent outdoors starting with the 6 to 10 year old age category and continuing through all age groups, up to and including >64 years of age. In addition, Graham and McCurdy (2004) evaluated the effect of physical activity and concluded that this was the most important factor in explaining time spent outdoors. For time spent indoors (Table 16-72), there were statistically significant effects for all the factors evaluated, with gender, weather, and day type being the most important variables. Regarding time spent in motor vehicles (Table 16-73), precipitation was the only factor found to have no significant effects (Graham and McCurdy, 2004).

Based on the results of these analyses, Graham and McCurdy (2004) noted that "besides age and gender, other important attributes for defining cohorts are the physical activity level of individuals, weather factors such as daily maximum temperature in combination with months of the year, and combined weekday/weekend with employment status." The authors also noted that even though the factors evaluated were found to be statistically significant in explaining differences in time spent outdoors, indoors, and in motor vehicles, "parameters such as lifestyle and life stages that are absent from CHAD might have reduced the amount of unexplained variance." The authors recommended that, in defining cohorts for exposure modeling, age and gender should be used as ''first-order'' attributes, followed by physical activity level, daily maximum temperature, and day type (weekend/weekday or day-of-the-week/working status) (Graham and McCurdy, 2004).

16.3.2.8 *Juster et al., 2004 - Changing Times of American Youth: 1983-2003*

Juster et al. (2004) evaluated changes in time use patterns of children by comparing data collected in a 1981-1982 pilot study of children ages 6 to 17 to data from the 2002-2003 Child Development Supplement (CDS) to the Panel Study of Income Dynamics (PSID). The 1981-1982 pilot study is the same study described in Timmer et al. (1985). The 2002-2003 CDS gathered 24-hour time diary data on 2,908 children ages 6 to 17; as was done in the 1997 CDS, information was collected on one randomly selected weekday and one randomly selected weekend day (Juster et al., 2004).

Tables 16-74 and 16-75 present the mean time children spent (in minutes/day) performing major activities on weekdays and weekend days, respectively, for the years 1981-82 and 2002-2003. Table 16-76 shows the weekly time spent in these activities for the years 1981-82 and 2002-2003. Juster et al. (2004) noted that the time spent in school and studying increased while time spent in active sports and outdoors activities decreased during the period studied.

16.3.2.9 *Vandewater et al., 2004 - Linking Obesity and Activity Level with Children's Television and Video Game Use*

Vandewater et al. (2004) evaluated children's media use and participation in active and sedentary activities using 24-hour time-use diaries collected in 1997, as part of the Child Development Supplement (CDS) to the Panel Study of Income Dynamics (PSID). The PSID is a ongoing, longitudinal study of U.S. individuals and their families conducted by the Survey Research Center of the University of Michigan. In 1997, PSID families with children younger than 12 years of age completed the CDS and reported all activities performed by the children on one randomly selected weekday and one randomly selected weekend day. Since minorities, low income families, and less educated individuals were oversampled in the PSID, sample weights were applied to the data (Vandewater et al., 2004). More information on the CDS can be found on-line at http://psidonline.isr.umich.edu/CDS/.

Using time diary data from 2,831 children participating in the CDS, Vandewater et al., (2004) estimated the time in minutes over the two-day study period (i.e., sum of time spent on one weekday and one weekend day) that children spent watching television, playing games on video games consoles or computers, reading, and using computers for other purposes besides playing games. In addition, the time spent participating in highly active (i.e., playing sports), moderately active (i.e., fishing, boating, camping, taking music lessons, and singing), and sedentary (i.e., using the phone, doing puzzles, playing board games, and relaxing) activities was determined. Table 16-77 presents the means and standard deviations for the time spent in the selected activities by age and gender.

A limitation of this study is that the survey was not designed for exposure assessment purposes. Therefore, the time use data set may be biased. However, the survey provides a database of current information on various human activities. This information can be used to assess various exposure pathways and scenarios associated with these activities.

16.3.2.10 *U.S. Department of Labor, 2007 - American Time Use Survey, 2006 Results*

The American Time Use Study (ATUS) has been conducted annually since 2003 by the U.S. Department of Labor's Bureau of Labor Statistics (U.S. DL, 2007). The purpose of the study is to collect "data on what activities people do during the day and how much time they spend doing them." In 2006, the survey focused on "the time Americans worked, did household activities, cared for household children, participated in educational activities, and engaged in leisure and sports activities." Approximately 13,000 individuals, 15 years of age and older, were interviewed during 2006. Participants were randomly selected and interviewed using the CATI method and were asked to recall their activities on the day before the interview. The survey response rate was 55.1 percent (BLS, 2007). Data were collected for all days of the week, including weekends (i.e., 10 percent of the individuals were interviewed about their activities on one of the five weekdays, and 25 percent of the individuals were interviewed about their activities on one of the two weekend days). Demographic information, including age, gender, race/ethnicity, marital status, and educational level were also collected, and sample weights were applied to records to "reduce bias in the estimates due to differences in sampling and response rates across subpopulations and days of the week." Data were collected for 17 major activities, which were subsequently combined into 12 categories for publication of the results. Table 16-78 provides information on the average amount of time spent in the 12 major time use categories by gender, age, race/ethnicity, marital status, and educational level USDL (2007). Estimates of time use in sub-categories of the 12 major categories are presented in Table 16-79. The majority of time was spent engaging in personal care activities (9.41 hours/day) which included sleeping (8.63 hours/day), followed by leisure and sports activities (5.09 hours/day), and work activities (3.75 hours/day). Note that because these data are averaged over both weekdays and weekends for the entire year, the amount of time spent daily on work-related activities does not reflect that of a typical work day.

Table 16-80 provides estimates of time use for all children ages 15 to 19 years by gender. It also provides a more detailed breakdown of the Leisure and Sports category for all children, ages 15 to 19 years old.

The limitations of this study is that it did not account for all activities during the day and therefore estimates about total time indoors and outdoors could not be calculated. The advantages are the large sample size, the representativeness of the sample, and the currency of the data.

16.3.2.11 *Nader et al. 2008 - Moderate-to-Vigorous Physical Activity from Ages 9 to 15 years*

Nader et al. (2008) conducted a longitudinal study of 1,032 children from ages 9 to 15 years. The purpose of the study was to determine the amount of time children 9 to 15 years of age engaged in moderate-to-vigorous activities (MVPA) and compare results with the recommendations issued by the U.S. Department of Health and Human Services and the U.S. Department of Agriculture (2005) of a minimum of 60 minutes per day. Children's activity levels were recorded for four to seven days using an accelerometer. The study participants included 517 boys and 515 girls. The study found that at age 9 children engaged in 3 hours of MVPA per day. By age 15, the amount of time engaged in MVPA was dropped to 49 minutes/day on weekdays and 35 minutes per day on weekends. Boys spent 18 more minutes/day of MVPA than girls on weekdays and 13 more minutes/day on weekends. Estimates of the mean time spent in moderate-to-vigorous activities by various age groups are presented in Table 16-81. The study did not provide information about the amount of time spent at specific activities.

16.4 OCCUPATIONAL MOBILITY

16.4.1 KEY OCCUPATIONAL MOBILITY STUDIES

16.4.1.1 *Carey, 1988 - Occupational Tenure in 1987: Many Workers Have Remained in Their Fields*

Carey (1988) presented median occupational and employer tenure for different age groups, gender, earnings, ethnicity, and educational attainment. Occupational tenure was defined as "the cumulative number of years a person worked in his or her current occupation, regardless of number of employers, interruptions in employment, or time spent in other occupations" (Carey, 1988). The information presented was obtained from supplemental data to the January 1987 Current Population Study, a U.S. Bureau of the Census publication. Carey (1988) did not present information on the survey design.

The median occupational tenure by age and gender, race, and employment status are presented in Tables 16-82, 16-83, and 16-84, respectively. The median occupational tenure of the working population (109.1 million people) 16 years of age and older in January of 1987, was 6.6 years (Table 16-82). Table 16-82 also shows that median occupational tenure increased from 1.9 years for workers 16-24 years old to 21.9 years for workers 70 years and older. The median occupational tenure for men 16 years and older was higher (7.9 years) than for women of the same age group (5.4 years). Table 16-83 indicates that whites had longer occupational tenure (6.7 years) than blacks (5.8 years), and

Hispanics (4.5 years). Full-time workers had more occupational tenure than part-time workers 7.2 years and 3.1 years, respectively (Table 16-84).

Table 16-85 presents the median occupational tenure among major occupational groups. The median tenure ranged from 4.1 years for service workers to 10.4 years for people employed in farming, forestry, and fishing.

The strength of an individual's attachment to a specific occupation has been attributed to the individual's investment in education (Carey, 1988). Carey (1988) reported the median occupational tenure for the surveyed working population by age and educational level. Workers with 5 or more years of college had the highest median occupational tenure of 10.1 years. Workers that were 65 years and older with 5 or more years of college had the highest occupational tenure level of 33.8 years. The median occupational tenure was 10.6 years for self-employed workers and 6.2 years for wage and salary workers (Carey, 1988).

A limitation associated with this study is that the survey design employed in the data collection was not presented, though it can be found on the U.S. Bureau of the Census's website. Therefore, the validity and accuracy of the data set cannot be determined. Another limitation is that only median values were reported in the study. An advantage of this study is that occupational tenure (years spent in a specific occupation) was obtained for various age groups by gender, ethnicity, employment status, and educational level. Another advantage of this study is that the data were based on a survey population which appears to represent the general U.S. population.

16.4.1.2 *Carey, 1990 - Occupational Tenure, Employer Tenure, and Occupational Mobility*

Carey (1990) conducted another study that was similar in scope to the study of Carey (1988). The January 1987 Current Population Study (CPS) was used. This study provided data on occupational mobility and employer tenure in addition to occupational tenure. Occupational tenure was defined in Carey (1988) as the "the cumulative number of years a person worked in his or her current occupation, regardless of number of employees, interruptions in employment, or time spent in other locations." Employer tenure was defined as "the length of time a worker has been with the same employer," while occupational mobility was defined as "the number of workers who change from one occupation to another" (Carey, 1990). Occupational mobility was measured by asking individuals who were employed in both January 1986 and January 1987 if they were doing the same kind of work in each of these months (Carey, 1990). Carey (1990) further analyzed the occupational mobility data and obtained information on entry and exit rates for occupations. These rates were defined as "the percentage of persons employed in an occupation who had voluntarily entered it from another occupation" and an exit rate was defined as "the percentage of persons employed in an occupation who had voluntarily left for a new occupation" (Carey, 1990).

Table 16-86 shows the voluntary occupational mobility rates in January 1987 for workers 16 years and older. For all workers, the overall voluntary occupational mobility rate was 5.3 percent. These data also show that younger workers left occupations at a higher rate than older workers. Carey (1990) reported that 10 million of the 100.1 million individuals employed in January 1986 and in January 1987 had changed occupations during that period, resulting in an overall mobility rate of 9.9 percent. Executive, administrative, and managerial occupations had the highest entry rate of 5.3 percent, followed by administrative support (including clerical) at 4.9 percent. Sales had the highest exit rate of 5.3 percent and service had the second highest exit rate of 4.8 percent (Carey, 1990). In January 1987, the median employer tenure for all workers was 4.2 years. The median employee tenure was 12.4 years for those workers that were 65 years of age and older (Carey, 1990).

Because the study was conducted by Carey (1990) in a manner similar to that of the previous study (Carey, 1988), the same advantages and disadvantages associated with Carey (1988) also apply to this data set.

16.5 POPULATION MOBILITY

16.5.1 KEY POPULATION MOBILITY STUDY

16.5.1.1 *Johnson and Capel (1992) - A Monte Carlo Approach to Simulating Residential Occupancy Periods and It's Application to the General U.S. Population*

Johnson and Capel developed a methodology to estimate the distribution of the residential occupancy period (ROP) in the national population. ROP denotes the time (years) between a person moving into a residence and the time the person moves out or dies. The methodology used a Monte Carlo approach to simulate a distribution of ROP for 500,000 persons using data on population, mobility, and mortality.

The methodology consisted of six steps. The first step defined the population of interest and categorized them by location, gender, age, sex, and race. Next the demographic groups were selected and the fraction of the specified population that fell into each group was developed using U.S. BOC data. A mobility table was developed based on census data, which provided the probability that a person with specified demographics did not move during the previous year. The fifth step used data on vital statistics published by the National Center for Health Statistics and developed a mortality table which provided the probability that individuals with specific demographic characteristics would die during the upcoming year. As a final step, a computer based algorithm was used to apply a Monte Carlo approach to a series of persons selected at random from the population being analyzed.

Table 16-87 presents the results for residential occupancy periods for the total population, by gender. The estimated mean ROP for the total population was 11.7 years. The distribution was skewed (Johnson and Capel, 1992): the 25th, 50th, and 75th percentiles were 3, 9, and 16 years, respectively. The 90^{th}, 95^{th}, and 99^{th} percentiles were 26, 33, and 47 years, respectively. The mean ROP was 11.1 years for males and 12.3 years for females, and the median value was 8 years for males and 9 years for females.

Descriptive statistics for subgroups defined by current ages were also calculated. These data, presented by gender, are shown in Table 16-88. The mean ROP increases from age 3 to age 12 and there is a noticeable decrease at age 24. However, there is a steady increase from age 24 through age 81.

There are a few biases within this methodology that have been noted by the authors. The probability of not moving is estimated as a function only of gender and age. The Monte Carlo process assumes that this probability is independent of (1) the calendar year to which it is applied, and (2) the past history of the person being simulated. These assumptions, according to Johnson and Capel (1992), are not entirely correct. They believe that extreme values are a function of sample size and will, for the most part, increase as the number of simulated persons increases.

16.5.1.2 *U.S. Bureau of the Census (2008a) – American Housing Survey for the United States in 2007*

This survey is a national sample of 55,000 interviews in which data were collected from presented owners, renters, Black householders, and Hispanic householders. The data reflect the number of years a unit has been occupied and represent all occupied housing units that the residents' rented or owned at the time of the survey.

The results of the survey pertaining to residence time of owner/renter occupied units in the U.S. are presented in Table 16-89. Using the data in Table 16-89, the percentages of householders living in houses for specified time ranges were determined and are presented in Table 16-90. Based on the BOC data in Table 16-90, the 50^{th} percentile and the 90^{th} percentile values were calculated for the number of years lived in the householder's current house. These values were calculated by apportioning the total sample size (110,692 households) to the indicated percentile associated with the applicable range of years lived in the current home. Assuming an even distribution within the appropriate range, the 50^{th} and 90^{th} percentile values for years living in current home were determined to be 8.0 and 32.0 years, respectively. Based on the above data, 8 and 32 years are assumed to best represent a central tendency estimate of length of residence and upper percentile estimate of residence time, respectively.

A limitation associated with the above analysis is the assumption that there is an even distribution within the different ranges. As a result, the 50^{th} and 90^{th} percentile values may be biased.

16.5.2 RELEVANT POPULATION MOBILITY STUDIES

16.5.2.1 *Israeli and Nelson (1992) - Distribution and Expected Time of Residence for U.S. Households*

In risk assessments, the average current residence time (time since moving into current residence) has often been used as a substitute for the average total residence time (time between moving into and out of a residence) (Israeli and Nelson, 1992). Israeli and Nelson (1992) have estimated distributions of expected time of residence for U.S. households. Distributions and averages for both current and total residence times were calculated for several housing categories using the 1985 and 1987 BOC housing survey data. The total residence time distribution was estimated from current residence time data by modeling the moving process (Israeli and Nelson, 1992). Israeli and Nelson (1992) estimated the average total residence time for a household to be approximately 4.6 years or 1/6 of the expected life span (see Table 16-91). The maximal total residence time that a given fraction of households will live in the same residence is presented in Table 16-92. For example, only 5 percent of the individuals in the "All Households" category will live in the same residence for 23 years and 95 percent will move in less than 23 years.

The authors note that the data presented are for the expected time a household will stay in the same residence. The data do not predict the expected residence time for each member of the household, which is generally expected to be smaller (Israeli and Nelson, 1992). These values are more realistic estimates for the individual total residence time, than the average time a household has been living at its current residence. The expected total residence time for a household is consistently less than the average current residence time. This is the result of greater weighting of short residence time when calculating the average total residence time than when calculating the average current residence time (Israeli and Nelson, 1992). When averaging total residence over a time interval, frequent movers may appear several times, but when averaging current residence times, each household appears only once (Israeli and Nelson, 1992). According to Israeli and Nelson (1992), the residence time distribution developed by the model is skewed and the median values are considerably less than the means (T), which are less than the average current residence times.

16.5.2.2 *National Association of Realtors (NAR) (1993) The Home Buying and Selling Process*

The NAR survey was conducted by mailing a questionnaire to 15,000 home buyers throughout the U.S. who purchased homes during the second half of 1993. The survey was conducted in December 1993 and 1,763 usable responses were received, equaling a response rate of 12 percent (NAR, 1993). Of the respondents, forty-one percent were first time buyers. Home buyer names and addresses were obtained from Dataman Information Services (DIS). DIS compiles information on residential real estate transactions from more than 600 counties throughout the United States using courthouse deed records. Most of the 250 Metropolitan Statistical Areas are also covered in the DIS data compilation.

The home buyers were questioned on the length of time they owned their previous home. Typical homebuyer (40%) was found to have lived in their previous home between 4 and 7 years (Table 16-93). The survey results indicate that the average tenure of home buyers is 7.1 years based on an overall residence history of the respondents (NAR, 1993). In addition, the median length of residence in respondents' previous homes was found to be 6 years (see Table 16-94).

The distances the respondents moved to their new homes were typically short distances. Data presented in Table 16-95 indicate that the mean distances range from 230 miles for new home buyers, 270 miles for repeat buyers to 110 miles for first time buyers and 190 for existing home buyers. Seventeen (17) percent of respondents purchased homes over 100 miles from their previous homes and 49 percent purchased homes less than 10 miles away.

16.5.2.3 *U.S. Bureau of the Census (2008b) – Current Population Survey 2007, Annual Social and Economic Supplement*

The Current Population Survey is conducted monthly by the U.S. Bureau of the Census. The sample is selected to be statistically representative of the civilian non-institutionalized U.S. population. The data presented in Tables 16-96 and 16-97 are yearly averages for the year 2006-2007. Approximately 50,000 people are surveyed each month.

Table 16-96 presents data on general mobility by demographic factors (i.e., gender, age, education, marital status, nativity, tenure and poverty status). "Movers" are respondents who did not report living at the same residence one year earlier than the date of interview. Of the total number of respondents, 13% had moved residences. Of those, 65% moved within the same county. Table 16-97 presents data on these Intercounty moves and shows that of these intercounty moves, over 60% moved less than 200 miles.

16.6 REFERENCES FOR CHAPTER 16

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Table 16-7. Mean Time (minutes/day) Children Under 12 Years of Age Spent in Ten Major Activity Categories, for All Respondents and Doers

Activity Category	Mean Duration (All)	% Doers[a]	Mean Duration (Doers)[a]	Median Duration (Doers)[a]	Maximum Duration (Doers)[a]	Detailed Activity with Highest Average Minutes
Work-related[b]	10	25	39	30	405	Eating at Work/School/Daycare
Household[c]	53	86	61	40	602	Travel to Household
Childcare[d]	<1	<1	83	30	290	Other Child Care
Goods/Services [e]	21	26	81	60	450	Errands
Personal Needs and Care[f]	794	100	794	770	1,440	Night Sleep
Education[g]	110	35	316	335	790	School Classes
Organizational Activities[h]	4	4	111	105	435	Attend Meetings
Entertain/Social [i]	15	17	87	60	490	Visiting with Others
Recreation [j]	239	92	260	240	835	Games
Communication/Passive Leisure [k]	192	93	205	180	898	TV Use
Don't know/Not coded	2	4	41	15	600	-
All Activities	1,440	-	-	-	-	-

[a] Doers indicate the respondents who reported participating in each activity category.
[b] Includes: travel to and during work/school; children's paid work; eating at work/school/daycare; and accompanying or watching adult at work.
[c] Includes: food preparation; meal cleanup; cleaning; clothes care; car and home repair/painting; building a fire; plant and pet care; and traveling to household.
[d] Includes: baby and child care; helping/teaching children; talking and reading; playing while caring for children; medical care; travel related to child care; and other care.
[e] Includes: shopping; medical appointments; obtaining personal care services (e.g., haircuts), government and financial services, and repairs; travel related to goods an services; and errands.
[f] Includes: bathing, showering, and going to bathroom; medical care; help and care; meals; night sleep and daytime naps, dressing and grooming; and travel for personal care.
[g] Includes: student and other classes; daycare; homework; library; and travel for education.
[h] Includes: attending meetings and associated travel.
[i] Includes: sports events; eating and amusements; movies and theater; visiting museums, zoos, art galleries, etc.; visiting others; parties and other social events; and travel to social activities.
[j] Includes: active sports; leisure; hobbies; crafts; art; music/drama/dance; games; playing; and travel to leisure activities.
[k] Includes: radio and television use; reading; conversation; paperwork; other passive leisure; and travel to passive leisure activities.

Source: Wiley et al., 1991.

Table 16-8. Mean Time (minutes/day) Children Under 12 Years of Age Spent in Ten Major Activity Categories, by Age and Gender

Activity Category[a]	Boys									
	Birth to 1 Month	1 to <3 Months	3 to <6 Months	6 to <12 Months	1 to <2 Years	2 to <3 Years	3 to <6 Years	6 to <11 Years	11 Years[b]	Birth to 11 Years
Work-related	0	0	0	1	8	9	10	12	13	11
Household	12	30	49	28	35	44	44	61	63	58
Childcare	0	0	0	0	0	0	0	0	3	2
Goods/Services	0	16	14	28	27	14	28	22	24	26
Personal Needs and Care	910	1,143	937	919	903	889	802	726	707	802
Education	180[c]	0	75	70	33	69	67	120	120	100
Organizational Activities	0	0	0	0	7	0	5	11	16	6
Entertainment/Social	0	0	0	0	8	6	15	15	43	18
Recreation	0	0	26	104	314	304	294	265	227	228
Communication/Passive Leisure	338	250	339	292	106	103	175	208	226	226
Sample Sizes (Unweighted)	3	7	15	31	54	62	151	239	62	624
Activity Category[a]	**Girls**									
	Birth to 1 Month	1 to <3 Months	3 to <6 Months	6 to <12 Months	1 to <2 Years	2 to <3 Years	3 to <6 Years	6 to <11 Years	11 Years[b]	Birth to 11 Years
Work-related	0	0	5	1	3	22	9	10	19	11
Household	28	29	23	25	45	65	49	67	78	58
Childcare	0	0	0	0	0	0	0	2	9	2
Goods/Services	0	18	14	24	24	34	31	26	15	26
Personal Needs and Care	1,123	1,115	971	922	894	858	820	747	703	802
Education	0	0	110	94	25	40	81	134	151	100
Organizational Activities	0	0	0	0	0	2	3	8	13	6
Entertainment/Social	0	0	0	1	13	6	16	17	52	18
Recreation	0	0	10	147	256	305	270	224	175	228
Communication/Passive Leisure	290	278	308	226	179	107	161	203	225	189
Sample Sizes (Unweighted)	4	10	11	23	43	50	151	225	59	576

[a] See Table 16-3 for a description of what is included in each activity category.
[b] The source data end at 11 years of age, so the 11 to <16 year category is truncated and the 16 to <21 year category is not included.
[c] The data for this age group and category are two values of zero and one of 540.
Note: Column totals may not sum to 1,440 due to rounding.

Source: U.S. EPA analysis of source data used by Wiley et al., 1991.

Table 16-9. Mean Time (minutes/day) Children Under 12 Years of Age Spent in Ten Major Activity Categories, Grouped by Seasons and Regions

Activity Category[a]	Season					Region of California			
	Winter (Jan-Mar)	Spring (Apr-June)	Summer (July-Sept)	Fall (Oct-Dec)	All Seasons	Southern Coast	Bay Area	Rest of State	All Regions
Work-related	10	10	6	13	10	10	10	8	10
Household	47	58	53	52	53	45	62	55	53
Childcare	<1	1	<1	<1	<1	<1	<1	1	<1
Goods/Services	19	17	26	23	21	20	21	23	21
Personal Needs and Care	799	774	815	789	794	799	785	794	794
Education	124	137	49	131	110	109	115	109	110
Organizational Activities	3	5	5	3	4	2	6	6	4
Entertainment/Social	14	12	12	22	15	17	10	16	15
Recreation	221	243	282	211	239	230	241	249	239
Communication/ Passive Leisure	203	180	189	195	192	206	190	175	192
Don't know/Not coded	<1	2	3	<1	2	1	1	3	2
All Activities[b]	1,442	1,439	1,441	1,441	1,441	1,440	1,442	1,439	1,441
Sample Sizes (Unweighted)	318	204	407	271	1,200	224	263	713	1,200

[a] See Table 16-3 for a description of what is included in each activity category.
[b] The column totals may not be equal to 1,440 due to rounding.

Source: Wiley et al., 1991.

Table 16-10. Time (minutes/day) Children Under 12 Years of Age Spent in Six Major Location Categories, for All Respondents and Doers

Location Category	Mean Duration (All)	% Doers[a]	Mean Duration (Doers)[a]	Median Duration (Doers)[a]	Maximum Duration (Doers)[a]	Detailed Location with Highest Average Time
Home	1,078	99	1,086	1,110	1,440	Home – Bedroom
School/Childcare	109	33	330	325	1,260	School or Daycare Facility
Friend's/Other's House	80	32	251	144	1,440	Friend's/Other's House – Bedroom
Stores, Restaurants, Shopping Places	24	35	69	50	475	Shopping Mall
In-transit	69	83	83	60	1,111	Traveling in Car
Other Locations	79	57	139	105	1,440	Park, Playground
Don't Know/Not Coded	<1	1	37	30	90	-
All Locations	1,440	-	-	-	-	-

[a] Doers indicate the respondents who reported participating in each activity category.

Source: Wiley et al., 1991.

Table 16-11. Mean Time (minutes/day) Children Under 12 Years of Age Spent in Six Location Categories, Grouped by Age and Gender

Location Category	Boys									
	Birth to 1 Month	1 to <3 Months	3 to <6 Months	6 to <12 Months	1 to <2 Years	2 to <3 Years	3 to <6 Years	6 to <11 Years	11 Years[a]	Birth to 11 Years
Home	938	1,295	1,164	1,189	1,177	1,161	1,102	1,016	1,010	1,079
School/Childcare	0	1	26	53	73	86	79	110	99	89
Friend's/Other's House	418	40	127	63	54	69	89	110	111	95
Stores, Restaurants, Shopping Places	0	14	21	36	29	22	24	23	20	24
In-transit	77	51	69	63	56	61	67	64	72	65
Other Locations	7	40	33	36	52	41	78	116	127	88
Don't Know/Not Coded	0	0	0	0	0	0	0	0	0	0
Sample Sizes (Unweighted)	3	7	15	31	54	62	151	239	62	624
Location Category	Girls									
	Birth to 1 Month	1 to <3 Months	3 to <6 Months	6 to <12 Months	1 to <2 Years	2 to <3 Years	3 to <6 Years	6 to <11 Years	11 Years[a]	Birth to 11 Years
Home	1,285	1,341	1,151	1,192	1,162	1,065	1,118	1,012	862	1,058
School/Childcare	0	0	109	99	56	61	78	116	128	95
Friend's/Other's House	0	12	44	32	109	103	66	119	193	103
Stores, Restaurants, Shopping Places	0	13	20	15	21	40	32	25	24	27
In-transit	73	56	42	58	55	86	78	70	95	74
Other Locations	83	19	73	43	38	86	67	97	137	84
Don't Know/Not Coded	0	0	0	0	0	0	1	0	0	0
Sample Sizes (Unweighted)	4	10	11	23	43	50	151	225	59	576

[a] The source data end at 11 years of age, so the 11 to <16 year category is truncated and the 16 to <21 year category is not included.

Note: Column totals may not sum to 1,440 due to rounding.

Source: U.S. EPA analysis of source data used by Wiley et al., 1991.

Table 16-12. Mean Time (minutes/day) Children Under 12 Years of Age Spent in Six Location Categories, Grouped by Season and Region

Location Category	Season					Region of California			
	Winter (Jan-Mar)	Spring (Apr-June)	Summer (July-Sept)	Fall (Oct-Dec)	All Seasons	Southern Coast	Bay Area	Rest of State	All Regions
Home	1,091	1,042	1,097	1,081	1,078	1,078	1,078	1,078	1,078
School/Childcare	119	141	52	124	109	113	103	108	109
Friend's/Other's House	69	75	108	69	80	73	86	86	80
Stores, Restaurants, Shopping Places	22	21	30	24	24	26	23	23	24
In transit	75	75	60	65	69	71	73	63	69
Other Locations	63	85	93	76	79	79	76	81	79
Don't Know/Not Coded	<1	<1	<1	<1	<1	<1	<1	<1	<1
All Locations[a]	1,439	1,439	1,440	1,439	1,439	1,439	1,440	1,440	1,439
Sample Sizes (Unweighted N's)	318	204	407	271	1,200	224	263	713	1,200

[a] The column totals may not sum to 1,440 due to rounding.

Source: Wiley et al., 1991.

Table 16-13. Mean Time (minutes/day) Children Under 12 Years of Age Spent in Proximity to Two Potential Sources of Exposure, Grouped by All Respondents, Age, and Gender

Potential Exposures	Boys									
	Birth to 1Month	1 to <3 Months	3 to <6 Months	6 to <12 Months	1 to <2 Years	2 to <3 Years	3 to <6 Years	6 to <11 Years	11 Years[a]	Birth to 11 Years
Gasoline Fumes	3	9	0	2	1	4	2	2	7	3
Gas Oven Fumes	0	0	2	2	1	3	0	1	0	1
Sample Sizes (Unweighted N's)	3	7	15	31	54	62	151	239	62	624
Potential Exposures	**Girls**									
	Birth to 1Month	1 to <3 Months	3 to <6 Months	6 to <12 Months	1 to <2 Years	2 to <3 Years	3 to <6 Years	6 to <11 Years	11 Years[a]	Birth to 11 Years
Gasoline Fumes	0	3	0	3	1	2	1	2	1	2
Gas Oven Fumes	0	0	0	0	0	3	2	1	0	1
Sample Sizes (Unweighted N's)	4	10	11	23	43	50	151	225	59	576

[a] The source data end at 11 years of age, so the 11 to <16 year category is truncated and the 16 to <21 year category is not included.

Source: U.S. EPA analysis of source data used by Wiley et al., 1991.

Table 16-14. Mean Time (minutes/day) Children Under 12 Years of Age Spent Indoors and Outdoors, Grouped by Age and Gender

	Boys			Girls		
Age Group	N	Indoors[a]	Outdoors[b]	N	Indoors[a]	Outdoors[b]
Birth to <1 Month	3	1,440	0	4	1,440	0
1 to <3 Months	7	1,432	8	10	1,431	9
3 to <6 Months	15	1,407	33	11	1,421	19
6 to <12 Months	31	1,322	118	23	1,280	160
1 to <2 Years	54	1,101	339	43	1,164	276
2 to <3 Years	62	1,121	319	50	1,102	338
3 to <6 Years	151	1,117	323	151	1,140	300
6 to <11 Years	239	1,145	295	225	1,183	255
11 Years[c]	62	1,166	274	59	1,215	225
All Ages	624	1,181	258	576	1,181	258

[a] Time indoors was estimating by adding the average times spent performing indoor activities (household work, child care, personal needs and care, education, and communication/passive leisure) and half the time spent in each activity which could have occurred either indoors or outdoors (i.e., work-related, goods/services, organizational activities, entertainment/social, don't know/not coded).

[b] Time outdoors was estimated by adding the average time spent in recreation activities and half the time spent in each activity which could have occurred either indoors or outdoors (i.e., work-related, goods/services, organizational activities, entertainment/social, don't know/not coded).

[c] The source data end at 11 years of age, so the 11 to <16 year category is truncated and the 16 to <21 year category is not included.

N = Sample size.

Note: Indoor and outdoor minutes/day may not sum to 1,440 minutes/day due to rounding.

Source: U.S. EPA analysis of source data used by Wiley et al., 1991.

Table 16-15. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined Whole Population and Doers Only, Children < 21 years

Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Kitchen – Whole Population															
Birth to <1	63	36	0	0	0	0	0	0	10	70	109	125	134	158	195
1 to <2	118	56	0	0	0	0	0	0	40	90	132	195	232	242	392
2 to <3	118	48	0	0	0	0	0	0	30	75	120	146	173	188	215
3 to <6	357	47	0	0	0	0	0	0	30	75	105	150	180	222	362
6 to <11	497	42	0	0	0	0	0	0	30	60	105	135	150	196	690
11 to <16	466	37	0	0	0	0	0	0	24	55	90	130	180	249	450
16 to <21	481	34	0	0	0	0	0	0	15	50	90	130	170	195	545
Kitchen – DOERS ONLY															
Birth to <1	33	69	10	10	10	13	15	30	70	90	124	133	157	176	195
1 to <4	76	87	10	10	13	19	30	45	70	110	173	214	240	281	392
2 to <3	80	70	10	10	11	15	15	30	60	105	136	155	184	195	215
3 to <6	252	67	2	5	10	15	15	30	60	90	133	165	210	232	362
6 to <11	342	61	1	2	5	10	15	30	50	79	120	145	172	229	690
11 to <16	323	54	1	2	4	5	10	20	40	65	114	150	218	281	450
16 to <21	305	54	1	2	3	5	10	20	35	65	120	159	194	209	545
Living Room/Family Room/Den – Whole Population															
Birth to <1	63	279	0	0	0	0	0	90	210	420	666	724	788	938	1,180
1 to <2	118	172	0	0	0	0	0	25	120	279	410	533	616	652	810
2 to <3	118	173	0	0	0	0	0	56	138	239	346	499	599	680	1,125
3 to <6	357	164	0	0	0	0	0	45	122	240	376	476	680	742	900
6 to <11	497	137	0	0	0	0	0	30	95	210	322	420	547	612	695
11 to <16	466	170	0	0	0	0	0	36	120	240	395	570	687	774	1,305
16 to <21	481	157	0	0	0	0	0	0	120	240	370	501	690	819	1,080
Living Room/Family Room/Den – DOERS ONLY															
Birth to <1	54	326	25	28	31	57	90	136	268	450	686	744	789	973	1,180
1 to <2	93	219	10	15	19	25	60	90	180	310	444	540	642	667	810
2 to <3	105	195	1	5	10	22	34	90	150	255	377	527	603	691	1,125
3 to <6	290	202	5	8	19	30	50	90	153	270	415	498	705	778	900
6 to <11	403	169	5	10	10	20	30	60	130	240	349	449	579	655	695
11 to <16	380	209	2	10	16	30	45	85	165	275	436	594	705	776	1,305
16 to <21	352	214	5	10	15	24	40	85	165	285	440	547	720	909	1,080
Dining Room – Whole Population															
Birth to <1	63	9	0	0	0	0	0	0	0	0	30	70	86	96	105
1 to <2	118	19	0	0	0	0	0	0	0	17	60	90	176	260	315
2 to <3	118	19	0	0	0	0	0	0	0	30	80	105	118	146	150
3 to <6	357	17	0	0	0	0	0	0	0	10	60	96	133	150	300
6 to <11	497	13	0	0	0	0	0	0	0	5	57	70	120	135	225
11 to <16	466	11	0	0	0	0	0	0	0	0	33	65	119	164	390
16 to <21	481	7	0	0	0	0	0	0	0	0	30	45	90	112	330
Dining Room – DOERS ONLY															
Birth to <1	9	60	15	-	-	-	-	-	-	-	-	-	-	-	105
1 to <2	32	72	10	12	13	16	30	34	53	66	110	237	287	301	315
2 to <3	34	65	15	15	15	18	29	30	60	90	105	134	150	150	150
3 to <6	93	65	10	10	10	15	16	30	55	85	120	150	209	286	300
6 to <11	126	53	5	5	5	6	15	30	45	60	98	135	150	196	225
11 to <16	90	59	5	5	5	10	15	30	38	69	122	166	202	283	390
16 to <21	67	50	5	5	7	15	15	20	35	60	90	124	135	201	330

Table 16-15. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined Whole Population and Doers Only, Children <21 years (continued)

Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Bathroom – Whole Population															
Birth to <1	63	16	0	0	0	0	0	0	0	30	40	59	81	87	90
1 to <2	118	26	0	0	0	0	0	0	15	30	45	60	80	239	600
2 to <3	118	29	0	0	0	0	0	1	20	30	60	62	138	290	345
3 to <6	357	22	0	0	0	0	0	0	15	30	49	65	90	120	270
6 to <11	497	22	0	0	0	0	0	0	15	30	45	60	81	118	535
11 to <16	466	20	0	0	0	0	0	0	15	30	45	60	86	97	220
16 to <21	481	26	0	0	0	0	0	10	20	32	59	65	105	123	547
Bathroom – DOERS ONLY															
Birth to <1	31	32	5	7	8	10	15	18	30	40	60	78	87	89	90
1 to <2	77	39	6	6	8	10	15	15	30	30	57	60	176	349	600
2 to <3	88	38	2	3	5	12	15	15	30	45	60	70	208	319	345
3 to <6	240	33	1	1	2	5	11	15	30	38	60	75	112	123	270
6 to <11	356	31	1	2	3	5	9	15	25	35	50	60	90	180	535
11 to <16	335	29	1	2	2	5	6	12	20	35	50	64	90	100	220
16 to <21	392	31	1	2	5	5	10	15	25	40	60	72	111	135	547
Bedroom – Whole Population															
Birth to <1	63	749	0	0	104	468	566	653	750	863	972	1,092	1,119	1,179	1,275
1 to <2	118	771	0	56	340	443	559	645	808	884	975	1,029	1,190	1,325	1,440
2 to <3	118	701	0	5	91	419	517	618	718	835	894	931	979	990	1,040
3 to <6	357	696	0	92	210	432	540	630	695	790	875	945	1,033	1,135	1,440
6 to <11	497	653	0	0	0	304	480	585	660	735	840	906	1,005	1,096	1,440
11 to <16	466	626	0	0	20	134	403	543	645	745	860	950	1,027	1,118	1,277
16 to <21	481	588	0	0	0	60	335	475	595	720	855	960	1,082	1,146	1,375
Bedroom – DOERS ONLY															
Birth to <1	61	774	435	453	470	495	590	660	750	865	975	1,095	1,119	1,182	1,275
1 to <2	116	785	330	362	384	450	570	656	810	885	975	1,030	1,191	1,328	1,440
2 to <3	116	713	30	215	266	484	520	620	720	836	896	931	981	990	1,040
3 to <6	353	704	165	210	268	464	540	630	695	790	875	945	1,034	1,137	1,440
6 to <11	486	667	120	183	261	439	513	599	660	735	843	912	1,005	1,100	1,440
11 to <16	457	638	15	55	115	179	430	550	646	750	860	951	1,029	1,122	1,277
16 to <21	463	611	15	34	100	273	395	480	600	725	859	974	1,090	1,147	1,375
Garage – Whole Population															
Birth to <1	63	1	0	0	0	0	0	0	0	0	0	0	0	34	89
1 to <2	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 to <3	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 to <6	357	1	0	0	0	0	0	0	0	0	0	0	0	7	165
6 to <11	497	0	0	0	0	0	0	0	0	0	0	0	0	0	120
11 to <16	466	2	0	0	0	0	0	0	0	0	0	0	19	51	240
16 to <21	481	0	0	0	0	0	0	0	0	0	0	0	0	0	60
Garage – DOERS ONLY															
Birth to <1	1	-	89	-	-	-	-	-	-	-	-	-	-	-	89
1 to <2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 to <3	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 to <6	4	-	15	-	-	-	-	-	-	-	-	-	-	-	165
6 to <11	3	-	30	-	-	-	-	-	-	-	-	-	-	-	120
11 to <16	12	79	10	11	11	13	16	20	40	139	183	210	228	234	240
16 to <21	4	-	10	-	-	-	-	-	-	-	-	-	-	-	60

Table 16-15. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined Whole Population and Doers Only, Children <21 years (continued)															
Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
All Rooms Combined – Whole Population															
Birth to <1	63	1,091	0	391	631	742	786	943	1,105	1,258	1,440	1,440	1,440	1,440	1,440
1 to <2	118	1,047	0	63	377	651	705	915	1,050	1,239	1,440	1,440	1,440	1,440	1,440
2 to <3	118	971	0	66	342	640	727	852	995	1,120	1,232	1,295	1,354	1,369	1,440
3 to <6	357	951	0	284	402	621	716	810	930	1,110	1,245	1,354	1,440	1,440	1,440
6 to <11	497	873	0	0	0	420	631	758	880	1,005	1,175	1,275	1,374	1,440	1,440
11 to <16	466	876	0	0	117	370	575	751	871	1,043	1,215	1,314	1,440	1,440	1,440
16 to <21	481	819	0	0	165	375	510	645	810	995	1,170	1,287	1,419	1,440	1,440
All Rooms Combined- DOERS ONLY															
Birth to <1	62	1,108	630	633	658	751	821	956	1,108	1,259	1,440	1,440	1,440	1,440	1,440
1 to <2	116	1,065	370	399	495	674	715	923	1,050	1,243	1,440	1,440	1,440	1,440	1,440
2 to <3	117	979	30	288	551	650	746	857	1,005	1,120	1,232	1,296	1,355	1,369	1,440
3 to <6	355	957	150	352	451	634	720	810	930	1,110	1,245	1,355	1,440	1,440	1,440
6 to <11	486	893	190	335	389	541	655	765	885	1,009	1,177	1,275	1,385	1,440	1,440
11 to <16	459	889	40	141	300	441	590	758	875	1,046	1,218	1,315	1,440	1,440	1,440
16 to <21	473	833	85	206	321	433	525	660	815	1,000	1,170	1,288	1,420	1,440	1,440

N = Sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes less than 10.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996 (NHAPS).

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only																
Kitchen																
								Percentiles								
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99	
All		7,063	92.6	94.2	1.1	1	1,320	10	30	60	120	205	270	365	460	
Gender	Male	2,988	75.0	80.8	1.5	1	840	10	30	55	90	155	215	300	392	
Gender	Female	4,072	105.6	101.0	1.6	1	1,320	10	35	75	145	230	295	395	475	
Gender	Refused	3	40.0	31.2	18.0	15	75	15	15	30	75	75	75	75	75	
Age (years)	-	144	102.7	110.8	9.2	5	840	15	30	70	130	215	260	485	540	
Age (years)	1-4	335	73.7	54.4	3.0	5	392	15	30	60	100	140	180	225	240	
Age (years)	5-11	477	60.5	53.0	2.4	1	690	10	30	50	75	120	150	180	235	
Age (years)	12-17	396	55.0	58.1	2.9	1	450	5	15	36	65	125	155	240	340	
Age (years)	18-64	4,531	90.3	90.9	1.4	1	1,320	10	30	60	120	200	260	345	420	
Age (years)	> 64	1,180	131.4	119.6	3.5	3	825	15	49	100	172	275	360	490	620	
Race	White	5,827	95.1	95.2	1.2	1	840	10	30	65	120	210	273	380	465	
Race	Black	641	79.4	92.0	3.6	2	1,320	10	30	60	100	175	230	275	380	
Race	Asian	113	89.4	95.5	9.0	5	690	10	30	75	115	150	220	265	650	
Race	Some Others	119	69.1	60.8	5.6	2	315	7	30	55	90	150	195	210	315	
Race	Hispanic	266	84.2	77.3	4.7	1	585	10	30	60	110	190	240	305	360	
Race	Refused	97	90.3	113.6	11.5	5	880	7	30	60	90	190	275	480	880	
Hispanic	No	6,458	93.4	94.8	1.2	1	1,320	10	30	60	120	210	270	370	460	
Hispanic	Yes	497	83.9	82.9	3.7	1	675	10	30	60	110	180	240	315	415	
Hispanic	DK	32	82.3	71.9	12.7	5	300	10	35	60	113	185	240	300	300	
Hispanic	Refused	76	88.4	118.6	13.6	5	880	7	30	60	90	190	240	480	880	
Employment	-	1,200	62.3	55.4	1.6	1	690	10	30	50	85	125	153	213	260	
Employment	Full Time	2,965	77.7	77.5	1.4	1	840	10	30	60	100	165	225	300	376	
Employment	Part Time	608	97.7	94.0	3.8	1	755	10	30	70	134	213	270	405	445	
Employment	Not Employed	2,239	126.9	115.8	2.4	1	1,320	12	45	95	175	270	342	470	545	
Employment	Refused	51	106.4	168.5	23.6	2	880	5	30	48	130	210	250	840	880	
Education	-	1,346	63.9	62.3	1.7	1	880	10	30	50	85	130	165	235	285	
Education	< High School	678	108.1	102.9	4.0	1	775	10	34	80	150	230	295	405	545	
Education	High School Graduate	2,043	107.2	102.3	2.3	1	840	10	35	75	150	235	300	415	500	
Education	< College	1,348	94.4	101.2	2.8	1	1,320	10	30	60	120	210	280	380	450	
Education	College Graduate	933	91.9	92.1	3.0	2	840	10	30	60	120	200	261	330	410	
Education	Post Graduate	715	88.2	87.7	3.3	1	770	10	30	60	113	190	260	380	405	
Census Region	Northeast	1,645	99.6	99.7	2.5	1	840	10	30	70	130	210	300	390	465	
Census Region	Midwest	1,601	96.1	93.6	2.3	1	833	10	30	65	125	213	270	355	450	
Census Region	South	2,383	86.3	87.1	1.8	1	880	10	30	60	115	190	245	330	420	
Census Region	West	1,434	91.4	99.1	2.6	1	1,320	10	30	60	119	195	255	380	480	
Day Of Week	Weekday	4,849	90.1	92.2	1.3	1	1,320	10	30	60	119	195	255	360	450	
Day Of Week	Weekend	2,214	98.3	98.2	2.1	1	840	10	30	66	135	220	280	390	480	
Season	Winter	1,938	96.6	100.3	2.3	1	1,320	10	30	65	120	210	285	390	485	
Season	Spring	1,780	89.0	90.2	2.1	1	840	10	30	60	120	195	255	350	420	
Season	Summer	1,890	89.3	91.0	2.1	1	880	10	30	60	120	195	255	362	430	
Season	Fall	1,455	96.2	94.5	2.5	1	770	10	30	65	125	210	275	375	470	
Asthma	No	6,510	92.4	93.6	1.2	1	1,320	10	30	60	120	205	270	365	450	
Asthma	Yes	503	94.0	96.0	4.3	1	785	10	30	60	120	210	270	345	450	
Asthma	DK	50	104.4	143.7	20.3	7	880	10	30	60	120	195	240	713	880	
Angina	No	6,798	91.6	93.0	1.1	1	1,320	10	30	60	120	200	265	360	450	
Angina	Yes	207	122.5	111.4	7.7	4	657	10	45	100	155	255	360	415	620	
Angina	DK	58	105.9	138.4	18.2	2	880	10	30	60	135	240	240	545	880	
Bronchitis/Emphysema	No	6,671	91.8	92.6	1.1	1	1,320	10	30	60	120	200	265	360	445	
Bronchitis/Emphysema	Yes	338	104.8	113.4	6.2	1	825	10	30	71	135	225	300	480	657	
Bronchitis/Emphysema	DK	54	117.9	142.4	19.4	2	880	10	30	76	160	240	275	545	880	

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only (continued)																
Bathroom																
								Percentiles								
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99	
All		6,661	35.0	48.8	0.6	1	870	5	15	25	40	60	90	137	255	
Gender	Male	3,006	32.7	50.4	0.9	1	870	5	15	20.5	35	60	75	150	300	
Gender	Female	3,653	36.9	47.4	0.8	1	665	5	15	30	45	70	90	135	240	
Gender	Refused	2	27.5	3.5	2.5	25	30	25	25	27.5	30	30	30	30	30	
Age (years)	-	122	43.9	67.0	6.1	2	530	5	15	30	45	85	120	300	360	
Age (years)	1-4	328	35.9	46.5	2.6	1	600	10	15	30	40	60	75	125	270	
Age (years)	5-11	490	31.0	38.6	1.7	1	535	5	15	27	35	52.5	60	100	200	
Age (years)	12-17	445	29.1	32.9	1.6	1	547	5	15	20	35	60	65	90	100	
Age (years)	18-64	4,486	34.5	46.1	0.7	1	665	5	15	25	40	60	90	135	250	
Age (years)	> 64	790	42.2	69.4	2.5	1	870	5	15	30	45	75	120	240	360	
Race	White	5,338	34.3	48.6	0.7	1	870	5	15	25	40	60	85	135	255	
Race	Black	711	36.9	39.6	1.5	1	460	5	15	30	45	70	98	135	186	
Race	Asian	117	33.6	41.4	3.8	5	375	5	15	25	40	60	90	110	210	
Race	Some Others	134	47.3	69.6	6.0	1	535	5	15	30	45	95	120	315	422	
Race	Hispanic	283	38.6	61.5	3.7	1	546	5	15	24	45	60	80	270	425	
Race	Refused	78	34.6	49.2	5.6	3	360	5	10	20	35	60	135	165	360	
Hispanic	No	6,067	34.5	45.9	0.6	1	705	5	15	25	40	60	90	135	240	
Hispanic	Yes	498	39.2	68.6	3.1	1	870	5	15	25	45	60	90	270	425	
Hispanic	DK	33	44.4	72.3	12.6	5	422	10	15	30	45	60	120	422	422	
Hispanic	Refused	63	44.1	95.2	12.0	3	665	5	10	20	35	60	150	360	665	
Employment	-	1,240	32.0	39.7	1.1	1	600	5	15	30	35	60	70	100	180	
Employment	Full Time	3,130	33.4	44.8	0.8	1	595	5	15	25	40	60	80	123	240	
Employment	Part Time	583	35.5	43.9	1.8	1	430	5	15	29	45	60	90	140	270	
Employment	Not Employed	1,661	40.2	61.6	1.5	1	870	5	15	30	45	75	110	210	340	
Employment	Refused	47	34.7	54.8	8.0	3	360	5	15	25	30	55	75	360	360	
Education	-	1,386	32.2	42.8	1.1	1	665	5	15	25	35	60	70	110	200	
Education	< High School	522	40.9	64.5	2.8	1	870	5	15	30	45	70	100	240	350	
Education	High School Graduate	1,857	35.8	50.2	1.2	1	600	5	15	25	40	63	90	135	270	
Education	< College	1,305	36.1	44.1	1.2	1	540	5	15	25	45	70	95	150	225	
Education	College Graduate	913	35.0	54.1	1.8	1	705	5	15	20	40	60	90	150	340	
Education	Post Graduate	678	32.1	42.8	1.6	1	460	5	15	22	40	60	75	110	300	
Census Region	Northeast	1,497	34.3	51.2	1.3	1	600	5	15	25	40	60	80	140	335	
Census Region	Midwest	1,465	35.8	54.5	1.4	1	870	5	15	25	40	60	90	145	315	
Census Region	South	2,340	35.1	42.0	0.9	1	510	5	15	30	40	60	90	135	214	
Census Region	West	1,359	34.9	50.4	1.4	1	705	5	15	25	40	60	90	140	250	
Day Of Week	Weekday	4,613	33.9	46.7	0.7	1	870	5	15	25	40	60	85	135	240	
Day Of Week	Weekend	2,048	37.5	53.2	1.2	1	600	5	15	30	45	65	90	150	300	
Season	Winter	1,853	37.0	50.7	1.2	1	665	5	15	30	42	65	90	150	270	
Season	Spring	1,747	36.6	50.5	1.2	1	870	5	15	30	45	60	90	135	240	
Season	Summer	1,772	32.8	44.5	1.1	1	570	5	15	25	38	60	80	135	210	
Season	Fall	1,289	33.0	49.1	1.4	1	540	5	11	20	35	60	90	140	303	
Asthma	No	6,132	34.9	48.8	0.6	1	870	5	15	25	40	60	90	135	255	
Asthma	Yes	493	35.2	38.2	1.7	1	410	5	15	30	45	65	90	140	220	
Asthma	DK	36	49.5	121.1	20.2	3	665	5	10	17.5	30	60	360	665	665	
Angina	No	6,473	34.6	46.8	0.6	1	870	5	15	25	40	60	90	135	240	
Angina	Yes	145	51.9	88.3	7.3	3	600	7	20	30	45	75	185	546	570	
Angina	DK	43	44.9	111.2	17.0	3	665	5	10	15	30	50	110	665	665	
Bronchitis/Emphysema	No	6,327	34.8	48.1	0.6	1	870	5	15	25	40	60	90	135	255	
Bronchitis/Emphysema	Yes	296	36.8	47.5	2.8	1	600	5	15	30	43.5	60	90	180	250	
Bronchitis/Emphysema	DK	38	54.6	122.7	19.9	3	665	5	10	17.5	30	110	360	665	665	

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only (continued)

Bedroom

Category	Population Group	N	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		9,151	563.1	184.6	1.9	3	1,440	300	460	540	660	780	880	1,005	1,141
Gender	Male	4,157	549.6	183.0	2.8	3	1,440	285	450	540	640	780	860	980	1,095
Gender	Female	4,990	574.3	185.3	2.6	5	1,440	312	470	555	660	790	900	1,030	1,185
Gender	Refused	4	648.8	122.8	61.4	540	785	540	545	635	753	785	785	785	785
Age (years)	-	184	525.1	193.5	14.3	15	1,440	195	420	513	600	720	860	950	1,295
Age (years)	1-4	488	742.0	167.1	7.6	30	1,440	489	635	740	840	930	990	1,095	1,200
Age (years)	5-11	689	669.1	162.9	6.2	35	1,440	435	600	665	740	840	915	1,065	1,140
Age (years)	12-17	577	636.2	210.9	8.8	15	1,375	165	542	645	750	875	970	1,040	1,210
Age (years)	18-64	5,891	532.7	173.0	2.3	3	1,440	295	440	520	610	723	820	975	1,110
Age (years)	> 64	1,322	550.8	172.0	4.7	15	1,440	315	475	540	610	735	840	1,000	1,140
Race	White	7,403	553.4	175.9	2.0	3	1,440	300	455	540	640	760	850	975	1,105
Race	Black	923	612.3	219.9	7.2	15	1,440	300	480	597	725	895	990	1,160	1,323
Race	Asian	153	612.3	187.4	15.2	25	1,285	345	510	600	705	830	950	1,005	1,245
Race	Some Others	174	590.7	200.2	15.2	15	1,405	300	464	580	700	830	960	1,050	1,152
Race	Hispanic	378	602.6	214.4	11.0	25	1,440	265	480	588	720	865	958	1,095	1,213
Race	Refused	120	555.8	198.6	18.1	30	1,405	285	440	534	630	763	875	1,290	1,295
Hispanic	No	8,326	560.9	182.6	2.0	3	1,440	300	460	540	650	780	870	1,000	1,140
Hispanic	Yes	684	597.4	206.3	7.9	15	1,440	300	480	585	713	840	958	1,095	1,200
Hispanic	DK	43	542.3	169.9	25.9	135	1,002	300	420	555	660	756	830	1,002	1,002
Hispanic	Refused	98	523.4	180.2	18.2	30	1,295	255	415	515	600	735	795	930	1,295
Employment	-	1,736	679.5	185.5	4.5	15	1,440	390	590	675	785	892	960	1,065	1,170
Employment	Full Time	3,992	513.5	157.6	2.5	3	1,440	283	435	510	585	680	765	890	1,000
Employment	Part Time	777	551.6	169.4	6.1	15	1,335	330	455	540	630	750	835	1,005	1,100
Employment	Not Employed	2,578	566.4	191.2	3.8	5	1,440	300	478	540	650	780	905	1,095	1,223
Employment	Refused	68	514.0	209.6	25.4	30	1,440	210	420	498	585	725	795	1,200	1,440
Education	-	1,925	668.3	188.8	4.3	15	1,440	360	575	663	780	885	960	1,060	1,170
Education	< High School	807	554.8	180.6	6.4	5	1,440	300	450	540	630	775	860	1,015	1,160
Education	High School Graduate	2,549	534.1	176.2	3.5	3	1,440	285	447	520	607	720	835	975	1,151
Education	< College	1,740	539.1	176.1	4.2	5	1,440	282	450	530	615	735	825	1,005	1,135
Education	College Graduate	1,223	526.0	164.9	4.7	15	1,404	300	445	515	600	713	785	965	1,070
Education	Post Graduate	907	525.2	160.6	5.3	3	1,355	315	445	510	600	690	780	950	1,095
Census Region	Northeast	2,037	561.5	185.3	4.1	5	1,440	300	457	540	655	781	885	1,020	1,139
Census Region	Midwest	2,045	552.4	179.2	4.0	3	1,440	280	450	540	643	765	860	965	1,035
Census Region	South	3,156	570.0	186.4	3.3	10	1,440	300	465	552	660	790	900	1,055	1,155
Census Region	West	1,913	564.9	186.4	4.3	5	1,440	305	460	540	660	793	875	995	1,152
Day Of Week	Weekday	6,169	552.6	174.5	2.2	3	1,440	325	450	539	635	760	855	975	1,130
Day Of Week	Weekend	2,982	584.9	202.4	3.7	3	1,440	223	480	570	690	825	920	1,055	1,170
Season	Winter	2,475	576.0	183.8	3.7	5	1,440	305	475	555	660	805	900	1,035	1,148
Season	Spring	2,365	559.0	176.7	3.6	15	1,440	315	455	540	655	770	855	960	1,095
Season	Summer	2,461	566.1	195.2	3.9	3	1,440	285	455	545	660	810	900	1,030	1,190
Season	Fall	1,850	547.2	179.9	4.2	3	1,440	270	450	538	630	750	850	960	1,100
Asthma	No	8,420	560.8	182.8	2.0	3	1,440	300	460	540	655	780	870	1,000	1,140
Asthma	Yes	671	593.8	201.5	7.8	30	1,440	300	475	580	690	835	946	1,060	1,327
Asthma	DK	60	543.1	218.4	28.2	30	1,295	223	423	540	605	760	983	1,275	1,295
Angina	No	8,836	564.2	183.9	2.0	3	1,440	300	460	540	660	785	880	1,005	1,140
Angina	Yes	244	535.5	203.9	13.1	20	1,440	215	450	523	613	770	840	1,135	1,230
Angina	DK	71	522.1	193.9	23.0	30	1,295	180	420	540	600	690	820	990	1,295
Bronchitis/Emphysema	No	8,660	563.1	184.2	2.0	3	1,440	300	460	540	660	780	880	1,005	1,141
Bronchitis/Emphysema	Yes	423	570.1	192.0	9.3	15	1,440	294	450	555	660	795	900	1,055	1,110
Bronchitis/Emphysema	DK	68	524.8	186.7	22.6	30	1,295	240	420	540	600	700	820	930	1,295

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only (continued)

Garage

Category	Population Group	N	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		193	117.8	144.5	10.4	1	790	5	20	60	150	296	480	665	690
Gender	Male	120	144.1	162.6	14.8	2	790	10	30	94	183	315	518	675	690
Gender	Female	73	74.6	94.3	11.0	1	530	5	15	30	120	180	240	450	530
Age (years)	-	1	20.0	-	-	20	20	20	20	20	20	20	20	20	20
Age (years)	1-4	4	83.5	47.5	23.7	15	120	15	52	100	115	120	120	120	120
Age (years)	5-11	6	63.3	63.4	25.9	10	165	10	25	30	120	165	165	165	165
Age (years)	12-17	12	80.8	78.4	22.6	10	240	10	20	51	148	185	240	240	240
Age (years)	18-64	130	134.5	165.1	14.5	1	790	5	20	68	180	360	526	675	690
Age (years)	> 64	40	88.6	84.1	13.3	5	300	8	25	60	143	228	270	300	300
Race	White	165	109.5	127.5	9.9	1	690	5	20	60	135	240	315	526	675
Race	Black	12	205.0	219.5	63.4	5	570	5	38	90	405	530	570	570	570
Race	Asian	1	5.0	-	-	5	5	5	5	5	5	5	5	5	5
Race	Some Others	6	186.3	308.4	125.9	10	790	10	18	30	240	790	790	790	790
Race	Hispanic	8	120.0	164.9	58.3	15	510	15	23	60	135	510	510	510	510
Race	Refused	1	120.0	-	-	120	120	120	120	120	120	120	120	120	120
Hispanic	No	174	116.6	138.5	10.5	1	690	5	20	60	155	296	460	570	675
Hispanic	Yes	17	128.6	207.3	50.3	5	790	5	20	60	110	510	790	790	790
Hispanic	Refused	2	127.5	10.6	7.5	120	135	120	120	128	135	135	135	135	135
Employment	-	21	79.7	67.5	14.7	10	240	15	25	51	120	165	185	240	240
Employment	Full Time	85	145.3	175.2	19.0	1	790	5	20	65	180	405	530	675	790
Employment	Part Time	17	50.1	52.0	12.6	5	194	5	15	30	60	135	194	194	194
Employment	Not Employed	70	112.3	127.4	15.2	5	690	5	30	75	135	255	450	480	690
Education	-	22	76.5	67.6	14.4	10	240	10	20	51	120	165	185	240	240
Education	< High School	14	188.9	195.0	52.1	5	675	5	30	120	235	510	675	675	675
Education	High School Graduate	63	127.3	159.3	20.1	2	690	5	25	60	165	300	530	665	690
Education	< College	48	121.6	147.8	21.3	5	790	10	30	60	140	296	450	790	790
Education	College Graduate	25	118.2	145.8	29.2	5	480	5	20	60	120	405	460	480	480
Education	Post Graduate	21	75.9	88.1	19.2	1	300	2	10	30	120	195	260	300	300
Census Region	Northeast	23	137.2	159.5	33.2	5	510	15	30	60	195	460	510	510	510
Census Region	Midwest	42	131.4	166.4	25.7	10	690	20	40	88	120	260	665	690	690
Census Region	South	60	103.7	128.6	16.6	2	570	5	13	53	128	283	428	480	570
Census Region	West	68	115.3	139.7	16.9	1	790	5	20	73	153	300	315	530	790
Day Of Week	Weekday	116	128.7	159.0	14.8	1	790	5	25	60	165	315	510	665	690
Day Of Week	Weekend	77	101.4	118.4	13.5	2	675	10	20	60	120	240	300	526	675
Season	Winter	51	115.6	161.8	22.7	2	690	5	15	50	150	240	526	665	690
Season	Spring	59	136.8	163.3	21.3	5	790	10	30	90	165	315	570	675	790
Season	Summer	51	101.1	121.3	17.0	1	530	5	20	60	120	260	450	460	530
Season	Fall	32	112.9	110.2	19.5	5	480	10	25	85	158	240	315	480	480
Asthma	No	184	118.6	146.3	10.8	1	790	5	25	60	150	300	480	665	690
Asthma	Yes	9	101.1	102.6	34.2	5	270	5	15	60	180	270	270	270	270
Angina	No	187	118.2	146.2	10.7	1	790	5	20	60	150	300	480	665	690
Angina	Yes	6	104.2	78.6	32.1	10	220	10	25	110	150	220	220	220	220
Bronchitis/Emphysema	No	185	114.1	142.9	10.5	1	790	5	20	60	135	260	480	665	690
Bronchitis/Emphysema	Yes	8	201.9	163.6	57.9	15	450	15	60	178	338	450	450	450	450

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only (continued)																	
Basement																	
								Percentiles									
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		274	142.2	162.9	9.8	1	931	10	30	90	180	330	535	705	765
Gender	Male	132	160.4	180.7	15.7	1	931	10	40	90	203	490	565	720	765
Gender	Female	141	125.7	143.3	12.1	2	810	10	30	75	175	265	420	705	720
Gender	Refused	1	60.0	-	-	60	60	60	60	60	60	60	60	60	60
Age (years)	-	3	171.7	122.7	70.8	30	245	30	30	240	245	245	245	245	245
Age (years)	1-4	8	94.8	55.7	19.7	28	180	28	48	90	138	180	180	180	180
Age (years)	5-11	25	135.4	145.9	29.2	15	705	15	60	105	140	270	420	705	705
Age (years)	12-17	26	97.5	113.1	22.2	1	515	10	30	60	150	240	275	515	515
Age (years)	18-64	170	151.3	172.7	13.2	1	810	5	30	90	210	410	555	720	765
Age (years)	> 64	42	143.8	173.5	26.8	5	931	10	40	90	170	330	455	931	931
Race	White	248	133.8	154.1	9.8	1	810	10	30	90	168	315	510	705	720
Race	Black	15	183.8	165.5	42.7	12	515	12	40	150	270	450	515	515	515
Race	Asian	2	135.0	106.1	75.0	60	210	60	60	135	210	210	210	210	210
Race	Some Others	3	468.7	455.7	263.1	20	931	20	20	455	931	931	931	931	931
Race	Hispanic	1	30.0	-	-	30	30	30	30	30	30	30	30	30	30
Race	Refused	5	263.2	173.1	77.4	60	540	60	231	240	245	540	540	540	540
Hispanic	No	263	139.0	161.7	10.0	1	931	10	30	90	180	330	510	705	765
Hispanic	Yes	6	185.0	197.3	80.6	15	555	15	30	150	210	555	555	555	555
Hispanic	DK	1	185.0	-	-	185	185	185	185	185	185	185	185	185	185
Hispanic	Refused	4	271.3	198.8	99.4	60	540	60	150	243	393	540	540	540	540
Employment	-	57	115.6	124.2	16.5	1	705	12	40	90	150	240	420	515	705
Employment	Full Time	107	149.1	178.6	17.3	1	810	5	30	75	210	450	540	720	765
Employment	Part Time	22	115.0	114.8	24.5	10	535	25	60	78	150	185	290	535	535
Employment	Not Employed	85	158.0	176.3	19.1	5	931	10	35	120	210	330	600	720	931
Employment	Refused	3	151.7	110.3	63.7	30	245	30	30	180	245	245	245	245	245
Education	-	65	129.5	133.4	16.6	1	705	15	45	90	160	270	420	535	705
Education	< High School	15	169.9	203.5	52.5	5	605	5	30	90	255	565	605	605	605
Education	High School Graduate	78	159.4	188.7	21.4	5	810	5	40	90	195	420	720	765	810
Education	< College	48	160.6	184.2	26.6	2	931	10	25	120	203	400	600	931	931
Education	College Graduate	39	146.7	150.8	24.1	10	555	10	30	70	210	450	510	555	555
Education	Post Graduate	29	73.1	66.3	12.3	1	245	10	30	60	100	210	210	245	245
Census Region	Northeast	90	115.6	118.7	12.5	5	555	10	40	73	150	250	400	540	555
Census Region	Midwest	123	129.0	146.9	13.2	2	765	10	30	90	180	270	510	605	630
Census Region	South	35	188.0	205.8	34.8	10	931	28	45	110	255	450	720	931	931
Census Region	West	26	234.4	247.7	48.6	1	810	1	30	165	325	705	720	810	810
Day Of Week	Weekday	178	135.3	159.4	11.9	1	810	10	30	83	180	315	535	720	765
Day Of Week	Weekend	96	154.8	169.3	17.3	5	931	10	50	98	190	450	540	600	931
Season	Winter	80	144.5	147.0	16.4	5	630	14	30	90	221	315	480	610	630
Season	Spring	65	174.2	196.8	24.4	1	931	5	60	105	210	490	555	810	931
Season	Summer	79	142.4	180.7	20.3	1	765	5	30	85	150	455	605	720	765
Season	Fall	50	96.4	83.1	11.7	5	332	10	30	60	145	240	255	301	332
Asthma	No	253	143.1	164.2	10.3	1	931	10	35	90	180	330	540	705	765
Asthma	Yes	20	124.7	151.0	33.8	1	510	6	16	73	178	383	510	510	510
Asthma	DK	1	245.0	-	-	245	245	245	245	245	245	245	245	245	245
Angina	No	269	141.4	163.7	10.0	1	931	10	30	90	180	330	535	705	765
Angina	Yes	3	201.7	122.1	70.5	65	300	65	65	240	300	300	300	300	300
Angina	DK	2	152.5	130.8	92.5	60	245	60	60	153	245	245	245	245	245
Bronchitis/Emphysema	No	265	139.0	161.0	9.9	1	931	10	30	90	180	330	515	705	765
Bronchitis/Emphysema	Yes	8	233.8	214.2	75.7	20	605	20	68	180	375	605	605	605	605
Bronchitis/Emphysema	DK	1	245.0	-	-	245	245	245	245	245	245	245	245	245	245

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only (continued)

Utility/Laundry Room

Group Name	Group Code	N	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		458	73.2	71.9	3.4	1	510	5	25	60	100	150	200	300	360
Gender	Male	70	78.4	95.7	11.4	1	510	5	20	60	90	168	345	360	510
Gender	Female	388	72.3	66.8	3.4	2	510	5	28	60	105	150	190	240	330
Age (years)	-	6	65.8	34.4	14.0	25	120	25	40	60	90	120	120	120	120
Age (years)	1-4	3	75.0	116.9	67.5	5	210	5	5	10	210	210	210	210	210
Age (years)	5-11	3	105.7	168.4	97.2	2	300	2	2	15	300	300	300	300	300
Age (years)	12-17	8	55.5	77.1	27.3	1	240	1	17	33	53	240	240	240	240
Age (years)	18-64	362	73.6	73.9	3.9	2	510	5	20	60	105	150	195	325	405
Age (years)	> 64	76	72.6	58.1	6.7	2	345	10	30	60	90	150	180	245	345
Race	White	400	69.2	65.8	3.3	2	510	5	25	60	90	150	180	258	353
Race	Black	35	100.5	103.2	17.5	1	510	5	20	60	135	240	300	510	510
Race	Asian	4	82.5	37.7	18.9	30	120	30	60	90	105	120	120	120	120
Race	Some Others	6	86.7	27.9	11.4	60	120	60	65	78	120	120	120	120	120
Race	Hispanic	10	95.9	78.8	24.9	4	225	4	20	105	120	218	225	225	225
Race	Refused	3	170.0	264.2	152.5	15	475	15	15	20	475	475	475	475	475
Hispanic	No	435	72.1	69.9	3.4	1	510	5	25	60	90	150	190	300	360
Hispanic	Yes	20	81.7	63.0	14.1	4	225	5	40	60	120	183	218	225	225
Hispanic	DK	1	55.0	-	-	55	55	55	55	55	55	55	55	55	55
Hispanic	Refused	2	247.5	321.7	227.5	20	475	20	20	248	475	475	475	475	475
Employment	-	12	76.8	107.8	31.1	1	300	1	4	23	135	240	300	300	300
Employment	Full Time	206	69.2	78.4	5.5	2	510	5	20	60	90	135	203	360	405
Employment	Part Time	51	72.2	62.5	8.8	2	225	5	15	55	120	150	180	225	225
Employment	Not Employed	187	77.7	63.8	4.7	5	475	10	30	60	115	150	180	245	345
Employment	Refused	2	76.0	104.7	74.0	2	150	2	2	76	150	150	150	150	150
Education	-	17	72.0	90.9	22.0	1	300	1	10	35	90	240	300	300	300
Education	< High School	51	71.8	49.4	6.9	15	245	20	30	60	90	120	180	195	245
Education	High School Graduate	163	71.6	71.6	5.6	2	510	6	30	60	90	140	180	325	405
Education	< College	107	77.2	71.7	6.9	2	475	5	20	60	120	155	200	225	240
Education	College Gradutae	60	74.0	77.3	10.0	5	510	10	27	60	98	154	190	203	510
Education	Post Graduate	60	71.3	79.9	10.3	5	360	5	18	60	90	155	263	360	360
Census Region	Northeast	105	80.9	84.6	8.3	2	510	5	25	60	120	180	225	345	360
Census Region	Midwest	116	64.9	63.3	5.9	2	475	5	15	60	90	135	155	215	240
Census Region	South	151	72.7	69.5	5.7	1	510	10	30	60	90	150	210	245	330
Census Region	West	86	75.9	69.9	7.5	4	405	5	30	60	115	150	180	360	405
Day Of Week	Weekday	322	68.6	66.7	3.7	1	510	5	23	60	90	140	180	240	345
Day Of Week	Weekend	136	84.1	82.1	7.0	5	510	10	30	60	120	180	240	360	405
Season	Winter	145	75.2	81.0	6.7	1	510	5	17	60	90	165	215	360	475
Season	Spring	89	81.9	83.0	8.8	5	510	10	30	60	100	180	240	405	510
Season	Summer	132	69.3	60.8	5.3	2	360	5	25	60	120	135	155	240	325
Season	Fall	92	67.3	58.6	6.1	3	345	10	22	60	90	125	180	245	345
Asthma	No	432	73.8	73.2	3.5	1	510	5	25	60	105	150	200	325	360
Asthma	Yes	26	64.2	44.8	8.8	10	200	10	25	60	90	120	130	200	200
Angina	No	440	72.1	70.2	3.3	1	510	5	25	60	100	150	185	270	360
Angina	Yes	16	103.1	109.9	27.5	5	360	5	30	60	138	345	360	360	360
Angina	DK	2	72.5	17.7	12.5	60	85	60	60	73	85	85	85	85	85
Bronchitis/emphysema	No	428	73.3	73.5	3.6	1	510	5	24	60	105	150	200	325	360
Bronchitis/emphysema	Yes	30	72.4	43.5	7.9	10	200	15	45	60	90	125	150	200	200

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only (continued)																
Indoors in a Residence (all rooms)																
								Percentiles								
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		9,343	1001.4	275.1	2.8	8	1,440	575	795	985	1,235	1,395	1,440	1,440	1,440
Gender	Male	4,269	945.9	273.5	4.2	8	1,440	540	750	900	1,160	1,350	1,430	1,440	1,440
Gender	Female	5,070	1048.1	267.9	3.8	30	1,440	620	840	1,050	1,280	1,420	1,440	1,440	1,440
Gender	Refused	4	1060.0	135.6	67.8	900	1,200	900	950	1,070	1,170	1,200	1,200	1,200	1,200
Age (years)	-	187	1001.1	279.9	20.5	265	1,440	565	799	955	1,230	1,440	1,440	1,440	1,440
Age (years)	1-4	498	1211.6	218.7	9.8	270	1,440	795	1,065	1,260	1,410	1,440	1,440	1,440	1,440
Age (years)	5-11	700	1005.1	222.3	8.4	190	1,440	686	845	975	1,165	1,334	1,412.5	1,440	1,440
Age (years)	12-17	588	969.5	241.8	10.0	95	1,440	585	812	950	1,155	1,310	1,405	1,440	1,440
Age (years)	18-64	6,022	947.9	273.0	3.5	8	1,440	540	750	900	1,165	1,350	1,428	1,440	1,440
Age (years)	> 64	1,348	1174.6	229.3	6.2	60	1,440	760	1,030	1,210	1,375	1,440	1,440	1,440	1,440
Race	White	7,556	999.4	275.7	3.2	8	1,440	570	795	980	1,235	1,395	1,440	1,440	1,440
Race	Black	941	1016.0	272.5	8.9	190	1,440	600	815	1,000	1,245	1,410	1,440	1,440	1,440
Race	Asian	157	983.5	254.7	20.3	30	1,440	600	810	930	1,180	1,355	1,420	1,440	1,440
Race	Some Others	181	996.1	268.3	19.9	10	1,440	604	805	975	1,198	1,380	1,440	1,440	1,440
Race	Hispanic	382	1009.4	281.8	14.4	55	1,440	555	810	1,005	1,250	1,410	1,440	1,440	1,440
Race	Refused	126	1019.7	276.6	24.6	270	1,440	575	840	975	1,255	1,440	1,440	1,440	1,440
Hispanic	No	8,498	1000.4	275.4	3.0	8	1,440	575	795	980	1,235	1,395	1,440	1,440	1,440
Hispanic	Yes	696	1009.8	270.8	10.3	55	1,440	585	810	1,000	1,230	1,405	1,440	1,440	1,440
Hispanic	DK	46	1097.9	286.7	42.3	401	1,440	645	835	1,173	1,355	1,440	1,440	1,440	1,440
Hispanic	Refused	103	984.1	269.5	26.6	270	1,440	565	810	950	1,200	1,375	1,440	1,440	1,440
Employment	-	1,768	1053.3	248.5	5.9	95	1,440	675	870	1,030	1,255	1,413	1,440	1,440	1,440
Employment	Full Time	4,068	881.0	259.2	4.1	8	1,440	515	715	835	1,046	1,290	1,385	1,440	1,440
Employment	Part Time	797	982.4	243.1	8.6	255	1,440	600	820	970	1,170	1,320	1,380	1,440	1,440
Employment	Not Employed	2,639	1158.0	233.8	4.6	60	1,440	735	1,015	1,190	1,350	1,440	1,440	1,440	1,440
Employment	Refused	71	995.1	268.1	31.8	445	1,440	575	810	940	1,255	1,440	1,440	1,440	1,440
Education	-	1,963	1044.5	251.9	5.7	95	1,440	660	855	1,020	1,254	1,410	1,440	1,440	1,440
Education	< High School	829	1093.4	278.6	9.7	150	1,440	630	870	1,130	1,345	1,440	1,440	1,440	1,440
Education	High School Graduate	2,602	1008.1	279.3	5.5	30	1,440	565	803	995	1,245	1,400	1,440	1,440	1,440
Education	< College	1,788	974.3	272.6	6.4	10	1,,440	570	775	930	1,205	1,371	1,436	1,440	1,440
Education	College Graduate	1,240	939.5	275.0	7.8	30	1,440	528	745	885	1,165	1,335	1,428	1,440	1,440
Education	Post Graduate	921	943.7	274.3	9.0	8	1,440	540	750	900	1,155	1,350	1,410	1,440	1,440
Census Region	Northeast	2,068	1003.4	278.4	6.1	30	1,440	570	795	980	1,245	1,405	1,440	1,440	1,440
Census Region	Midwest	2,087	1001.7	280.6	6.1	8	1,440	565	790	989	1,250	1,390	1,440	1,440	1,440
Census Region	South	3,230	999.0	270.2	4.8	10	1,440	585	800	970	1,228	1,400	1,440	1,440	1,440
Census Region	West	1,958	1002.8	274.0	6.2	30	1,440	575	800	1,000	1,230	1,390	1,440	1,440	1,440
Day Of Week	Weekday	6,286	965.7	272.6	3.4	30	1,440	567	770	911	1,190	1,380	1,440	1,440	1,440
Day Of Week	Weekend	3,057	1074.8	265.7	4.8	8	1,440	615	895	1,105	1,290	1,420	1,440	1,440	1,440
Season	Winter	2,513	1034.9	278.2	5.6	30	1,440	590	825	1,015	1,285	1,432	1,440	1,440	1,440
Season	Spring	2,424	977.9	267.2	5.4	10	1,440	580	780	955	1,185	1,370	1,435	1,440	1,440
Season	Summer	2,522	980.5	274.0	5.5	8	1,440	555	785	960	1,201	1,365	1,440	1,440	1,440
Season	Fall	1,884	1014.8	277.5	6.4	30	1,440	589	805	997	1,260	1,405	1,440	1,440	1,440
Asthma	No	8,591	999.1	274.4	3.0	8	1,440	576	795	980	1,230	1,393	1,440	1,440	1,440
Asthma	Yes	689	1027.4	284.4	10.8	190	1,440	555	825	1,025	1,260	1,430	1,440	1,440	1,440
Asthma	DK	63	1025.7	264.3	33.3	445	1,440	630	840	960	1,315	1,410	1,440	1,440	1,440
Angina	No	9,019	997.8	274.1	2.9	8	1,440	575	795	975	1,230	1,391	1,440	1,440	1,440
Angina	Yes	249	1125.5	281.4	17.8	180	1,440	660	925	1,185	1,380	1,440	1,440	1,440	1,440
Angina	DK	75	1024.1	285.1	32.9	150	1,440	560	840	975	1,305	1,425	1,440	1,440	1,440
Bronchitis/Emphysema	No	8,840	997.7	274.8	2.9	8	1,440	575	795	975	1,230	1,395	1,440	1,440	1,440
Bronchitis/Emphysema	Yes	432	1070.5	273.8	13.2	205	1,440	585	868	1,110	1,293	1,440	1,440	1,440	1,440
Bronchitis/Emphysema	DK	71	1045.5	273.0	32.4	445	1,440	565	845	975	1,320	1,440	1,440	1,440	1,440

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only (continued)

-	=Indicates missing data.
DK	= The respondent replied "don't know".
Refused	= Refused data.
N	= doer sample size.
Mean	= Mean 24-hour cumulative number of minutes for doers.
SD	= standard deviation.
SE	= standard error.
Min	= minimum number of minutes.
Max	= maximum number of minutes. Percentiles are the percentage of doers below or equal to a given number of minutes.
Source:	U.S. EPA, 1996.

Table 16-17. Time Spent (minutes/day) at Selected Indoor Locations Whole Population and Doers Only, Children <21 years

Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Restaurants – Whole Population															
Birth to <1	63	13	0	0	0	0	0	0	0	0	45	69	105	194	330
1 to <2	118	7	0	0	0	0	0	0	0	0	30	62	88	102	120
2 to <3	118	9	0	0	0	0	0	0	0	0	45	62	92	111	120
3 to <6	357	7	0	0	0	0	0	0	0	0	21	52	90	120	130
6 to <11	497	6	0	0	0	0	0	0	0	0	15	45	85	110	180
11 to <16	466	10	0	0	0	0	0	0	0	0	35	60	90	137	315
16 to <21	481	35	0	0	0	0	0	0	0	20	105	240	380	466	645
Restaurants – DOERS ONLY															
Birth to <1	10	85	10	-	-	-	-	-	-	-	-	-	-	-	330
1 to <2	15	58	5	6	8	12	21	33	55	83	99	110	116	118	120
2 to <3	17	63	20	21	22	24	28	45	60	80	102	116	118	119	120
3 to <6	43	57	4	7	9	10	16	30	45	90	120	120	122	126	130
6 to <11	57	54	5	5	6	10	15	30	45	60	107	124	140	158	180
11 to <16	78	59	2	3	7	10	18	30	45	65	102	141	223	283	315
16 to <21	135	126	1	4	5	10	17	30	60	170	334	437	537	546	645
School – Whole Population															
Birth to <1	63	4	0	0	0	0	0	0	0	0	0	0	46	100	165
1 to <2	118	13	0	0	0	0	0	0	0	0	0	22	156	453	665
2 to <3	118	23	0	0	0	0	0	0	0	0	0	193	414	503	545
3 to <6	357	75	0	0	0	0	0	0	0	0	416	540	569	589	630
6 to <11	497	187	0	0	0	0	0	0	0	397	444	480	552	601	665
11 to <16	466	201	0	0	0	0	0	0	0	420	459	495	578	630	855
16 to <21	481	131	0	0	0	0	0	0	0	308	430	495	566	629	855
School – DOERS ONLY															
Birth to <1	2	-	60	-	-	-	-	-	-	-	-	-	-	-	165
1 to <2	8	-	5	-	-	-	-	-	-	-	-	-	-	-	665
2 to <3	11	251	10	10	10	10	10	83	269	388	510	528	538	542	545
3 to <6	71	379	5	23	34	110	160	228	418	540	570	590	615	627	630
6 to <11	235	396	5	64	129	195	305	370	400	435	480	540	612	643	665
11 to <16	229	409	15	38	96	132	290	395	420	450	495	559	631	696	855
16 to <21	171	367	15	22	31	90	185	270	388	440	525	576	726	801	855
Grocery/Convenience Stores, Other Stores, and Malls – Whole Population															
Birth to <1	63	39	0	0	0	0	0	0	0	30	98	178	224	241	250
1 to <2	118	16	0	0	0	0	0	0	0	0	62	87	146	202	255
2 to <3	118	18	0	0	0	0	0	0	0	0	60	86	133	250	360
3 to <6	357	17	0	0	0	0	0	0	0	0	62	111	189	223	420
6 to <11	497	14	0	0	0	0	0	0	0	0	49	101	167	225	320
11 to <16	466	18	0	0	0	0	0	0	0	0	54	122	204	300	413
16 to <21	481	36	0	0	0	0	0	0	0	15	120	230	402	484	960
Grocery/Convenience Stores, Other Stores, and Malls – DOERS ONLY															
Birth to <1	21	88	5	5	5	5	24	30	55	130	190	235	244	247	250
1 to <2	23	81	5	7	9	17	30	55	65	93	152	205	235	245	255
2 to <3	27	80	10	11	13	20	33	45	60	82	120	234	313	337	360
3 to <6	64	96	5	5	5	16	23	50	73	116	204	236	339	382	420
6 to <11	91	76	3	3	5	5	14	20	60	110	170	230	255	262	320
11 to <16	104	82	1	2	5	10	10	20	45	120	199	300	359	383	413
16 to <21	146	120	2	4	5	5	10	22	60	149	330	456	517	562	960

N = Sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes less than 10.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996 (NHAPS).

Table 16-18. Time Spent (minutes/day) at Selected Indoor Locations, Doers Only																
Restaurant																
								Percentiles								
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		2,059	94.5	119.9	2.6	1	925	10	30	60	95	185	351	548	660
Gender	Male	986	87.5	114.2	3.6	1	900	10	30	60	90	160	305	550	660
Gender	Female	1,073	101.0	124.7	3.8	1	925	10	40	60	105	230	380	540	670
Age (years)	-	30	126.1	138.2	25.2	15	495	30	45	60	150	398	490	495	495
Age (years)	1-4	61	62.7	47.7	6.1	4	330	10	35	55	85	115	120	130	330
Age (years)	5-11	84	56.7	38.1	4.2	5	180	10	30	45	85	120	120	140	180
Age (years)	12-17	122	69.8	78.4	7.1	2	455	10	30	45	65	165	250	325	360
Age (years)	18-64	1,503	101.2	131.2	3.4	1	925	10	30	60	105	211	400	570	675
Age (years)	> 64	259	83.6	83.5	5.2	3	750	19	45	60	90	150	215	315	520
Race	White	1,747	91.7	114.7	2.7	1	925	10	30	60	95	175	320	535	640
Race	Black	148	102.8	141.3	11.6	3	805	5	30	60	95	295	430	555	735
Race	Asian	37	81.3	78.9	13.0	15	480	18	30	60	90	135	200	480	480
Race	Some Others	30	145.2	194.8	35.6	5	765	10	45	83	120	433	750	765	765
Race	Hispanic	78	123.0	156.8	17.8	10	700	15	40	60	110	375	585	660	700
Race	Refused	19	123.8	127.6	29.3	20	480	20	30	70	210	330	480	480	480
Hispanic	No	1,911	92.9	117.6	2.7	1	925	10	30	60	95	180	330	542	645
Hispanic	Yes	129	116.7	148.0	13.0	1	765	15	40	60	115	360	435	660	700
Hispanic	DK	5	76.0	134.3	60.1	5	315	5	10	10	40	315	315	315	315
Hispanic	Refused	14	114.5	134.7	36.0	30	480	30	30	60	90	330	480	480	480
Employment	-	263	62.3	57.9	3.6	2	455	10	30	45	80	120	140	273	330
Employment	Full Time	1,063	105.5	142.4	4.4	1	925	10	35	60	105	235	485	630	735
Employment	Part Time	208	122.6	144.8	10.0	1	805	5	33	65	123	320	441	595	660
Employment	Not Employed	515	76.3	61.4	2.7	3	490	15	40	60	90	145	195	260	315
Employment	Refused	10	135.0	133.5	42.2	30	425	30	60	83	135	378	425	425	425
Education	-	299	72.2	79.6	4.6	1	548	10	30	50	85	130	250	360	480
Education	< High School	132	134.8	171.8	15.0	5	925	10	30	60	152	375	535	700	750
Education	High School Graduate	590	99.4	136.3	5.6	3	910	10	35	60	90	203	435	645	680
Education	< College	431	94.9	114.9	5.5	1	770	10	35	60	105	180	340	550	640
Education	College Graduate	359	89.5	104.1	5.5	1	765	10	35	60	100	165	295	490	570
Education	Post Graduate	248	95.0	109.4	6.9	3	765	15	40	60	115	180	260	560	675
Census Region	Northeast	409	94.4	113.6	5.6	2	765	15	35	60	100	210	330	507	585
Census Region	Midwest	504	96.9	120.9	5.4	1	805	10	30	60	105	190	340	560	675
Census Region	South	680	92.7	125.1	4.8	2	910	10	30	60	90	195	365	550	650
Census Region	West	466	94.9	116.9	5.4	1	925	10	30	60	110	175	375	535	640
Day Of Week	Weekday	1,291	97.3	128.8	3.6	1	925	10	30	60	93	210	377	555	700
Day Of Week	Weekend	768	89.8	103.2	3.7	1	770	10	36	60	105	155	280	510	620
Season	Winter	524	97.7	125.7	5.5	3	875	15	35	60	105	178	351	595	685
Season	Spring	559	91.6	109.7	4.6	2	925	10	35	60	95	180	360	505	555
Season	Summer	556	95.1	123.0	5.2	1	910	10	30	60	94	210	360	555	675
Season	Fall	420	93.6	121.7	5.9	1	900	10	30	60	95	185	325	540	653
Asthma	No	1,903	94.1	117.4	2.7	1	910	10	35	60	100	180	330	545	653
Asthma	Yes	150	96.3	143.6	11.7	4	925	10	30	46	90	238	485	590	670
Asthma	DK	6	196.3	220.9	90.2	30	480	30	30	79	480	480	480	480	480
Angina	No	1,998	94.9	120.7	2.7	1	925	10	30	60	100	190	355	550	660
Angina	Yes	50	69.0	53.6	7.6	3	340	15	45	60	90	105	120	286	340
Angina	DK	11	140.3	171.3	51.6	30	480	30	30	70	120	480	480	480	480
Bronchitis/Emphysema	No	1,945	93.7	117.7	2.7	1	910	10	30	60	97	180	335	548	653
Bronchitis/Emphysema	Yes	104	96.1	130.1	12.8	5	925	15	30	60	90	235	360	500	620
Bronchitis/Emphysema	DK	10	232.8	288.2	91.1	10	875	10	30	79	480	678	875	875	875

Table 16-18. Time Spent (minutes/day) at Selected Indoor Locations, Doers Only (continued)																
Indoors at Bar/Nightclub/Bowling Alley																
								Percentiles								
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		352	175.8	132.2	7.0	3	870	30	90	150	223	328	487	570	615
Gender	Male	213	174.3	133.2	9.1	5	870	30	90	140	220	340	479	568	615
Gender	Female	139	178.1	131.2	11.1	3	630	30	95	150	225	300	530	600	605
Age (years)	-	4	158.8	98.0	49.0	75	300	75	98	130	220	300	300	300	300
Age (years)	5-11	4	98.8	57.5	28.8	45	170	45	53	90	145	170	170	170	170
Age (years)	12-17	8	151.3	77.7	27.5	50	270	50	80	160	205	270	270	270	270
Age (years)	18-64	313	180.2	136.7	7.7	3	870	30	90	150	225	370	498	590	615
Age (years)	> 64	23	141.2	85.2	17.8	5	328	30	75	135	180	240	325	328	328
Race	White	297	173.6	132.6	7.7	3	870	30	90	140	220	328	487	590	630
Race	Black	25	205.4	126.6	25.3	50	540	60	120	180	240	417	498	540	540
Race	Asian	8	169.9	153.3	54.2	5	479	5	38	175	225	479	479	479	479
Race	Some Others	7	197.3	187.6	70.9	70	615	70	110	135	185	615	615	615	615
Race	Hispanic	10	121.3	52.3	16.5	5	198	5	105	118	160	179	198	198	198
Race	Refused	5	246.6	127.2	56.9	73	410	73	180	270	300	410	410	410	410
Hispanic	No	327	177.1	134.5	7.4	3	870	30	90	150	225	340	489	590	615
Hispanic	Yes	20	144.9	85.1	19.0	5	440	38	110	120	160	222	343	440	440
Hispanic	DK	2	142.5	31.8	22.5	120	165	120	120	143	165	165	165	165	165
Hispanic	Refused	3	261.0	171.9	99.2	73	410	73	73	300	410	410	410	410	410
Employment	-	12	133.8	73.6	21.2	45	270	45	60	135	178	225	270	270	270
Employment	Full Time	223	182.4	138.3	9.3	5	870	30	90	150	228	340	525	600	630
Employment	Part Time	43	201.2	155.5	23.7	5	615	45	90	150	270	455	520	615	615
Employment	Not Employed	70	146.3	97.4	11.6	3	479	30	73	123	180	255	328	462	479
Employment	Refused	4	176.3	115.1	57.6	45	300	45	83	180	270	300	300	300	300
Education	-	13	146.5	84.2	23.3	45	300	45	60	150	185	270	300	300	300
Education	< High School	28	218.0	170.2	32.2	60	870	75	120	175	235	420	568	870	870
Education	High School Graduate	117	177.8	130.1	12.0	3	630	25	90	150	225	360	489	540	570
Education	< College	95	205.3	152.8	15.7	5	650	30	105	180	240	462	590	615	650
Education	College Graduate	55	141.8	92.8	12.5	10	417	20	75	120	205	265	340	410	417
Education	Post Graduate	44	131.4	90.2	13.6	30	400	30	60	110	178	265	290	400	400
Census Region	Northeast	83	179.3	137.0	15.0	5	650	45	89	140	240	328	489	630	650
Census Region	Midwest	88	169.8	126.2	13.5	5	615	30	90	148	212	299	487	568	615
Census Region	South	91	175.7	132.0	13.8	3	870	35	90	148	225	270	462	570	870
Census Region	West	90	178.5	135.5	14.3	5	605	30	85	153	225	407	479	590	605
Day Of Week	Weekday	192	167.5	133.5	9.6	5	650	30	80	120	210	340	520	590	605
Day Of Week	Weekend	160	185.9	130.4	10.3	3	870	45	108	165	228	322	475	568	630
Season	Winter	93	182.7	131.7	13.7	5	650	40	87	150	240	410	455	560	650
Season	Spring	83	186.1	147.6	16.2	5	870	30	90	140	230	380	498	570	870
Season	Summer	99	160.3	130.7	13.1	3	630	30	75	120	189	285	530	605	630
Season	Fall	77	176.4	117.2	13.4	15	615	30	100	165	220	299	410	600	615
Asthma	No	331	176.3	133.7	7.4	3	870	30	90	150	225	340	487	590	615
Asthma	Yes	18	169.4	109.0	25.7	60	530	60	105	135	210	270	530	530	530
Asthma	DK	3	160.0	124.9	72.1	60	300	60	60	120	300	300	300	300	300
Angina	No	345	177.0	132.8	7.1	3	870	30	90	150	225	340	487	590	615
Angina	Yes	5	82.0	47.2	21.1	5	120	5	75	90	120	120	120	120	120
Angina	DK	2	210.0	127.3	90.0	120	300	120	120	210	300	300	300	300	300
Bronchitis/Emphysema	No	333	177.3	133.3	7.3	3	870	30	90	150	225	340	487	590	615
Bronchitis/Emphysema	Yes	17	148.6	108.5	26.3	50	530	50	110	120	175	210	530	530	530
Bronchitis/Emphysema	DK	2	165.0	190.9	135.0	30	300	30	30	165	300	300	300	300	300

Table 16-18. Time Spent (minutes/day) at Selected Indoor Locations, Doers Only (continued)																
Indoors at School																
								Percentiles								
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99	
All		1,224	343.4	179.1	5.1	1	995	10	210	395	454	540	585	660	723	
Gender	Male	581	358.6	167.7	7.0	1	995	30	255	400	450	540	600	690	778	
Gender	Female	643	329.6	187.9	7.4	1	855	5	180	390	455	540	582	640	683	
Age (years)	-	18	314.1	230.9	54.4	5	713	5	165	248	520	625	713	713	713	
Age (years)	1-4	43	288.5	217.6	33.2	5	665	10	60	269	500	580	595	665	665	
Age (years)	5-11	302	396.3	109.2	6.3	5	665	170	365	403	445	535	565	625	640	
Age (years)	12-17	287	402.6	125.5	7.4	15	855	120	383	420	450	500	565	710	778	
Age (years)	18-64	550	295.4	207.3	8.8	1	995	5	104	300	460	553	612	683	785	
Age (years)	> 64	24	187.7	187.0	38.2	2	585	3	45	120	328	480	510	585	585	
Race	White	928	348.5	180.5	5.9	1	995	10	213	400	458	545	600	665	723	
Race	Black	131	339.8	169.3	14.8	2	855	15	230	390	445	510	580	624	645	
Race	Asian	39	332.4	179.9	28.8	5	840	20	190	365	450	560	580	840	840	
Race	Some Others	36	363.6	155.6	25.9	10	820	105	273	366	458	502	598	820	820	
Race	Hispanic	76	294.0	175.7	20.2	2	565	10	143	363	432	495	525	540	565	
Race	Refused	14	279.7	221.3	59.1	5	681	5	60	260	440	625	681	681	681	
Hispanic	No	1,082	344.9	179.6	5.5	1	995	10	210	395	455	540	598	665	730	
Hispanic	Yes	127	333.0	173.8	15.4	2	820	15	200	390	445	500	565	600	630	
Hispanic	DK	5	293.0	244.7	109.4	3	562	3	65	415	420	562	562	562	562	
Hispanic	Refused	10	329.5	180.1	56.9	5	625	5	200	350	445	538	625	625	625	
Employment	-	616	390.3	130.2	5.2	5	855	115	365	410	450	525	570	640	665	
Employment	Full Time	275	331.3	222.0	13.4	1	995	5	115	405	510	575	625	690	755	
Employment	Part Time	138	280.9	174.8	14.9	1	800	10	160	285	412	480	537	660	683	
Employment	Not Employed	190	258.7	199.5	14.5	1	855	5	60	263	410	528	572	778	840	
Employment	Refused	5	166.0	179.1	80.1	5	440	5	5	180	200	440	440	440	440	
Education	-	679	388.9	132.8	5.1	5	855	100	360	410	450	525	580	640	710	
Education	< High School	24	233.3	179.6	36.7	1	540	2	30	298	374	460	465	540	540	
Education	High School Graduate	114	186.6	193.6	18.1	1	785	4	20	108	295	480	580	645	690	
Education	< College	173	281.4	209.9	16.0	1	995	5	120	255	425	550	640	820	855	
Education	College Graduate	93	300.4	208.7	21.6	1	755	5	115	320	470	540	580	730	755	
Education	Post Graduate	141	373.5	193.4	16.3	1	683	15	250	442	510	575	615	655	680	
Census Region	Northeast	261	345.7	181.5	11.2	1	995	11	210	385	455	535	620	710	855	
Census Region	Midwest	290	334.4	176.7	10.4	1	730	10	180	390	440	530	585	645	683	
Census Region	South	427	354.0	178.5	8.6	1	855	10	235	415	462	540	575	640	755	
Census Region	West	246	332.8	180.3	11.5	1	820	15	195	378	440	555	595	681	713	
Day Of Week	Weekday	1,179	346.8	177.5	5.2	1	995	10	222	395	455	540	585	655	723	
Day Of Week	Weekend	45	252.0	198.5	29.6	20	820	40	105	180	360	555	632	820	820	
Season	Winter	392	369.3	164.4	8.3	1	855	20	285	405	457	545	600	680	710	
Season	Spring	353	355.1	165.5	8.8	1	855	12	250	400	455	535	575	636	713	
Season	Summer	207	316.8	196.4	13.6	2	995	10	125	365	445	557	585	640	723	
Season	Fall	272	311.0	195.3	11.8	1	855	5	120	365	445	540	595	660	778	
Asthma	No	1,095	342.8	179.2	5.4	1	995	10	200	390	455	540	585	660	723	
Asthma	Yes	124	350.7	178.8	16.1	1	855	10	250	402	445	535	605	645	800	
Asthma	DK	5	287.0	190.7	85.3	5	445	5	180	365	440	445	445	445	445	
Angina	No	1,209	344.6	178.9	5.1	1	995	10	210	395	455	540	595	660	723	
Angina	Yes	9	205.8	169.5	56.5	15	510	15	90	180	275	510	510	510	510	
Angina	DK	6	292.2	178.9	73.0	5	480	5	180	324	440	480	480	480	480	
Bronchitis/Emphysema	No	1,175	344.8	178.8	5.2	1	995	10	212	395	455	540	595	660	730	
Bronchitis/Emphysema	Yes	42	306.7	188.2	29.0	3	632	10	120	378	444	465	580	632	632	
Bronchitis/Emphysema	DK	7	315.4	163.7	61.9	5	440	5	180	378	440	440	440	440	440	

Table 16-18. Time Spent (minutes/day) at Selected Indoor Locations, Doers Only (continued)															
Office or Factory															
								Percentiles							
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		1,975	394.0	230.8	5.2	1	1,440	9	180	485	550	630	675	765	818
Gender	Male	1,012	410.8	233.5	7.3	1	1,440	10	225	495	565	645	710	780	855
Gender	Female	963	376.3	226.7	7.3	1	855	5	120	480	540	600	645	710	750
Age (years)	-	49	438.9	232.6	33.2	10	900	20	299	500	555	675	780	900	900
Age (years)	1-4	12	31.6	25.6	7.4	5	90	5	13	25	45	60	90	90	90
Age (years)	5-11	14	100.9	155.1	41.5	2	580	2	10	33	178	195	580	580	580
Age (years)	12-17	19	145.4	181.1	41.6	1	625	1	10	50	240	510	625	625	625
Age (years)	18-64	1,749	419.0	218.4	5.2	1	1,440	10	273	500	555	630	680	765	818
Age (years)	> 64	132	145.8	194.0	16.9	1	705	3	10	40	205	495	540	640	675
Race	White	1,612	387.6	232.0	5.8	1	1,440	6	150	480	550	628	675	750	800
Race	Black	191	413.9	218.0	15.8	1	1,037	10	268	485	540	635	720	803	900
Race	Asian	42	428.0	216.8	33.4	10	780	30	285	492	553	660	745	780	780
Race	Some Others	28	480.9	200.9	38.0	40	795	75	348	540	583	715	780	795	795
Race	Hispanic	74	394.5	237.8	27.6	1	840	5	230	493	560	645	720	765	840
Race	Refused	28	482.9	246.1	46.5	30	997	30	373	533	608	818	860	997	997
Hispanic	No	1,805	393.5	229.6	5.4	1	1,440	10	180	483	550	630	675	755	810
Hispanic	Yes	138	393.6	238.6	20.3	1	840	5	180	498	560	644	675	765	795
Hispanic	DK	7	262.6	242.1	91.5	1	610	1	12	245	540	610	610	610	610
Hispanic	Refused	25	470.0	258.8	51.8	17	860	30	311	525	615	810	818	860	860
Employment	-	43	121.3	178.0	27.1	1	685	2	10	40	178	307	580	685	685
Employment	Full Time	1,535	455.6	200.3	5.1	1	1,440	15	400	510	570	644	700	775	837
Employment	Part Time	164	293.0	197.0	15.4	1	750	10	95	343	480	525	555	585	615
Employment	Not Employed	213	77.6	123.0	8.4	1	705	3	10	30	90	215	305	570	640
Employment	Refused	20	449.2	184.8	41.3	30	675	60	334	523	550	645	675	675	675
Education	-	80	225.1	248.5	27.8	1	860	3	15	105	470	608	675	780	860
Education	< High School	104	329.5	264.4	25.9	2	930	5	51	389	553	640	705	765	855
Education	High School Graduate	631	396.9	228.1	9.1	1	997	10	210	492	550	615	675	760	800
Education	< College	462	393.1	228.8	10.6	1	1,440	5	210	480	540	615	660	770	820
Education	College Graduate	415	437.2	205.2	10.1	1	900	10	325	510	570	640	690	750	800
Education	Post Graduate	283	396.9	232.2	13.8	2	860	5	175	480	565	640	675	780	818
Census Region	Northeast	465	399.1	226.2	10.5	1	930	10	215	485	550	625	675	765	840
Census Region	Midwest	439	389.3	229.1	10.9	1	997	8	180	480	550	630	670	750	800
Census Region	South	666	408.6	228.2	8.8	1	1,440	10	225	498	555	630	675	760	840
Census Region	West	405	369.1	240.4	11.9	1	900	5	95	470	550	630	675	760	800
Day Of Week	Weekday	1,759	406.8	225.2	5.4	1	997	10	237	495	555	630	675	755	810
Day Of Week	Weekend	216	289.6	249.1	16.9	1	1,440	3	30	283	495	600	670	800	900
Season	Winter	531	390.7	231.7	10.1	1	997	10	180	480	550	625	675	755	835
Season	Spring	470	385.2	240.7	11.1	1	1,440	5	120	480	553	630	695	775	837
Season	Summer	550	393.5	224.5	9.6	1	1,037	9	200	483	540	614	675	753	810
Season	Fall	424	408.4	226.6	11.0	1	840	10	239	500	567	640	675	750	770
Asthma	No	1,845	395.0	230.4	5.4	1	1,440	8	185	490	550	630	675	760	810
Asthma	Yes	114	371.7	231.3	21.7	3	840	10	120	463	540	630	675	800	837
Asthma	DK	16	437.0	272.1	68.0	5	860	5	233	520	588	780	860	860	860
Angina	No	1,931	395.7	229.7	5.2	1	1,440	10	195	490	550	630	675	760	811
Angina	Yes	26	265.5	246.8	48.4	5	650	9	15	175	490	630	645	650	650
Angina	DK	18	392.3	282.6	66.6	5	860	5	30	490	550	780	860	860	860
Bronchitis/Emphysema	No	1,873	395.6	230.0	5.3	1	1,440	8	195	490	550	630	675	760	818
Bronchitis/Emphysema	Yes	86	356.4	236.1	25.5	5	800	10	75	428	540	620	660	720	800
Bronchitis/Emphysema	DK	16	403.9	289.5	72.4	5	860	5	30	490	583	780	860	860	860

Table 16-18. Time Spent (minutes/day) at Selected Indoor Locations, Doers Only (continued)																
Schools, Churches, Hospitals, and Public Buildings																
								Percentile								
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		2,932	274.3	205.9	3.8	1	1,440	20	95	221	430	540	615	725	805
Gender	Male	1,234	285.1	206.7	5.9	1	1,440	30	110	255	425	540	620	745	840
Gender	Female	1,698	266.5	205.1	5.0	1	1,440	20	90	200	430	540	610	713	800
Age (years)	-	50	269.0	221.0	31.3	5	1,030	30	100	193	400	590	625	872	1030
Age (years)	1-4	98	233.0	235.8	23.8	1	1,440	5	60	150	390	545	595	900	1440
Age (years)	5-11	391	351.2	149.6	7.6	5	665	70	245	389	440	535	562	625	645
Age (years)	12-17	355	366.3	161.2	8.6	1	935	60	260	415	446	502	605	710	805
Age (years)	18-64	1,653	267.7	221.2	5.4	1	1,440	15	87	190	450	570	655	760	855
Age (years)	> 64	385	151.1	128.6	6.6	5	710	21	60	115	195	340	435	525	615
Race	White	2,310	268.2	204.3	4.3	1	1,440	20	90	210	429	540	612	705	765
Race	Black	332	303.5	207.1	11.4	1	1,440	35	135	285	440	540	630	775	1000
Race	Asian	61	295.0	199.4	25.5	5	900	30	135	240	425	535	565	840	900
Race	Some Others	57	314.7	203.5	27.0	10	967	30	135	360	455	525	598	820	967
Race	Hispanic	141	283.9	229.8	19.4	2	1,440	11	100	237	430	525	630	840	940
Race	Refused	31	257.8	192.5	34.6	5	681	5	120	240	430	495	625	681	681
Hispanic	No	2,654	271.3	203.6	4.0	1	1,440	20	94	215	425	540	612	712	800
Hispanic	Yes	240	306.4	230.8	14.9	1	1,440	20	110	288	445	568	695	840	940
Hispanic	DK	13	279.4	230.7	64.0	35	760	35	65	235	420	562	760	760	760
Hispanic	Refused	25	286.6	175.4	35.1	5	625	55	145	255	440	495	565	625	625
Employment	-	821	343.5	171.1	6.0	1	1,440	55	190	393	441	520	570	645	713
Employment	Full Time	1,029	300.3	239.8	7.5	1	1,440	15	90	215	510	610	685	775	900
Employment	Part Time	293	251.3	199.3	11.6	1	1,030	20	85	200	387	525	610	800	880
Employment	Not Employed	775	176.4	148.4	5.3	1	855	15	60	121	250	400	475	570	641
Employment	Refused	14	212.9	147.7	39.5	5	440	5	120	190	305	430	440	440	440
Education	-	917	340.3	172.6	5.7	1	1,440	45	190	390	440	525	580	645	713
Education	< High School	166	172.6	138.0	10.7	1	735	27	70	124	235	375	465	525	640
Education	High School Graduate	617	207.3	199.0	8.0	1	1,440	15	60	135	295	510	585	690	785
Education	< College	520	247.5	213.6	9.4	1	1,000	15	85	165	420	553	640	760	855
Education	College Graduate	351	261.6	214.3	11.4	1	1,005	15	85	180	450	560	625	750	800
Education	Post Graduate	361	319.1	236.2	12.4	1	1,440	30	110	290	510	615	683	765	900
Census Region	Northeast	645	272.7	211.6	8.3	1	1,440	25	90	215	420	545	630	735	855
Census Region	Midwest	686	275.4	207.2	7.9	1	1,440	30	88	239	425	540	615	745	850
Census Region	South	1,036	278.4	201.0	6.2	1	1,440	20	110	230	440	535	600	690	778
Census Region	West	565	267.4	207.2	8.7	1	1,440	15	100	200	420	555	620	712	820
Day Of Week	Weekday	2,091	309.8	212.6	4.6	1	1,440	15	115	340	460	565	632	750	855
Day Of Week	Weekend	841	186.0	156.9	5.4	1	1,440	40	85	140	230	385	525	640	735
Season	Winter	847	296.6	201.2	6.9	1	1,440	30	120	285	444	545	615	710	770
Season	Spring	805	276.8	204.6	7.2	1	1,440	30	110	220	420	535	600	725	840
Season	Summer	667	254.1	209.7	8.1	1	1,015	20	80	180	420	550	630	738	890
Season	Fall	613	262.4	207.3	8.4	1	1,005	14	75	210	425	540	615	712	778
Asthma	No	2,689	273.2	207.3	4.0	1	1,440	20	94	217	430	540	615	725	820
Asthma	Yes	229	288.0	191.6	12.7	1	855	25	120	275	435	533	605	645	800
Asthma	DK	14	270.0	171.2	45.8	5	565	5	145	280	430	445	565	565	565
Angina	No	2,836	277.1	206.4	3.9	1	1,440	20	100	230	430	540	615	725	805
Angina	Yes	78	176.4	172.8	19.6	5	890	28	60	120	195	480	575	625	890
Angina	DK	18	258.3	165.6	39.0	3	565	3	145	270	378	480	565	565	565
Bronchitis/Emphysema	No	2,794	277.0	207.3	3.9	1	1,440	20	95	228	430	540	615	726	840
Bronchitis/Emphysema	Yes	121	212.6	166.3	15.1	10	662	30	90	145	375	445	490	605	630
Bronchitis/Emphysema	DK	17	275.8	163.4	39.6	5	565	5	145	305	415	440	565	565	565

Table 16-18. Time Spent (minutes/day) at Selected Indoor Locations, Doers Only (continued)																
Malls, Grocery Stores, or Other Stores																
								Percentiles								
Group Name	Group Code	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		2,697	115.0	141.0	2.7	1	1,080	10	30	60	135	285	482	570	640
Gender	Male	1,020	120.2	157.1	4.9	1	840	5	30	60	130	375	530	609	658
Gender	Female	1,677	111.8	130.1	3.2	1	1,080	10	30	60	135	255	400	550	600
Age (years)	-	50	139.4	137.6	19.5	15	660	20	45	93	180	339	420	565	660
Age (years)	1-4	110	90.0	77.9	7.4	5	420	10	40	65	105	210	250	359	360
Age (years)	5-11	129	77.7	68.0	6.0	3	320	5	30	60	110	180	225	255	280
Age (years)	12-17	140	88.7	101.4	8.6	1	530	5	20	45	124	223	318	384	413
Age (years)	18-64	1,871	125.9	156.8	3.6	1	1,080	10	30	60	150	360	525	600	658
Age (years)	> 64	397	88.6	88.5	4.4	1	655	10	30	60	120	180	255	400	470
Race	White	2,234	111.6	139.4	3.0	1	1,080	10	30	60	130	265	495	570	640
Race	Black	237	123.0	152.3	9.9	2	800	10	25	60	135	370	480	600	613
Race	Asian	37	158.9	151.7	24.9	2	600	14	50	105	220	410	480	600	600
Race	Some Others	52	150.2	146.7	20.3	5	660	14	65	103	180	280	588	600	660
Race	Hispanic	110	133.1	138.3	13.2	1	720	10	35	90	195	310	450	535	540
Race	Refused	27	124.7	131.1	25.2	10	515	10	30	60	207	300	380	515	515
Hispanic	No	2,476	114.4	141.8	2.9	1	1,080	10	30	60	132	285	495	570	640
Hispanic	Yes	188	126.1	133.2	9.7	1	720	10	30	90	173	270	450	540	610
Hispanic	DK	12	49.4	37.7	10.9	2	122	2	18	48	70	105	122	122	122
Hispanic	Refused	21	122.4	138.5	30.2	10	515	20	33	60	180	290	380	515	515
Employment	-	372	86.9	86.3	4.5	1	660	5	30	60	120	206	255	360	384
Employment	Full Time	1,170	136.8	176.7	5.2	1	1,080	10	30	60	150	480	562	640	690
Employment	Part Time	285	134.1	147.7	8.8	2	540	6	30	65	186	400	480	520	540
Employment	Not Employed	854	91.2	87.2	3.0	1	585	10	30	60	120	195	255	360	420
Employment	Refused	16	98.9	110.0	27.5	10	357	10	32	53	115	290	357	357	357
Education	-	420	88.3	91.9	4.5	1	660	5	29	60	120	210	263	384	420
Education	< High School	206	128.9	155.7	10.8	2	1,080	10	30	75	150	330	500	570	605
Education	High School Graduate	792	126.3	158.9	5.6	1	960	5	30	60	150	365	524	600	660
Education	< College	583	129.8	149.5	6.2	1	800	10	30	70	165	345	510	563	651
Education	College Graduate	411	117.9	144.1	7.1	1	720	10	30	60	135	290	515	600	640
Education	Post Graduate	285	78.2	95.7	5.7	1	630	10	25	50	90	160	250	450	555
Census Region	Northeast	622	110.2	134.9	5.4	1	755	5	30	60	130	280	465	563	600
Census Region	Midwest	601	108.2	133.1	5.4	2	840	10	30	60	130	250	440	560	645
Census Region	South	871	127.9	155.8	5.3	1	1,080	10	30	60	155	320	520	600	660
Census Region	West	603	107.9	130.7	5.3	1	840	10	30	60	120	255	430	550	600
Day Of Week	Weekday	1,721	117.5	148.9	3.6	1	1,080	10	30	60	135	320	510	586	650
Day Of Week	Weekend	976	110.6	125.7	4.0	1	840	5	30	65	135	255	380	560	608
Season	Winter	683	111.7	134.0	5.1	2	840	10	30	60	135	255	420	568	660
Season	Spring	679	115.8	142.2	5.5	1	720	10	30	60	130	300	500	588	645
Season	Summer	759	113.1	147.5	5.4	1	1,080	5	30	60	125	300	510	570	610
Season	Fall	576	120.2	138.9	5.8	1	840	10	30	60	160	295	480	550	640
Asthma	No	2,480	116.2	142.4	2.9	1	1,080	10	30	60	135	288	495	575	640
Asthma	Yes	208	101.1	125.0	8.7	1	600	5	30	60	120	245	420	545	550
Asthma	DK	9	85.1	79.6	26.5	33	290	33	55	58	60	290	290	290	290
Angina	No	2,607	116.0	142.1	2.8	1	1,080	10	30	60	135	290	495	570	640
Angina	Yes	74	90.8	103.9	12.1	2	630	15	37	64	105	150	190	510	630
Angina	DK	16	62.7	68.1	17.0	2	290	2	30	55	60	110	290	290	290
Bronchitis/Emphysema	No	2,553	115.7	141.7	2.8	1	1,080	10	30	60	135	285	481	570	640
Bronchitis/Emphysema	Yes	130	104.8	131.3	11.5	5	613	10	25	60	135	193	505	575	609
Bronchitis/Emphysema	DK	14	71.1	66.9	17.9	20	290	20	35	57	70	110	290	290	290

Table 16-18. Time Spent (minutes/day) at Selected Indoor Locations, Doers Only (continued)

Indoors at a Gym/Health Club

Category	Population Group	N	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		364	129.7	104.3	5.5	5	686	30	60	110	155	240	320	525	600
Gender	Male	176	147.2	115.6	8.7	5	686	30	78	120	175	285	360	533	660
Gender	Female	188	113.2	89.9	6.6	5	660	30	60	93	135	200	279	420	560
Age (years)	-	6	202.5	227.9	93.0	30	560	30	55	75	420	560	560	560	560
Age (years)	1-4	5	156.0	29.9	13.4	105	180	105	160	160	175	180	180	180	180
Age (years)	5-11	28	105.3	69.5	13.1	5	325	30	58	83	141	165	270	325	325
Age (years)	12-17	39	165.4	122.1	19.5	15	660	30	90	138	206	330	440	660	660
Age (years)	18-64	254	123.1	98.8	6.2	5	686	30	60	100	150	210	295	475	600
Age (years)	> 64	32	141.4	114.2	20.2	10	533	30	60	103	173	292	340	533	533
Race	White	307	134.3	109.4	6.2	5	686	30	65	110	164	255	330	533	600
Race	Black	30	117.7	75.4	13.8	5	320	10	60	115	145	235	285	320	320
Race	Asian	10	75.2	36.5	11.5	30	145	30	54	60	95	133	145	145	145
Race	Some Others	11	112.9	69.1	20.8	25	270	25	65	90	153	179	270	270	270
Race	Hispanic	4	83.8	42.7	21.3	40	140	40	53	78	115	140	140	140	140
Race	Refused	2	57.5	3.5	2.5	55	60	55	55	58	60	60	60	60	60
Hispanic	No	345	132.0	105.9	5.7	5	686	30	65	110	160	240	325	533	600
Hispanic	Yes	17	90.1	58.8	14.3	5	255	5	60	90	115	140	255	255	255
Hispanic	Refused	2	57.5	3.5	2.5	55	60	55	55	58	60	60	60	60	60
Employment	-	72	139.6	103.3	12.2	5	660	30	76	120	165	265	330	440	660
Employment	Full Time	176	131.2	112.5	8.5	5	686	30	60	110	150	240	330	560	660
Employment	Part Time	40	129.3	92.8	14.7	25	420	35	60	95	168	285	325	420	420
Employment	Not Employed	75	117.9	91.3	10.5	5	533	25	60	90	145	230	285	475	533
Employment	Refused	1	40.0	-	-	40	40	40	40	40	40	40	40	40	40
Education	-	81	136.9	99.7	11.1	5	660	30	75	120	164	215	325	440	660
Education	< High School	9	110.6	97.7	32.6	10	300	10	30	80	165	300	300	300	300
Education	High School Graduate	61	128.5	110.0	14.1	5	660	25	75	105	145	210	310	525	660
Education	< College	71	145.6	129.1	15.3	5	600	35	65	110	170	285	533	560	600
Education	College Graduate	81	122.0	99.5	11.1	15	686	30	60	98	135	220	285	420	686
Education	Post Graduate	61	115.6	76.9	9.8	10	415	40	60	90	145	225	265	320	415
Census Region	Northeast	83	140.5	107.2	11.8	20	660	40	70	120	170	240	330	600	660
Census Region	Midwest	62	127.0	88.7	11.3	5	440	25	60	113	170	285	300	340	440
Census Region	South	118	125.7	107.0	9.9	5	660	15	60	105	150	240	330	533	540
Census Region	West	101	127.0	108.5	10.8	5	686	50	60	92	135	225	292	525	560
Day Of Week	Weekday	281	121.3	96.6	5.8	5	686	30	60	98	145	210	295	475	560
Day Of Week	Weekend	83	158.1	123.7	13.6	5	660	30	77	120	180	285	415	600	660
Season	Winter	127	139.8	108.3	9.6	5	686	25	75	120	177	240	330	533	660
Season	Spring	85	141.5	115.2	12.5	10	600	30	65	102	164	285	340	560	600
Season	Summer	81	109.9	87.4	9.7	5	525	30	60	90	130	160	310	440	525
Season	Fall	71	119.9	99.0	11.7	20	660	30	56	98	150	215	295	420	660
Asthma	No	333	132.4	106.8	5.9	5	686	30	62	110	160	255	325	533	600
Asthma	Yes	28	100.1	69.4	13.1	5	330	25	60	86	118	210	230	330	330
Asthma	DK	3	101.7	55.8	32.2	60	165	60	60	80	165	165	165	165	165
Angina	No	357	130.5	105.0	5.6	5	686	30	62	110	155	240	325	525	600
Angina	Yes	4	90.0	47.6	23.8	60	160	60	60	70	120	160	160	160	160
Angina	DK	3	81.7	65.3	37.7	30	155	30	30	60	155	155	155	155	155
Bronchitis/Emphysema	No	352	130.7	104.8	5.6	5	686	30	61	110	158	240	320	525	600
Bronchitis/Emphysema	Yes	10	97.3	92.8	29.4	10	330	10	45	77	120	245	330	330	330
Bronchitis/Emphysema	DK	2	107.5	67.2	47.5	60	155	60	60	108	155	155	155	155	155

- = Indicates missing data.
DK = The respondent replied “don’t know”.
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996

Table 16-19. Time Spent (minutes/day) in Selected Outdoor Locations Whole Population and Doers Only, Children <21 years

Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
School Grounds/Playground – Whole Population															
Birth to <1	63	2	0	0	0	0	0	0	0	0	0	0	0	53	140
1 to <2	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 to <3	118	4	0	0	0	0	0	0	0	0	0	0	50	131	175
3 to <6	357	5	0	0	0	0	0	0	0	0	0	0	64	127	625
6 to <11	497	8	0	0	0	0	0	0	0	0	10	60	121	170	315
11 to <16	466	10	0	0	0	0	0	0	0	0	20	80	120	160	570
16 to <21	481	8	0	0	0	0	0	0	0	0	0	50	135	180	510
School Grounds/Playground – DOERS ONLY															
Birth to <1	1	-	140	-	-	-	-	-	-	-	-	-	-	-	140
1 to <2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 to <3	5	-	10	-	-	-	-	-	-	-	-	-	-	-	175
3 to <6	12	138	20	22	24	31	42	59	118	138	150	364	521	573	625
6 to <11	52	80	10	10	10	10	15	30	59	106	169	217	280	298	315
11 to <16	62	72	3	4	5	5	5	21	53	95	149	178	217	360	570
16 to <21	34	116	10	10	10	13	18	46	95	161	201	305	418	464	510
Parks or Golf Courses – Whole Population															
Birth to <1	63	3	0	0	0	0	0	0	0	0	0	0	45	63	85
1 to <2	118	3	0	0	0	0	0	0	0	0	0	0	0	25	360
2 to <3	118	12	0	0	0	0	0	0	0	0	0	24	126	246	755
3 to <6	357	10	0	0	0	0	0	0	0	0	0	71	163	220	585
6 to <11	497	16	0	0	0	0	0	0	0	0	0	72	328	483	665
11 to <16	466	19	0	0	0	0	0	0	0	0	0	114	265	452	1,065
16 to <21	481	22	0	0	0	0	0	0	0	0	0	150	381	546	870
Parks or Golf Courses – DOERS ONLY															
Birth to <1	3	-	30	-	-	-	-	-	-	-	-	-	-	-	85
1 to <2	2	-	30	-	-	-	-	-	-	-	-	-	-	-	360
2 to <3	7	-	21	-	-	-	-	-	-	-	-	-	-	-	755
3 to <6	26	144	25	26	28	31	44	63	113	165	273	388	505	545	585
6 to <11	34	236	25	30	35	43	52	73	123	394	568	644	662	663	665
11 to <16	38	237	15	15	15	15	27	86	164	266	470	851	954	1,010	1,065
16 to <21	47	225	1	7	14	15	24	60	160	308	557	633	677	773	870
Pool, River, or Lake – Whole Population															
Birth to <1	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 to <2	118	1	0	0	0	0	0	0	0	0	0	0	0	0	118
2 to <3	118	12	0	0	0	0	0	0	0	0	0	14	228	352	435
3 to <6	357	5	0	0	0	0	0	0	0	0	0	0	85	163	630
6 to <11	497	9	0	0	0	0	0	0	0	0	0	0	220	295	375
11 to <16	466	4	0	0	0	0	0	0	0	0	0	0	60	160	235
16 to <21	481	8	0	0	0	0	0	0	0	0	0	0	145	240	570
Pool, River, or Lake – DOERS ONLY															
Birth to <1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 to <2	1	-	118	-	-	-	-	-	-	-	-	-	-	-	118
2 to <3	6	-	95	-	-	-	-	-	-	-	-	-	-	-	435
3 to <6	9	-	45	-	-	-	-	-	-	-	-	-	-	-	630
6 to <11	24	178	25	26	27	32	46	75	155	294	319	359	370	373	375
11 to <16	16	121	58	58	59	59	60	60	85	206	225	228	232	234	235
16 to <21	22	179	20	22	24	31	40	55	125	238	415	548	564	567	570

N = Sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes less than 10.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996 (NHAPS).

Table 16-20. Time Spent (minutes/day) in Selected Outdoor Locations, Doers Only																
Outdoors on School Grounds/Playground																
								Percentiles								
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		259	98.4	110.1	6.8	1	690	5	30	70	120	208	300	540	570
Gender	Male	0.136	118.0	126.4	10.8	1	690	10	35	85	149	255	370	555	625
Gender	Female	123	76.7	83.9	7.6	1	570	5	20	51	120	180	225	270	440
Age (years)	-	2	275.0	374.8	265.0	10	540	10	10	275	540	540	540	540	540
Age (years)	1-4	9	85.0	61.1	20.4	10	175	10	30	65	140	175	175	175	175
Age (years)	5-11	64	88.0	95.6	12.0	5	625	10	30	60	120	170	220	315	625
Age (years)	12-17	76	78.7	88.2	10.1	3	570	5	25	55	105	165	225	370	570
Age (years)	18-64	101	119.8	127.6	12.7	1	690	5	30	85	165	240	360	540	555
Age (years)	> 64	7	65.0	47.3	17.9	5	150	5	30	60	95	150	150	150	150
Race	White	208	98.2	106.5	7.4	1	690	9	30	70	125	190	281	510	555
Race	Black	23	128.4	157.5	32.9	5	570	5	25	67	170	300	540	570	570
Race	Asian	6	59.0	66.1	27.0	10	179	10	10	35	85	179	179	179	179
Race	Some Others	7	70.0	59.7	22.6	10	180	10	10	60	105	180	180	180	180
Race	Hispanic	15	83.7	103.0	26.6	1	370	1	10	30	120	228	370	370	370
Hispanic	No	225	102.6	113.7	7.6	3	690	9	30	70	125	210	300	540	570
Hispanic	Yes	32	71.2	79.9	14.1	1	370	1	13	33	110	150	228	370	370
Hispanic	DK	2	57.5	31.8	22.5	35	80	35	35	58	80	80	80	80	80
Employment	-	143	80.2	88.0	7.4	3	625	9	25	55	115	160	215	315	570
Employment	Full Time	48	130.3	127.2	18.4	1	555	10	40	85	180	300	360	555	555
Employment	Part Time	24	129.7	158.9	32.4	3	690	10	35	85	144	228	510	690	690
Employment	Not Employed	42	95.4	94.8	14.6	1	440	5	30	80	120	180	235	440	440
Employment	Refused	2	322.5	307.6	217.5	105	540	105	105	323	540	540	540	540	540
Education	-	162	86.6	94.6	7.4	3	625	10	27	60	120	170	220	370	570
Education	< High School	11	124.8	171.9	51.8	1	540	1	5	45	180	345	540	540	540
Education	High School Graduate	33	113.6	110.7	19.3	3	555	5	30	90	160	240	290	555	555
Education	< College	19	129.8	147.4	33.8	5	510	5	33	70	210	440	510	510	510
Education	College Graduate	19	122.1	149.9	34.4	5	690	5	50	85	125	235	690	690	690
Education	Post Graduate	15	102.9	98.1	25.3	1	360	1	30	75	125	235	360	360	360
Census Region	Northeast	66	106.0	115.2	14.2	5	690	10	30	85	150	190	281	540	690
Census Region	Midwest	53	86.1	109.2	15.0	3	540	5	20	50	115	190	290	510	540
Census Region	South	82	85.5	92.4	10.2	1	570	5	30	60	115	180	255	360	570
Census Region	West	58	119.3	125.6	16.5	1	625	10	30	85	160	235	440	555	625
Day Of Week	Weekday	205	87.0	105.5	7.4	1	625	5	25	55	115	180	240	540	555
Day Of Week	Weekend	54	141.5	117.1	15.9	10	690	25	67	113	180	290	345	440	690
Season	Winter	53	72.2	102.0	14.0	1	555	3	20	35	85	130	315	440	555
Season	Spring	88	108.6	96.5	10.3	5	540	10	45	85	148	215	255	510	540
Season	Summer	65	116.4	137.9	17.1	5	690	10	30	75	135	270	360	625	690
Season	Fall	53	85.5	96.2	13.2	5	540	5	20	55	120	180	235	345	540
Asthma	No	237	100.9	113.2	7.4	1	690	5	30	70	120	215	315	540	570
Asthma	Yes	22	70.9	62.0	13.2	5	179	10	15	45	145	160	165	179	179
Angina	No	254	99.1	110.8	7.0	1	690	5	30	69	120	208	300	540	570
Angina	Yes	5	61.2	53.4	23.9	1	130	1	15	70	90	130	130	130	130
Bronchitis/Emphysema	No	248	100.6	111.6	7.1	1	690	5	30	71	125	210	300	540	570
Bronchitis/Emphysema	Yes	10	52.7	45.4	14.4	9	160	9	22	44	60	125	160	160	160
Bronchitis/Emphysema	DK	1	15.0	0.0	0.0	15	15	15	15	15	15	15	15	15	15

Table 16-20. Time Spent (minutes/day) in Selected Outdoor Locations, Doers Only (continued)

Outdoors at a Park/Golf Course

								Percentiles							
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		506	198.6	190.2	8.5	1	1,065	20	60	135	270	465	590	748	870
Gender	Male	291	205.8	183.1	10.7	1	1,015	25	60	150	285	510	590	730	755
Gender	Female	214	187.7	199.4	13.6	5	1,065	15	55	120	250	435	590	870	930
Gender	Refused	1	420.0	-	-	420	420	420	420	420	420	420	420	420	420
Age (years)	-	10	122.4	60.2	19.0	30	225	30	60	120	160	202	225	225	225
Age (years)	1-4	21	149.9	176.3	38.5	21	755	25	50	85	150	360	425	755	755
Age (years)	5-11	54	207.6	184.5	25.1	25	665	35	70	125	275	555	635	660	665
Age (years)	12-17	52	238.5	242.2	33.6	15	1,065	15	60	148	338	590	840	915	1065
Age (years)	18-64	314	197.8	185.9	10.5	1	1,015	20	60	150	270	440	580	748	870
Age (years)	> 64	55	189.0	182.9	24.7	10	735	20	30	120	300	510	570	590	735
Race	White	441	205.3	195.3	9.3	1	1,065	20	60	150	275	480	605	795	915
Race	Black	19	114.5	103.7	23.8	15	425	15	30	90	155	240	425	425	425
Race	Asian	8	185.6	233.4	82.5	30	665	30	33	48	315	665	665	665	665
Race	Some Others	16	171.3	154.2	38.6	30	560	30	58	120	235	405	560	560	560
Race	Hispanic	20	169.5	135.8	30.4	30	555	33	77	145	205	373	495	555	555
Race	Refused	2	75.0	63.6	45.0	30	120	30	30	75	120	120	120	120	120
Hispanic	No	469	202.7	193.6	8.9	1	1,065	20	60	135	270	480	605	755	915
Hispanic	Yes	34	154.8	135.0	23.2	15	555	30	60	138	175	310	555	555	555
Hispanic	DK	1	10.0	-	-	10	10	10	10	10	10	10	10	10	10
Hispanic	Refused	2	75.0	63.6	45.0	30	120	30	30	75	120	120	120	120	120
Employment	-	128	208.2	209.6	18.5	15	1,065	25	60	120	275	555	645	840	915
Employment	Full Time	201	195.8	189.0	13.3	8	1,015	25	60	135	270	450	570	748	930
Employment	Part Time	41	213.5	215.6	33.7	20	870	20	60	132	260	540	660	870	870
Employment	Not Employed	132	190.9	166.0	14.5	1	810	15	60	160	270	420	525	730	735
Employment	Refused	4	130.0	106.8	53.4	30	280	30	60	105	200	280	280	280	280
Education	-	140	202.7	204.7	17.3	15	1,065	21	60	120	270	499	640	840	915
Education	< High School	32	180.8	207.8	36.7	30	995	30	30	110	245	385	570	995	995
Education	High School Graduate	108	219.7	197.2	19.0	10	1,015	20	78	163	281	545	625	730	810
Education	<College	93	191.6	171.2	17.8	1	870	15	60	150	275	440	510	748	870
Education	College Graduate	83	203.5	183.1	20.1	5	930	23	60	145	270	450	590	795	930
Education	Post Graduate	50	157.8	166.6	23.6	10	735	20	45	75	255	338	555	703	735
Census Region	Northeast	106	184.9	177.4	17.2	1	1,065	20	60	124	240	450	574	635	660
Census Region	Midwest	124	194.6	188.7	16.9	10	1,015	30	60	135	255	420	590	735	995
Census Region	South	136	218.8	211.5	18.1	10	930	20	60	150	325	525	720	840	915
Census Region	West	140	192.9	179.4	15.2	5	870	18	58	131	273	430	575	755	810
Day Of Week	Weekday	276	196.0	189.3	11.4	5	1,015	20	60	145	253	510	625	748	840
Day Of Week	Weekend	230	201.7	191.8	12.6	1	1,065	20	60	130	280	455	580	810	915
Season	Winter	83	209.1	195.2	21.4	15	1,065	30	60	165	275	440	660	795	1065
Season	Spring	163	168.5	159.1	12.5	8	930	20	50	120	235	360	510	570	755
Season	Summer	192	219.6	199.9	14.4	5	1,015	20	65	155	290	535	630	840	915
Season	Fall	68	198.7	217.9	26.4	1	995	20	60	118	280	555	735	810	995
Asthma	No	466	192.1	178.8	8.3	1	1,015	20	60	135	270	450	580	700	755
Asthma	Yes	38	284.5	288.7	46.8	30	1,065	35	90	170	390	870	995 1	65	1065
Asthma	DK	2	75.0	63.6	45.0	30	120	30	30	75	120	120	120	120	120
Angina	No	494	197.9	189.8	8.5	1	1,065	20	60	135	270	459	590	755	915
Angina	Yes	9	247.8	235.3	78.4	35	730	35	60	120	330	730	730	730	730
Angina	DK	3	170.0	170.6	98.5	30	360	30	30	120	360	360	360	360	360
Bronchitis/Emphysema	No	490	197.0	184.6	8.3	1	1,065	20	60	145	270	455	585	735	840
Bronchitis/Emphysema	Yes	14	273.1	339.1	90.6	20	995	20	75	100	280	930	995	995	995
Bronchitis/Emphysema	DK	2	75.0	63.6	45.0	30	120	30	30	75	120	120	120	120	120

Table 16-20. Time Spent (minutes/day) in Selected Outdoor Locations, Doers Only (continued)

Outdoors at a Pool/River/Lake

								Percentiles							
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		283	209.6	185.7	11.0	5	1,440	25	60	150	296	480	570	670	690
Gender	Male	152	229.8	202.7	16.4	10	1,440	30	83	174	305	510	600	690	900
Gender	Female	131	186.0	161.3	14.1	5	645	20	60	135	280	440	550	630	630
Age (years)	-	6	175.0	157.0	64.1	60	480	60	85	115	195	480	480	480	480
Age (years)	1-4	14	250.6	177.5	47.4	90	630	90	130	168	370	560	630	630	630
Age (years)	5-11	29	175.4	117.9	21.9	25	390	30	60	145	293	365	375	390	390
Age (years)	12-17	22	128.3	94.4	20.1	40	420	58	60	83	210	225	235	420	420
Age (years)	18-64	187	224.5	203.8	14.9	5	1,440	20	60	150	320	511	615	690	900
Age (years)	> 64	25	194.2	161.8	32.4	20	525	30	60	115	277	480	510	525	525
Race	White	246	201.6	182.3	11.6	5	1,440	25	60	145	285	440	560	670	690
Race	Black	12	380.6	231.9	66.9	20	690	20	178	450	563	615	690	690	690
Race	Asian	4	265.0	247.1	123.5	30	505	30	53	263	478	505	505	505	505
Race	Some Others	5	237.0	129.9	58.1	70	435	70	220	225	235	435	435	435	435
Race	Hispanic	12	161.0	131.7	38.0	20	390	20	53	113	265	375	390	390	390
Race	Refused	4	243.8	208.6	104.3	90	550	90	115	168	373	550	550	550	550
Hispanic	No	259	208.9	187.8	11.7	5	1,440	25	60	150	295	480	585	670	690
Hispanic	Yes	20	210.9	160.1	35.8	20	540	29	88	155	338	451	526	540	540
Hispanic	Refused	4	243.8	208.6	104.3	90	550	90	115	168	373	550	550	550	550
Employment	-	66	176.9	131.3	16.2	25	630	40	70	143	235	370	420	560	630
Employment	Full Time	119	210.7	176.1	16.1	10	900	20	65	150	298	510	600	645	670
Employment	Part Time	26	217.0	199.9	39.2	20	670	30	60	120	320	570	580	670	670
Employment	Not Employed	69	238.9	236.2	28.4	5	1,440	20	65	145	370	510	630	690	1,440
Employment	Refused	3	141.7	52.5	30.3	90	195	90	90	140	195	195	195	195	195
Education	-	73	172.9	130.0	15.2	20	630	30	70	140	225	370	420	560	630
Education	< High School	18	267.6	159.4	37.6	40	600	40	145	248	375	525	600	600	600
Education	High School Graduate	69	213.2	224.1	27.0	10	1,440	20	60	145	285	511	670	690	1,440
Education	< College	62	233.3	192.4	24.4	5	690	30	65	150	360	550	580	615	690
Education	College Graduate	37	230.9	187.3	30.8	14	645	20	70	173	400	505	630	645	645
Education	Post Graduate	24	172.7	197.0	40.2	20	900	25	45	113	240	370	480	900	900
Census Region	Northeast	61	220.7	172.4	22.1	30	900	30	60	180	325	390	510	670	900
Census Region	Midwest	41	219.2	257.2	40.2	10	1,440	20	60	120	280	480	600	1,440	1,440
Census Region	South	111	182.2	161.3	15.3	5	670	20	60	118	280	420	525	630	645
Census Region	West	70	237.6	181.8	21.7	25	690	40	90	180	300	548	615	690	690
Day Of Week	Weekday	165	188.8	179.9	14.0	10	1,440	30	60	125	255	420	511	615	670
Day Of Week	Weekend	118	238.6	190.4	17.5	5	900	20	75	188	350	555	630	690	690
Season	Winter	30	173.2	181.7	33.2	20	630	20	40	103	270	493	585	630	630
Season	Spring	77	206.5	163.6	18.6	15	690	30	80	180	288	480	555	670	690
Season	Summer	151	219.7	196.8	16.0	5	1,440	26	65	155	300	445	580	630	900
Season	Fall	25	201.4	189.7	37.9	20	670	45	70	105	310	510	510	670	670
Asthma	No	262	209.0	188.2	11.6	5	1,440	25	60	150	295	480	580	670	690
Asthma	Yes	17	238.8	162.0	39.3	15	570	15	105	225	350	525	570	570	570
Asthma	DK	4	121.3	59.2	29.6	60	195	60	75	115	168	195	195	195	195
Angina	No	272	205.9	185.2	11.2	5	1,440	25	60	145	291	480	570	645	690
Angina	Yes	8	359.4	178.8	63.2	60	690	60	288	340	435	690	690	690	690
Angina	DK	3	141.7	52.5	30.3	90	195	90	90	140	195	195	195	195	195
Bronchitis/Emphysema	No	266	211.0	189.1	11.6	5	1,440	25	60	150	296	480	580	670	690
Bronchitis/Emphysema	Yes	14	197.1	131.5	35.2	15	440	15	90	173	300	370	440	440	440
Bronchitis/Emphysema	DK	3	141.7	52.5	30.3	90	195	90	90	140	195	195	195	195	195

Table 16-20. Time Spent (minutes/day) in Selected Outdoor Locations, Doers Only (continued)

Outdoors on a Sidewalk, Street, or in the Neighborhood

								Percentiles							
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		896	85.8	133.8	4.5	1	1,440	2	15	40	90	223	405	565	615
Gender	Male	409	108.8	168.1	8.3	1	1,440	3	20	45	120	330	525	615	710
Gender	Female	487	66.5	91.9	4.2	1	580	1	15	35	75	152	255	435	465
Age (years)	-	15	72.5	69.4	17.9	1	290	1	40	55	90	120	290	290	290
Age (years)	1-4	30	54.8	52.7	9.6	1	235	2	10	43	78	125	158	235	235
Age (years)	5-11	75	110.8	116.8	13.5	1	540	5	20	65	178	240	410	465	540
Age (years)	12-17	74	52.6	74.8	8.7	1	435	2	15	30	60	125	200	338	435
Age (years)	18-64	580	94.3	153.9	6.4	1	1,440	2	15	40	83	278	480	600	690
Age (years)	> 64	122	59.4	61.5	5.6	1	380	2	20	40	75	120	190	235	270
Race	White	727	85.7	136.5	5.1	1	1,440	2	15	41	90	215	405	570	675
Race	Black	87	89.2	132.7	14.2	1	565	2	10	35	120	324	426	540	565
Race	Asian	11	88.7	114.0	34.4	2	405	2	30	45	120	149	405	405	405
Race	Some Others	18	80.6	106.0	25.0	10	420	10	20	40	75	240	420	420	420
Race	Hispanic	42	71.4	110.8	17.1	1	525	1	20	40	75	135	290	525	525
Race	Refused	11	122.9	117.7	35.5	2	310	2	40	60	290	300	310	310	310
Hispanic	No	807	87.5	136.1	4.8	1	1,440	2	15	45	90	225	410	565	600
Hispanic	Yes	79	67.8	110.3	12.4	1	615	1	15	30	62	140	300	525	615
Hispanic	DK	1	2.0	-	-	2	2	2	2	2	2	2	2	2	2
Hispanic	Refused	9	100.8	115.9	38.6	2	310	2	40	60	90	310	310	310	310
Employment	-	176	79.2	96.3	7.3	1	540	2	15	45	110	200	260	435	465
Employment	Full Time	384	102.2	169.5	8.7	1	1,440	3	15	41	75	330	525	600	710
Employment	Part Time	74	74.4	113.9	13.2	1	795	1	15	43	86	180	255	390	795
Employment	Not Employed	255	70.0	94.0	5.9	1	615	1	15	40	85	152	270	380	485
Employment	Refused	7	45.1	36.6	13.8	2	90	2	4	40	90	90	90	90	90
Education	-	198	74.9	92.3	6.6	1	540	2	15	41	90	185	240	435	465
Education	< High School	56	131.2	247.3	33.0	1	1,440	1	15	40	118	465	710	735	1,440
Education	High School Graduate	223	100.2	146.9	9.8	1	795	5	20	45	95	275	480	600	680
Education	< College	172	77.2	128.8	9.8	1	675	1	10	30	75	180	435	570	600
Education	College Graduate	138	76.3	106.6	9.1	1	600	3	20	45	70	205	310	485	565
Education	Post Graduate	109	78.2	121.3	11.6	1	710	5	20	45	60	200	330	560	570
Census Region	Northeast	202	89.1	132.3	9.3	1	735	3	15	45	90	235	410	530	570
Census Region	Midwest	193	87.9	153.3	11.0	1	1,440	2	15	30	85	240	355	565	600
Census Region	South	298	79.9	125.5	7.3	1	710	2	15	35	75	185	420	532	680
Census Region	West	203	89.1	127.9	9.0	1	795	1	20	45	105	210	300	570	615
Day Of Week	Weekday	642	86.7	143.9	5.7	1	1,440	2	15	40	80	223	426	585	680
Day Of Week	Weekend	254	83.5	104.2	6.5	1	565	2	25	45	90	220	310	440	480
Season	Winter	210	73.5	144.3	10.0	1	1,440	1	15	33	60	160	270	560	710
Season	Spring	242	97.9	137.2	8.8	1	795	4	25	45	120	240	435	570	675
Season	Summer	276	84.0	123.1	7.4	1	690	4	15	45	90	200	420	525	580
Season	Fall	168	86.6	131.9	10.2	1	710	2	15	40	90	240	405	600	615
Asthma	No	832	86.1	129.5	4.5	1	795	2	15	40	90	225	418	565	600
Asthma	Yes	57	85.6	193.1	25.6	1	1,440	1	15	35	90	180	235	260	1,440
Asthma	DK	7	48.9	28.0	10.6	2	90	2	30	60	60	90	90	90	90
Angina	No	857	86.2	134.9	4.6	1	1,440	2	15	40	90	223	410	565	615
Angina	Yes	33	81.7	117.4	20.4	1	465	1	17	45	60	250	380	465	465
Angina	DK	6	52.0	29.3	11.9	2	90	2	40	60	60	90	90	90	90
Bronchitis/Emphysema	No	855	84.8	132.3	4.5	1	1,440	2	15	40	85	225	405	560	600
Bronchitis/Emphysema	Yes	34	117.7	176.4	30.3	3	735	8	30	45	120	215	690	735	735
Bronchitis/Emphysema	DK	7	46.3	27.5	10.4	2	90	2	32	40	60	90	90	90	90

Table 16-20. Time Spent (minutes/day) in Selected Outdoor Locations, Doers Only (continued)																	
At Home in the Yard or Other Areas Outside the House																	
								Percentiles									
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		2,308	137.6	144.1	3.0	1	1,290	10	40	90	180	320	420	570	660
Gender	Male	1,198	158.4	160.0	4.6	1	1,290	10	60	120	198	360	500	627	730
Gender	Female	1,107	114.9	120.9	3.6	1	1,065	5	30	75	150	285	360	450	560
Gender	Refused	3	183.3	60.3	34.8	120	240	120	120	190	240	240	240	240	240
Age (years)	-	27	167.4	164.5	31.7	2	600	5	60	120	230	395	600	600	600
Age (years)	1-4	151	135.3	111.5	9.1	5	630	25	60	90	180	305	345	450	480
Age (years)	5-11	271	150.6	135.1	8.2	2	1,250	20	60	120	190	310	405	553	570
Age (years)	12-17	157	113.2	117.7	9.4	2	660	5	30	80	150	240	405	462	610
Age (years)	18-64	1,301	136.4	147.9	4.1	1	1,080	5	30	90	180	330	435	570	715
Age (years)	> 64	401	141.1	155.2	7.8	1	1,290	10	45	90	180	302	465	598	660
Race	White	1,966	139.0	145.5	3.3	1	1,290	10	40	90	180	330	435	570	670
Race	Black	173	128.4	144.6	11.0	1	1,250	5	30	95	180	270	390	462	745
Race	Asian	21	101.2	88.5	19.3	12	360	15	35	90	125	210	240	360	360
Race	Some Others	37	183.5	161.9	26.6	2	750	3	84	120	270	380	553	750	750
Race	Hispanic	83	106.1	96.8	10.6	2	610	5	35	75	145	240	270	330	610
Race	Refused	28	152.3	151.0	28.5	5	600	5	60	98	210	360	510	600	600
Hispanic	No	2,122	137.7	144.3	3.1	1	1,290	10	40	90	180	320	420	570	670
Hispanic	Yes	153	125.0	134.3	10.9	1	750	5	30	85	150	270	435	575	630
Hispanic	DK	10	213.8	192.2	60.8	3	585	3	60	145	380	503	585	585	585
Hispanic	Refused	23	176.7	156.6	32.6	5	600	5	60	160	240	360	510	600	600
Employment	-	581	137.5	125.6	5.2	2	1,250	15	60	110	180	300	370	480	570
Employment	Full Time	807	131.1	150.7	5.3	1	1,080	5	30	80	175	307	450	600	745
Employment	Part Time	166	126.1	134.1	10.4	1	1,080	10	30	78	180	300	360	450	485
Employment	Not Employed	739	146.1	149.7	5.5	1	1,290	10	45	100	185	360	465	585	655
Employment	Refused	15	198.0	239.0	61.7	5	660	5	30	120	465	600	660	660	660
Education	-	615	136.3	125.7	5.1	2	1,250	15	60	105	180	300	370	480	570
Education	< High School	236	161.0	186.5	12.1	2	1,290	10	45	105	195	390	510	765	915
Education	High School Graduate	618	144.7	144.9	5.8	1	840	5	40	100	195	360	479	555	660
Education	< College	381	128.8	141.2	7.2	1	1,080	5	35	85	175	300	400	585	720
Education	College Graduate	251	123.0	135.8	8.6	1	750	10	30	75	160	300	390	575	690
Education	Post Graduate	207	127.1	150.0	10.4	1	1,065	5	30	78	150	320	435	570	630
Census Region	Northeast	473	137.7	132.8	6.1	1	750	10	45	90	185	317	420	532	600
Census Region	Midwest	456	138.9	155.7	7.3	2	1,290	10	45	90	180	300	440	575	690
Census Region	South	832	136.5	146.7	5.1	1	1,080	10	35	90	180	310	420	570	730
Census Region	West	547	138.2	139.9	6.0	1	750	5	36	90	180	330	460	570	630
Day Of Week	Weekday	1,453	126.9	131.6	3.5	1	1,250	5	35	90	165	300	395	553	610
Day Of Week	Weekend	855	155.7	161.7	5.5	1	1,290	10	45	110	210	360	475	630	745
Season	Winter	399	112.2	136.0	6.8	1	1,080	5	30	60	140	300	380	540	690
Season	Spring	787	149.7	139.2	5.0	1	915	10	60	120	195	338	430	555	660
Season	Summer	796	143.7	155.9	5.5	1	1,290	10	45	99	180	330	450	610	715
Season	Fall	326	124.5	130.5	7.2	1	720	10	35	88	160	300	380	510	655
Asthma	No	2,129	137.7	144.4	3.1	1	1,290	10	40	90	180	315	420	570	690
Asthma	Yes	166	131.6	136.0	10.6	1	670	10	30	90	165	345	450	553	610
Asthma	DK	13	188.5	192.1	53.3	5	600	5	60	90	300	480	600	600	600
Angina	No	2,228	136.5	141.1	3.0	1	1,290	10	41	90	180	315	420	570	660
Angina	Yes	63	158.7	216.3	27.3	2	1,080	5	30	75	180	420	485	1065	1080
Angina	DK	17	199.1	191.3	46.4	5	600	5	35	120	325	480	600	600	600
Bronchitis/Emphysema	No	2,191	138.8	145.0	3.1	1	1,290	10	45	90	180	320	430	570	690
Bronchitis/Emphysema	Yes	105	104.4	111.3	10.9	1	553	5	30	60	145	270	360	415	475
Bronchitis/Emphysema	DK	12	207.5	192.2	55.5	5	600	5	60	140	330	480	600	600	600

Table 16-20. Time Spent (minutes/day) in Selected Outdoor Locations, Doers Only (continued)

Cumulative Outdoors (outside the residence)

Group Name	Group Code	N	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		3,124	154.0	158.3	2.8	1	1,290	5	40	105	210	362	480	610	715
Gender	Male	1,533	174.9	173.7	4.4	1	1,290	10	60	120	240	420	540	680	745
Gender	Female	1,588	133.5	138.8	3.5	1	1,065	5	30	90	190	325	415	525	610
Gender	Refused	3	340.0	140.0	80.8	240	500	240	240	280	500	500	500	500	500
Age (years)	-	40	164.0	179.6	28.4	2	720	4	40	108	213	430	600	720	720
Age (years)	1-4	201	195.7	163.7	11.5	3	715	30	75	135	270	430	535	625	699
Age (years)	5-11	353	187.6	158.6	8.4	4	1,250	20	80	150	265	365	479	600	720
Age (years)	12-17	219	135.3	137.0	9.3	1	720	5	35	100	190	300	452	545	610
Age (years)	18-64	1,809	144.2	155.1	3.6	1	1,080	5	30	90	199	360	470	600	715
Age (years)	> 64	502	156.4	168.3	7.5	1	1,290	5	36	110	210	375	485	645	735
Race	White	2,622	156.8	160.2	3.1	1	1,290	5	45	105	215	375	485	625	720
Race	Black	255	141.6	153.2	9.6	1	1,250	5	30	95	195	330	420	535	645
Race	Asian	34	115.8	135.6	23.2	1	480	5	20	60	150	360	450	480	480
Race	Some Others	53	167.0	149.0	20.5	3	750	5	60	130	238	320	475	553	750
Race	Hispanic	125	117.3	128.9	11.5	1	720	5	30	70	150	270	355	590	610
Race	Refused	35	187.1	163.8	27.7	5	600	5	60	170	240	450	510	600	600
Hispanic	No	2,857	153.8	158.4	3.0	1	1,290	5	40	105	210	362	480	610	720
Hispanic	Yes	222	146.4	154.1	10.3	1	750	5	30	113	200	345	480	640	690
Hispanic	DK	15	191.5	178.3	46.0	15	585	15	40	140	380	420	585	585	585
Hispanic	Refused	30	212.5	165.3	30.2	5	600	5	60	180	345	458	510	600	600
Employment	-	774	175.8	156.1	5.6	1	1,250	15	60	125	245	380	480	610	705
Employment	Full Time	1,110	141.3	159.9	4.8	1	1,080	5	30	85	195	359	490	660	745
Employment	Part Time	240	134.7	140.8	9.1	1	1,080	5	30	90	183	333	423	485	525
Employment	Not Employed	978	156.1	159.2	5.1	1	1,290	5	40	115	220	375	480	610	701
Employment	Refused	22	152.7	209.8	44.7	5	660	5	15	60	125	555	600	660	660
Education	-	825	174.1	156.2	5.4	1	1,250	15	60	125	240	380	480	610	699
Education	< High School	306	171.9	188.4	10.8	1	1,290	7	45	120	240	405	510	765	855
Education	High School Graduate	837	153.6	154.8	5.4	1	840	5	35	105	215	380	480	598	701
Education	< College	527	143.4	157.1	6.8	1	1,080	5	30	90	195	360	465	615	720
Education	College Graduate	355	126.9	142.6	7.6	1	750	5	30	80	170	300	415	615	690
Education	Post Graduate	274	130.5	151.0	9.1	1	1,065	5	30	75	180	325	465	570	660
Census Region	Northeast	635	148.0	143.7	5.7	1	750	5	35	105	215	345	450	575	610
Census Region	Midwest	639	156.0	169.2	6.7	1	1,290	5	45	102	210	360	500	655	750
Census Region	South	1,120	158.6	165.2	4.9	1	1,080	5	40	110	210	390	495	640	745
Census Region	West	730	150.6	149.6	5.5	1	855	5	36	105	213	360	465	575	660
Day Of Week	Weekday	1,933	141.2	149.0	3.4	1	1,250	5	31	90	190	345	452	598	698
Day Of Week	Weekend	1,191	174.9	170.4	4.9	1	1,290	10	50	120	260	400	500	660	745
Season	Winter	548	114.0	138.1	5.9	1	1,080	5	25	60	150	280	380	540	690
Season	Spring	1,034	171.9	159.4	5.0	1	990	10	60	120	240	390	495	645	730
Season	Summer	1,098	168.3	168.2	5.1	1	1,290	5	50	120	235	400	510	630	715
Season	Fall	444	126.5	140.7	6.7	1	960	5	30	75	163	313	420	575	655
Asthma	No	2,869	154.5	159.2	3.0	1	1,290	5	40	105	210	365	480	615	720
Asthma	Yes	236	145.8	145.5	9.5	1	885	5	45	105	190	360	450	575	610
Asthma	DK	19	182.4	181.0	41.5	1	600	1	60	120	300	480	600	600	600
Angina	No	3,023	153.2	156.3	2.8	1	1,290	5	40	105	210	360	479	610	707
Angina	Yes	76	172.9	222.3	25.5	2	1,080	5	30	69	253	465	660	1,065	1,080
Angina	DK	25	195.0	170.4	34.1	5	600	5	60	150	300	465	480	600	600
Bronchitis/Emphysema	No	2,968	154.9	158.8	2.9	1	1,290	5	40	105	210	367	480	615	715
Bronchitis/Emphysema	Yes	139	129.4	142.5	12.1	1	855	5	30	75	175	327	415	553	735
Bronchitis/Emphysema	DK	17	206.8	179.8	43.6	5	600	5	60	170	300	480	600	600	600

- = Indicates missing data.
DK = The respondent replied "don't know".
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996.

Table 16-21. Mean Time Spent (minutes/day) Inside and Outside, by Age Category, Children <21 years				
Age (years)	N	Average Indoor Minutes[a]	Average Outdoor Minutes[b]	Average Unclassified Minutes[c]
Birth to <1	25	1,353	44	43
1 to < 2	90	1,353	36	51
2 to <3	131	1,316	76	48
3 to <6	360	1,278	107	54
6 to <11	511	1,244	132	64
11 to <16	449	1,260	100	80
16 to <21	493	1,248	102	90

a Time indoors was estimating by adding the average times spent indoors at the respondents' home (kitchen, living room, bathroom, etc.), at other houses, and inside other locations such as school, restaurants, etc.

b Time outdoors was estimated by adding the average time spent outdoors at the respondents' pool and yard, others' pool and yard, and outside other locations such as sidewalk, street, neighborhood, parking lot, service station/gas station, school grounds, park/golf course, pool, river, lake, farm, etc.

c Includes time spent in vehicles or in activities that could not be assigned an indoor or outdoor location.

N = Sample size.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996 (NHAPS).

Table 16-22. Mean Time Spent (minutes/day) Outside and Inside, Adults 18 Years and Older, Doers Only

Time Outdoors						
	Time Outdoors away from Residence[a]		Time Outdoors at Residence[b]		Total Time Outdoors[c]	
	Mean	95th %ile	Mean	95th %ile	Mean	95th %ile
18-64	144.2	470	136.4	435	281	-
≥65	156.5	485	141.1	465	298	-

Time Indoors			
	Total Minutes per 24 hours	Total Time Outdoors	Total Time Indoors[c]
		Mean	Mean
18-64	1,440	281	1,159
≥65	1,440	298	1,142

a For additional statistics see Table 16-27

b For additional statistics see Table 16-27

c Total Time Outdoors was calculated by summing the time spent outdoors away from the residence and the time outdoors at the residence.

Source: U.S. EPA, 1996.

Table 16-23. Time Spent (minutes/day) in Selected Vehicles and All Vehicles Combined Whole Population and Doers Only, Children <21 Years															
Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Car – Whole Population															
Birth to <1	63	36	0	0	0	0	0	0	10	49	107	171	208	220	235
1 to <2	118	41	0	0	0	0	0	0	20	60	98	151	246	336	390
2 to <3	118	33	0	0	0	0	0	0	20	50	90	126	163	187	215
3 to <6	357	43	0	0	0	0	0	0	20	60	117	155	221	272	620
6 to <11	497	37	0	0	0	0	0	0	15	55	102	146	185	212	630
11 to <16	466	39	0	0	0	0	0	0	15	55	99	150	254	302	900
16 to <21	481	61	0	0	0	0	0	8	40	90	155	195	249	321	380
Car – DOERS ONLY															
Birth to <1	35	65	2	5	7	10	14	20	40	73	159	203	218	227	235
1 to <2	68	72	5	8	10	10	15	30	58	85	147	186	323	363	390
2 to <3	73	54	4	4	4	8	10	24	42	65	118	141	181	197	215
3 to <6	227	67	4	4	5	7	10	25	45	88	150	180	267	327	620
6 to <11	317	58	1	2	2	5	10	20	40	82	127	163	202	300	630
11 to <16	286	64	1	3	5	5	10	20	40	75	122	193	279	338	900
16 to <21	364	81	2	9	10	10	17	30	60	105	180	210	275	334	380
Truck (Pickup or Van) – Whole Population															
Birth to <1	63	2	0	0	0	0	0	0	0	0	0	0	0	42	110
1 to <2	118	2	0	0	0	0	0	0	0	0	0	0	52	81	90
2 to <3	118	14	0	0	0	0	0	0	0	0	14	31	124	201	955
3 to <6	357	5	0	0	0	0	0	0	0	0	0	30	60	114	245
6 to <11	497	7	0	0	0	0	0	0	0	0	15	45	95	110	240
11 to <16	466	9	0	0	0	0	0	0	0	0	15	59	153	181	352
16 to <21	481	11	0	0	0	0	0	0	0	0	25	90	150	190	445
Truck (Pickup or Van) – DOERS ONLY															
Birth to <1	1	-	110	-	-	-	-	-	-	-	-	-	-	-	110
1 to <2	5	-	20	-	-	-	-	-	-	-	-	-	-	-	90
2 to <3	15	109	10	10	10	10	11	15	30	53	188	434	746	851	955
3 to <6	34	53	1	2	4	8	10	16	30	59	117	207	222	233	245
6 to <11	69	48	1	4	6	10	10	15	30	65	110	124	151	186	240
11 to <16	62	67	5	5	5	5	7	15	35	89	180	185	258	299	352
16 to <21	70	78	5	5	5	10	11	22	54	115	170	213	238	304	445
Bus – Whole Population															
Birth to <1	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 to <2	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 to <3	118	1	0	0	0	0	0	0	0	0	0	0	0	25	120
3 to <6	357	2	0	0	0	0	0	0	0	0	0	0	30	47	80
6 to <11	497	11	0	0	0	0	0	0	0	0	50	70	90	110	140
11 to <16	466	16	0	0	0	0	0	0	0	15	60	89	119	148	370
16 to <21	481	6	0	0	0	0	0	0	0	0	0	45	108	135	225
Bus – DOERS ONLY															
Birth to <1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 to <2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 to <3	2	-	30	-	-	-	-	-	-	-	-	-	-	-	120
3 to <6	14	40	15	16	16	18	21	30	33	49	67	74	77	79	80
6 to <11	115	49	5	5	6	14	17	25	43	67	90	107	120	122	140
11 to <16	130	58	7	10	10	10	15	30	54	71	101	131	159	175	370
16 to <21	41	75	10	12	14	20	25	30	60	100	135	175	193	209	225

Table 16-23. Time Spent (minutes/day) in Selected Vehicles and All Vehicles Combined Whole Population and Doers Only, Children <21 Years (continued)

Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
All Vehicles – Whole Population															
Birth to <1	63	39	0	0	0	0	0	0	20	60	113	171	208	220	235
1 to <2	118	44	0	0	0	0	0	0	28	60	98	151	246	336	390
2 to <3	118	50	0	0	0	0	0	0	30	60	120	151	203	214	955
3 to <6	357	50	0	0	0	0	0	0	30	65	122	167	238	272	620
6 to <11	497	57	0	0	0	0	0	15	40	85	124	155	212	289	630
11 to <16	466	67	0	0	0	0	0	15	45	85	155	206	291	383	900
16 to <21	481	84	0	0	0	0	0	25	62	120	180	239	328	382	675
All Vehicles – DOERS ONLY															
Birth to <1	37	66	2	5	8	10	16	20	46	75	151	202	217	226	235
1 to <2	72	72	5	9	10	10	20	30	60	85	143	178	316	362	390
2 to <3	86	69	4	4	5	10	10	26	45	83	128	166	212	326	955
3 to <6	261	68	1	4	6	10	13	30	46	85	150	190	261	309	620
6 to <11	417	68	1	2	4	10	14	25	55	90	130	161	240	306	630
11 to <16	383	82	1	5	5	10	16	30	60	99	177	235	314	392	900
16 to <21	428	94	5	8	10	15	20	40	75	120	190	240	345	386	675

N = Sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes less than 10.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996 (NHAPS).

Table 16-24. Time Spent (minutes/day) in Selected Vehicles and All Vehicles Combined, Doers Only

Car

								Percentiles								
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		6,560	87.4	88.2	1.1	1	1,280	10	34	63	110	175	240	345	450
Gender	Male	2,852	90.7	97.3	1.8	1	1,280	10	30	63	115	185	254	360	526
Gender	Female	3,706	84.9	80.4	1.3	1	878	10	35	64	110	165	220	335	420
Gender	Refused	2	30.0	14.1	10.0	20	40	20	20	30	40	40	40	40	40
Age (years)	-	120	94.0	90.2	8.2	7	593	10	38	72	120	180	223	435	450
Age (years)	1-4	297	63.0	56.8	3.3	2	390	10	25	45	80	135	180	235	270
Age (years)	5-11	449	64.6	81.1	3.8	1	900	5	20	40	85	145	175	310	345
Age (years)	12-17	393	64.8	71.0	3.6	1	630	9	20	41	80	136	185	300	380
Age (years)	18-64	4,489	93.8	92.3	1.4	1	1,280	13	40	70	120	184	250	360	495
Age (years)	> 64	812	83.5	79.4	2.8	4	780	10	30	60	110	165	225	315	405
Race	White	5,337	87.6	89.7	1.2	1	1,280	10	31	64	110	175	240	360	460
Race	Black	640	86.8	74.3	2.9	1	690	10	35	65	115	180	240	305	330
Race	Asian	117	78.8	66.3	6.1	5	360	20	35	60	95	135	225	320	330
Race	Some Others	121	87.7	84.5	7.7	3	540	10	30	60	120	180	250	330	345
Race	Hispanic	265	90.1	101.5	6.2	2	825	15	35	65	100	165	235	465	620
Race	Refused	80	82.4	73.3	8.2	5	420	12	30	60	120	168	230	315	420
Hispanic	No	5,987	87.5	87.6	1.1	1	1,280	10	35	65	110	175	240	345	440
Hispanic	Yes	477	88.5	97.2	4.5	2	825	10	30	60	103	180	240	388	595
Hispanic	DK	29	63.9	73.1	13.6	5	325	6	20	40	60	187	200	325	325
Hispanic	Refused	67	86.1	78.4	9.6	5	420	14	30	60	120	180	239	315	420
Employment	-	1,124	64.2	72.3	2.2	1	900	5	20	45	81	136	180	270	345
Employment	Full Time	3,134	93.6	92.2	1.6	2	1,280	15	40	70	120	180	242	360	490
Employment	Part Time	632	90.1	82.0	3.3	2	878	10	40	70	117	175	230	330	384
Employment	Not Employed	1,629	90.4	90.2	2.2	1	780	10	35	60	115	195	250	365	465
Employment	Refused	41	97.2	84.0	13.1	10	330	15	30	75	120	220	290	330	330
Education	-	1,260	66.5	72.3	2.0	1	900	6	21	45	85	145	187	270	350
Education	< High School	434	86.0	82.1	3.9	5	620	10	35	60	115	165	210	360	455
Education	High School Graduate	1,805	91.8	91.1	2.1	1	870	10	38	65	115	190	255	385	465
Education	< College	1,335	93.2	94.3	2.6	2	1,280	10	36	70	120	180	250	380	460
Education	College Graduate	992	95.7	95.5	3.0	4	840	14	40	73	120	185	250	370	580
Education	Post Graduate	734	91.5	82.0	3.0	4	905	20	40	75	115	175	235	330	380
Census Region	Northeast	1,412	85.8	83.8	2.2	1	780	10	33	60	110	170	240	330	410
Census Region	Midwest	1,492	89.1	86.6	2.2	4	825	10	35	65	113	180	250	360	465
Census Region	South	2,251	88.3	89.3	1.9	1	900	10	34	65	115	175	235	338	490
Census Region	West	1,405	85.9	92.2	2.5	2	1,280	10	30	60	110	175	235	345	435
Day Of Week	Weekday	4,427	83.9	85.0	1.3	1	905	10	30	60	105	165	225	330	440
Day Of Week	Weekend	2,133	94.7	94.0	2.0	1	1,280	10	35	70	120	190	265	360	455
Season	Winter	1,703	83.5	82.1	2.0	1	870	10	30	60	105	165	230	350	425
Season	Spring	1,735	88.6	91.5	2.2	1	905	10	30	60	110	180	250	380	480
Season	Summer	1,767	88.0	86.5	2.1	1	900	10	35	65	115	170	235	330	450
Season	Fall	1,355	90.1	93.2	2.5	1	1,280	10	35	70	115	170	240	335	545
Asthma	No	6,063	87.4	88.0	1.1	1	1,280	10	34	63	110	175	240	350	450
Asthma	Yes	463	88.2	92.1	4.3	4	870	15	34	64	110	165	245	345	505
Asthma	DK	34	78.4	57.4	9.8	10	239	10	30	71	100	160	220	239	239
Angina	No	6,368	87.5	88.7	1.1	1	1,280	10	34	64	110	175	240	350	450
Angina	Yes	154	82.2	68.6	5.5	8	365	10	30	60	115	162	214	285	320
Angina	DK	38	89.6	72.9	11.8	10	360	10	35	74	120	180	239	360	360
Bronchitis/Emphysema	No	6,224	87.6	88.9	1.1	1	1,280	10	34	62	110	175	240	350	450
Bronchitis/Emphysema	Yes	300	85.6	76.2	4.4	1	505	10	35	69	109	185	238	305	435
Bronchitis/Emphysema	DK	36	81.1	63.1	10.5	5	239	10	30	71	120	175	220	239	239

Table 16-24. Time Spent (minutes/day) in Selected Vehicles and All Vehicles Combined, Doers Only (continued)

Truck (Pick-up/Van)

								Percentiles							
Group Name	Group Code	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		1,172	85.3	95.9	2.8	1	955	10	30	60	110	180	240	395	478
Gender	Male	760	91.1	105.4	3.8	1	955	10	30	60	115	190	265	450	620
Gender	Female	412	74.6	74.2	3.7	1	510	10	25	55	95	165	220	300	355
Age (years)	-	13	110.8	129.2	35.8	10	450	10	35	60	90	300	450	450	450
Age (years)	1-4	41	80.8	154.3	24.1	1	955	10	15	35	70	206	210	955	955
Age (years)	5-11	89	47.6	44.2	4.7	1	240	7	15	30	65	110	130	180	240
Age (years)	12-17	80	66.8	71.1	7.9	5	352	6	15	37	94	180	223	265	352
Age (years)	18-64	859	91.4	98.0	3.3	2	750	10	30	60	115	189	260	440	555
Age (years)	> 64	90	79.0	82.4	8.7	10	453	12	30	49	105	185	265	390	453
Race	White	1,022	84.7	96.2	3.0	1	955	10	30	60	110	180	235	390	510
Race	Black	68	91.3	98.5	11.9	6	453	14	28	63	106	220	295	450	453
Race	Asian	3	138.3	63.3	36.6	90	210	90	90	115	210	210	210	210	210
Race	Some Others	20	67.2	48.5	10.8	5	165	8	25	63	103	137	155	165	165
Race	Hispanic	48	92.8	99.3	14.3	5	440	10	28	60	120	224	330	440	440
Race	Refused	11	88.2	110.8	33.4	10	390	10	30	60	65	190	390	390	390
Hispanic	No	1,069	85.1	95.6	2.9	1	955	10	30	60	110	180	240	390	478
Hispanic	Yes	87	89.1	100.8	10.8	5	630	5	29	60	115	210	230	440	630
Hispanic	DK	5	58.0	36.2	16.2	20	97	20	20	68	85	97	97	97	97
Hispanic	Refused	11	85.9	111.6	33.7	10	390	10	30	35	65	190	390	390	390
Employment	-	205	60.2	86.4	6.0	1	955	7	15	30	75	146	185	240	265
Employment	Full Time	642	93.3	101.4	4.0	4	750	10	30	60	120	192	270	450	555
Employment	Part Time	97	89.4	89.0	9.0	2	460	6	30	60	120	190	270	450	460
Employment	Not Employed	217	83.0	85.8	5.8	5	655	10	30	60	110	180	235	300	355
Employment	Refused	11	96.4	114.3	34.5	10	390	10	30	35	170	190	390	390	390
Education	-	230	64.0	86.9	5.7	1	955	7	15	35	85	160	206	245	352
Education	< High School	119	90.5	81.7	7.5	5	453	14	35	60	120	195	280	295	450
Education	High School Graduate	392	87.6	94.7	4.8	2	675	10	30	60	115	185	255	450	510
Education	< College	238	92.0	111.8	7.2	4	750	10	30	60	110	190	290	555	655
Education	College Graduate	127	85.2	74.6	6.6	5	370	15	30	60	110	180	230	345	355
Education	Post Graduate	66	112.4	118.0	14.5	10	650	10	35	80	135	220	412	445	650
Census Region	Northeast	170	85.4	104.2	8.0	2	695	10	20	50	110	186	260	445	630
Census Region	Midwest	268	91.2	94.4	5.8	1	750	10	30	60	119	205	245	390	460
Census Region	South	491	87.3	100.1	4.5	4	955	10	30	60	111	180	235	445	595
Census Region	West	243	74.7	81.3	5.2	5	478	10	23	52	90	160	235	395	440
Day Of Week	Weekday	796	80.1	90.6	3.2	1	750	10	30	55	101	170	230	375	510
Day Of Week	Weekend	376	96.3	105.5	5.4	2	955	12	30	61	120	192	280	430	460
Season	Winter	322	78.5	91.6	5.1	1	955	10	29	51	95	170	220	355	445
Season	Spring	300	92.5	100.2	5.8	1	695	10	30	60	120	208	268	443	549
Season	Summer	323	86.1	99.3	5.5	2	750	10	30	60	110	180	233	430	595
Season	Fall	227	84.2	90.9	6.0	5	675	10	30	60	105	165	265	395	465
Asthma	No	1,092	85.3	93.5	2.8	1	750	10	30	60	110	184	240	412	478
Asthma	Yes	72	83.6	125.3	14.8	5	955	10	20	46	115	170	235	395	955
Asthma	DK	8	101.9	129.7	45.8	10	390	10	20	60	128	390	390	390	390
Angina	No	1,142	84.9	95.2	2.8	1	955	10	30	60	110	180	235	395	475
Angina	Yes	20	93.4	116.0	25.9	5	555	8	38	70	103	141	351	555	555
Angina	DK	10	118.5	128.6	40.7	10	390	10	30	60	190	340	390	390	390
Bronchitis/Emphysema	No	1,128	85.5	96.6	2.9	1	955	10	30	60	110	180	240	412	478
Bronchitis/Emphysema	Yes	35	77.8	60.5	10.2	5	240	5	30	60	120	165	220	240	240
Bronchitis/Emphysema	DK	9	93.3	123.9	41.3	10	390	10	20	60	65	390	390	390	390

Table 16-24. Time Spent (minutes/day) in Selected Vehicles and All Vehicles Combined, Doers Only (continued)

Bus

								Percentiles							
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		469	74.6	93.5	4.3	2	945	10	30	55	90	125	180	435	570
Gender	Male	219	77.3	104.1	7.0	5	945	10	30	55	90	135	180	460	570
Gender	Female	250	72.4	83.3	5.3	2	640	15	30	55	90	120	175	420	501
Age (years)	-	14	145.0	167.2	44.7	10	605	10	60	100	140	435	605	605	605
Age (years)	1-4	5	56.0	40.2	18.0	15	120	15	30	55	60	120	120	120	120
Age (years)	5-11	133	48.4	29.4	2.6	5	140	10	25	43	67	90	110	120	122
Age (years)	12-17	143	59.4	46.3	3.9	7	370	10	30	54	75	110	135	179	225
Age (years)	18-64	147	96.6	128.4	10.6	2	945	10	30	60	110	180	405	640	690
Age (years)	> 64	27	132.0	144.6	27.8	10	570	20	45	73	130	435	460	570	570
Race	White	311	70.1	89.5	5.1	2	945	10	30	54	80	120	147	405	501
Race	Black	101	85.2	92.4	9.2	5	570	15	35	60	110	140	185	460	468
Race	Asian	15	58.0	58.5	15.1	5	175	5	20	20	120	155	175	175	175
Race	Some Others	14	107.1	176.5	47.2	20	690	20	30	43	100	225	690	690	690
Race	Hispanic	24	65.5	71.5	14.6	15	370	20	30	43	87	90	120	370	370
Race	Refused	4	168.0	196.2	98.1	10	435	10	21	114	315	435	435	435	435
Hispanic	No	415	72.8	86.1	4.2	2	945	10	30	55	90	125	165	420	468
Hispanic	Yes	46	83.9	138.9	20.5	7	690	15	30	38	85	145	370	690	690
Hispanic	DK	2	47.5	10.6	7.5	40	55	40	40	48	55	55	55	55	55
Hispanic	Refused	6	137.8	159.6	65.2	10	435	10	32	78	195	435	435	435	435
Employment	-	274	54.0	39.4	2.4	5	370	10	29	50	70	100	120	150	179
Employment	Full Time	95	122.6	168.8	17.3	5	945	10	30	60	120	405	570	690	945
Employment	Part Time	34	83.3	79.3	13.6	2	468	10	40	60	100	135	185	468	468
Employment	Not Employed	61	80.3	69.2	8.9	5	460	10	30	65	120	135	165	205	460
Employment	Refused	5	167.4	169.9	76.0	10	435	10	32	165	195	435	435	435	435
Education	-	295	55.3	45.0	2.6	5	435	10	29	49	70	100	120	155	225
Education	< High School	25	120.4	124.3	24.9	10	570	30	45	90	135	195	405	570	570
Education	High School Graduate	57	111.6	116.7	15.5	10	501	20	45	73	120	225	435	468	501
Education	< College	38	108.8	133.4	21.6	10	640	20	40	75	120	195	605	640	640
Education	College Graduate	30	84.6	128.1	23.4	2	690	5	30	60	90	130	300	690	690
Education	Post Graduate	24	110.5	199.2	40.7	5	945	10	29	60	102	125	460	945	945
Census Region	Northeast	145	77.1	75.4	6.3	7	435	15	30	60	95	135	180	435	435
Census Region	Midwest	102	69.7	103.3	10.2	2	945	10	30	55	85	120	125	175	468
Census Region	South	142	71.7	82.8	7.0	5	570	10	30	50	80	135	180	460	501
Census Region	West	80	81.8	124.3	13.9	5	690	13	30	42	90	128	298	640	690
Day Of Week	Weekday	426	70.6	84.6	4.1	2	690	10	30	50	85	120	165	435	501
Day Of Week	Weekend	43	114.7	152.2	23.2	10	945	20	45	90	120	180	300	945	945
Season	Winter	158	78.3	98.1	7.8	5	690	10	30	58	90	125	180	435	605
Season	Spring	140	61.6	53.5	4.5	2	460	10	30	50	75	120	138	205	225
Season	Summer	94	86.6	116.7	12.0	5	945	10	30	60	95	155	225	435	945
Season	Fall	77	76.2	107.5	12.3	5	640	10	30	50	80	125	175	570	640
Asthma	No	413	76.4	96.8	4.8	2	945	10	30	55	90	125	180	435	570
Asthma	Yes	50	55.4	39.3	5.6	5	195	10	30	48	71	115	135	165	195
Asthma	DK	6	111.5	161.5	65.9	10	435	10	32	46	100	435	435	435	435
Angina	No	459	73.4	91.3	4.3	2	945	10	30	55	90	125	179	420	570
Angina	Yes	4	168.8	182.7	91.3	20	435	20	60	110	278	435	435	435	435
Angina	DK	6	109.5	162.4	66.3	10	435	10	30	41	100	435	435	435	435
Bronchitis/Emphysema	No	442	74.8	94.3	4.5	2	945	10	30	55	90	125	180	435	570
Bronchitis/Emphysema	Yes	19	58.2	39.9	9.1	10	155	10	30	55	65	125	155	155	155
Bronchitis/Emphysema	DK	8	104.6	137.9	48.8	10	435	10	29	68	100	435	435	435	435

Table 16-24. Time Spent (minutes/day) in Selected Vehicles and All Vehicles Combined, Doers Only (continued)

All Vehicles Combined

								Percentiles								
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		7,743	97.3	104.9	1.2	1	1,440	12	40	70	120	190	270	425	570
Gender	Male	3,603	103.7	119.7	2.0	1	1,440	10	40	70	120	205	295	478	655
Gender	Female	4,138	91.7	89.8	1.4	1	995	12	40	70	115	180	240	385	465
Gender	Refused	2	30.0	14.1	10.0	20	40	20	20	30	40	40	40	40	40
Age (years)	-	144	117.0	129.1	10.8	5	810	20	40	80	143	210	435	593	660
Age (years)	1-4	335	68.1	75.5	4.1	1	955	10	30	47	85	150	200	245	270
Age (years)	5-11	571	71.0	77.6	3.2	1	900	10	25	51	90	140	171	275	360
Age (years)	12-17	500	81.5	79.8	3.6	1	790	10	30	60	100	166	233	345	405
Age (years)	18-64	5,286	104.0	111.1	1.5	1	1,440	15	43	75	120	200	285	450	620
Age (years)	> 64	907	90.9	93.9	3.1	4	900	10	35	60	120	190	258	400	460
Race	White	6,288	97.2	107.2	1.4	1	1,440	10	40	70	120	190	270	425	595
Race	Black	766	98.7	91.3	3.3	2	810	15	45	75	120	195	265	390	485
Race	Asian	133	83.4	74.9	6.5	5	540	20	35	70	105	150	210	330	360
Race	Some Others	144	96.2	94.0	7.8	3	690	10	40	70	128	180	250	345	540
Race	Hispanic	319	101.7	110.4	6.2	2	825	20	41	70	120	190	335	465	620
Race	Refused	93	93.6	90.1	9.3	10	480	15	30	65	120	205	255	420	480
Hispanic	No	7,050	97.1	104.8	1.2	1	1,440	10	40	70	120	190	270	420	566
Hispanic	Yes	578	100.0	109.0	4.5	2	825	15	40	70	120	190	285	480	630
Hispanic	DK	34	73.0	68.3	11.7	5	325	6	25	60	97	175	200	325	325
Hispanic	Refused	81	98.9	95.3	10.6	10	480	15	30	65	130	220	255	420	480
Employment	-	1,388	73.6	77.8	2.1	1	955	10	30	55	90	150	195	275	382
Employment	Full Time	3,732	105.8	116.2	1.9	4	1,440	16	45	75	124	198	290	475	660
Employment	Part Time	720	98.8	95.0	3.5	2	960	10	45	75	120	195	260	380	470
Employment	Not Employed	1,849	96.6	99.5	2.3	1	995	10	37	65	120	200	275	420	526
Employment	Refused	54	120.3	108.6	14.8	10	480	20	35	88	190	290	330	390	480
Education	-	1,550	76.4	78.9	2.0	1	955	10	30	60	95	155	201	303	385
Education	< High School	561	100.8	120.2	5.1	5	1,440	15	40	70	120	180	265	460	620
Education	High School Graduate	2,166	101.6	107.6	2.3	1	1,210	12	40	70	120	210	286	445	570
Education	< College	1,556	103.2	110.1	2.8	2	1,280	15	40	75	120	195	285	460	630
Education	College Graduate	1,108	104.5	109.5	3.3	4	1,215	15	45	75	125	200	280	450	675
Education	Post Graduate	802	101.9	108.7	3.8	4	1,357	20	45	76	120	195	270	365	480
Census Region	Northeast	1,662	98.6	106.6	2.6	1	1,215	15	40	70	120	190	275	425	570
Census Region	Midwest	1,759	101.2	114.6	2.7	1	1,440	10	40	70	120	205	290	435	595
Census Region	South	2,704	96.1	97.7	1.9	1	955	13	40	70	120	190	250	420	558
Census Region	West	1,618	93.7	103.7	2.6	2	1,280	10	35	65	115	180	260	420	540
Day Of Week	Weekday	5,289	94.4	101.4	1.4	1	1,215	10	40	66	115	180	260	435	575
Day Of Week	Weekend	2,454	103.4	111.9	2.3	1	1,440	13	40	75	125	205	280	420	540
Season	Winter	2,037	94.3	101.4	2.2	1	1,080	10	35	65	116	190	270	425	544
Season	Spring	2,032	99.6	110.5	2.5	1	1,440	12	40	70	120	200	275	440	546
Season	Summer	2,090	97.8	103.8	2.3	1	1,357	10	40	70	120	190	260	415	558
Season	Fall	1,584	97.4	103.7	2.6	1	1,280	14	40	70	120	180	265	420	620
Asthma	No	7,152	97.3	104.6	1.2	1	1,440	10	40	70	120	190	270	425	570
Asthma	Yes	544	97.2	110.8	4.8	4	955	17	40	65	117	180	255	460	705
Asthma	DK	47	100.0	95.2	13.9	10	480	10	30	75	120	220	239	480	480
Angina	No	7,516	97.3	105.2	1.2	1	1,440	11	40	70	120	190	270	425	570
Angina	Yes	172	93.1	93.1	7.1	8	615	15	30	65	120	185	280	420	540
Angina	DK	55	108.9	99.7	13.4	10	480	20	35	75	150	235	360	390	480
Bronchitis/Emphysema	No	7,349	97.6	106.1	1.2	1	1,440	10	40	70	120	190	270	425	580
Bronchitis/Emphysema	Yes	342	91.0	79.3	4.3	2	505	15	40	70	115	195	240	325	460
Bronchitis/Emphysema	DK	52	98.9	93.8	13.0	5	480	10	30	74	145	195	239	390	480

- = Indicates missing data.
DK = The respondent replied "don't know".
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996.

Table 16-25. Time Spent (minutes/day) in Selected Activities Whole Population and Doers Only, Children <21 Years

Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Sleeping/Napping – Whole Population															
Birth to <1	63	782	485	519	546	579	613	668	762	873	1,011	1,080	1,121	1,144	1,175
1 to <2	118	779	360	483	510	579	627	700	780	855	925	962	987	1098	1,320
2 to <3	118	716	270	365	470	523	594	635	708	805	870	917	937	944	990
3 to <6	357	681	0	480	510	539	573	630	675	735	795	840	893	916	1,110
6 to <11	497	613	120	295	390	458	510	570	625	660	720	750	831	868	945
11 to <16	466	569	0	320	376	415	450	510	558	630	705	762	809	907	1,015
16 to <21	481	537	0	239	295	360	390	450	525	615	690	750	840	906	1,317
Sleeping/Napping – DOERS ONLY															
Birth to <1	63	782	485	519	546	579	613	668	762	873	1,011	1,080	1,121	1,144	1,175
1 to <2	118	779	360	483	510	579	627	700	780	855	925	962	987	1,098	1,320
2 to <3	118	716	270	365	470	523	594	635	708	805	870	917	937	944	990
3 to <6	356	683	420	491	510	540	578	630	675	738	795	840	893	916	1,110
6 to <11	497	613	120	295	390	458	510	570	625	660	720	750	831	868	945
11 to <16	465	571	150	341	379	415	450	510	560	630	705	762	809	907	1,015
16 to <21	480	538	85	252	299	360	390	450	525	615	690	751	840	906	1,317
Eating – Whole Population															
Birth to <1	63	117	0	6	12	36	45	73	110	145	194	224	334	345	345
1 to <2	118	98	0	10	10	29	40	60	90	120	167	206	233	244	270
2 to <3	118	92	15	15	15	20	30	60	89	120	157	176	198	208	270
3 to <6	357	78	0	0	0	15	28	45	75	105	135	150	180	217	265
6 to <11	497	65	0	0	0	10	20	35	60	88	115	139	155	176	255
11 to <16	466	52	0	0	0	0	10	30	45	74	100	120	146	162	205
16 to <21	481	52	0	0	0	0	0	20	40	65	105	135	192	210	630
Eating – DOERS ONLY															
Birth to <1	62	118	10	16	23	40	46	77	110	148	195	224	335	345	345
1 to <2	117	99	10	10	12	30	40	60	90	120	167	206	234	244	270
2 to <3	118	92	15	15	15	20	30	60	89	120	157	176	198	208	270
3 to <6	349	80	2	10	15	20	30	45	75	105	135	150	180	218	265
6 to <11	480	67	5	10	10	15	20	40	60	90	115	140	157	179	255
11 to <16	432	56	2	5	7	10	20	30	50	75	100	125	148	163	205
16 to <21	426	59	2	5	9	10	15	30	45	75	105	144	197	210	630
Attending School Full-Time – Whole Population															
Birth to <1	63	11	0	0	0	0	0	0	0	0	0	0	83	265	550
1 to <2	118	28	0	0	0	0	0	0	0	0	0	204	546	594	665
2 to <3	118	65	0	0	0	0	0	0	0	0	334	502	564	618	710
3 to <6	357	73	0	0	0	0	0	0	0	0	392	510	558	581	630
6 to <11	497	183	0	0	0	0	0	0	0	390	435	460	525	570	645
11 to <16	466	187	0	0	0	0	0	0	0	409	445	464	487	500	595
16 to <21	481	117	0	0	0	0	0	0	0	270	408	445	489	551	825
Attending School Full-Time – DOERS ONLY															
Birth to <1	3	-	60	-	-	-	-	-	-	-	-	-	-	-	550
1 to <2	9	-	20	-	-	-	-	-	-	-	-	-	-	-	665
2 to <3	20	385	20	37	53	103	119	226	458	520	576	632	679	694	710
3 to <6	71	366	30	37	66	128	165	203	395	510	558	583	615	627	630
6 to <11	234	389	60	125	164	211	311	370	390	425	460	497	570	600	645
11 to <16	217	401	10	86	108	270	343	385	415	440	467	485	505	548	595
16 to <21	162	347	20	46	78	126	195	270	370	420	459	519	567	609	825

Table 16-25. Time Spent (minutes/day) in Selected Activities Whole Population and Doers Only, Children <21 Years (continued)															
Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Outdoor Recreation –Whole Population															
Birth to <1	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 to <2	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 to <3	118	4	0	0	0	0	0	0	0	0	0	0	15	28	370
3 to <6	357	6	0	0	0	0	0	0	0	0	0	0	60	172	630
6 to <11	497	7	0	0	0	0	0	0	0	0	0	0	142	226	574
11 to <16	466	6	0	0	0	0	0	0	0	0	0	0	142	191	465
16 to <21	481	6	0	0	0	0	0	0	0	0	0	0	103	189	570
Outdoor Recreation – DOERS ONLY															
Birth to <1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 to <2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 to <3	4	-	15	-	-	-	-	-	-	-	-	-	-	-	370
3 to <6	11	207	30	30	30	30	30	60	150	240	585	608	621	626	630
6 to <11	17	204	60	60	60	60	66	120	165	245	351	403	506	540	574
11 to <16	22	138	5	5	5	5	11	60	126	180	234	411	446	456	465
16 to <21	13	228	30	35	41	57	77	130	180	300	420	480	534	552	570
Active Sports – Whole Population															
Birth to <1	63	15	0	0	0	0	0	0	0	0	60	90	131	143	155
1 to <2	118	20	0	0	0	0	0	0	0	0	68	131	180	201	270
2 to <3	118	27	0	0	0	0	0	0	0	0	110	180	257	319	390
3 to <6	357	40	0	0	0	0	0	0	0	30	135	242	330	408	630
6 to <11	497	51	0	0	0	0	0	0	0	60	172	272	371	435	975
11 to <16	466	53	0	0	0	0	0	0	0	74	168	245	309	425	1,065
16 to <21	481	35	0	0	0	0	0	0	0	0	145	180	285	386	565
Active Sports – DOERS ONLY															
Birth to <1	13	75	25	26	26	28	31	40	60	90	132	143	150	153	155
1 to <2	24	96	10	15	19	30	33	60	73	131	180	201	240	255	270
2 to <3	26	124	15	18	20	26	30	41	98	179	253	314	360	375	390
3 to <6	97	149	15	20	29	30	30	60	120	180	315	354	559	625	630
6 to <11	175	146	2	12	15	20	30	60	110	193	312	393	450	522	975
11 to <16	179	137	5	5	15	15	30	60	115	180	261	314	442	533	1,065
16 to <21	117	143	5	15	15	20	30	60	120	180	272	371	501	519	565
Exercise – Whole Population															
Birth to <1	63	13	0	0	0	0	0	0	0	0	0	0	122	354	670
1 to <2	118	2	0	0	0	0	0	0	0	0	0	0	25	30	150
2 to <3	118	1	0	0	0	0	0	0	0	0	0	0	0	0	60
3 to <6	357	3	0	0	0	0	0	0	0	0	0	0	0	54	525
6 to <11	497	5	0	0	0	0	0	0	0	0	0	0	100	137	450
11 to <16	466	5	0	0	0	0	0	0	0	0	0	30	70	114	245
16 to <21	481	8	0	0	0	0	0	0	0	0	0	60	151	176	300
Exercise – DOERS ONLY															
Birth to <1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 to <2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 to <3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 to <6	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6 to <11	20	124	15	17	19	25	30	60	100	146	226	284	384	417	450
11 to <16	28	75	20	21	23	27	30	42	60	101	128	148	194	219	245
16 to <21	41	99	15	15	15	25	30	40	90	145	180	240	260	280	300

Table 16-25. Time Spent (minutes/day) in Selected Activities Whole Population and Doers Only, Children <21 Years (continued)															
Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Walking – Whole Population															
Birth to <1	63	6	0	0	0	0	0	0	0	0	9.2	29	64	104	160
1 to <2	118	2	0	0	0	0	0	0	0	0	0	10	40	58	60
2 to <3	118	3	0	0	0	0	0	0	0	0	10	17	45	54	60
3 to <6	357	3	0	0	0	0	0	0	0	0	4	20	35	60	60
6 to <11	497	4	0	0	0	0	0	0	0	0	14	30	40	55	170
11 to <16	466	10	0	0	0	0	0	0	0	0	30	55	79	130	190
16 to <21	481	8	0	0	0	0	0	0	0	0	20	45	90	127	410
Walking – DOERS ONLY															
Birth to <1	9	-	4	-	-	-	-	-	-	-	-	-	-	-	160
1 to <2	9	-	4	-	-	-	-	-	-	-	-	-	-	-	60
2 to <3	19	19	1	1	1	2	2	7	10	28	51	56	58	59	60
3 to <6	44	20	1	1	1	1	2	5	15	30	56	60	60	60	60
6 to <11	118	18	1	1	1	2	2	5	10	25	40	51	65	94	170
11 to <16	190	25	1	1	1	2	3	5	14	30	60	78	134	154	190
16 to <21	128	30	1	1	2	2	3	5	18	32	62	120	148	175	410

N = Sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes less than 10.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996 (NHAPS).

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only																
Sleeping/Napping																
								Percentiles								
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		9,362	526.3	134.4	1.4	30	1,430	345	445	510	600	690	760	850	925
Gender	Male	4,283	523.3	135.2	2.1	30	1,295	330	435	510	600	690	765	860	925
Gender	Female	5,075	528.7	133.7	1.8	30	1,430	350	450	510	600	690	750	840	925
Gender	Refused	4	645.0	123.7	61.8	540	780	540	540	630	750	780	780	780	780
Age (years)	-	185	502.3	125.4	9.2	195	908	330	420	480	555	655	745	865	900
Age (years)	1-4	499	732.4	124.3	5.6	270	1,320	540	655	720	810	900	930	1,005	1,110
Age (years)	5-11	702	625.1	100.7	3.8	120	1,110	480	570	630	680	725	780	840	875
Age (years)	12-17	588	563.7	110.8	4.6	150	1,015	395	484	550	630	705	750	810	900
Age (years)	18-64	6,041	496.9	123.0	1.6	30	1,420	330	420	480	555	630	705	780	868
Age (years)	> 64	1,347	517.1	117.5	3.2	30	1,430	345	450	510	570	660	720	780	860
Race	White	7,576	523.6	129.5	1.5	30	1,430	350	445	510	600	690	750	840	900
Race	Black	940	541.3	162.7	5.3	60	1,415	315	424	530	630	738	823	940	1,020
Race	Asian	156	537.1	118.1	9.5	300	920	345	468	540	600	690	735	840	870
Race	Some Others	181	528.8	142.3	10.6	60	905	300	420	525	630	720	769	810	842
Race	Hispanic	383	538.0	148.9	7.6	60	1,125	315	450	540	630	720	765	870	930
Race	Refused	126	523.4	143.7	12.8	180	1,140	330	420	510	600	720	780	870	930
Hispanic	No	8,514	525.2	133.2	1.4	30	1,430	345	445	510	600	690	750	855	925
Hispanic	Yes	700	540.1	147.1	5.6	60	1,125	320	450	540	630	720	778	843	915
Hispanic	DK	45	527.5	139.3	20.8	195	842	345	420	515	659	690	710	842	842
Hispanic	Refused	103	521.6	138.9	13.7	240	930	330	420	510	590	720	780	865	870
Employment	-	1,771	636.6	128.5	3.1	120	1,320	440	555	630	705	802	860	930	975
Employment	Full Time	4,085	487.2	118.9	1.9	30	1,420	325	420	480	540	628	685	770	840
Employment	Part Time	798	502.8	117.4	4.2	60	1,005	330	435	495	570	645	720	780	860
Employment	Not Employed	2,638	520.3	125.5	2.4	30	1,430	345	450	510	590	660	720	800	885
Employment	Refused	70	513.7	136.5	16.3	210	930	320	420	490	570	697	780	900	930
Education	-	1,966	625.6	134.0	3.0	120	1,420	420	540	628	699	790	855	926	975
Education	< High School	832	515.4	135.7	4.7	30	1,317	300	435	510	585	670	750	860	900
Education	High School Graduate	2,604	505.4	123.0	2.4	30	1,430	330	420	495	570	659	720	780	840
Education	< College	1,791	496.6	119.9	2.8	60	1,350	315	420	480	565	630	690	779	845
Education	College Graduate	1,245	492.5	117.6	3.3	75	1,404	330	420	480	540	629	690	775	900
Education	Post Graduate	924	486.7	110.4	3.6	105	1,295	345	420	480	540	615	660	725	800
Census Region	Northeast	2,068	523.1	133.7	2.9	55	1,420	345	435	510	600	690	760	860	930
Census Region	Midwest	2,096	520.8	127.6	2.8	30	1,215	330	440	510	598	690	745	840	870
Census Region	South	3,234	529.0	135.7	2.4	30	1,430	345	450	510	600	699	765	855	925
Census Region	West	1,964	530.9	140.0	3.2	60	1,404	345	450	510	600	690	769	862	940
Day Of Week	Weekday	6,303	511.1	131.8	1.7	30	1,430	330	420	495	570	670	745	840	920
Day Of Week	Weekend	3,059	557.5	134.4	2.4	30	1,420	360	480	540	630	720	780	870	925
Season	Winter	2,514	534.9	134.7	2.7	55	1,404	355	450	520	600	700	780	870	930
Season	Spring	2,431	526.8	130.5	2.6	30	1,175	345	445	510	600	690	750	840	900
Season	Summer	2,533	527.7	139.5	2.8	30	1,430	330	435	510	600	699	765	840	930
Season	Fall	1,884	512.2	131.1	3.0	60	1,420	330	430	505	570	660	735	840	900
Asthma	No	8,608	525.1	133.6	1.4	30	1,430	345	445	510	600	690	750	840	915
Asthma	Yes	692	540.1	143.6	5.5	30	1,404	330	450	538	618	715	780	900	945
Asthma	DK	62	544.2	141.0	17.9	300	1,035	330	465	535	600	720	780	930	1035
Angina	No	9,039	526.8	134.2	1.4	30	1,420	345	445	510	600	690	760	855	925
Angina	Yes	249	513.7	137.7	8.7	60	1,430	300	445	510	595	660	735	795	845
Angina	DK	74	511.4	146.3	17.0	30	930	300	420	510	600	720	780	840	930
Bronchitis/Emphysema	No	8,860	526.5	134.3	1.4	30	1,430	345	445	510	600	690	760	850	924
Bronchitis/Emphysema	Yes	432	521.7	138.5	6.7	80	1,110	300	420	510	600	705	765	840	930
Bronchitis/Emphysema	DK	70	521.2	131.9	15.8	210	930	300	450	510	600	690	745	840	930

Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)															
Eating or Drinking															
								Percentiles							
All		8,627	74.9	54.8	0.6	1	900	15	35	60	96	140	175	215	270
Gender	Male	3,979	75.8	56.2	0.9	1	900	15	39	60	96	140	180	210	270
Gender	Female	4,644	74.1	53.6	0.8	2	640	15	34	60	98	140	170	225	270
Gender	Refused	4	60.0	21.2	10.6	30	75	30	45	68	75	75	75	75	75
Age (years)	-	157	75.3	50.1	4.0	10	315	15	30	65	100	145	150	195	285
Age (years)	1-4	492	93.5	52.9	2.4	2	345	20	60	90	120	160	190	225	270
Age (years)	5-11	680	68.5	39.0	1.5	5	255	15	40	65	90	120	143	165	195
Age (years)	12-17	538	55.9	35.0	1.5	2	210	10	30	50	75	105	125	150	170
Age (years)	18-64	5,464	71.9	55.1	0.7	1	900	15	30	60	90	135	170	220	270
Age (years)	> 64	1,296	91.7	62.7	1.7	5	750	20	50	80	120	165	200	270	295
Race	White	7,049	77.0	55.7	0.7	1	900	15	40	64	100	145	180	225	270
Race	Black	808	59.9	46.6	1.6	2	505	15	30	50	75	119	140	200	225
Race	Asian	148	80.4	47.8	3.9	2	305	15	45	73	107	150	160	200	200
Race	Some Others	168	66.0	52.1	4.0	7	525	15	30	60	83	120	135	190	200
Race	Hispanic	345	68.7	51.9	2.8	2	435	12	30	60	90	125	165	195	225
Race	Refused	109	74.2	60.8	5.8	8	410	20	30	60	90	130	180	290	315
Hispanic	No	7,861	75.6	55.2	0.6	1	900	15	35	60	100	140	175	220	270
Hispanic	Yes	639	68.3	50.2	2.0	2	435	15	30	60	90	120	155	195	225
Hispanic	DK	41	60.4	37.1	5.8	5	150	15	30	55	90	120	130	150	150
Hispanic	Refused	86	68.9	55.5	6.0	8	410	15	30	60	90	115	155	210	410
Employment	-	1,695	72.2	44.9	1.1	2	345	15	40	65	90	133	150	195	210
Employment	Full Time	3,684	70.6	55.1	0.9	1	900	15	30	60	90	135	165	225	270
Employment	Part Time	715	72.2	55.4	2.1	2	509	15	30	60	90	135	170	230	260
Employment	Not Employed	2,472	83.9	59.1	1.2	2	750	15	45	75	110	150	185	235	285
Employment	Refused	61	71.0	61.0	7.8	8	385	15	30	55	90	120	145	235	385
Education	-	1,867	70.9	45.4	1.1	2	375	15	38	60	90	130	150	190	210
Education	< High School	758	72.3	57.4	2.1	2	460	15	30	60	90	135	180	230	315
Education	High School Graduate	2,363	74.9	57.1	1.2	1	900	15	35	60	96	140	175	220	270
Education	< College	1,612	73.9	56.5	1.4	2	525	15	30	60	90	145	175	230	275
Education	College Graduate	1,160	78.5	55.4	1.6	1	640	15	40	65	105	145	180	220	265
Education	Post Graduate	867	82.8	59.7	2.0	2	750	15	40	70	110	150	185	240	270
Census Region	Northeast	1,916	78.3	59.2	1.4	1	750	15	37	65	103	145	180	240	285
Census Region	Midwest	1,928	75.8	51.4	1.2	1	435	15	40	64	100	140	175	210	255
Census Region	South	2,960	71.4	55.1	1.0	2	900	15	30	60	90	135	165	210	270
Census Region	West	1,823	76.0	53.0	1.2	2	500	15	35	60	100	150	180	210	240
Day Of Week	Weekday	5,813	71.2	52.0	0.7	1	900	15	33	60	90	130	165	210	250
Day Of Week	Weekend	2,814	82.5	59.5	1.1	2	630	15	40	70	110	150	190	240	297
Season	Winter	2,332	76.1	56.4	1.2	2	640	15	39	65	96	140	175	240	275
Season	Spring	2,222	76.3	55.2	1.2	1	630	15	35	60	100	145	178	220	275
Season	Summer	2,352	73.5	53.3	1.1	1	750	15	35	60	95	135	170	210	260
Season	Fall	1,721	73.3	54.3	1.3	2	900	15	30	60	95	140	175	210	232
Asthma	No	7,937	75.2	54.8	0.6	1	900	15	35	60	100	140	175	215	270
Asthma	Yes	635	71.4	55.0	2.2	2	460	15	30	60	90	133	170	225	285
Asthma	DK	55	69.3	56.6	7.6	8	335	15	30	60	90	120	210	215	335
Angina	No	8,318	74.6	54.4	0.6	1	900	15	35	60	95	140	175	210	265
Angina	Yes	243	85.0	63.5	4.1	2	500	15	45	75	115	160	180	285	330
Angina	DK	66	75.7	67.3	8.3	5	435	15	30	60	90	150	195	215	435
Bronchitis/Emphysema	No	8,169	74.7	54.3	0.6	1	900	15	35	60	95	140	170	210	260
Bronchitis/Emphysema	Yes	397	80.7	65.2	3.3	2	460	15	30	60	110	150	180	285	360
Bronchitis/Emphysema	DK	61	67.0	47.7	6.1	8	230	15	30	60	90	120	155	215	230

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)															
Working in a Main Job															
								Percentiles							
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		3,259	475.9	179.1	3.1	1	1,440	120	395	500	570	660	740	840	930
Gender	Male	1,733	492.3	187.0	4.5	1	1,440	120	417	510	595	690	770	890	955
Gender	Female	1,526	457.3	167.7	4.3	2	1,440	120	390	485	543	620	690	785	850
Age (years)	-	80	472.4	183.3	20.5	5	940	118	378	483	560	673	850	900	940
Age (years)	1-4	3	16.7	11.5	6.7	10	30	10	10	10	30	30	30	30	30
Age (years)	5-11	10	150.4	185.8	58.8	2	550	2	10	68	264	448	550	550	550
Age (years)	12-17	38	293.2	180.7	29.3	5	840	15	185	269	390	510	675	840	840
Age (years)	18-64	2,993	484.8	173.1	3.2	1	1,440	140	420	505	570	660	745	840	930
Age (years)	> 64	135	366.1	208.7	18.0	5	990	30	185	395	500	600	660	840	940
Race	White	2,630	477.5	179.0	3.5	1	1,440	120	400	500	570	660	735	845	933
Race	Black	343	466.6	176.0	9.5	5	1037	105	390	490	550	655	735	880	990
Race	Asian	57	464.1	177.3	23.5	5	870	45	390	493	553	660	750	780	870
Race	Some Others	56	477.4	181.7	24.3	45	855	75	415	510	570	680	765	780	855
Race	Hispanic	125	465.9	185.3	16.6	2	840	95	360	485	580	720	750	825	840
Race	Refused	48	492.1	191.6	27.7	50	957	120	410	508	575	810	840	957	957
Hispanic	No	2,980	475.4	179.2	3.3	1	1,440	120	395	500	570	660	740	850	940
Hispanic	Yes	221	481.5	174.3	11.7	2	1,106	150	405	505	580	670	740	825	840
Hispanic	DK	12	529.6	146.2	42.2	295	757	295	425	554	610	710	757	757	757
Hispanic	Refused	46	468.5	201.3	29.7	10	860	115	350	498	585	780	818	860	860
Employment	-	47	257.9	202.8	29.6	2	840	5	65	245	390	540	625	840	840
Employment	Full Time	2,679	504.4	164.8	3.2	1	1,440	180	450	510	582	675	750	855	950
Employment	Part Time	395	364.6	159.4	8.0	5	945	80	250	365	480	540	600	675	795
Employment	Not Employed	112	270.9	216.0	20.4	4	990	9	83	245	378	600	675	795	870
Employment	Refused	26	513.6	155.5	30.5	170	840	225	440	510	570	778	790	840	840
Education	-	108	343.0	211.9	20.4	2	860	10	177	343	510	610	675	840	840
Education	< High School	217	473.5	216.7	14.7	4	1,440	85	360	485	568	710	795	940	1,080
Education	High School Graduate	1,045	482.0	180.6	5.6	1	1,440	120	405	500	565	670	765	890	979
Education	< College	795	475.6	174.0	6.2	2	1,440	140	409	495	563	648	750	825	905
Education	College Graduate	627	484.5	159.8	6.4	5	1,005	120	424	510	570	645	720	765	815
Education	Post Graduate	467	483.0	169.6	7.8	1	945	125	400	510	590	660	730	810	860
Census Region	Northeast	721	476.0	180.8	6.7	1	1,440	120	405	495	570	669	740	890	950
Census Region	Midwest	755	477.0	182.2	6.6	2	1,440	120	395	495	570	660	750	825	940
Census Region	South	1,142	478.2	176.7	5.2	1	1,440	105	405	505	570	660	735	840	900
Census Region	West	641	470.4	177.8	7.0	5	1,080	120	390	500	570	657	730	850	880
Day Of Week	Weekday	2,788	487.9	166.2	3.1	1	1,440	155	425	505	570	660	740	840	930
Day Of Week	Weekend	471	405.2	229.5	10.6	2	1,440	30	245	415	555	670	770	870	960
Season	Winter	864	475.8	172.8	5.9	5	1,440	150	390	495	570	660	735	835	900
Season	Spring	791	473.0	195.4	6.9	1	1,440	75	390	495	570	670	765	850	915
Season	Summer	910	477.2	179.9	6.0	1	1,215	120	400	500	565	670	750	890	979
Season	Fall	694	477.7	166.0	6.3	2	1,005	130	405	510	570	645	720	780	840
Asthma	No	3,042	477.0	177.0	3.2	1	1,440	120	400	500	570	660	740	840	930
Asthma	Yes	195	453.4	204.2	14.6	5	1,440	45	345	480	550	668	793	855	979
Asthma	DK	22	523.2	217.0	46.3	170	1,215	225	430	500	565	780	860	1,215	1,215
Angina	No	3,192	475.7	178.4	3.2	1	1,440	120	395	500	570	660	740	840	930
Angina	Yes	44	472.1	200.7	30.3	10	990	60	386	500	573	679	730	990	990
Angina	DK	23	507.4	230.3	48.0	80	1,215	170	430	500	565	780	860	1,215	1,215
Bronchitis/Emphysema	No	3,120	476.5	178.2	3.2	1	1,440	120	400	500	570	660	740	840	930
Bronchitis/Emphysema	Yes	116	447.0	189.4	17.6	5	985	30	368	480	558	644	720	800	855
Bronchitis/Emphysema	DK	23	535.2	226.3	47.2	170	1,215	225	430	500	600	860	875	1,215	1,215

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)																
Attending Full Time School																
								Percentiles								
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		884	358.5	130.3	4.4	1	840	95	300	390	435	483	550	600	640
Gender	Male	468	369.3	123.2	5.7	20	840	120	320	390	435	485	555	595	645
Gender	Female	416	346.4	137.1	6.7	1	710	75	263	385	430	480	535	600	628
Age (years)	-	7	232.1	148.1	56.0	10	495	10	180	210	320	495	495	495	495
Age (years)	1-4	56	365.0	199.2	26.6	20	710	30	173	428	530	595	628	665	710
Age (years)	5-11	297	387.8	98.0	5.7	60	645	170	360	390	435	485	555	600	630
Age (years)	12-17	271	392.3	85.0	5.2	10	605	200	375	405	435	460	485	510	555
Age (years)	18-64	247	292.2	154.6	9.8	1	840	60	180	289	400	480	535	645	785
Age (years)	> 64	6	203.3	147.4	60.2	75	480	75	120	153	240	480	480	480	480
Race	White	665	362.9	128.5	5.0	1	825	107	310	392	435	485	550	600	630
Race	Black	92	351.8	129.6	13.5	40	710	70	287	388	433	465	526	645	710
Race	Asian	33	346.3	156.0	24.2	90	840	120	225	365	435	500	565	840	840
Race	Some Others	29	337.8	148.1	27.5	58	553	70	212	360	445	502	540	553	553
Race	Hispanic	58	345.3	124.0	16.3	30	565	85	260	378	430	480	510	510	565
Race	Refused	7	285.0	157.0	59.4	60	440	60	150	290	440	440	440	440	440
Hispanic	No	771	359.6	130.8	4.7	1	840	100	300	390	435	483	550	600	645
Hispanic	Yes	103	353.1	126.4	12.5	30	630	85	269	385	425	483	510	595	600
Hispanic	DK	4	315.5	167.8	83.9	65	416	65	221	391	410	415	415	415	415
Hispanic	Refused	6	348.3	140.6	57.4	150	445	150	185	435	440	445	445	445	445
Employment	-	608	386.5	107.3	4.4	10	710	165	361	400	440	485	550	595	625
Employment	Full Time	49	206.6	133.6	19.1	5	502	15	115	180	305	430	461	502	502
Employment	Part Time	89	304.7	134.8	14.3	25	695	90	210	295	395	480	500	585	695
Employment	Not Employed	135	325.3	161.0	13.9	1	840	60	215	340	420	500	605	785	825
Employment	Refused	3	270.0	147.2	85.0	185	440	185	185	440	440	440	440	440	440
Education	-	666	385.0	107.9	4.2	10	710	160	360	400	440	485	550	595	625
Education	< High School	14	267.1	129.3	34.6	5	415	5	175	310	357	385	415	415	415
Education	High School Graduate	54	238.5	141.1	19.2	58	785	60	125	212	330	400	480	480	785
Education	< College	100	303.4	170.6	17.1	1	840	60	185	273	415	526	614	760	833
Education	College Graduate	24	238.4	145.9	29.8	25	565	30	135	200	360	430	460	565	565
Education	Post Graduate	26	302.8	144.1	28.3	10	535	95	210	300	461	500	502	535	535
Census Region	Northeast	186	351.6	127.0	9.3	60	825	120	268	375	420	483	520	600	785
Census Region	Midwest	200	358.1	123.9	8.8	5	645	88	308	393	425	470	528	578	602
Census Region	South	322	373.9	139.7	7.8	10	840	60	330	405	450	500	565	625	645
Census Region	West	176	338.3	120.5	9.1	1	630	120	263	375	410	465	540	555	600
Day Of Week	Weekday	858	363.7	126.0	4.3	1	840	120	310	390	435	485	550	600	640
Day Of Week	Weekend	26	189.5	158.4	31.1	15	465	20	60	120	300	460	465	465	465
Season	Winter	302	375.1	118.5	6.8	5	695	150	330	395	440	495	550	612	640
Season	Spring	287	353.4	133.7	7.9	10	840	90	290	390	430	475	500	570	710
Season	Summer	125	332.4	142.1	12.7	40	630	70	217	375	425	470	550	600	600
Season	Fall	170	357.0	132.8	10.2	1	785	120	285	380	430	510	565	605	645
Asthma	No	784	358.0	130.7	4.7	1	840	95	295	390	435	485	550	595	630
Asthma	Yes	96	363.0	127.9	13.1	20	695	95	334	390	428	475	540	645	695
Asthma	DK	4	363.8	162.6	81.3	120	450	120	280	443	448	450	450	450	450
Angina	No	875	358.6	130.5	4.4	1	840	95	300	390	435	483	550	600	640
Angina	Yes	4	382.5	87.7	43.9	255	455	255	330	410	435	455	455	455	455
Angina	DK	5	333.6	140.5	62.8	120	460	120	270	378	440	460	460	460	460
Bronchitis/Emphysema	No	851	359.1	130.4	4.5	1	840	95	300	390	435	485	550	600	640
Bronchitis/Emphysema	Yes	27	340.1	132.7	25.5	30	605	60	305	365	435	450	460	605	605
Bronchitis/Emphysema	DK	6	357.2	121.5	49.6	120	440	120	350	397	440	440	440	440	440

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)

Outdoor Recreation

Category	Population Group	N	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		253	211.2	185.5	11.7	5	1,440	20	60	165	300	480	574	670	690
Gender	Male	140	231.8	207.4	17.5	5	1,440	18	68	177	330	503	600	690	735
Gender	Female	112	183.7	150.2	14.2	5	645	20	60	150	255	380	525	585	630
Gender	Refused	1	420.0	-	-	420	420	420	420	420	420	420	420	420	420
Age (years)	-	2	337.5	201.5	142.5	195	480	195	195	338	480	480	480	480	480
Age (years)	1-4	13	166.5	177.1	49.1	15	630	15	30	130	180	370	630	630	630
Age (years)	5-11	21	206.1	156.2	34.1	30	585	60	90	165	245	360	574	585	585
Age (years)	12-17	27	155.1	128.3	24.7	5	465	5	60	135	225	420	420	465	465
Age (years)	18-64	158	223.6	193.0	15.4	5	1,440	30	80	173	310	505	585	690	690
Age (years)	> 64	32	211.1	206.6	36.5	5	735	5	30	171	375	495	600	735	735
Race	White	225	209.8	182.7	12.2	5	1,440	20	60	165	300	460	570	670	690
Race	Black	16	233.9	231.3	57.8	5	690	5	43	150	450	585	690	690	690
Race	Asian	3	203.3	262.2	151.4	30	505	30	30	75	505	505	505	505	505
Race	Some Others	2	327.5	130.8	92.5	235	420	235	235	328	420	420	420	420	420
Race	Hispanic	4	77.5	53.9	27.0	20	150	20	43	70	113	150	150	150	150
Race	Refused	3	308.3	209.4	120.9	180	550	180	180	195	550	550	550	550	550
Hispanic	No	238	211.8	187.1	12.1	5	1,440	20	60	165	300	480	585	690	690
Hispanic	Yes	12	175.5	149.1	43.0	15	511	15	70	150	255	340	511	511	511
Hispanic	Refused	3	308.3	209.4	120.9	180	550	180	180	195	550	550	550	550	550
Employment	-	60	177.1	150.0	19.4	5	630	13	60	148	230	395	520	585	630
Employment	Full Time	104	210.7	153.4	15.0	5	670	30	83	180	294	419	511	600	645
Employment	Part Time	19	205.3	204.0	46.8	30	690	30	60	150	180	570	690	690	690
Employment	Not Employed	68	244.4	245.0	29.7	5	1,440	15	60	180	375	525	690	735	1,440
Employment	Refused	2	187.5	10.6	7.5	180	195	180	180	188	195	195	195	195	195
Education	-	64	176.7	145.3	18.2	5	630	15	60	153	225	370	465	585	630
Education	< High School	22	259.4	178.0	37.9	5	600	30	105	248	380	525	600	600	600
Education	High School Graduate	59	238.2	229.0	29.8	15	1,440	20	90	175	310	511	670	690	1,440
Education	< College	54	218.1	172.2	23.4	5	690	25	65	173	345	460	550	570	690
Education	College Graduate	31	224.7	193.1	34.7	20	690	30	60	150	325	505	645	690	690
Education	Post Graduate	23	157.6	178.2	37.2	5	735	10	50	80	200	370	480	735	735
Census Region	Northeast	52	189.6	160.9	22.3	5	690	30	60	163	232	370	574	670	690
Census Region	Midwest	54	212.1	228.4	31.1	5	1,440	20	60	178	280	419	600	735	1,440
Census Region	South	84	217.3	175.3	19.1	5	645	15	63	150	348	495	525	600	645
Census Region	West	63	220.3	179.7	22.6	10	690	30	75	165	280	545	585	690	690
Day Of Week	Weekday	129	197.2	195.3	17.2	5	1,440	15	60	150	275	465	525	670	735
Day Of Week	Weekend	124	225.8	174.3	15.6	5	690	20	85	180	310	480	600	690	690
Season	Winter	31	196.6	165.5	29.7	5	585	5	60	165	280	440	550	585	585
Season	Spring	75	198.9	161.7	18.7	5	690	25	75	180	270	465	545	670	690
Season	Summer	102	228.2	204.2	20.2	5	1,440	30	75	180	325	459	585	690	690
Season	Fall	45	203.5	193.8	28.9	5	735	20	60	120	330	505	574	735	735
Asthma	No	232	208.2	187.7	12.3	5	1,440	20	60	159	294	480	585	690	690
Asthma	Yes	19	250.2	166.6	38.2	15	570	15	80	255	350	525	570	570	570
Asthma	DK	2	187.5	10.6	7.5	180	195	180	180	188	195	195	195	195	195
Angina	No	245	206.8	184.9	11.8	5	1,440	20	60	160	288	480	570	670	690
Angina	Yes	6	399.2	151.2	61.7	285	690	285	310	345	420	690	690	690	690
Angina	DK	2	187.5	10.6	7.5	180	195	180	180	188	195	195	195	195	195
Bronchitis/Emphysema	No	238	212.2	189.2	12.3	5	1,440	20	60	165	300	495	585	690	690
Bronchitis/Emphysema	Yes	13	196.3	122.2	33.9	5	370	5	117	160	310	340	370	370	370
Bronchitis/Emphysema	DK	2	187.5	10.6	7.5	180	195	180	180	188	195	195	195	195	195

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)

Active Sports

Category	Population Group	N	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		1,384	124.0	112.8	3.0	1	1,130	15	50	90	165	267	330	435	525
Gender	Male	753	136.8	120.8	4.4	1	1,130	20	60	105	180	285	375	500	558
Gender	Female	629	108.6	100.6	4.0	1	1,065	15	38	75	150	240	300	370	435
Gender	Refused	2	142.5	38.9	27.5	115	170	115	115	143	170	170	170	170	170
Age (years)	-	23	108.7	78.6	16.4	5	290	30	40	90	155	220	225	290	290
Age (years)	1-4	105	115.8	98.9	9.6	10	630	30	45	90	159	250	330	345	390
Age (years)	5-11	247	148.9	126.6	8.1	2	975	20	60	120	188	320	390	510	558
Age (years)	12-17	215	137.5	124.5	8.5	5	1065	15	60	110	180	265	375	470	520
Age (years)	18-64	642	120.3	110.4	4.4	1	1,130	15	45	90	160	250	330	450	525
Age (years)	> 64	152	88.0	80.2	6.5	1	380	15	30	60	120	220	285	315	330
Race	White	1,139	126.0	116.2	3.4	1	1,130	15	50	90	165	270	340	452	530
Race	Black	109	113.4	96.8	9.3	5	440	10	45	86	150	240	332	430	435
Race	Asian	30	89.9	79.2	14.5	5	310	10	30	60	145	215	235	310	310
Race	Some Others	35	135.4	112.2	19.0	15	553	20	60	105	195	270	330	553	553
Race	Hispanic	59	116.3	91.3	11.9	1	520	15	45	115	145	240	305	345	520
Race	Refused	12	120.0	86.6	25.0	40	300	40	60	95	130	290	300	300	300
Hispanic	No	1,250	124.5	113.5	3.2	1	1,130	15	45	90	165	270	330	435	515
Hispanic	Yes	120	121.2	110.8	10.1	1	630	15	50	90	148	240	335	520	553
Hispanic	DK	4	113.8	57.5	28.8	60	185	60	68	105	160	185	185	185	185
Hispanic	Refused	10	102.0	72.1	22.8	40	290	40	60	83	105	215	290	290	290
Employment	-	561	137.1	120.8	5.1	2	1065	20	60	110	180	285	370	452	558
Employment	Full Time	375	117.6	107.3	5.5	5	1,130	20	45	90	155	240	305	380	525
Employment	Part Time	87	116.2	87.6	9.4	1	450	15	60	95	160	235	285	355	450
Employment	Not Employed	352	112.5	110.0	5.9	1	600	10	30	70	150	270	330	475	520
Employment	Refused	9	99.4	77.2	25.7	30	280	30	45	90	120	280	280	280	280
Education	-	610	137.7	121.2	4.9	2	1,065	20	60	110	180	285	370	470	558
Education	< High School	86	101.0	99.7	10.8	10	570	15	30	60	135	225	270	510	570
Education	High School Graduate	233	116.8	116.8	7.7	1	1,130	20	45	85	150	240	300	420	530
Education	< College	178	115.8	100.3	7.5	1	525	15	45	90	160	270	340	418	475
Education	College Graduate	165	116.2	97.9	7.6	1	600	15	50	90	150	250	310	380	450
Education	Post Graduate	112	106.4	97.9	9.2	5	375	10	40	60	143	270	330	360	375
Census Region	Northeast	333	132.0	129.1	7.1	1	1,130	15	60	100	170	275	345	485	558
Census Region	Midwest	254	116.9	101.9	6.4	5	570	18	45	90	150	255	315	430	440
Census Region	South	479	119.5	108.7	5.0	1	975	15	45	90	160	265	330	410	462
Census Region	West	318	128.1	108.8	6.1	1	625	25	55	93	175	295	330	500	525
Day Of Week	Weekday	902	115.5	97.8	3.3	1	650	15	45	90	150	240	300	395	485
Day Of Week	Weekend	482	139.9	135.2	6.2	1	1,130	20	59	100	180	300	380	500	565
Season	Winter	316	115.6	115.2	6.5	1	1,065	15	45	85	155	240	305	370	475
Season	Spring	423	130.8	105.0	5.1	5	650	30	60	105	175	270	330	435	515
Season	Summer	425	129.5	115.1	5.6	1	625	15	45	95	178	290	375	462	530
Season	Fall	220	112.3	118.3	8.0	1	1,130	15	43	78	144	240	290	460	565
Asthma	No	1,266	122.5	109.6	3.1	1	1,130	15	45	90	162	266	330	430	515
Asthma	Yes	105	144.8	145.8	14.2	1	1,065	15	60	110	180	300	390	553	565
Asthma	DK	13	105.0	110.4	30.6	30	450	30	60	60	90	165	450	450	450
Angina	No	1,343	125.5	113.6	3.1	1	1,130	15	50	90	165	270	332	440	525
Angina	Yes	33	72.1	74.0	12.9	5	330	5	30	50	60	180	275	330	330
Angina	DK	8	86.9	41.1	14.5	40	155	40	60	75	115	155	155	155	155
Bronchitis/Emphysema	No	1,331	124.1	113.2	3.1	1	1,130	15	50	90	165	267	330	435	520
Bronchitis/Emphysema	Yes	43	130.0	112.7	17.2	10	553	30	45	110	165	270	340	553	553
Bronchitis/Emphysema	DK	10	84.0	39.8	12.6	40	155	40	60	75	105	148	155	155	155

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)

Exercise

Category	Population Group	N	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		564	77.4	70.4	3.0	4	670	15	30	60	100	150	195	275	420
Gender	Male	262	84.7	75.8	4.7	5	670	20	30	60	117	165	205	285	450
Gender	Female	302	71.1	64.9	3.7	4	525	15	30	60	90	125	175	265	360
Age (years)	-	10	76.5	74.0	23.4	15	270	15	30	60	90	188	270	270	270
Age (years)	1-4	11	127.3	187.2	56.4	15	670	15	30	60	150	160	670	670	670
Age (years)	5-11	26	132.5	126.3	24.8	15	525	25	60	90	180	275	450	525	525
Age (years)	12-17	35	67.8	41.6	7.0	15	180	20	30	60	100	120	150	180	180
Age (years)	18-64	407	77.6	63.6	3.2	4	480	20	30	60	100	145	185	265	300
Age (years)	> 64	75	54.9	44.5	5.1	6	195	10	25	40	70	120	150	193	195
Race	White	480	78.0	71.5	3.3	4	670	15	30	60	100	150	194	285	450
Race	Black	34	74.7	44.7	7.7	15	250	15	45	60	105	120	130	250	250
Race	Asian	10	46.3	25.0	7.9	15	95	15	30	42	60	83	95	95	95
Race	Some Others	14	80.2	73.9	19.8	30	275	30	30	48	90	179	275	275	275
Race	Hispanic	19	63.0	60.7	13.9	15	265	15	30	45	60	160	265	265	265
Race	Refused	7	128.6	130.5	49.3	30	360	30	55	60	270	360	360	360	360
Hispanic	No	516	76.9	70.1	3.1	4	670	15	30	60	99	145	193	275	420
Hispanic	Yes	38	76.6	59.5	9.7	15	265	20	30	60	110	160	250	265	265
Hispanic	DK	3	65.0	69.5	40.1	20	145	20	20	30	145	145	145	145	145
Hispanic	Refused	7	128.6	130.5	49.3	30	360	30	55	60	270	360	360	360	360
Employment	-	72	99.0	111.6	13.2	15	670	20	30	60	120	180	275	525	670
Employment	Full Time	300	72.7	55.6	3.2	5	460	20	30	60	90	130	180	240	291
Employment	Part Time	50	86.0	83.6	11.8	10	420	20	30	60	92	168	300	390	420
Employment	Not Employed	139	72.7	63.4	5.4	4	480	10	30	60	90	135	195	240	265
Employment	Refused	3	113.3	135.8	78.4	30	270	30	30	40	270	270	270	270	270
Education	-	83	102.0	111.0	12.2	15	670	25	30	60	120	205	275	525	670
Education	< High School	21	58.2	66.1	14.4	10	300	10	28	30	60	90	165	300	300
Education	High School Graduate	124	81.0	63.0	5.7	4	298	15	30	60	115	179	205	250	265
Education	< College	104	80.9	70.2	6.9	15	480	20	30	60	113	150	170	240	420
Education	College Graduate	110	73.6	62.5	6.0	5	460	20	30	60	98	130	180	285	297
Education	Post Graduate	122	60.9	38.4	3.5	5	240	15	30	60	80	110	127	165	185
Census Region	Northeast	130	88.4	77.6	6.8	10	450	15	30	60	120	200	240	297	420
Census Region	Midwest	101	63.6	44.3	4.4	10	300	15	30	60	89	115	120	170	215
Census Region	South	177	75.3	71.6	5.4	5	525	15	30	60	90	150	185	298	480
Census Region	West	156	79.6	75.3	6.0	4	670	20	30	60	104	130	183	270	460
Day Of Week	Weekday	426	73.1	63.9	3.1	4	670	15	30	60	90	130	180	240	298
Day Of Week	Weekend	138	90.8	86.6	7.4	6	525	15	30	60	120	200	265	420	460
Season	Winter	150	67.4	49.9	4.1	8	285	15	30	60	90	128	175	213	240
Season	Spring	140	74.9	55.4	4.7	10	360	18	30	60	90	148	181	220	298
Season	Summer	192	93.2	91.3	6.6	5	670	20	30	63	120	180	250	450	525
Season	Fall	82	63.3	63.3	7.0	4	460	15	30	45	75	120	135	300	460
Asthma	No	523	76.6	70.2	3.1	4	670	15	30	60	100	150	185	265	420
Asthma	Yes	37	78.2	51.5	8.5	20	275	20	45	65	100	120	200	275	275
Asthma	DK	4	175.0	167.0	83.5	10	360	10	35	165	315	360	360	360	360
Angina	No	553	77.3	69.4	2.9	4	670	15	30	60	100	145	193	265	420
Angina	Yes	7	27.3	19.6	7.4	6	60	6	10	25	45	60	60	60	60
Angina	DK	4	188.8	150.4	75.2	60	360	60	63	168	315	360	360	360	360
Bronchitis/Emphysema	No	542	77.1	69.5	3.0	4	670	15	30	60	100	145	185	265	420
Bronchitis/Emphysema	Yes	17	64.6	60.6	14.7	10	275	10	30	50	63	120	275	275	275
Bronchitis/Emphysema	DK	5	157.0	149.6	66.9	15	360	15	60	80	270	360	360	360	360

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)																
Walking																
								Percentiles								
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99	
All		1,639	29.7	41.6	1.0	1	540	2	6	16	39	65	95	151	190	
Gender	Male	755	32.5	48.3	1.8	1	540	2	7	20	40	70	100	170	270	
Gender	Female	883	27.3	34.8	1.2	1	360	2	6	15	35	60	94	140	171	
Gender	Refused	1	20.0	-	-	20	20	20	20	20	20	20	20	20	20	
Age (years)	-	38	29.5	23.7	3.9	1	100	2	10	25	40	60	80	100	100	
Age (years)	1-4	58	24.3	26.3	3.5	1	160	2	10	15	35	60	60	70	160	
Age (years)	5-11	155	18.2	21.0	1.7	1	170	1	5	10	25	40	60	65	100	
Age (years)	12-17	223	25.8	32.4	2.2	1	190	2	6	15	30	60	100	135	151	
Age (years)	18-64	944	31.8	45.0	1.5	1	410	2	6	19	40	70	110	171	250	
Age (years)	> 64	221	33.8	49.3	3.3	1	540	2	10	20	45	73	95	155	180	
Race	White	1,289	29.6	43.7	1.2	1	540	2	6	15	35	65	100	160	225	
Race	Black	175	34.8	39.7	3.0	1	250	2	10	20	50	75	125	160	194	
Race	Asian	36	26.6	24.7	4.1	1	100	1	10	20	30	60	78	100	100	
Race	Some Others	30	23.8	21.2	3.9	1	60	1	6	17	43	60	60	60	60	
Race	Hispanic	88	23.1	21.1	2.2	1	100	2	6	15	37	50	60	92	100	
Race	Refused	21	33.2	33.0	7.2	4	150	8	15	20	40	65	65	150	150	
Hispanic	No	1,467	29.9	41.0	1.1	1	410	2	6	16	40	65	100	155	194	
Hispanic	Yes	144	26.8	48.7	4.1	1	540	2	6	15	35	60	70	100	135	
Hispanic	DK	10	30.2	28.8	9.1	2	80	2	10	18	55	78	80	80	80	
Hispanic	Refused	18	35.7	34.8	8.2	8	150	8	15	25	55	65	150	150	150	
Employment	-	431	22.8	28.0	1.3	1	190	2	5	13	30	55	65	131	151	
Employment	Full Time	561	31.0	43.8	1.8	1	365	2	7	16	40	70	100	180	250	
Employment	Part Time	153	26.9	37.1	3.0	1	295	2	5	15	35	60	92	135	165	
Employment	Not Employed	482	35.5	49.4	2.3	1	540	2	10	20	50	75	120	150	250	
Employment	Refused	12	18.4	13.5	3.9	5	55	5	10	17	20	30	55	55	55	
Education	-	472	22.7	27.6	1.3	1	190	2	5	13	30	55	65	130	151	
Education	< High School	138	42.7	71.9	6.1	1	540	3	7	20	50	115	145	360	365	
Education	High School Graduate	366	29.3	41.6	2.2	1	410	2	5	18	35	65	100	150	240	
Education	< College	288	32.5	39.3	2.3	1	295	2	10	20	45	75	100	160	180	
Education	College Graduate	210	29.8	38.8	2.7	1	300	2	8	19	40	60	90	140	225	
Education	Post Graduate	165	34.6	44.6	3.5	1	360	2	10	20	45	80	95	180	200	
Census Region	Northeast	507	34.9	45.3	2.0	1	365	2	10	20	45	75	107	170	250	
Census Region	Midwest	321	29.3	46.9	2.6	1	540	2	6	15	31	60	105	160	180	
Census Region	South	423	25.0	37.7	1.8	1	410	2	5	10	30	60	80	135	171	
Census Region	West	388	28.2	35.0	1.8	1	285	2	8	15	40	60	90	140	180	
Day Of Week	Weekday	1,182	29.3	39.2	1.1	1	540	2	7	18	40	65	92	145	180	
Day Of Week	Weekend	457	30.7	47.4	2.2	1	410	2	5	15	35	60	120	171	200	
Season	Winter	412	32.3	47.7	2.4	1	365	2	6	20	39	75	120	180	250	
Season	Spring	459	28.9	41.5	1.9	1	540	2	6	16	35	60	90	146	180	
Season	Summer	475	26.6	31.3	1.4	1	270	2	6	15	35	60	85	123	160	
Season	Fall	293	32.2	46.7	2.7	1	410	2	8	20	45	61	105	155	295	
Asthma	No	1,504	29.6	42.0	1.1	1	540	2	6	16	36	65	95	152	190	
Asthma	Yes	120	29.7	38.3	3.5	1	250	2	5	15	40	70	118	135	150	
Asthma	DK	15	36.2	27.8	7.2	5	90	5	10	30	60	75	90	90	90	
Angina	No	1,578	29.5	41.5	1.0	1	540	2	6	16	38	65	95	151	190	
Angina	Yes	44	29.0	36.1	5.4	2	150	4	6	15	36	60	115	150	150	
Angina	DK	17	46.6	63.1	15.3	5	270	5	10	30	60	90	270	270	270	
Bronchitis/Emphysema	No	1,553	29.7	42.1	1.1	1	540	2	6	16	38	65	95	151	194	
Bronchitis/Emphysema	Yes	67	27.0	31.9	3.9	1	165	2	5	16	40	60	90	130	165	
Bronchitis/Emphysema	DK	19	35.4	31.4	7.2	3	110	3	10	30	60	90	110	110	110	

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)																
Housekeeping[a]																
								Percentiles								
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		1,943	118.8	113.4	2.6	1	810	10	40	90	165	270	345	465	540
Gender	Male	370	109.4	116.5	6.1	1	810	10	30	60	150	270	360	425	560
Gender	Female	1,573	121.0	112.5	2.8	1	790	15	45	90	165	270	345	465	540
Age (years)	-	47	146.0	121.3	17.7	10	480	10	45	115	240	300	375	480	480
Age (years)	1-4	11	74.1	69.4	20.9	10	270	10	40	60	90	90	270	270	270
Age (years)	5-11	54	42.9	34.1	4.6	1	180	5	20	30	53	80	120	150	180
Age (years)	12-17	72	78.1	75.5	8.9	1	300	5	28	60	105	210	240	285	300
Age (years)	18-64	1,316	120.4	113.7	3.1	1	810	15	40	90	165	270	360	465	525
Age	> 64	443	128.2	118.9	5.7	3	790	10	55	90	180	270	345	540	570
Race	White	1,649	119.1	112.2	2.8	1	790	10	40	90	165	265	340	465	540
Race	Black	137	116.6	109.4	9.3	1	490	5	30	90	150	300	358	480	484
Race	Asian	32	98.8	100.5	17.8	15	425	15	30	60	128	265	345	425	425
Race	Some Others	26	82.4	56.4	11.1	5	210	15	40	60	115	185	190	210	210
Race	Hispanic	71	112.6	129.3	15.3	5	660	8	30	60	135	270	465	518	660
Race	Refused	28	189.3	176.2	33.3	10	810	20	53	148	248	420	465	810	810
Hispanic	No	1,771	117.4	110.6	2.6	1	790	10	40	90	165	265	335	425	525
Hispanic	Yes	134	121.7	129.6	11.2	5	660	10	35	85	135	270	470	540	658
Hispanic	DK	15	146.9	127.9	33.0	10	510	10	30	120	210	240	510	510	510
Hispanic	Refused	23	191.1	180.3	37.6	10	810	20	45	150	255	390	420	810	810
Employment	-	138	65.6	68.8	5.9	1	375	5	25	45	80	180	240	285	300
Employment	Full Time	673	106.6	102.4	3.9	1	655	10	30	70	145	240	325	413	490
Employment	Part Time	193	124.7	117.5	8.5	1	660	15	45	90	180	270	390	480	540
Employment	Not Employed	925	132.7	119.4	3.9	3	790	15	55	105	180	295	370	484	600
Employment	Refused	14	236.8	208.2	55.6	10	810	10	120	183	300	430	810	810	810
Education	-	171	82.2	96.9	7.4	1	810	5	30	45	105	220	270	300	375
Education	< High School	246	140.7	125.4	8.0	3	715	10	60	120	180	300	400	540	660
Education	High School Graduate	677	125.1	120.5	4.6	2	790	15	45	90	175	270	375	490	610
Education	< College	433	112.9	100.1	4.8	1	570	10	40	90	150	240	320	420	470
Education	College Graduate	245	107.3	102.2	6.5	1	585	15	30	60	150	240	328	405	465
Education	Post Graduate	171	130.8	118.0	9.0	5	655	15	60	90	180	280	390	495	540
Census Region	Northeast	464	119.2	116.4	5.4	2	790	10	35	90	165	245	330	480	655
Census Region	Midwest	413	117.9	112.6	5.5	1	715	10	34	88	165	255	345	480	525
Census Region	South	648	119.9	116.2	4.6	1	810	10	40	90	165	285	370	435	540
Census Region	West	418	117.7	106.6	5.2	5	720	15	40	90	165	255	340	420	470
Day Of Week	Weekday	1,316	113.2	111.9	3.1	1	790	10	30	75	150	255	330	470	550
Day Of Week	Weekend	627	130.6	115.6	4.6	1	810	15	55	90	180	290	370	435	525
Season	Winter	470	111.4	100.6	4.6	1	810	10	45	85	160	240	290	390	480
Season	Spring	451	122.6	114.0	5.4	3	720	15	40	90	180	270	360	465	540
Season	Summer	563	111.8	114.5	4.8	1	690	10	30	75	135	255	365	465	610
Season	Fall	459	131.3	122.4	5.7	1	790	15	45	90	180	300	390	480	560
Asthma	No	1,789	118.5	112.1	2.6	1	790	10	40	90	165	270	345	465	540
Asthma	Yes	140	115.7	115.8	9.8	5	690	10	37	67	150	278	378	470	480
Asthma	DK	14	189.3	208.6	55.7	10	810	10	45	123	255	340	810	810	810
Angina	No	1,853	117.7	112.3	2.6	1	790	13	40	90	160	265	345	465	540
Angina	Yes	75	122.9	103.8	12.0	5	394	5	30	90	210	270	320	370	394
Angina	DK	15	234.7	204.0	52.7	10	810	10	120	240	300	480	810	810	810
Bronchitis/Emphysema	No	1,816	118.1	112.9	2.7	1	790	10	40	90	160	270	355	465	540
Bronchitis/Emphysema	Yes	107	118.7	102.9	10.0	5	480	10	30	90	180	255	290	465	470
Bronchitis/Emphysema	DK	20	188.5	176.4	39.5	5	810	8	85	155	240	320	575	810	810

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)

Yardwork/Maintenance[b]

Category	Population Group	N	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		1,414	147.7	148.2	3.9	1	1,080	5	45	100	205	360	470	570	655
Gender	Male	804	174.8	160.2	5.6	2	1,080	10	60	120	250	415	510	600	670
Gender	Female	610	111.9	122.0	4.9	1	900	5	30	75	145	278	360	465	510
Age (years)	-	20	181.9	170.3	38.1	5	600	10	60	116	240	468	570	600	600
Age (years)	1-4	12	93.2	80.8	23.3	5	285	5	30	83	133	178	285	285	285
Age (years)	5-11	26	96.2	85.5	16.8	5	330	5	39	60	120	210	300	330	330
Age (years)	12-17	54	116.0	116.8	15.9	3	505	5	30	90	150	285	385	450	505
Age (years)	18-64	1,015	150.2	154.5	4.8	1	1,080	5	35	100	210	360	480	585	670
Age (years)	> 64	287	149.3	133.8	7.9	2	810	10	60	120	205	330	420	525	630
Race	White	1,249	151.5	150.2	4.3	1	1,080	5	45	105	210	360	480	575	660
Race	Black	77	114.5	127.1	14.5	2	750	5	20	65	165	285	355	405	750
Race	Asian	13	140.0	150.1	41.6	5	425	5	15	85	210	360	425	425	425
Race	Some Others	26	117.2	110.6	21.7	5	380	5	30	88	178	290	360	380	380
Race	Hispanic	37	102.1	113.5	18.7	5	565	5	20	60	120	255	300	565	565
Race	Refused	12	177.1	190.8	55.1	30	600	30	60	98	215	510	600	600	600
Hispanic	No	1,331	148.7	148.0	4.1	1	1,080	5	45	105	209	360	465	570	660
Hispanic	Yes	65	106.2	127.4	15.8	5	575	5	20	60	120	255	300	565	575
Hispanic	DK	8	248.8	206.5	73.0	5	585	5	90	190	420	585	585	585	585
Hispanic	Refused	10	203.5	200.1	63.3	60	600	60	60	120	300	555	600	600	600
Employment	-	92	106.8	101.8	10.6	3	505	5	32	77	148	240	330	450	505
Employment	Full Time	664	146.7	155.5	6.0	1	1,080	5	35	90	203	360	490	575	690
Employment	Part Time	121	134.5	130.8	11.9	2	554	5	30	90	200	317	390	490	495
Employment	Not Employed	526	157.8	147.0	6.4	2	810	10	60	120	220	370	480	595	655
Employment	Refused	11	211.6	198.7	59.9	2	600	2	60	120	375	465	600	600	600
Education	-	105	113.5	113.9	11.1	2	600	5	33	79	150	285	360	450	505
Education	< High School	160	158.5	164.8	13.0	2	900	8	45	111	210	413	493	595	810
Education	High School Graduate	465	151.4	147.0	6.8	3	840	5	50	110	210	345	460	575	690
Education	< College	305	152.8	157.0	9.0	2	1,080	5	45	95	210	360	473	600	630
Education	College Graduate	211	145.4	138.8	9.6	1	625	5	40	105	225	330	465	525	533
Education	Post Graduate	168	142.2	147.8	11.4	2	690	5	30	90	180	340	470	570	630
Census Region	Northeast	291	140.5	139.6	8.2	3	840	5	40	90	200	330	450	525	600
Census Region	Midwest	314	145.1	143.2	8.1	2	780	10	55	95	195	360	445	560	655
Census Region	South	438	152.7	156.4	7.5	2	1,080	5	45	111	205	375	480	585	635
Census Region	West	371	149.6	149.3	7.8	1	750	5	40	104	210	350	480	575	690
Day Of Week	Weekday	878	140.9	140.8	4.8	1	810	5	40	93	190	345	460	560	625
Day Of Week	Weekend	536	158.9	159.2	6.9	2	1,080	5	50	117	225	380	510	600	690
Season	Winter	289	139.4	151.7	8.9	1	690	5	30	75	195	360	480	565	600
Season	Spring	438	162.2	150.5	7.2	3	900	10	60	120	220	360	480	570	700
Season	Summer	458	137.9	140.3	6.6	2	1,080	5	40	90	180	310	440	555	630
Season	Fall	229	150.0	153.4	10.1	2	720	5	40	97	210	390	480	600	655
Asthma	No	1,311	147.0	147.1	4.1	1	1,080	5	45	100	200	355	465	570	635
Asthma	Yes	98	149.3	155.8	15.7	5	670	5	30	90	210	445	480	670	670
Asthma	DK	5	312.0	230.0	102.9	60	600	60	120	300	480	600	600	600	600
Angina	No	1,360	145.3	145.1	3.9	1	900	5	45	100	200	355	465	570	655
Angina	Yes	42	192.6	203.4	31.4	5	1,080	15	60	143	255	465	485	1080	1080
Angina	DK	12	257.1	216.7	62.6	5	600	5	53	233	473	510	600	600	600
Bronchitis/Emphysema	No	1,352	148.5	148.5	4.0	1	1,080	5	45	105	205	360	470	570	660
Bronchitis/Emphysema	Yes	57	114.7	121.4	16.1	5	460	5	30	60	135	340	375	405	460
Bronchitis/Emphysema	DK	5	312.0	230.0	102.9	60	600	60	120	300	480	600	600	600	600

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)

-	= Indicates missing data.
DK	= The respondent replied “don’t know”.
Refused	= Refused data.
N	= Doer sample size.
SD	= Standard deviation.
SE	= Standard error.
Min	= Minimum number of minutes.
Max	= Maximum number of minutes.

[a] Includes cleaning house, other repairs, and household work.

[b] Includes car repair services, other repairs services, outdoor cleaning, car repair maintenance, other repairs, plant care, other household work, domestic crafts, domestic arts.

Source: U.S. EPA, 1996.

Table 16-27. Number of Showers Taken per Day, by Number of Respondent, Children <21 Years

Age (years)	N	Showers per Day				
		0	1	2	3	Don't Know
Birth to <1	37	36	1	0	0	0
1 to <2	53	48	5	0	0	0
2 to <3	67	54	10	2	0	1
3 to <6	187	153	25	7	1	1
6 to <11	245	122	95	25	1	2
11 to <16	258	51	150	53	3	1
16 to <21	232	23	147	57	5	0

N = Total number.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996 (NHAPS).

Table 16-28. Time Spent (minutes) Bathing, Showering, and in Bathroom Immediately after Bathing and Showering, Children <21 Years

Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Duration of Bath (minutes)															
Birth to <1	26	19	5	5	5	6	8	10	18	28	30	30	45	53	60
1 to <2	37	23	10	10	10	10	10	15	20	30	30	32	41	43	45
2 to <3	48	23	1	2.9	5	7	10	15	20	30	30	45	60	60	60
3 to <6	125	24	5	5	5	6	10	15	25	30	35	60	60	61	61
6 to <11	89	24	5	5	5	10	10	15	20	30	31	46	60	60	61
11 to <16	38	25	5	6	6	10	10	16	20	30	40	43	60	61	61
16 to <21	17	33	10	11	12	14	18	20	30	45	60	60	61	61	61
Duration in Bathroom Immediately Following a Bath (minutes)															
Birth to <1	26	2	0	0	0	0	0	0	1	3	9	10	10	10	10
1 to <2	37	3	0	0	0	0	0	1	2	5	5	6	10	10	10
2 to <3	48	4	0	0	0	0	0	0	1.5	5	10	15	15	18	20
3 to <6	125	4	0	0	0	0	0	1	2	5	10	15	15	19	30
6 to <11	89	4	0	0	0	0	0	1	3	5	10	10	16	21	30
11 to <16	38	9	0	0	0	1	1	2	5	14	20	26	33	36	40
16 to <21	17	11	0	0	1	2	3	5	10	10	19	29	39	42	45
Sum of Duration in Bath and in Bathroom Immediately Following Bath (minutes)															
Birth to <1	26	22	6	7	8	9	10	12	19	29	32	38	55	63	70
1 to <2	37	26	10	10	11	12	16	17	30	32	35	41	46	48	50
2 to <3	48	26	6	7	8	10	14	16	23	34	45	50	60	61	61
3 to <6	125	28	5	6	7	10	12	18	30	32	48	60	66	69	76
6 to <11	89	28	6	6	9	10	13	20	25	33	41	60	63	71	80
11 to <16	38	33	7	8	10	12	16	23	31	41	52	64	70	70	70
16 to <21	17	45	15	15	16	17	21	30	40	60	73	77	82	83	85
Duration of Shower (minutes)															
Birth to <1	1	15	15	-	-	-	-	-	-	-	-	-	-	-	15
1 to <2	5	20	5	-	-	-	-	-	-	-	-	-	-	-	30
2 to <3	12	22	5	5	5	5	6	14	20	30	30	44	53	57	60
3 to <6	33	17	3	4	4	5	5	10	15	20	30	34	47	54	60
6 to <11	119	18	4	5	5	5	7	10	15	20	30	41	57	60	60
11 to <16	204	18	3	4	5	5	6	10	15	20	30	40	50	60	60
16 to <21	207	20	3	5	5	5	8	10	15	30	40	45	60	60	61
Duration in Shower Room Immediately Following a Shower (minutes)															
Birth to <1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	1
1 to <2	5	10	0	-	-	-	-	-	-	-	-	-	-	-	45
2 to <3	12	5	0	0	0	1	1	1	4	6	10	12	14	14	15
3 to <6	33	7	0	0	1	2	2	3	5	10	15	20	22	23	25
6 to <11	119	6	0	0	0	0	1	2	5	10	13	16	26	30	30
11 to <16	204	8	0	0	0	0	1	3	5	10	19	30	40	45	60
16 to <21	207	8	0	0	0	0	1	3	5	10	15	20	30	39	61

Table 16-28. Time Spent (minutes) Bathing, Showering, and in Bathroom Immediately after Bathing and Showering, Children <21 Years (continued)

Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Sum of Shower Duration and Time Spent in Shower Room Immediately Following Shower (minutes)															
Birth to <1	1	16	16	-	-	-	-	-	-	-	-	-	-	-	16
1 to <2	5	30	6	-	-	-	-	-	-	-	-	-	-	-	60
2 to <3	12	27	6	6	7	8	11	19	21	33	44	56	65	67	70
3 to <6	33	24	8	8	8	8	8	13	25	30	40	45	57	64	70
6 to <11	119	24	5	6	6	8	10	15	20	30	43	50	61	68	90
11 to <16	204	26	4	5	7	10	11	15	22	35	50	60	65	70	70
16 to <21	207	28	4	5	7	10	10	15	25	35	50	60	74	89	121

N = Doer sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes less than 10.
Note: A value of “61” was used for any shower, bath, or bathroom stay longer than 60 minutes. A value of “121” for the sum of shower duration and time spent in bathroom following shower (or the sum of bath duration and time spent in bathroom following bath) signifies that more than 120 minutes were spent.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996 (NHAPS).

Table 16-29. Mean Time Spent (minutes/day) and Bathing/Showering, Adults 18 Years and Older, Doers Only

	Mean No. Baths/Showers per Day[a]	Median Time Spent in Shower/Bath[b] (minutes/bath)	Time Spent in Shower/Bath[c] (minutes/day)
18-64	1.27	13.5	17.1
≥65	1.14	15.0	17.1

[a] For additional statistics see Table 16-31. Calculated by averaging the reported number of baths/showers taken per day (truncated at 11), by the number of respondents. Respondents responding Missing and Don’t Know were excluded (n=5).
[b] For additional statistics see Table 16-32
[c] Calculated by multiplying the mean number of showers/baths per day by the median time spent in shower/bath.

Source: U.S. EPA, 1996.

Table 16-30. Number of Times Respondent Took Shower or Bathed, Doers Only											
Group Name	N	-	1	2	3	4	5	8	10	11+	DK
All	3,594	2	2,747	802	30	1	1	1	1	4	5
Gender											
Male	1,720	-	1,259	436	21	1	-	-	-	1	2
Female	1,872	2	1,486	366	9	-	1	1	1	3	3
Refused	2	-	2	-	-	-	-	-	-	-	-
Age											
-	64	-	46	17	-	-	-	-	-	-	1
1-4	41	-	30	9	1	-	-	-	-	-	1
5-11	140	-	112	26	1	-	-	-	-	-	1
12-17	270	-	199	65	6	-	-	-	-	-	-
18-64	2,650	1	1,983	636	21	-	-	-	-	3	2
> 64	429	1	377	49	1	-	-	-	-	1	-
Race											
White	2,911	2	2,323	562	17	-	1	-	-	4	2
Black	349	-	199	140	7	1	-	1	-	-	1
Asian	64	-	49	14	1	-	-	-	-	-	-
Some Others	65	-	40	23	2	-	-	-	-	-	-
Hispanic	162	-	103	56	2	-	-	-	1	-	-
Refused	43	-	33	7	1	-	-	-	-	-	2
Hispanic											
No	3,269	2	2,521	711	24	1	1	1	-	4	4
Yes	277	-	190	81	5	-	-	-	1	-	-
DK	17	-	13	4	-	-	-	-	-	-	-
Refused	31	-	23	6	1	-	-	-	-	-	1
Employment											
-	439	-	330	99	8	-	-	-	-	-	2
Full Time	1,838	1	1,361	454	17	-	-	-	1	2	2
Part Time	328	1	261	65	-	-	1	-	-	-	-
Not Employed	967	-	780	177	5	1	-	1	-	2	1
Refused	22	-	15	7	-	-	-	-	-	-	-
Education											
-	515	-	382	121	9	-	-	-	-	-	3
< High School	297	-	240	54	2	-	-	-	-	1	-
High School Graduate	1,042	1	789	243	5	-	1	1	-	1	1
< College	772	1	589	176	4	-	-	-	1	-	1
College Graduate	576	-	434	133	7	1	-	-	-	1	-
Post Graduate	392	-	313	75	3	-	-	-	-	1	-
Census Region											
Northeast	828	-	622	196	7	-	-	-	-	-	3
Midwest	756	-	621	131	3	-	-	-	-	-	1
South	1,246	1	893	334	14	1	-	-	-	3	-
West	764	1	611	141	6	-	1	1	1	1	1
Day Of Week											
Weekday	2,481	-	1,889	563	17	1	1	1	1	4	4
Weekend	1,113	2	858	239	13	-	-	-	-	-	1
Season											
Winter	941	-	732	198	9	-	-	-	-	1	1
Spring	889	-	674	205	7	-	-	-	1	-	2
Summer	1,003	-	735	254	10	1	-	-	-	2	1
Fall	761	2	606	145	4	-	1	1	-	1	1
Asthma											
No	3,312	2	2,543	730	25	1	1	1	1	4	4
Yes	261	-	189	67	5	-	-	-	-	-	-
DK	21	-	15	5	-	-	-	-	-	-	1
Angina											
No	3,481	1	2,653	730	25	1	1	1	1	4	4
Yes	261	-	189	67	5	-	-	-	-	-	-
DK	22	-	17	4	-	-	-	-	-	-	1

Table 16-30. Number of Times Respondent Took Shower or Bathed, Doers Only (continued)											
Group Name	N	-	1	2	3	4	5	8	10	11+	DK
Bronchitis/Emphysema											
No	3,419	2	2,620	758	27	1	1	1	1	4	4
Yes	154	-	112	39	3	-	-	-	-	-	-
DK	21	-	15	5	-	-	-	-	-	-	1

- = Indicates missing data.
DK = The respondent replied "don't know".
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996

Table 16-31. Time Spent (minutes/day) Bathing and Showering, Doers Only [a]

								Percentiles							
Group Name	Group Code	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		6,416	26.1	29.7	0.4	1	705	5	10	20	30	50	60	90	120
Gender	Male	2,930	24.2	31.0	0.6	1	705	5	10	20	30	45	60	75	100
Gender	Female	3,484	27.6	28.4	0.5	1	555	5	10	20	30	60	75	105	135
Gender	Refused	2	20.0	14.1	10.0	10	30	10	10	20	30	30	30	30	30
Age (years)	-	114	29.0	39.0	3.7	2	300	5	10	20	30	60	60	105	275
Age (years)	1-4	330	30.0	19.4	1.1	1	170	10	15	30	31	55	60	85	90
Age (years)	5-11	438	25.8	35.3	1.7	1	690	5	15	20	30	45	60	60	75
Age (years)	12-17	444	23.1	18.7	0.9	1	210	5	10	18	30	45	60	65	90
Age (years)	18-64	4,383	25.4	27.2	0.4	1	555	5	10	20	30	50	60	90	120
Age (years)	> 64	707	29.9	44.5	1.7	1	705	5	10	20	30	60	85	120	150
Race	White	5,117	25.0	28.5	0.4	1	705	5	10	20	30	45	60	90	115
Race	Black	707	31.5	31.6	1.2	1	295	5	15	22	40	60	80	120	170
Race	Asian	112	28.2	29.8	2.8	5	270	5	15	20	30	60	75	90	90
Race	Some Others	122	30.2	27.3	2.5	1	240	8	15	28	35	50	60	100	150
Race	Hispanic	280	28.8	39.3	2.3	2	546	5	15	20	32	55	63	90	155
Race	Refused	78	27.6	40.3	4.6	3	275	5	10	15	30	60	100	195	275
Hispanic	No	5,835	25.9	28.5	0.4	1	705	5	10	20	30	50	60	90	120
Hispanic	Yes	486	28.8	40.6	1.8	2	570	5	15	20	30	50	60	90	140
Hispanic	DK	33	25.8	16.8	2.9	5	65	10	15	20	30	55	65	65	65
Hispanic	Refused	62	24.3	37.2	4.7	3	275	5	10	15	25	30	60	105	275
Employment	-	1,189	26.1	26.4	0.8	1	690	5	15	20	30	45	60	75	90
Employment	Full Time	3,095	24.1	25.1	0.5	1	555	5	10	15	30	45	60	85	110
Employment	Part Time	558	24.8	23.2	1.0	1	295	5	10	20	30	46	60	90	110
Employment	Not Employed	1,528	30.3	39.9	1.0	1	705	5	10	20	30	60	85	120	155
Employment	Refused	46	30.4	45.2	6.7	3	275	5	10	15	30	55	105	275	275
Education	-	1,330	25.7	26.4	0.7	1	690	5	15	20	30	45	60	75	90
Education	< High School	474	33.3	53.0	2.4	1	570	5	15	21	33	60	85	110	300
Education	High School Graduate	1,758	25.8	23.6	0.6	1	270	5	10	20	30	50	60	90	120
Education	< College	1,288	26.4	27.0	0.8	1	255	5	10	20	30	55	75	105	150
Education	College Graduate	897	25.4	34.8	1.2	1	705	5	10	15	30	50	65	105	135
Education	Post Graduate	669	22.8	23.1	0.9	1	257	5	10	15	30	45	60	85	100
Census Region	Northeast	1,444	25.0	24.3	0.6	1	360	5	10	20	30	50	60	90	105
Census Region	Midwest	1,402	24.6	30.3	0.8	1	570	5	10	15	30	45	60	85	115
Census Region	South	2,266	27.4	26.1	0.5	1	300	5	15	20	30	55	65	100	135
Census Region	West	1,304	26.5	38.8	1.1	1	705	5	10	20	30	48	60	90	133
Day Of Week	Weekday	4,427	25.3	30.3	0.5	1	705	5	10	20	30	45	60	90	115
Day Of Week	Weekend	1,989	27.9	28.2	0.6	1	555	5	15	20	30	60	68	100	130
Season	Winter	1,796	26.9	26.9	0.6	1	546	5	11	20	30	50	60	90	110
Season	Spring	1,645	28.6	41.1	1.0	1	705	5	15	20	30	60	70	115	150
Season	Summer	1,744	23.9	20.7	0.5	1	270	5	10	20	30	45	60	80	100
Season	Fall	1,231	24.7	25.6	0.7	1	340	5	10	17	30	50	60	95	120
Asthma	No	5,912	26.1	30.0	0.4	1	705	5	10	20	30	50	60	90	120
Asthma	Yes	468	26.5	23.0	1.1	1	210	5	15	20	30	46	60	100	120
Asthma	DK	36	23.1	44.1	7.3	3	275	5	10	15	25	30	30	275	275
Angina	No	6,243	26.0	29.0	0.4	1	705	5	10	20	30	50	60	90	120
Angina	Yes	131	31.1	49.5	4.3	5	546	5	15	25	30	50	60	105	131
Angina	DK	42	22.2	40.9	6.3	3	275	5	10	15	25	30	30	275	275
Bronchitis/Emphysema	No	6,112	26.1	29.9	0.4	1	705	5	10	20	30	50	60	90	120
Bronchitis/Emphysema	Yes	268	27.2	22.2	1.4	1	150	5	13	20	30	60	60	95	131
Bronchitis/Emphysema	DK	36	22.5	44.1	7.3	3	275	5	10	15	23	30	30	275	275

- = Indicates missing data.
DK = The respondent replied "don't know".
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

[a] Includes baby and child care, personal care services, washing and personal hygiene (bathing, showering, etc.)

Source: U.S. EPA, 1996.

Table 16-32. Range of Number of Times Washing the Hands at Specified Daily Frequencies by the Number of Respondents, Children <21 Years

Age (years)	N	Number of Times/Day							
		0	1-2	3-5	6-9	10-19	20-29	30+	DK
Birth to <1	37	2	15	12	2	1	1	0	4
1 to <2	53	7	8	23	8	4	0	2	1
2 to <3	67	0	15	39	10	0	1	0	2
3 to <6	187	2	37	101	27	10	1	2	7
6 to <11	245	2	47	131	34	16	3	1	11
11 to <16	258	8	37	128	49	22	5	2	7
16 to <21	232	0	23	115	47	38	4	3	2

N = Total number.
DK = Respondents answered "don't know."

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996 (NHAPS).

Table 16-33. Range of Number of Times Washing the Hands at Specified Daily Frequencies by the Number of Respondents, Doers Only

	Number of Times/Day									
	Total N	-	0-0	1-2	3-5	6-9	10-19	20-29	30+	DK
Overall	4,663	38	34	311	1,692	1,106	892	223	178	189
Gender										
Male	2,163	16	19	218	975	487	286	59	49	54
Female	2,498	22	15	92	716	619	606	164	129	135
Refused	2	-	-	1	1	-	-	-	-	-
Age (years)										
-	84	8	-	1	25	15	11	4	5	15
1-4	263	-	15	62	125	35	11	2	3	10
5-11	348	1	5	61	191	48	21	4	2	15
12-17	326	3	6	46	159	64	30	7	2	9
18-64	2,972	18	7	131	1,029	760	640	168	143	76
> 64	670	8	1	10	163	184	179	38	23	64
Race										
White	3,774	21	28	251	1,377	902	740	181	140	134
Black	463	6	2	30	149	120	85	19	23	29
Asian	77	1	-	5	29	19	12	4	1	6
Some Others	96	-	1	10	39	16	15	8	5	2
Hispanic	193	1	3	14	78	42	31	10	5	9
Refused	60	9	-	1	20	7	9	1	4	9
Hispanic										
No	4,244	27	29	276	1,536	1,022	823	205	164	162
Yes	347	2	5	33	130	76	57	17	10	17
DK	26	-	-	1	12	4	5	1	1	2
Refused	46	9	-	1	14	4	7	-	3	8
Employment										
-	926	4	26	165	471	145	61	13	7	34
Full Time	2,017	12	4	96	707	525	406	116	103	48
Part Time	379	-	-	13	142	101	86	10	15	12
Not Employed	1,309	18	4	36	365	327	334	83	52	90
Refused	32	4	-	1	7	8	5	1	1	5
Education										
-	1,021	13	26	174	507	158	74	13	12	44
< High School	399	2	-	8	120	96	88	26	24	35
High School Graduate	1,253	12	4	56	391	318	298	70	47	57
< College	895	2	3	28	284	246	197	59	48	28
College Graduate	650	6	-	23	238	174	139	28	27	15
Post Graduate	445	3	1	22	152	114	96	27	20	10
Census Region										
Northeast	1,048	9	6	68	404	243	195	55	38	30
Midwest	1,036	5	7	68	373	251	212	41	38	41
South	1,601	14	11	108	559	379	299	79	66	86
West	978	10	10	67	356	233	186	48	36	32
Day of Week										
Weekday	3,156	34	22	199	1,103	764	599	155	147	133
Weekend	1,507	4	12	112	589	342	293	68	31	56
Season										
Winter	1,264	6	10	91	507	286	223	55	51	35
Spring	1,181	13	9	78	406	283	238	60	44	50
Summer	1,275	15	9	78	443	315	232	65	48	70
Fall	943	4	6	64	336	222	199	43	35	34
Asthma										
No	4,287	28	32	283	1,562	1,024	819	207	165	167
Yes	341	1	2	26	126	77	69	16	10	14
DK	35	9	-	2	4	5	4	-	3	8
Angina										
No	4,500	28	34	306	1,652	1,069	851	218	171	171
Yes	125	2	-	3	32	34	36	5	3	10
DK	38	8	-	2	8	3	5	-	4	8
Bronchitis/Emphysema										
No	4,424	27	33	302	1,627	1,040	835	213	172	175
Yes	203	3	1	7	57	61	55	10	3	6
DK	36	8	-	2	8	5	2	-	3	8

- = Indicates missing data.
DK = The respondent replied "don't know".
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996

Table 16-34. Number of Times Swimming in a Month in Freshwater Swimming Pool by the Number of Respondents, Children <21 Years

Age (years)	N	Times/Month															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Birth to <1	10	1	4	1	0	0	2	0	0	0	1	0	0	0	0	0	0
1to < 2	8	2	3	1	0	1	0	0	1	0	0	0	0	0	0	0	0
2 to <3	18	3	4	1	0	1	1	0	1	1	2	0	2	0	0	1	0
3 to <6	45	5	7	6	5	2	1	1	2	0	2	0	0	1	1	5	0
6 to <11	76	15	10	5	5	5	3	1	3	0	6	0	5	0	0	7	2
11 to <16	66	19	10	6	3	5	4	1	3	1	4	0	1	0	0	2	0
16 to <21	50	6	6	2	6	6	2	2	1	0	5	1	1	0	0	0	0

Age (years)	N	Times/Month															
		18	20	23	24	25	26	28	29	30	32	40	42	45	50	60	DK
Birth to <1	10	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1to < 2	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 to <3	18	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
3 to <6	45	0	2	0	0	1	0	0	0	3	1	0	0	0	0	0	0
6 to <11	76	0	3	0	1	1	0	0	0	3	0	0	0	0	1	0	0
11 to <16	66	1	2	0	0	0	0	0	0	2	0	0	0	0	0	1	1
16 to <21	50	0	6	0	0	1	2	0	0	3	0	0	0	0	0	0	0

N = Doer sample size.
DK = Respondents answered "don't know."

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996 (NHAPS).

Table 16-35. Time Spent (minutes/month) Swimming in Freshwater Swimming Pool, Children <21 Years

Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Birth to <1	10	96	6	-	-	-	-	-	-	-	-	-	-	-	181
1 to <2	7	105	45	-	-	-	-	-	-	-	-	-	-	-	181
2 to <3	18	116	15	16	17	19	27	60	120	181	181	181	181	181	181
3 to <6	42	137	6	8	9	12	40	83	181	181	181	181	181	181	181
6 to <11	72	151	8	13	17	30	60	150	181	181	181	181	181	181	181
11 to <16	65	139	4	8	11	20	30	90	181	181	181	181	181	181	181
16 to <21	50	145	2	3	5	25	39	124	181	181	181	181	181	181	181

N = Doer sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes of 10 or fewer.
Note: A value of 181 for number of minutes signifies that more than 180 minutes were spent.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996 (NHAPS).

Table 16-36. Number of Times Swimming in a Month in Freshwater Swimming Pool by the Number of Respondents, Doers Only

		Times/Month															
	Total N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Overall	653	147	94	73	47	42	26	11	26	2	38	3	27	2	2	27	2
Gender																	
Male	300	62	47	37	20	16	17	5	9	2	16	2	13	1	-	16	1
Female	352	85	47	36	27	26	9	6	17	-	22	1	14	1	1	11	1
Refused	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Age (years)																	
-	8	2	2	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1-4	63	11	14	7	3	3	4	1	3	1	4	-	2	1	1	2	-
5-11	100	16	15	7	9	6	4	2	4	-	7	-	5	-	-	11	2
12-17	84	21	13	7	4	8	4	2	3	1	8	-	1	-	-	2	-
18-64	360	86	48	50	27	22	11	5	14	-	18	3	15	1	1	10	-
> 64	38	11	2	1	3	2	2	1	2	-	1	-	4	-	-	2	-
Race																	
White	555	126	74	64	44	32	25	10	23	2	36	1	23	2	2	21	1
Black	30	8	7	1	-	2	-	-	1	-	-	2	-	-	-	2	1
Asian	13	3	2	2	-	1	-	1	1	-	1	-	1	-	-	-	-
Some Others	12	2	-	2	2	1	-	-	-	-	-	-	-	-	-	4	-
Hispanic	35	5	8	4	1	6	1	-	1	-	1	-	3	-	-	-	-
Refused	8	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hispanic																	
No	591	135	81	68	44	35	25	10	25	2	36	3	24	1	2	24	2
Yes	55	10	11	5	2	6	1	1	1	-	2	-	3	1	-	3	-
DK	2	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
Refused	5	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Employment																	
-	243	47	41	21	17	15	12	5	10	2	18	-	8	1	1	15	2
Full Time	240	56	38	38	15	13	10	3	8	-	10	1	8	1	1	6	-
Part Time	43	13	2	4	3	8	-	1	1	-	4	2	2	-	-	1	-
Not Employed	122	30	12	10	12	6	3	2	7	-	6	-	9	-	-	5	-
Refused	5	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Education																	
-	257	51	43	21	18	17	12	5	11	2	19	-	8	1	1	15	2
< High School	16	2	2	3	-	3	1	1	1	-	-	1	-	-	-	-	-
High School Graduate	112	28	15	16	11	6	5	1	1	-	5	1	5	-	1	3	-
<College	104	29	11	11	2	9	2	3	7	-	4	1	7	-	-	3	-
College Graduate	93	22	12	14	10	2	3	-	2	-	5	-	6	-	-	4	-
Post Graduate	71	15	11	8	6	5	3	1	4	-	5	-	1	1	-	2	-
Census Region																	
Northeast	136	32	15	10	16	9	4	1	4	-	13	1	8	1	2	4	-
Midwest	130	35	21	17	8	6	7	2	4	-	9	-	4	1	-	6	-
South	235	46	36	29	13	15	12	7	10	2	10	2	8	-	-	9	2
West	152	34	22	17	10	12	3	1	8	-	6	-	7	-	-	8	-
Day of Week																	
Weekday	445	97	67	52	36	25	15	9	14	1	24	2	18	2	2	21	1
Weekend	208	50	27	21	11	17	11	2	12	1	14	1	9	-	-	6	1
Season																	
Winter	62	19	12	5	3	1	2	-	6	-	2	1	3	-	-	-	-
Spring	174	55	25	19	13	9	7	3	7	-	8	-	7	-	-	2	1
Summer	363	61	45	41	29	26	15	8	12	2	27	2	14	2	2	24	1
Fall	54	12	12	8	2	6	2	-	1	-	1	-	3	-	-	1	-
Asthma																	
No	590	132	81	67	43	38	25	10	24	2	37	3	25	2	2	22	2
Yes	56	14	11	5	4	3	1	1	2	-	1	-	2	-	-	5	-
DK	7	1	2	1	-	1	-	-	-	-	-	-	-	-	-	-	-
Angina																	
No	639	143	90	73	47	41	26	10	26	2	37	3	27	2	2	26	2
Yes	8	3	1	-	-	1	-	1	-	-	-	-	-	-	-	1	-
DK	6	1	3	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Bronchitis/Emphysema																	
No	621	138	91	71	45	40	25	10	24	2	38	2	27	2	2	25	2
Yes	26	8	1	2	1	2	1	1	1	-	-	1	-	-	-	2	-
DK	6	1	2	-	1	-	-	-	1	-	-	-	-	-	-	-	-

Table 16-36. Number of Times Swimming in a Month in Freshwater Swimming Pool by the Number of Respondents Doers Only (continued)

	Times/Month																
	18	20	23	24	25	26	28	29	30	31	32	40	42	45	50	60	DK
Overall	2	25	1	1	9	2	1	1	26	2	1	2	2	1	1	2	5
Gender																	
Male	-	10	-	-	4	2	1	-	10	2	1	1	1	-	-	-	4
Female	2	15	1	1	5	-	-	1	16	-	-	1	1	1	1	2	1
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Age (years)																	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1-4	-	2	-	-	-	-	-	1	2	-	1	-	-	-	-	-	-
5-11	-	3	-	1	2	-	-	-	5	-	-	-	-	-	1	-	-
12-17	1	4	-	-	-	1	-	-	2	-	-	-	-	-	-	1	1
18-64	-	15	1	-	7	1	1	-	15	2	-	2	1	1	-	-	3
> 64	1	1	-	-	-	-	-	-	2	-	-	-	1	-	-	1	1
Race																	
White	2	19	1	1	9	2	1	1	19	2	1	2	2	-	-	2	5
Black	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-
Asian	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Some Others	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Hispanic	-	1	-	-	-	-	-	-	3	-	-	-	-	1	-	-	-
Refused	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Hispanic																	
No	2	23	1	1	9	2	1	1	20	2	1	2	2	-	1	2	4
Yes	-	1	-	-	-	-	-	-	6	-	-	-	-	1	-	-	1
DK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Employment																	
-	1	9	-	1	2	1	-	1	9	-	1	-	-	-	1	1	1
Full Time	-	8	-	-	5	-	1	-	10	2	-	2	1	1	-	-	2
Part Time	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
Not Employed	1	7	1	-	1	1	-	-	6	-	-	-	1	-	-	1	1
Refused	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Education																	
-	1	11	-	1	2	2	-	1	9	-	1	-	-	-	1	1	1
< High School	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
High School Graduate	-	6	-	-	1	-	-	-	4	-	-	-	1	-	-	1	1
< College	-	3	1	-	4	-	-	-	4	-	-	-	-	1	-	-	2
College Graduate	-	2	-	-	2	-	-	-	3	2	-	2	1	-	-	-	1
Post Graduate	1	2	-	-	-	-	1	-	5	-	-	-	-	-	-	-	-
Census Region																	
Northeast	-	7	-	-	2	1	-	-	2	1	-	1	1	-	-	-	1
Midwest	-	4	-	-	1	-	-	-	4	-	-	-	1	-	-	-	-
South	2	7	1	1	4	-	1	1	9	1	-	1	-	-	1	1	4
West	-	7	-	-	2	1	-	-	11	-	1	-	-	1	-	1	-
Day of Week																	
Weekday	1	18	1	1	7	1	1	-	19	-	1	1	-	1	1	2	4
Weekend	1	7	-	-	2	1	-	1	7	2	-	1	2	-	-	-	1
Season																	
Winter	1	3	-	-	-	1	1	-	-	1	-	-	1	-	-	-	-
Spring	-	8	-	-	2	-	-	-	3	-	-	-	1	-	1	1	2
Summer	1	10	1	1	7	1	-	1	21	1	1	2	-	1	-	1	3
Fall	-	4	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
Asthma																	
No	2	21	1	1	9	1	1	1	23	2	1	2	2	1	-	2	5
Yes	-	3	-	-	-	1	-	-	2	-	-	-	-	-	1	-	-
DK	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Angina																	
No	2	24	1	1	9	2	1	1	26	2	1	2	1	1	1	2	5
Yes	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
DK	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bronchitis/Emphysema																	
No	2	22	1	1	9	2	1	1	23	2	1	2	2	1	1	2	4
Yes	-	2	-	-	-	-	-	-	3	-	-	-	-	-	-	-	1
DK	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 16-36. Number of Times Swimming in a Month in Freshwater Swimming Pool by the Number of Respondents Doers Only (continued)																	
	Times/Month																
	18	20	23	24	25	26	28	29	30	31	32	40	42	45	50	60	DK
Overall	2	25	1	1	9	2	1	1	26	2	1	2	2	1	1	2	5
Gender																	
Male	-	10	-	-	4	2	1	-	10	2	1	1	1	-	-	-	4
Female	2	15	1	1	5	-	-	1	16	-	-	1	1	1	1	2	1
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Age (years)																	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1-4	-	2	-	-	-	-	-	1	2	-	1	-	-	-	-	-	-
5-11	-	3	-	1	2	-	-	-	5	-	-	-	-	-	1	-	-
12-17	1	4	-	-	-	1	-	-	2	-	-	-	-	-	-	1	1
18-64	-	15	1	-	7	1	1	-	15	2	-	2	1	1	-	-	3
> 64	1	1	-	-	-	-	-	-	2	-	-	-	1	-	-	1	1
Race																	
White	2	19	1	1	9	2	1	1	19	2	1	2	2	-	-	2	5
Black	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-
Asian	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Some Others	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Hispanic	-	1	-	-	-	-	-	-	3	-	-	-	-	1	-	-	-
Refused	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Hispanic																	
No	2	23	1	1	9	2	1	1	20	2	1	2	2	-	1	2	4
Yes	-	1	-	-	-	-	-	-	6	-	-	-	-	1	-	-	1
DK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Employment																	
-	1	9	-	1	2	1	-	1	9	-	1	-	-	-	1	1	1
Full Time	-	8	-	-	5	-	1	-	10	2	-	2	1	1	-	-	2
Part Time	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
Not Employed	1	7	1	-	1	1	-	-	6	-	-	-	1	-	-	1	1
Refused	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Education																	
-	1	11	-	1	2	2	-	1	9	-	1	-	-	-	1	1	1
< High School	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
High School Graduate	-	6	-	-	1	-	-	-	4	-	-	-	1	-	-	1	1
< College	-	3	1	-	4	-	-	-	4	-	-	-	-	1	-	-	2
College Graduate	-	2	-	-	2	-	-	-	3	2	-	2	1	-	-	-	1
Post Graduate	1	2	-	-	-	-	1	-	5	-	-	-	-	-	-	-	-
Census Region																	
Northeast	-	7	-	-	2	1	-	-	2	1	-	1	1	-	-	-	1
Midwest	-	4	-	-	1	-	-	-	4	-	-	-	1	-	-	-	-
South	2	7	1	1	4	-	1	1	9	1	-	1	-	-	1	1	4
West	-	7	-	-	2	1	-	-	11	-	1	-	-	1	-	1	-
Day of Week																	
Weekday	1	18	1	1	7	1	1	-	19	-	1	1	-	1	1	2	4
Weekend	1	7	-	-	2	1	-	1	7	2	-	1	2	-	-	-	1

- = Indicates missing data.
DK = The respondent replied "don't know".
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996

Table 16-37. Time spent (minutes/month) in Freshwater Swimming Pool, Doers Only														
			Percentiles											
Category	Population Group	N	1	2	5	10	25	50	75	90	95	98	99	100
Overall		640	2	3	10	15	30	60	90	180	181	181	181	181
Gender	Male	295	3	4	8	10	30	45	90	180	181	181	181	181
Gender	Female	345	2	3	10	15	30	60	90	180	181	181	181	181
Age (years)	1-4	60	3	3	7.5	15	20	42.5	120	180	181	181	181	181
Age (years)	5-11	95	2	3	20	30	45	60	120	180	181	181	181	181
Age (years)	12-17	83	4	5	15	20	40	60	120	180	181	181	181	181
Age (years)	18-64	357	2	3	5	10	20	45	60	120	181	181	181	181
Age (years)	> 64	38	5	5	8	10	30	40	60	120	120	181	181	181
Race	White	548	2	3	10	15	30	45	90	180	181	181	181	181
Race	Black	27	10	10	15	30	60	60	150	181	181	181	181	181
Race	Asian	13	4	4	4	20	30	60	60	120	181	181	181	181
Race	Some Others	12	2	2	2	15	25	60	150	181	181	181	181	181
Race	Hispanic	34	3	3	5	10	20	60	120	180	181	181	181	181
Hispanic	No	580	2	3	10	15	30	60	90	180	181	181	181	181
Hispanic	Yes	54	3	5	5	15	30	52.5	120	180	181	181	181	181
Employment	Full Time	237	3	4	5	10	20	45	60	150	181	181	181	181
Employment	Part Time	43	2	2	5	15	20	30	90	120	181	181	181	181
Employment	Not Employed	121	2	2	8	10	20	45	60	120	180	181	181	181
Education	< High School	16	1	1	1	2	12.5	30	60.5	181	181	181	181	181
Education	High School Graduate	111	3	5	8	10	30	60	90	180	181	181	181	181
Education	< College	102	3	3	5	10	20	30	60	120	120	180	181	181
Education	College Graduate	92	2	3	10	15	22.5	42.5	60.5	150	181	181	181	181
Education	Post Graduate	71	5	10	10	10	20	30	60	70	120	180	181	181
Census Region	Northeast	134	4	8	10	15	30	45	120	180	181	181	181	181
Census Region	Midwest	127	5	5	10	15	30	45	90	150	180	181	181	181
Census Region	South	227	2	3	5	15	30	60	120	180	181	181	181	181
Census Region	West	152	2	3	5	10	20	45	61	120	180	181	181	181
Day of Week	Weekday	434	2	3	8	10	30	60	90	180	181	181	181	181
Day of Week	Weekend	206	4	5	10	15	30	60	90	180	181	181	181	181
Season	Winter	60	2	3	5	12.5	30	52.5	90	120	180.5	181	181	181
Season	Spring	171	2	4	5	10	20	40	60	120	180	181	181	181
Season	Summer	356	3	3	10	15	30	60	120	180	181	181	181	181
Season	Fall	53	2	10	10	10	20	45	70	180	181	181	181	181
Asthma	No	578	2	3	10	15	30	55	90	180	181	181	181	181
Asthma	Yes	55	2	3	4	10	30	60	120	180	181	181	181	181
Angina	No	626	2	3	10	15	30	60	90	180	181	181	181	181
Angina	Yes	8	15	15	15	15	25	42.5	75	120	120	120	120	120
Bronchitis/Emphysema	No	608	3	3	10	15	30	60	90	180	181	181	181	181
Bronchitis/Emphysema	Yes	26	2	2	5	5	15	42.5	60	181	181	181	181	181

N = Doer sample size.
Note: A Value of 181 for number of minutes signifies that more than 180 minutes were spent.

Source: U.S. EPA, 1996.

Table 16-38. Time Spent (minutes/day) Playing on Dirt, Sand/Gravel, or Grass Whole Population and Doers only, Children <21 Years

Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Playing on Dirt – Whole Population															
Birth to <1	11	15	0	0	0	0	0	0	0	10	20	71	101	111	121
1 to <2	37	20	0	0	0	0	0	0	0	10	84	121	121	121	121
2 to <3	61	18	0	0	0	0	0	0	0	20	60	120	121	121	121
3 to <6	179	29	0	0	0	0	0	0	0	59	120	121	121	121	121
6 to <11	98	28	0	0	0	0	0	0	0	60	120	121	121	121	121
11 to <16	35	25	0	0	0	0	0	0	1	30	77	120	120	121	121
16 to <21	7	9	0	-	-	-	-	-	-	-	-	-	-	-	30
Playing on Dirt – DOERS ONLY															
Birth to <1	5	33	2	-	-	-	-	-	-	-	-	-	-	-	121
1 to <2	13	56	5	5	5	5	6	10	45	120	121	121	121	121	121
2 to <3	24	47	5	5	5	5	7	15	30	60	121	121	121	121	121
3 to <6	82	63	1	1	1	1	6	30	60	120	121	121	121	121	121
6 to <11	44	63	2	3	5	10	15	30	60	120	121	121	121	121	121
11 to <16	18	49	1	2	2	4	9	19	30	60	120	120	121	121	121
16 to <21	2	30	30	-	-	-	-	-	-	-	-	-	-	-	30
Playing on Sand/Gravel – Whole Population															
Birth to <1	10	4	0	-	-	-	-	-	-	-	-	-	-	-	20
1 to <2	37	17	0	0	0	0	0	0	0	30	60	84	121	121	121
2 to <3	58	24	0	0	0	0	0	0	0	30	120	121	121	121	121
3 to <6	186	30	0	0	0	0	0	0	2	60	120	121	121	121	121
6 to <11	101	30	0	0	0	0	0	0	0	60	120	121	121	121	121
11 to <16	36	30	0	0	0	0	0	0	0	38	120	121	121	121	121
16 to <21	8	42	0	-	-	-	-	-	-	-	-	-	-	-	121
Playing on Sand/Gravel – DOERS ONLY															
Birth to <1	2	18	15	-	-	-	-	-	-	-	-	-	-	-	20
1 to <2	15	43	5	5	5	5	7	15	30	60	103	121	121	121	121
2 to <3	26	53	1	1	1	1	3	10	30	120	121	121	121	121	121
3 to <6	93	60	3	3	3	5	8	25	60	90	121	121	121	121	121
6 to <11	46	67	5	7	10	11	15	30	60	120	121	121	121	121	121
11 to <16	16	67	1	3	5	12	15	26	60	120	121	121	121	121	121
16 to <21	4	83	30	-	-	-	-	-	-	-	-	-	-	-	121
Playing on Grass – Whole Population															
Birth to <1	11	43	0	0	0	0	0	2	30	73	121	121	121	121	121
1 to <2	38	62	0	0	0	0	9	16	60	120	121	121	121	121	121
2 to <3	59	55	0	0	0	0	1	15	30	120	121	121	121	121	121
3 to <6	180	69	0	0	0	0	0	28	60	121	121	121	121	121	121
6 to <11	99	62	0	0	0	0	0	20	60	120	121	121	121	121	121
11 to <16	36	67	0	0	0	0	1	30	60	120	121	121	121	121	121
16 to <21	8	45	0	-	-	-	-	-	-	-	-	-	-	-	120
Playing on Grass – DOERS ONLY															
Birth to <1	9	52	1	-	-	-	-	-	-	-	-	-	-	-	121
1 to <2	35	68	5	7	8	10	15	25	60	120	121	121	121	121	121
2 to <3	53	62	1	2	3	3	5	20	60	120	121	121	121	121	121
3 to <6	157	79	1	2	2	10	15	60	70	121	121	121	121	121	121
6 to <11	85	73	1	5	9	11	17	30	60	120	121	121	121	121	121
11 to <16	32	75	1	5	10	23	30	30	60	120	121	121	121	121	121
16 to <21	6	60	15	-	-	-	-	-	-	-	-	-	-	-	120

N = Sample size.
Min = Minimum.
Max = Maximum.
- = Percentiles were not calculated for sample sizes of 10 or fewer.
Note: A value of “121” for number of minutes signifies that more than 120 minutes were spent.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996 (NHAPS).

Table 16-39. Number of Minutes Spent Playing on Selected Outdoor Surfaces (minutes/day), Doers Only

Dirt

Category	Population Group	N	Percentiles 1	2	5	10	25	50	75	90	95	98	99	100
Overall		647	0	0	0	0	0	0	30	100	121	121	121	121
Gender	Male	326	0	0	0	0	0	0	30	120	121	121	121	121
Gender	Female	320	0	0	0	0	0	0	30	60	121	121	121	121
Age (years)	1-4	205	0	0	0	0	0	0	30	120	121	121	121	121
Age (years)	5-11	185	0	0	0	0	0	0	30	120	121	121	121	121
Age (years)	12-17	38	0	0	0	0	0	0.5	30	60	120	120	120	120
Age (years)	18-64	214	0	0	0	0	0	0	15	60	120	121	121	121
Age (years)	> 64	2	0	0	0	0	0	0	0	0	0	0	0	0
Race	White	528	0	0	0	0	0	0	30	120	121	121	121	121
Race	Black	60	0	0	0	0	0	0	30	74	120	121	121	121
Race	Asian	5	0	0	0	0	0	30	30	121	121	121	121	121
Race	Some Others	16	0	0	0	0	0	0	20	40	60	60	60	60
Race	Hispanic	36	0	0	0	0	0	1	60	120	121	121	121	121
Hispanic	No	574	0	0	0	0	0	0	30	90	121	121	121	121
Hispanic	Yes	69	0	0	0	0	0	1	30	120	121	121	121	121
Employment	Full Time	138	0	0	0	0	0	0	15	60	120	121	121	121
Employment	Part Time	25	0	0	0	0	0	0	10	60	60	121	121	121
Employment	Not Employed	52	0	0	0	0	0	0	10	60	60	121	121	121
Education	< High School	17	0	0	0	0	0	0	60	121	121	121	121	121
Education	High School Graduate	67	0	0	0	0	0	0	10	60	88	120	121	121
Education	< College	62	0	0	0	0	0	0	15	60	60	121	121	121
Education	College Graduate	51	0	0	0	0	0	0	15	30	60	121	121	121
Education	Post Graduate	18	0	0	0	0	0	0	0	60	120	120	120	120
Census Region	Northeast	118	0	0	0	0	0	0	30	60	121	121	121	121
Census Region	Midwest	116	0	0	0	0	0	0	20	60	120	121	121	121
Census Region	South	250	0	0	0	0	0	0	30	90	121	121	121	121
Census Region	West	163	0	0	0	0	0	1	60	121	121	121	121	121
Day of Week	Weekday	406	0	0	0	0	0	0	30	88	121	121	121	121
Day of Week	Weekend	241	0	0	0	0	0	0	30	120	121	121	121	121
Season	Winter	93	0	0	0	0	0	0	45	121	121	121	121	121
Season	Spring	230	0	0	0	0	0	0	30	105	121	121	121	121
Season	Summer	245	0	0	0	0	0	0	30	90	121	121	121	121
Season	Fall	79	0	0	0	0	0	0	10	60	120	121	121	121
Asthma	No	590	0	0	0	0	0	0	30	110	121	121	121	121
Asthma	Yes	56	0	0	0	0	0	10	60	60	121	121	121	121
Angina	No	646	0	0	0	0	0	0	30	100	121	121	121	121
Bronchitis/Emphysema	No	627	0	0	0	0	0	0	30	120	121	121	121	121
Bronchitis/Emphysema	Yes	20	0	0	0	0	0	0	37.5	60	90.5	121	121	121

Table 16-39. Number of Minutes Spent Playing on Selected Outdoor Surfaces (minutes/day), Doers Only (continued)														
Sand or Gravel														
			Percentiles											
Category	Population Group	N	1	2	5	10	25	50	75	90	95	98	99	100
Overall		659	0	0	0	0	0	0	45	120	121	121	121	121
Gender	Male	334	0	0	0	0	0	0	45	120	121	121	121	121
Gender	Female	324	0	0	0	0	0	1	60	120	121	121	121	121
Age (years)	1-4	203	0	0	0	0	0	0	30	120	121	121	121	121
Age (years)	5-11	193	0	0	0	0	0	3	60	121	121	121	121	121
Age (years)	12-17	40	0	0	0	0	0	0	45	120	121	121	121	121
Age (years)	18-64	219	0	0	0	0	0	0	45	120	121	121	121	121
Age (years)	> 64	2	0	0	0	0	0	0	0	0	0	0	0	0
Race	White	534	0	0	0	0	0	0	50	120	121	121	121	121
Race	Black	64	0	0	0	0	0	0	15	120	121	121	121	121
Race	Asian	5	0	0	0	0	0	30	60	121	121	121	121	121
Race	Some Others	15	0	0	0	0	0	0	60	121	121	121	121	121
Race	Hispanic	39	0	0	0	0	0	15	60	121	121	121	121	121
Hispanic	No	583	0	0	0	0	0	0	45	120	121	121	121	121
Hispanic	Yes	72	0	0	0	0	0	1.5	60	120	121	121	121	121
Employment	Full Time	140	0	0	0	0	0	0	45	105	121	121	121	121
Employment	Part Time	27	0	0	0	0	0	10	60	121	121	121	121	121
Employment	Not Employed	53	0	0	0	0	0	0	30	120	121	121	121	121
Education	< High School	17	0	0	0	0	0	0	60	121	121	121	121	121
Education	High School Graduate	69	0	0	0	0	0	0	30	121	121	121	121	121
Education	< College	64	0	0	0	0	0	0	37.5	120	121	121	121	121
Education	College Graduate	50	0	0	0	0	0	0	30	60	60	121	121	121
Education	Post Graduate	20	0	0	0	0	0	15	60	120	120	120	120	120
Census Region	Northeast	116	0	0	0	0	0	0	60	120	121	121	121	121
Census Region	Midwest	122	0	0	0	0	0	0	30	60	121	121	121	121
Census Region	South	256	0	0	0	0	0	0	45	120	121	121	121	121
Census Region	West	165	0	0	0	0	0	0	60	121	121	121	121	121
Day of Week	Weekday	410	0	0	0	0	0	0	40	120	121	121	121	121
Day of Week	Weekend	249	0	0	0	0	0	0	60	121	121	121	121	121
Season	Winter	97	0	0	0	0	0	5	45	120	121	121	121	121
Season	Spring	232	0	0	0	0	0	1	52.5	120	121	121	121	121
Season	Summer	250	0	0	0	0	0	0	60	120	121	121	121	121
Season	Fall	80	0	0	0	0	0	0	30	105	121	121	121	121
Asthma	No	600	0	0	0	0	0	0	45	120	121	121	121	121
Asthma	Yes	58	0	0	0	0	0	3	60	120	121	121	121	121
Angina	No	659	0	0	0	0	0	0	45	120	121	121	121	121
Bronchitis/emphysema	No	638	0	0	0	0	0	0	45	120	121	121	121	121
Bronchitis/emphysema	Yes	21	0	0	0	0	0	30	60	121	121	121	121	121

Table 16-39. Number of Minutes Spent Playing on Selected Outdoor Surfaces (minutes/day), Doers Only (continued)

Grass

			Percentiles											
Category	Population Group	N	1	2	5	10	25	50	75	90	95	98	99	100
Overall		657	0	0	0	0	20	60	120	121	121	121	121	121
Gender	Male	327	0	0	0	0	20	60	121	121	121	121	121	121
Gender	Female	329	0	0	0	0	15	60	120	121	121	121	121	121
Age (years)	1-4	206	0	0	0	0	15	60	120	121	121	121	121	121
Age (years)	5-11	185	0	0	0	0	30	60	121	121	121	121	121	121
Age (years)	12-17	39	0	0	0	0	30	60	120	121	121	121	121	121
Age (years)	18-64	221	0	0	0	0	20	60	120	121	121	121	121	121
Age (years)	> 64	3	30	30	30	30	30	121	121	121	121	121	121	121
Race	White	532	0	0	0	0	20	60	121	121	121	121	121	121
Race	Black	65	0	0	0	3	20	58	90	121	121	121	121	121
Race	Asian	5	10	10	10	10	30	30	30	121	121	121	121	121
Race	Some Others	16	0	0	0	0	10	60	120	121	121	121	121	121
Race	Hispanic	37	0	0	0	0	30	60	110	121	121	121	121	121
Hispanic	No	581	0	0	0	0	20	60	121	121	121	121	121	121
Hispanic	Yes	72	0	0	0	0	10	35	100	121	121	121	121	121
Employment	Full Time	141	0	0	0	0	20	60	121	121	121	121	121	121
Employment	Part Time	27	0	0	0	0	15	60	120	121	121	121	121	121
Employment	Not Employed	55	0	0	0	5	23	60	121	121	121	121	121	121
Education	< High School	20	0	0	0	5	30	60	120.5	121	121	121	121	121
Education	High School Graduate	69	0	0	0	0	15	60	121	121	121	121	121	121
Education	< College	64	0	0	0	0	17.5	46.5	60	121	121	121	121	121
Education	College Graduate	51	0	0	0	1	30	60	121	121	121	121	121	121
Education	Post Graduate	19	0	0	0	0	25	60	121	121	121	121	121	121
Census Region	Northeast	119	0	0	0	0	30	60	121	121	121	121	121	121
Census Region	Midwest	120	0	0	0	7.5	30	60	121	121	121	121	121	121
Census Region	South	252	0	0	0	1	20	60	120	121	121	121	121	121
Census Region	West	166	0	0	0	0	10	45	120	121	121	121	121	121
Day of Week	Weekday	412	0	0	0	0	15	60	120	121	121	121	121	121
Day of Week	Weekend	245	0	0	0	1	30	60	121	121	121	121	121	121
Season	Winter	95	0	0	0	0	4	30	120	121	121	121	121	121
Season	Spring	231	0	0	0	1	30	60	121	121	121	121	121	121
Season	Summer	250	0	0	0	1.5	30	60	121	121	121	121	121	121
Season	Fall	81	0	0	0	0	10	35	120	121	121	121	121	121
Asthma	No	600	0	0	0	0	20	60	120	121	121	121	121	121
Asthma	Yes	56	0	0	0	0	22.5	60	120.5	121	121	121	121	121
Angina	No	656	0	0	0	0	20	60	120	121	121	121	121	121
Bronchitis/Emphysema	No	636	0	0	0	0	20	60	120	121	121	121	121	121
Bronchitis/Emphysema	Yes	21	0	0	0	0	30	60	121	121	121	121	121	121

N = Doer sample size.

NOTE: A value of "121" for number of minutes signifies that more than 120 minutes were spent.

Source: U.S. EPA,1996

Table 16-40. Time Spent (minutes/day) Working or Being Near Excessive Dust in the Air, Children <21 Years															
Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Birth to <1	2	63	5	-	-	-	-	-	-	-	-	-	-	-	121
1 to <2	5	44	0	-	-	-	-	-	-	-	-	-	-	-	121
2 to <3	1	121	121	-	-	-	-	-	-	-	-	-	-	-	121
3 to <6	15	63	0	0	1	1	2	8	60	121	121	121	121	121	121
6 to <11	12	60	0	0	0	1	2	5	45	121	121	121	121	121	121
11 to <16	14	53	0	0	0	1	2	6	38	113	121	121	121	121	121
16 to <21	14	65	2	2	3	4	7	16	53	121	121	121	121	121	121

N = Doer sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes of 10 or fewer.
Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996 (NHAPS).

Table 16-41. Time Spent (minutes/day) Working or Being Near Excessive Dust in the Air, Doers Only

Category	Population Group	N	Percentiles 1	2	5	10	25	50	75	90	95	98	99	100
Overall		679	0	2	5	7	30	121	121	121	121	121	121	121
Gender	Male	341	1	2	5	8	30	121	121	121	121	121	121	121
Gender	Female	338	0	2	5	5	30	121	121	121	121	121	121	121
Age (years)	1-4	22	0	0	0	2	5	75	121	121	121	121	121	121
Age (years)	5-11	50	0	0.5	2	4	15	75	121	121	121	121	121	121
Age (years)	12-17	52	0	1	2	5	5	20	120	121	121	121	121	121
Age (years)	18-64	513	2	5	5	10	30	121	121	121	121	121	121	121
Age (years)	5:> 64	38	2	2	2	5	35	105.5	121	121	121	121	121	121
Race	White	556	0	2	5	8	30	121	121	121	121	121	121	121
Race	Black	66	1	3	5	5	20	121	121	121	121	121	121	121
Race	Asian	7	20	20	20	20	60	90	121	121	121	121	121	121
Race	Some Others	15	5	5	5	10	60	120	121	121	121	121	121	121
Race	Hispanic	29	3	3	5	7	20	121	121	121	121	121	121	121
Hispanic	No	611	0	2	5	5	30	121	121	121	121	121	121	121
Hispanic	Yes	57	0	3	3	10	30	121	121	121	121	121	121	121
Employment	Full Time	368	2	5	7	15	37.5	121	121	121	121	121	121	121
Employment	Part Time	66	0	2	5	5	20	120	121	121	121	121	121	121
Employment	Not Employed	122	0	2	5	8	30	121	121	121	121	121	121	121
Education	< High School	52	2	5	5	7	35	121	121	121	121	121	121	121
Education	High School Graduate	199	0	0	5	10	30	121	121	121	121	121	121	121
Education	< College	140	5	5	10	20	60	121	121	121	121	121	121	121
Education	College Graduate	82	1	2	5	15	30	121	121	121	121	121	121	121
Education	Post Graduate	76	3	5	5	10	37.5	121	121	121	121	121	121	121
Census Region	Northeast	138	0	0	5	5	20	121	121	121	121	121	121	121
Census Region	Midwest	145	2	2	5	10	30	121	121	121	121	121	121	121
Census Region	South	227	1	2	5	5	30	121	121	121	121	121	121	121
Census Region	West	169	0	3	5	10	30	120	121	121	121	121	121	121
Day of Week	Weekday	471	0	1	5	7	30	121	121	121	121	121	121	121
Day of Week	Weekend	208	2	2	5	5	30	121	121	121	121	121	121	121
Season	Winter	154	0	0	5	5	30	121	121	121	121	121	121	121
Season	Spring	193	0	1	3	5	20	121	121	121	121	121	121	121
Season	Summer	193	2	2	5	10	30	121	121	121	121	121	121	121
Season	Fall	139	3	5	5	10	30	121	121	121	121	121	121	121
Asthma	No	606	0	2	5	5	30	121	121	121	121	121	121	121
Asthma	Yes	73	0	3	5	10	30	121	121	121	121	121	121	121
Angina	No	662	0	2	5	7	30	121	121	121	121	121	121	121
Angina	Yes	15	3	3	3	30	60	121	121	121	121	121	121	121
Bronchitis/Emphysema	No	637	0	2	5	7	30	121	121	121	121	121	121	121
Bronchitis/Emphysema	Yes	41	0	0	5	5	30	121	121	121	121	121	121	121

N = Doer sample size.
Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent.

Source: U.S. EPA, 1996.

Age (years)	N	Mean	SD	SE	Min	Percentiles 5	25	50	75	90	95	98	99	Max
1 to 4	155	367	325	26	5	30	90	273	570	825	1,010	1,140	1,305	1,440
5 to 11	224	318	314	21	1	25	105	190	475	775	1,050	1,210	1,250	1,440
12 to 17	256	246	244	15	1	10	60	165	360	595	774	864	1,020	1,260

Table 16-42. Time Spent (minutes/day) with Smokers Present, Children <21 Years

N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum.
Max = Maximum.

Source: U.S. EPA, 1996 (NHAPS).

Table 16-43. Time Spent (minutes/day) with Smokers Present, Doers Only

								Percentiles							
Category	Population Group	N	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		4,005	381.5	300.5	4.7	1	1,440	30	120	319	595	815	925	1,060	1,170
Gender	Male	1,967	411.4	313.0	7.1	1	1,440	30	135	355	638	855	965	1,105	1,217
Gender	Female	2,035	352.8	285.1	6.3	1	1,440	29	105	285	545	780	870	995	1,110
Gender	Refused	3	283.3	188.2	108.6	105	480	105	105	265	480	480	480	480	480
Age (years)	-	54	386.3	305.4	41.6	5	1,440	25	105	370	555	780	995	995	1,440
Age (years)	1-4	155	366.6	324.5	26.1	5	1,440	30	90	273	570	825	1,010	1,140	1,305
Age (years)	5-11	224	318.1	314.0	21.0	1	1,440	25	105	190	475	775	1,050	1,210	1,250
Age (years)	12-17	256	245.8	243.6	15.2	1	1,260	10	60	165	360	595	774	864	1,020
Age (years)	18-64	2,976	403.1	299.4	5.5	2	1,440	30	135	355	625	830	930	1,047	1,150
Age (years)	> 64	340	342.7	292.2	15.8	5	1,440	30	100	240	540	798	880	1,015	1,205
Race	White	3,279	389.2	303.0	5.3	1	1,440	30	120	330	610	825	930	1,060	1,190
Race	Black	395	360.0	288.0	14.5	2	1,440	22	118	300	538	775	905	1,080	1,160
Race	Asian	48	262.1	209.9	30.3	5	800	10	64	213	413	560	630	800	800
Race	Some Others	79	420.7	339.2	38.2	10	1,328	30	135	310	655	885	1,140	1,305	1,328
Race	Hispanic	165	292.6	250.2	19.5	5	1,095	15	75	220	475	660	800	845	945
Race	Refused	39	393.5	325.3	52.1	25	1,110	30	115	290	655	865	1,040	1,110	1,110
Hispanic	No	3,666	384.9	301.2	5.0	1	1,440	30	120	324	600	822	930	1,060	1,170
Hispanic	Yes	288	336.2	280.9	16.6	1	1,440	20	115	252	512	760	850	1,010	1,260
Hispanic	DK	18	369.8	371.5	87.6	15	1,440	15	90	220	600	760	1,440	1,440	1,440
Hispanic	Refused	33	403.4	322.8	56.2	25	1,110	30	120	325	655	840	1,040	1,110	1,110
Employment	-	624	301.7	295.5	11.8	1	1,440	15	75	190	450	735	900	1,140	1,230
Employment	Full Time	2,042	405.9	296.3	6.6	2	1,440	30	135	365	625	835	925	1,005	1,110
Employment	Part Time	381	378.0	291.1	14.9	5	1,440	30	135	325	585	805	915	1,080	1,245
Employment	Not Employed	935	383.8	308.7	10.1	3	1,440	30	120	310	600	825	930	1,110	1,290
Employment	Refused	23	342.0	254.2	53.0	25	925	30	120	325	450	715	885	925	925
Education	-	704	308.6	292.8	11.0	1	1,440	15	88	205	465	741	900	1,095	1,217
Education	< High School	377	497.7	317.8	16.4	2	1,440	40	225	465	775	905	990	1,120	1,369
Education	High School Graduate	1,315	425.7	301.7	8.3	3	1,440	30	155	390	650	840	928	1,060	1,202
Education	< College	829	388.8	295.8	10.3	5	1,435	30	135	330	600	810	930	1,050	1,155
Education	College Graduate	473	325.9	272.7	12.5	2	1,140	30	90	240	499	735	860	990	1,035
Education	Post Graduate	307	282.5	257.1	14.7	3	1,205	20	60	200	430	665	810	900	983
Census Region	Northeast	932	369.5	287.7	9.4	2	1,440	30	120	314	565	800	892	990	1,095
Census Region	Midwest	938	384.1	304.8	10.0	2	1,440	29	120	320	600	825	930	1,080	1,140
Census Region	South	1,409	404.0	308.5	8.2	1	1,440	30	130	345	630	840	943	1,090	1,205
Census Region	West	726	349.9	292.0	10.8	1	1,440	30	110	274	541	800	900	1,045	1,180
Day Of Week	Weekday	2,661	374.7	296.2	5.7	1	1,440	30	120	315	578	810	915	1,045	1,150
Day Of Week	Weekend	1,344	394.9	308.5	8.4	1	1,440	30	120	322	625	833	940	1,110	1,260
Season	Winter	1,046	374.2	304.2	9.4	1	1,440	25	115	295	590	815	925	1,080	1,170
Season	Spring	1,034	384.8	301.6	9.4	2	1,440	30	120	320	610	810	900	1,105	1,215
Season	Summer	1,059	385.1	300.4	9.2	2	1,440	30	120	330	591	840	940	1,040	1,130
Season	Fall	866	382.0	295.1	10.0	2	1,440	30	120	324	590	810	915	1,030	1,150
Asthma	No	3,687	378.8	298.4	4.9	1	1,440	30	120	315	591	810	915	1,050	1,170
Asthma	Yes	298	416.9	324.0	18.8	5	1,440	20	135	343	652	870	1,015	1,202	1,335
Asthma	DK	20	350.0	304.3	68.0	25	995	28	60	290	540	795	902.5	995	995
Angina	No	3,892	380.9	299.5	4.8	1	1,440	30	120	320	595	815	920	1,060	1,170
Angina	Yes	87	404.3	345.1	37.0	2	1,380	30	120	270	703	910	1,015	1,320	1,380
Angina	DK	26	390.6	300.4	58.9	25	995	30	115	343	670	780	790	995	995
Bronchitis/Emphysema	No	3,749	378.7	298.6	4.9	1	1,440	30	120	315	590	810	915	1,060	1,170
Bronchitis/Emphysema	Yes	236	431.2	326.8	21.3	5	1,380	30	150	363	680	892	980	1,205	1,260
Bronchitis/Emphysema	DK	20	326.3	291.1	65.1	10	995	18	85	223	540	755	888	995	995

- = Indicates missing data.
DK = The respondent replied "don't know".
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996

Table 16-44. Mean Time Spent (hours/week)[a] in Ten Major Activity Categories Grouped by Regions

Activity	West N=200	North Central N=304	Northeast N=185	South N=286	Total[b] N=975 Mean	Total[b] N=975 S.D.[c]
Activity Category						
Market Work	23.44	29.02	27.34	24.21	26.15	23.83
House/yard work	14.64	14.17	14.29	15.44	14.66	12.09
Child care	2.50	2.82	2.32	2.66	2.62	5.14
Services/shop	5.22	5.64	4.92	4.72	5.15	5.40
Personal care	79.23	76.62	78.11	79.38	78.24	12.70
Education	2.94	1.43	0.95	1.45	1.65	6.34
Organizations	3.42	2.97	2.45	2.68	2.88	5.40
Social entertainment	8.26	8.42	8.98	8.22	8.43	8.17
Active leisure	5.94	5.28	4.77	5.86	5.49	7.81
Passive leisure	22.47	21.71	23.94	23.47	22.80	13.35
Total Time	168.00	168.00	168.00	168.00	168.00	0.09

[a] Weighted for day of week, panel loss (not defined in report), and correspondence to Census. Data may not add to totals shown due to rounding.
[b] N = surveyed population.
[c] S.D. = standard deviation.

Source: Hill, 1985.

Table 16-45. Total Mean Time Spent (minutes/day) in Ten Major Activity Categories Grouped by Type of Day

	Time Duration (mins/day) Weekday [N[a] = 831]	Saturday [N = 831]	Sunday [N = 831]
Activity Category			
Market Work	288.0 (257.7)[b]	97.9 (211.9)	58.0 (164.8)
House/Yardwork	126.3 (119.3)	160.5 (157.2)	124.5 (133.3)
Child Care	26.6 (50.9)	19.4 (51.5)	24.8 (61.9)
Services/Shopping	48.7 (58.7)	64.4 (92.5)	21.6 (49.9)
Personal Care	639.2 (114.8)	706.8 (169.8)	734.3 (156.5)
Education	16.4 (64.4)	5.4 (38.1)	7.3 (48.0)
Organizations	21.1 (49.7)	18.4 (75.2)	58.5 (104.5)
Social Entertainment	54.9 (69.2)	1,114.1 (156.0)	110.0 (151.2)
Active Leisure	37.9 (71.11)	61.4 (126.5)	64.5 (120.6)
Passive Leisure	181.1 (121.9)	191.8 (161.6)	236.5 (167.1)
Total Time	1,440	1,440	1,440

[a] N = Number of respondents.
[b] ( ) = Numbers in parentheses are standard deviations.

Source: Hill, 1985.

Table 16-46. Mean Time Spent (minutes/day) in Ten Major Activity Categories During Four Waves of Interviews[a]

	Fall (Nov. 1, 1975)[b] N=861	Winter (Feb. 28, 1976)[b]	Spring (June 1, 1976)[b] N=861	Summer (Sept. 21, 1976)[b] N=861	Range of Standard Deviations
Activity Category	**Wave 1**	**Wave 2**	**Wave 3**	**Wave 4**	
Market work	222.94	226.53	210.44	230.92	272-287
House/yard work	133.16	135.58	143.10	119.95	129-156
Child care	25.50	22.44	25.51	21.07	49-58
Services/shop	48.98	44.09	44.61	47.75	76-79
Personal care	652.95	678.14	688.27	674.85	143-181
Education	22.79	12.57	2.87	10.76	32-93
Organizations	25.30	22.55	23.21	29.91	68-87
Social entertainment	63.87	67.11	83.90	72.24	102-127
Active leisure	42.71	47.46	46.19	42.30	96-105
Passive leisure	210.75	183.48	171.85	190.19	144-162
Total Time	1,440.00	1,440.00	1,440.00	1,440.00	--

a Weighted for day of week, panel loss (not defined in report), and correspondence to Census.
b Dates by which 50% of the interviews for each wave were taken.

Source: Hill, 1985.

Table 16-47. Mean Time Spent (hours/week) in Ten Major Activity Categories Grouped by Gender[a]

	Time duration (hours/week)					
	Men n = 140		Women n = 561		Men and Women n = 971	
Activity Category						
Market work	35.8	(23.6)[b]	17.9	(20.7)	26.2	(23.8)
House/yard	8.5	(9.0)	20.0	(11.9)	14.7	(12.1)
Child care	1.2	(2.5)	3.9	(6.4)	2.6	(5.2)
Services/shop	3.9	(4.5)	6.3	(5.9)	5.2	(5.4)
Personal care	77.3	(13.0)	79.0	(12.4)	78.2	(12.7)
Education	2.3	(7.7)	1.1	(4.8)	1.7	(6.4)
Organizations	2.5	(5.5)	3.2	(5.3)	2.9	(5.4)
Social entertainment	7.9	(8.3)	8.9	(8.0)	8.4	(8.2)
Active leisure	5.9	(8.2)	5.2	(7.4)	5.5	(7.8)
Passive leisure	22.8	(14.1)	22.7	(12.7)	22.8	(13.3)
Total time	168.1		168.1		168.1	

a Detailed components of activities (87) are presented in Table 1A-4.
b ( ) = Numbers in parentheses are standard deviations.

Source: Hill, 1985.

Table 16-48. Mean Time Spent (minutes/day) Performing Major Activities, by Age, Sex and Type of Day

Activity	Age (3 to 11 years)				Age (12 to 17 years)			
	Weekdays		Weekends		Weekdays		Weekends	
	Boys (N=118)	Girls (N=111)	Boys (N=118)	Girls (N=111)	Boys (N=77)	Girls (N=83)	Boys (N=77)	Girls (N=83)
Market Work	16	0	7	4	23	21	58	25
Household Work	17	21	32	43	16	40	46	89
Personal Care	43	44	42	50	48	71	35	76
Eating	81	78	78	84	73	65	58	75
Sleeping	584	590	625	619	504	478	550	612
School	252	259	-	-	314	342	-	-
Studying	14	19	4	9	29	37	25	25
Church	7	4	53	61	3	7	40	36
Visiting	16	9	23	37	17	25	46	53
Sports	25	12	33	23	52	37	65	26
Outdoors	10	7	30	23	10	10	36	19
Hobbies	3	1	3	4	7	4	4	7
Art Activities	4	4	4	4	12	6	11	9
Playing	137	115	177	166	37	13	35	24
TV	117	128	181	122	143	108	187	140
Reading	9	7	12	10	10	13	12	19
Household Conversations	10	11	14	9	21	30	24	30
Other Passive Leisure	9	14	16	17	21	14	43	33
NA	22	25	20	29	14	17	10	4
Percent of Time Accounted for by Activities Above	94	92	93	89	93	92	88	89

N = Sample size.
NA = Unknown.
\- = No data

Source: Timmer et al., 1985.

Table 16-49. Mean Time Spent (minutes/day) in Major Activities, by Type of Day for Five Different Age Groups

Activity	Weekday Age (years)					Weekend Age (years)					Significant Effects[a]
	3-5	6-8	9-11	12-14	15-17	3-5	6-8	9-11	12-14	15-17	
Market Work	-	14	8	14	28	-	4	10	29	48	
Personal Care	41	49	40	56	60	47	45	44	60	51	A,S,AxS (F>M)
Household Work	14	15	18	27	34	17	27	51	72	60	A,S, AxS (F>M)
Eating	82	81	73	69	67	81	80	78	68	65	A
Sleeping	630	595	548	473	499	634	641	596	604	562	A
School	137	292	315	344	314	-	-	-	-	-	
Studying	2	8	29	33	33	1	2	12	15	30	A
Church	4	9	9	9	3	55	56	53	32	37	A
Visiting	14	15	10	21	20	10	8	13	22	56	A (Weekend Only)
Sports	5	24	21	40	46	3	30	42	51	37	A,S (M>F)
Outdoor Activities	4	9	8	7	11	8	23	39	25	26	
Hobbies	0	2	2	4	6	1	5	3	8	3	
Art Activities	5	4	3	3	12	4	4	4	7	10	
Other Passive Leisure	9	1	2	6	4	6	10	7	10	18	A
Playing	218	111	65	31	14	267	180	92	35	21	A,S (M>F)
TV	111	99	146	142	108	122	136	185	169	157	A,S, AxS (M>F)
Reading	5	5	9	10	12	4	9	10	10	18	A
Being Read to	2	2	0	0	0	3	2	0	0	0	A
NA	30	14	23	25	7	52	7	14	4	9	A

[a] Effects are significant for weekdays and weekends, unless otherwise specified. A = age effect, P<0.05, for both weekdays and weekend activities; S = sex effect P<0.05, F>M, M>F = females spend more time than males, or vice versa; and AxS = age by sex interaction, P<0.05.

NA = Unknown.

\- = No data.

Source: Timmer et al., 1985.

Table 16-50. Mean Time Spent (hours/day) Indoors and Outdoors, by Age and Day of the Week				
Age Group	Indoors[a]		Outdoors[b]	
	Weekday	Weekend	Weekday	Weekend
3 to 5 years	19.4	18.9	2.5	3.1
6 to 8 years	20.7	18.6	1.8	2.5
9 to 11 years	20.8	18.6	1.3	2.3
12 to 14 years	20.7	18.5	1.6	1.9
15 to 17 years	19.9	17.9	1.4	2.3

[a] Time indoors was estimated by adding the average times spent performing indoor activities (household work, personal care, eating, sleeping, attending school, studying, attending church, watching television, and engaging in conversation) and half the time spent in each activity which could have occurred either indoors or outdoors (i.e., market work, sports, hobbies, art activities, playing, reading, and other passive leisure).

[b] Time outdoors was estimated by adding the average time spent in outdoor activities and half the time spent in each activity which could have occurred either indoors or outdoors (i.e., market work, sports, hobbies, art activities, playing, reading, and other passive leisure).

Source: Adapted from Timmer et al., 1985.

Table 16-51. Mean Time Spent (minutes/day) in Various Microenvironments by Age Groups for the National and California Surveys, by age group (years)

National Data
Mean Duration (Standard Error)

Microenvironment	Age 12-17 N=340[a]	Doer[b]	Age 18-24 N=340	Doer	Age 24-44 N=340	Doer	Age 45-64 N=340	Doer	Age 65+ N=340	Doer
Autoplaces	2 (1)	73	7 (2)	137	2 (1)	43	4 (1)	73	4 (2)	57
Restaurant/bar	9 (2)	60	28 (3)	70	25 (3)	86	19 (2)	67	20 (5)	74
In-vehicle/internal combustion	79 (7)	88	103 (8)	109	94 (4)	101	82 (5)	91	62 (5)	80
In-vehicle/other	0 (0)	12	1 (1)	160	1 (0)	80	1 (1)	198	1 (1)	277
Physical/outdoors	32 (8)	130	17 (4)	110	19 (4)	164	7 (1)	79	15 (4)	81
Physical/indoors	15 (3)	87	8 (2)	76	7 (1)	71	7 (2)	77	7 (1)	51
Work/study-residence	22 (4)	82	19 (6)	185	16 (2)	181	9 (2)	169	5 (3)	297
Work/study-other	159 (14)	354	207 (20)	391	220 (11)	422	180 (13)	429	35 (6)	341
Cooking	11 (3)	40	18 (2)	39	38 (2)	57	43 (3)	64	50 (5)	65
Other activities/kitchen	53 (4)	64	42 (3)	55	70 (4)	86	90 (6)	101	108 (9)	119
Chores/child	91 (7)	92	124 (9)	125	133 (6)	134	121 (6)	122	119 (7)	121
Shop/errands	26 (4)	68	31 (4)	65	33 (2)	66	33 (3)	67	35 (5)	69
Other/outdoors	70 (13)	129	34 (4)	84	48 (6)	105	60 (7)	118	82 (13)	140
Social/cultural	87 (10)	120	100 (12)	141	56 (3)	94	73 (6)	116	85 (8)	122
Leisure-eat/indoors	237 (16)	242	181 (11)	189	200 (8)	208	238 (11)	244	303 (20)	312
Sleep/indoors	548 (31)	551	511 (26)	512	479 (14)	480	472 (15)	472	507 (26)	509

CARB Data
Mean Duration (Standard Error)

Microenvironment	Age 12-17 N=340[a]	Doer	Age 18-24 N=340	Doer	Age 24-44 N=340	Doer	Age 45-64 N=340	Doer	Age 65+ N=340	Doer
Autoplaces	16 (8)	124	16 (4)	71	25 (9)	114	20 (5)	94	9 (2)	53
Restaurant/bar	16 (4)	44	40 (8)	98	44 (5)	116	31 (4)	82	25 (7)	99
In-vehicle/internal combustion	78 (11)	89	111 (13)	122	98 (5)	111	100 (11)	117	63 (8)	89
In-vehicle/other	1 (0)	19	3 (1)	60	5 (2)	143	2 (1)	56	2 (1)	53
Physical/outdoors	32 (7)	110	13 (3)	88	17 (3)	128	14 (3)	123	15 (4)	104
Physical/indoors	20 (4)	65	5 (2)	77	6 (1)	61	5 (1)	77	3 (1)	48
Work/study-residence	25 (5)	76	30 (11)	161	7 (2)	137	10 (3)	139	5 (3)	195
Work/study-other	196 (30)	339	201 (24)	344	215 (14)	410	173 (20)	429	30 (11)	336
Cooking	3 (1)	19	14 (2)	40	32 (2)	59	31 (3)	68	41 (7)	69
Other activities/kitchen	31 (4)	51	31 (5)	55	43 (3)	65	62 (6)	91	97 (14)	119
Chores/child	72 (11)	77	79 (8)	85	110 (6)	119	99 (8)	109	123 (15)	141
Shop/errands	14 (3)	50	35 (7)	71	33 (4)	71	32 (3)	77	35 (5)	76
Other/outdoors	58 (8)	78	80 (15)	130	68 (8)	127	76 (12)	134	55 (7)	101
Social/cultural	63 (14)	109	65 (10)	110	50 (5)	122	50 (5)	107	49 (7)	114
Leisure-eat/indoors	260 (27)	270	211 (19)	234	202 (9)	215	248 (15)	261	386 (34)	394
Sleep/indoors	557 (44)	560	506 (30)	510	487 (17)	491	485 (23)	491	502 (31)	502

[a] All N's are weighted number.
[b] Doer = Respondents who reported participating in each activity/location spent in microenvironments.

Source: Robinson and Thomas, 1991.

Table 16-52. Mean Time Spent in Ten Major Activity Categories Grouped by Total Sample and Gender for the CARB and National Studies (age 18-64 years)

Activity Category	Time Duration (min/day)					
	CARB (1987-88)	National (1985)	CARB (1987-88)		National (1985)	
	Total Sample		Men	Women	Men	Women
	N[a] = 1,359	N = 1,980	N = 639	N = 720	N = 921	N = 1,059
Paid Work	273	252	346	200	323	190
Household Work	102	118	68	137	79	155
Child Care	23	25	12	36	11	43
Obtaining Goods and Services	61	55	48	73	44	62
Personal Needs and Care	642	642	630	655	636	645
Education and Training	22	19	25	20	21	16
Organizational Activities	12	17	11	13	12	20
Entertainment/Social Activities	60	62	57	55	64	62
Recreation	43	50	53	31	69	43
Communication	202	196	192	214	197	194

[a] N = total diary days.

Source: Robinson and Thomas, 1991

Table 16-53. Total Mean Time Spent at Three Major Locations Grouped by Total Sample and Gender for the CARB and National Study (ages 18-64 years)

Location[a]	CARB (1987-88)	National (1985)	CARB (1987-88)		National (1985)	
	Total Sample		Men	Women	Men	Women
	N[a] = 1,359	N = 1,980	N = 39	N = 720	N = 921	N = 1,059
At Home	892	954	822	963	886	1,022
Away From Home	430	384	487	371	445	324
Travel	116	94	130	102	101	87
Not Ascertained	2	8	1	4	8	7
Total Time	1,440	1,440	1,440	1,440	1,440	1,440

[a] N = total diary days.

Source: Robinson and Thomas, 1991.

Table 16-54. Mean Time Spent at Three Locations for both CARB and National Studies (ages 12 years and older)				
	Mean duration (min/day)			
Location Category	CARB (N = 1,762)[b]	SE[a]	National (N = 2,762)[b]	SE
Indoor	1,255[c]	28	1,279[c]	21
Outdoor	86[d]	5	74[d]	4
In-Vehicle	98[d]	4	87[d]	2
Total Time Spent	1,440		1,440	

[a] SE = Standard error of mean
[b] N=Weighted Number – National sample population was weighted to obtain a ratio of 46.5 males and 53.5 females, in equal proportion for each day of the week, and for each quarter of the year.
[c] Difference between the mean values for the CARB and national studies is not statistically significant.
[d] Difference between the mean values for the CARB and national studies is statistically significant at the 0.05 level.

Source: Robinson and Thomas, 1991.

Table 16-55. Gender and Age Groups			
Age Group	Subgroup	Sample Size	Age Range
Adults	Men	724	≥ 18 years
	Women	855	≥ 18 years
Adolescents	Males	98	12-17 years
	Females	85	12-17 years
Children[a]	Young males	145	6-8 years
	Young females	124	6-8 years
	Old males	156	9-11 years
	Old females	160	9-11 years

[a] Children under the age of 6 are excluded for the present study (too few responses in CARB study).

Source: Funk et al., 1998.

Table 16-56. Assignment of At-Home Activities to Inhalation Rate Levels for All individuals

Children		Adolescents and Adults		
Low	Moderate	Low	Moderate	High
Watching child care Night sleep Watch personal care Homework Radio use TV use Records/tapes Reading books Reading magazines Reading newspapers Letters/writing Other leisure Homework/watch TV Reading/TV Reading/listen music Paperwork	Outdoor cleaning Food Preparation Metal clean-up Cleaning house Clothes care Car/boat repair Home repair Plant care Other household Pet care Baby care Child care Helping/teaching Talking/reading Indoor playing Outdoor playing Medical child care Washing, hygiene Medical care Help and care Meals at home Dressing Visiting at home Hobbies Domestic crafts Art Music/dance/drama Indoor dance Conservations Painting room/home Building fire Washing/dressing Outdoor play Playing/eating Playing/talking Playing/watch TV TV/eating TV/something else Reading book/eating Read magazine/eat Read newspaper/eat	Night sleep Naps/resting Doing homework Radio use TV use Records/tapes Read books Read magazines Writing/paperwork Other passive leisure	Food preparation Food clean-up Cleaning house Clothes care Car care Household repairs Plant care Animal care Other household Baby care Child care Helping/teaching Talking/reading Indoor playing Outdoor playing Medical child care Washing Medical care Help and care Meals at home Dressing/grooming Not ascertained Visiting at home Hobbies Domestic crafts Art Music/drama/dance Games Computer use Conversations	Outdoor cleaning

Source: Funk et al., 1998.

Table 16-57. Aggregate Time Spent (minutes/day) At-Home in Activity Groups						
Activity Group	Adults		Adolescents		Children	
	Mean	SD	Mean	SD	Mean	SD
Low	702	214	789	230	823	153
Moderate	257	183	197	131	241[b]	136
High	9	38	1	11	3	17
$High_{participants}$[c]	92	83	43	72	58	47

[a] Time spent engaging in all activities embodied by inhalation rate category (minutes/day).
[b] Significantly different from adolescents ($p < 0.05$).
[c] Participants in high inhalation rate level activities (i.e., doers).
SD = Standard deviation.

Source: Funk et al., 1998.

Table 16-58. Comparison of Mean Time Spent (minutes/day) At-Home, by Gender[a]				
	Male		Female	
Activity Group	Mean	SD	Mean	SD
Adults				
Low	691	226	714	200
Moderate	190	150	323[b]	189
High	14	50	4[b]	18
$High_{participants}$[c]	109	97	59[b]	40
Adolescents				
Low	775	206	804	253
Moderate	181	126	241	134
High	2	16	0	0

[a] Time spent engaging in all activities embodied by inhalation rate category (minutes/day).
[b] Significantly different from male ($p < 0.05$).
[c] Participants in high inhalation rate activities (i.e., doers).
SD = Standard deviation.

Source: Funk et al., 1998.

Table 16-59. Comparison of Mean Time Spent (minutes/day) At-Home, by Gender and Age for Children[a]								
Activity Group	Males				Females			
	6-8 Years		9-11 Years		6-8 Years		9-11 Years	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Low	806	134	860	157	828	155	803	162
Moderate	259	135	198	111	256	141	247	146
High	3	17	7	27	1	9	2	10
$High_{participant}$[b]	77	59	70	54	68	11	30	23

a Time spent engaging in all activities embodied by inhalation rate category (minutes/day).
b Participants in high inhalation rate activities (i.e., doers).
SD = Standard deviation.

Source : Funk et al., 1998.

Table 16-60. Number of Person-Days/Individuals[a] for Children Less than 12 Years in CHAD Database					
Age Group	All Studies	California[b]	Cincinnati[c]	NHAPS-Air	NHAPS-Water
0 Year	223/199	104	36/12	39	44
0 to 6 Months	-	50	15/5	-	-
6 to 12 Months	-	54	21/7	-	-
1 Year	259/238	97	31/11	64	67
12 to 18 Months	-	57	-	-	-
18 to 24 Months	-	40	-	-	-
2 Years	317/264	112	81/28	57	67
3 Years	278/242	113	54/18	51	60
4 Years	259/232	91	41/14	64	63
5 Years	254/227	98	40/14	52	64
6 Years	237/199	81	57/19	59	40
7 Years	243/213	85	45/15	57	56
8 Years	259/226	103	49/17	51	55
9 Years	229/195	90	51/17	42	46
10 Years	224/199	105	38/13	39	42
11 Years	227/206	121	32/11	44	30
Total	3,009/2,640	1,200	556/187	619	634

a The number of person-days of data are the same as the number of individuals for all studies except for the Cincinnati study. Since up to three days of activity pattern data were obtained from each participant in this study, the number of person-days of data is approximately three times the number of individuals.
b The California study referred to in this table is the Wiley et al. (1991) study.
c The Cincinnati study referred to in this table is the Johnson (1989) study.
\- = No data.

Source: Hubal et al., 2000.

Table 16-61. Time Spent (hours/day) in Various Microenvironments, by Age					
Age (years)	Average Time ± Standard Deviation (Percent >0 Hours)				
	Indoors at Home	Outdoors at Home	Indoors at School	Outdoors at Park	In Vehicle
0	19.6 ± 4.3 (99)	1.4 ± 1.5 (20)	3.5 ± 3.7 (2)	1.6 ± 1.5 (9)	1.2 ± 1.0 (65)
1	19.5 ± 4.1 (99)	1.6 ± 1.3 (35)	3.4 ± 3.8 (5)	1.9 ± 2.7 (10)	1.1 ± 0.9 (66)
2	17.8 ± 4.3 (100)	2.0 ± 1.7 (46)	6.2 ± 3.3 (9)	2.0 ± 1.7 (17)	1.2 ± 1.5 (76)
3	18.0 ± 4.2 (100)	2.1 ± 1.8 (48)	5.7 ± 2.8 (14)	1.5 ± 0.9 (17)	1.4 ± 1.9 (73)
4	17.3 ± 4.3 (100)	2.4 ± 1.8 (42)	4.9 ± 3.2 (16)	2.3 ± 1.9 (20)	1.1 ± 0.8 (78)
5	16.3 ± 4.0 (99)	2.5 ± 2.1 (52)	5.4 ± 2.5 (39)	1.6 ± 1.5 (28)	1.3 ± 1.8 (80)
6	16.0 ± 4.2 (98)	2.6 ± 2.2 (48)	5.8 ± 2.2 (34)	2.1 ± 2.4 (32)	1.1 ± 0.8 (79)
7	15.5 ± 3.9 (99)	2.6 ± 2.0 (48)	6.3 ± 1.3 (40)	1.5 ± 1.0 (28)	1.1 ± 1.1 (77)
8	15.6 ± 4.1 (99)	2.1 ± 2.5 (44)	6.2 ± 1.1 (41)	2.2 ± 2.4 (37)	1.3 ± 2.1 (82)
9	15.2 ± 4.3 (99)	2.3 ± 2.8 (49)	6.0 ± 1.5 (39)	1.7 ± 1.5 (34)	1.2 ± 1.2 (76)
10	16.0 ± 4.4 (96)	1.7 ± 1.9 (40)	5.9 ± 1.5 (39)	2.2 ± 2.3 (40)	1.1 ± 1.1 (82)
11	14.9 ± 4.6 (98)	1.9 ± 2.3 (45)	5.9 ± 1.5 (41)	2.0 ± 1.7 (44)	1.6 ± 1.9 (74)
Source: Hubal et al., 2000.					

Table 16-62. Mean Time Children Spent (hours/day) Doing Various Macroactivities While Indoors at Home							
Age (years)	Mean Time (Percent >0 Hours)						
	Eat	Sleep or Nap	Shower or Bathe	Play Games	Watch TV or Listen to Radio	Read, Write, Homework	Think, Relax, Passive
0	1.9 (96)	12.6 (99)	0.4 (44)	4.3 (29)	1.1 (9)	0.4 (4)	3.3 (62)
1	1.5 (97)	12.1 (99)	0.5 (56)	3.9 (68)	1.8 (41)	0.6 (19)	2.3 (20)
2	1.3 (92)	11.5 (100)	0.5 (53)	2.5 (59)	2.1 (69)	0.6 (27)	1.4 (18)
3	1.2 (95)	11.3 (99)	0.4 (53)	2.6 (59)	2.6 (81)	0.8 (27)	1.0 (19)
4	1.1 (93)	10.9 (100)	0.5 (52)	2.6 (54)	2.5 (82)	0.7 (31)	1.1 (17)
5	1.1 (95)	10.5 (98)	0.5 (54)	2.0 (49)	2.3 (85)	0.8 (31)	1.2 (19)
6	1.1 (94)	10.4 (98)	0.4 (49)	1.9 (35)	2.3 (82)	0.9 (38)	1.1 (14)
7	1.0 (93)	9.9 (99)	0.4 (56)	2.1 (38)	2.5 (84)	0.9 (40)	0.6 (10)
8	0.9 (91)	10.0 (96)	0.4 (51)	2.0 (35)	2.7 (83)	1.0 (45)	0.7 (7)
9	0.9 (90)	9.7 (96)	0.5 (43)	1.7 (28)	3.1 (83)	1.0 (44)	0.9 (17)
10	1.0 (86)	9.6 (94)	0.4 (43)	1.7 (38)	3.5 (79)	1.5 (47)	0.6 (10)
11	0.9 (89)	9.3 (94)	0.4 (45)	1.9 (27)	3.1 (85)	1.1 (47)	0.6 (10)
Source: Hubal et al., 2000.							

Table 16-63. Time Children Spent (hours/day) in Various Microenvironments, by Age Recast into New Standard Age Categories

Age Group	N	Indoors at Home		Outdoors at Home		Indoors at School		Outdoors at Park		In Vehicle	
		Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing
Birth to <1 month	123	19.6	98	1.7	21	4.3	3	1.3	3	1.3	63
1 to <3 months	33	20.9	100	1.8	9	0.2	3	1.6	9	1.3	27
3 to <6 months	120	19.6	100	0.8	8	7.8	7	1.3	6	1.1	14
6 to <12 months	287	19.1	99	1.1	15	7.6	8	1.8	5	1.3	14
1 to <2 years	728	19.2	99	1.4	34	6.4	9	1.5	5	1.1	27
2 to <3 years	765	18.2	99	1.8	38	6.8	12	2.1	7	1.3	28
3 to <6 years	2,110	17.3	100	1.9	43	5.9	26	1.6	10	1.3	29
6 to <11 years	3,283	15.7	99	1.9	40	6.5	44	2.1	17	1.1	29
11 to <16 years	2,031	15.5	97	1.7	30	6.6	45	2.6	15	1.3	42
16 to <21 years	1,005	14.6	98	1.4	20	5.7	33	3.1	10	1.7	90

N = Sample size.

Source: Based on data source used by Hubal et al., 2000 (CHAD).

Table 16-64. Time Children Spent (hours/day) in Various Macroactivities While Indoors at Home Recast Into New Standard Age Categories

Age Group	N	Eat		Sleep or Nap		Shower or Bathe		Play Games		Watch TV/ Listen to Radio		Read, Write, Homework		Think, Relax, Passive	
		Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing
Birth to <1 month	123	2.2	98	13.0	100	0.5	41	5.0	53	1.3	8	0.7	2	2.7	48
1 to <3 months	33	2.4	100	14.8	100	0.4	24	0.7	6	1.6	15	0.0	0	3.5	79
3 to <6 months	120	2.0	100	13.5	100	0.5	9	1.3	31	1.0	21	1.1	3	2.5	59
6 to <12 months	287	1.8	100	12.9	100	0.4	11	1.1	30	1.3	25	0.5	4	2.5	35
1 to <2 years	728	1.7	99	12.5	100	0.5	21	3.2	45	1.8	52	0.6	13	1.4	26
2 to <3 years	765	1.5	98	12.0	100	0.5	22	2.6	45	2.0	77	0.6	18	0.8	30
3 to <6 years	2,110	1.4	99	11.2	100	0.5	38	2.5	38	2.3	86	0.7	25	0.8	28
6 to <11 years	3,283	1.2	98	10.2	100	0.4	54	2.0	28	2.6	84	1.0	43	0.8	20
11 to <16 years	2,031	1.1	94	9.7	98	0.4	50	1.8	18	3.0	85	1.4	45	0.8	20
16 to <21 years	1,005	1.0	84	8.9	98	0.4	45	1.9	5	3.2	73	2.2	37	1.3	24

N = Sample size.

Source: Based on data source used by Hubal et al., 2000 (CHAD).

Table 16-65. Number and Percentage of Respondents with Children and Those Reporting Outdoor Play[a] Activities in both Warm and Cold Weather

Source	Respondents with Children	Child Players[a]		Child non-Players		Warm Weather Players[a]	Cold Weather Players	Players in Both Seasons
	N	N	%	N	%	N	N	%
SCS-II base	197	128	65.0	69	35.0	127	100	50.8
SCS-II over sample	483	372	77.0	111	23.0	370	290	60.0
Total	680	500	73.5	180	26.5	497	390	57.4

[a] "Play" and "player" refer specifically to participation in outdoor play on bare dirt or mixed grass and dirt.
[b] Does not include three "Don't know/refused" responses regarding warm weather play.
N = Sample size.

Source: Wong et al., 2000.

Table 16-66. Play Frequency and Duration for all Child Players (from SCS-II data)

Statistic	Cold Weather			Warm Weather		
	Frequency (days/week)	Duration (hours/day)	Total (hours/week)	Frequency (days/week)	Duration (hours/day)	Total (hours/week)
N	372	374	373	488	479	480
5th Percentile	1	1	1	2	1	4
50th Percentile	3	1	5	7	3	20
95th Percentile	7	4	20	7	8	50

N = Sample size.

Source: Wong et al., 2000.

Table 16-67. Hand Washing and Bathing Frequency for all Child Players (from SCS-II data)

Statistic	Cold Weather		Warm Weather	
	Hand washing (times/day)	Bathing (times/week)	Hand washing (times/day)	Bathing (times/week)
N	329	388	433	494
5th Percentile	2	2	2	3
50th Percentile	4	7	4	7
95th Percentile	10	10	12	14

N = Sample size.

Source: Wong et al., 2000.

Table 16-68. NHAPS and SCS-II Play Duration[a] Comparison (Children Only)				
Data Source	Mean Play Duration (minutes/day)			X^2 test[b]
	Cold Weather	Warm Weather	Total	
NHAPS	114	109	223	p<0.0001
SCS-II	102	206	308	

[a] Selected previous day activities in NHAPS; average day outdoor play on bare dirt or mixed grass and dirt in SCS-II.
[b] 2x2 Chi-square test for contingency between NHAPS and SCS-II.

Source: Wong et al., 2000.

Table 16-69. NHAPS and SCS-II Hand Wash Frequency[a] Comparison (Children only)										
Data Source	Season	Percent[b] Reporting Frequency (times/day) of:								X^2 test[c]
		0	1-2	3-5	6-9	10-19	20-29	30+	"Don't Know"	
NHAPS	Cold	3	18	51	17	7	1	1	3	p = 0.06
SCS-II	Cold	1	16	50	11	7	1	0	15	
NHAPS	Warm	3	18	51	15	7	2	1	4	p = 0.001
SCS-II	Warm	0	12	46	16	10	1	0	13	

[a] Selected previous day activities in NHAPS; average day outdoor play on bare dirt or mixed grass and dirt in SCS-II.
[b] Results are reported as percentage of total for clarity. Incidence data were used in statistical tests.
[c] 2x2 Chi-square test for contingency between NHAPS and SCS-II.

Source: Wong et al., 2000.

Table 16-70. Time Spent (minutes/day) Outdoors
Based on CHAD Data (Doers Only)[a]

Age Group	N	Time Spent Outdoors					COV(%)	Participation[b] (%)
		Minimum	Median	Maximum	Mean	SD		
<1 month	57	2	60	700	99	124	125	47
1 to 2 months	5	4	60	225	102	90	89	36
3 to 5 months	27	10	90	510	114	98	86	23
6 to 11 months	91	5	60	450	91	76	84	33
1 year	389	1	75	1,035	102	99	97	58
2 years	448	1	100	550	134	108	80	64
3 to 5 years	1,336	1	120	972	146	117	80	68
6 to 10 years	2,216	1	120	1,440	162	144	89	71
11 to 15 years	1,423	1	110	1,440	154	163	106	73
16 to 17 years	356	1	85	1,083	129	145	112	81
18 to 20 years	351	1	70	788	132	155	118	72
21 to 44 years	3,660	1	61	1,305	131	165	126	62
45 to 64 years	1,914	1	69	1,015	135	162	120	62
>64 years	1,002	1	65	840	118	130	110	57

[a] Only data for individuals that spent >0 time outdoors and had 30 or more records are included in the analysis.
[b] Participation rates or percent of sample days in the study spending some time (>0 minutes per day) outdoors. The mean time spent outdoors for the age group may be obtained by multiplying the participation rate by the mean time shown above.
SD = Standard deviation.
COV = Coefficient of variation (SD/mean x 100).

Source: Graham and McCurdy, 2004.

Table 16-71. Comparison of Daily Time Spent Outdoors (minutes/day),Considering Gender and Age Cohort (Doers Only)[a]

Age Group	Gender	N	Time Spent Outdoors in Minutes					COV (%)	K-S Test[b]			
			Minimum	Median	Maximum	Mean	SD		Dn	X^2	p	Reject H_0
< 1 month	Male	35	7	69	700	116	144	125	0.24	0.90	0.3964	No
	Female	22	2	58	333	73	78	106				
1 to 2 months	Male	4	4	58	165	71	68	95		Cannot Test		
	Female	1	225	225	225	225	-	0				
3 to 5 months	Male	20	10	86	210	89	56	63	0.42	0.96	0.3158	No
	Female	7	50	140	510	187	153	81				
6 to 11 months	Male	53	10	60	450	95	83	87	0.07	1.00	0.3200	No
	Female	38	5	68	270	86	67	77				
1 year	Male	184	1	80	1,035	110	114	104	0.07	0.71	0.6896	No
	Female	205	4	70	511	95	82	86				
2 years	Male	232	1	105	550	136	105	77	0.09	1.00	0.2705	No
	Female	216	2	90	525	131	111	84				
3 to 5 years	Male	723	1	120	972	146	119	81	0.04	0.74	0.6465	No
	Female	612	2	120	701	144	113	78				
6 to 10 years	Male	1,228	1	132	1,440	173	148	86	0.09	2.05	0.0004	Yes
	Female	987	2	115	1,380	148	138	93				
11 to 15 years	Male	779	1	125	1,440	171	169	99	0.17	3.12	<0.0001	Yes
	Female	640	1	90	1,371	134	153	114				
16 to 17 years	Male	168	2	113	810	151	147	97	0.19	1.80	0.0030	Yes
	Female	188	1	68	1,083	109	141	127				
18 to 20 years	Male	184	2	95	788	162	176	109	0.20	1.84	0.0023	Yes
	Female	167	1	50	606	99	119	120				
21 to 44 years	Male	1,702	1	82	1,005	164	191	117	0.14	4.23	<0.0001	Yes
	Female	1,956	1	55	1,305	103	133	129				
45 to 64 years	Male	839	1	91	1,015	178	193	109	0.18	3.90	<0.0001	Yes
	Female	1,075	1	58	930	102	124	121				
> 64 years	Male	396	2	118	840	164	156	96	0.25	3.81	<0.0001	Yes
	Female	605	1	60	630	88	98	111				

[a] Only data for individuals that spent >0 time outdoors and had 30 or more records are included in the analysis.
[b] The two-sample Kolmogoroz-Smirnov (K-S) test H_0 is that the distribution of variable 1 is the same as variable 2, using a x^2 test statistic at % = 0.050.
- Data not available.
SD = Standard deviation.
COV = Coefficient of variation (SD/mean x 100).

Source: Graham and McCurdy, 2004.

Table 16-72. Time Spent (minutes/day) Indoors
Based on CHAD Data (Doers Only)[a]

Age Group	N	Time Spent Indoors					COV(%)	Participation[b] (%)
		Minimum	Median	Maximum	Mean	SD		
<1 month	121	490	1,380	1,440	1,336	137	10	100.0
1 to 2 months	14	1,125	1,380	1,440	1,348	105	8	100.0
3 to 5 months	115	840	1,385	1,440	1,359	93	7	100.0
6 to 11 months	278	840	1,370	1,440	1,353	81	6	100.0
1 year	668	315	1,350	1,440	1,324	107	8	100.0
2 years	700	290	1,319	1,440	1,286	138	11	100.0
3 to 5 years	1,977	23	1,307	1,440	1,276	136	11	100.0
6 to 10 years	3,118	7	1,292	1,440	1,256	153	12	100.0
11 to 15 years	1,939	69	1,300	1,440	1,255	160	13	99.8
16 to 17 years	438	161	1,296	1,440	1,251	171	14	100.0
18 to 20 years	485	512	1,310	1,440	1,242	180	15	100.0
21 to 44 years	5,872	60	1,317	1,440	1,259	176	14	100.0
45 to 64 years	3,073	23	1,320	1,440	1,262	172	14	100.0
> 64 years	1,758	600	1,350	1,440	1,310	141	11	100.0

[a] Only data for individuals that spent >0 time indoors and had 30 or more records are included in the analysis.
[b] Participation rates or percent of sample days in the study spending some time (>0 minutes per day) indoors. The mean time spent indoors for the age group may be obtained by multiplying the participation rate (as a decimal) by the mean time shown above.
N = Sample size.
SD = Standard deviation.
COV = Coefficient of variation (SD/mean x 100).

Source: Graham and McCurdy, 2004.

Table 16-73. Time Spent (minutes/day) in Motor Vehicles Based on CHAD Data (Doers Only)[a]

Age Group	N	Time Spent in Motor Vehicles					COV(%)	Participation[b] (%)
		Minimum	Median	Maximum	Mean	SD		
<1 month	80	2	68	350	86	68	79	66
1 to 2 months	9	20	83	105	67	32	48	64
3 to 5 months	75	13	60	335	71	49	69	65
6 to 11 months	226	4	51	425	62	47	76	81
1 year	515	1	52	300	67	50	76	77
2 years	581	2	54	955	73	76	104	83
3 to 5 years	1,702	1	55	1,389	70	70	99	86
6 to 10 years	2,766	1	58	1,214	71	68	95	89
11 to 15 years	1,685	1	60	825	76	74	97	87
16 to 17 years	400	4	73	1,007	92	90	98	91
18 to 20 years	449	4	76	852	109	106	98	93
21 to 44 years	5,429	1	80	1,440	105	100	96	92
45 to 64 years	2,739	1	75	1,357	102	105	103	89
> 64 years	1,259	4	60	798	86	85	99	72

[a] Only data for individuals that spent >0 time in motor vehicles and had 30 or more records are included in the analysis.
[b] Participation rates or percent of sample days in the study spending some time (>0 minutes per day) in motor vehicles. The mean time spent in motor vehicles for the age group may be obtained by multiplying the participation rate (as a decimal) by the mean time shown above.
N = Sample size.
SD = Standard deviation.
COV = Coefficient of variation (SD/mean x 100).

Source: Graham and McCurdy, 2004.

Table 16-74. Mean Time Spent (minutes/day) in Various Activity Categories, by Age – Weekday (Children Only)

Activity Category	2002-2003				1981-1982			
	6 to 8 years	9 to 11 years	12 to 14 years	15 to 17 years	6 to 8 years	9 to 11 years	12 to 14 years	15 to 17 years
Market work	0	0	1	22	-	-	-	28
Household work	25	32	38	39	15	18	27	34
Personal care	68	66	68	73	49	40	56	60
Eating	60	57	54	49	81	73	69	67
Sleeping, naps	607	583	542	515	595	548	473	499
School	406	398	395	352	292	315	344	314
Studying	29	39	49	50	8	29	33	33
Church	4	5	5	3	9	9	9	3
Visiting, socializing	16	25	25	53	-	-	-	-
Sports	10	17	33	33	24	21	40	46
Outdoor Activities	6	6	4	6	9	8	7	11
Hobbies	1	1	1	2	2	2	4	6
Art Activities	8	7	7	4	4	3	3	12
Television	94	106	111	115	99	146	142	108
Other passive leisure	9	10	24	39	-	-	-	-
Playing	74	56	45	35	111	65	31	14
Reading	11	12	11	7	5	9	10	12
Being read to	2	1	0	0	-	-	-	-
Computer activities	6	10	25	38	-	-	-	-
Missing data	4	8	4	6	-	-	-	-

- Data not provided.

Source: Juster et al., 2004.

Table 16-75. Mean Time Spent (minutes/day) in Various Activity Categories, by Age – Weekend Day (Children Only)								
Activity Category	2002-2003				1981-1982			
	6 to 8 years	9 to 11 years	12 to 14 years	15 to 17 years	6 to 8 years	9 to 11 years	12 to 14 years	15 to 17 years
Market work	0	0	9	39	-	-	-	48
Household work	81	91	100	79	27	51	72	60
Personal care	78	72	73	77	45	44	60	51
Eating	89	80	69	64	80	78	68	65
Sleeping, naps	666	644	633	629	641	596	604	562
School	3	6	7	7	-	-	-	-
Studying	5	9	20	24	2	12	15	30
Church	41	37	36	30	56	53	32	37
Visiting, socializing	61	66	58	91	-	-	-	-
Sports	23	40	40	27	30	42	51	37
Outdoor Activities	12	12	12	11	23	39	25	26
Hobbies	2	1	4	5	5	3	8	3
Art Activities	11	7	9	6	4	4	7	10
Television	155	184	181	162	136	185	169	157
Other passive leisure	14	15	40	54	-	-	-	-
Playing	163	134	148	59	180	92	35	21
Reading	14	15	13	7	9	10	10	18
Being read to	1	1	0	0	-	-	-	-
Computer activities	12	19	39	58	-	-	-	-
Missing data	9	8	9	11	-	-	-	-

\- Data not provided.

Source: Juster et al., 2004.

Table 16-76. Mean Time Spent (minutes/week) in
Various Activity Categories for Children, Ages 6 to 17 Years

Activity Category	2002-2003	1981-1982
Market work	53	126
Household work	343	223
Personal care	493	356
Eating	426	508
Sleeping, naps	4,092	3,758
School	1,947	1,581
Studying	238	158
Church	94	125
Visiting, socializing	287	132
Sports	179	244
Outdoor Activities	50	100
Hobbies	12	27
Art Activities	48	40
Television	876	944
Other passive leisure	166	39
Playing	485	440
Reading	77	69
Being read to	5	3
Computer activities	165	0
Missing data	45	1,206

Source: Juster et al., 2004.

Table 16-77. Time Spent (minutes/two-day period)[a] in Various Activities by Children Participating in the Panel Study of Income Dynamics (PSID), 1997 Child Development Supplement (CDS)

Age Group	Boys (N = 1,444)		Girls (N = 1,387)	
	Mean[a]	Standard Deviation	Mean[a]	Standard Deviation
Television Use				
1 to 5 years	197	168	184	163
6 to 8 years	263	165	239	159
9 to 12 years	251	185	266	194
Electronic Game Use				
1 to 5 years	8	38	5	40
6 to 8 years	44	113	14	39
9 to 12 years	57	102	18	47
Computer Use				
1 to 5 years	7	28	7	35
6 to 8 years	13	43	8	28
9 to 12 years	27	71	15	43
Print Use[b]				
1 to 5 years	21	32	23	34
6 to 8 years	20	37	20	32
9 to 12 years	19	47	29	56
Highly Active Activities[c]				
1 to 5 years	42	74	34	78
6 to 8 years	107	123	62	92
9 to 12 years	137	149	63	88
Moderately Active Activities[d]				
1 to 5 years	55	81	59	92
6 to 8 years	31	65	37	69
9 to 12 years	40	73	46	89
Sedentary Activities[e]				
1 to 5 years	55	71	54	71
6 to 8 years	75	77	80	84
9 to 12 years	110	109	122	111

[a] Means represent minutes spent in each activity over a 2-day period (one weekday and one weekend day).
[b] Print use represents time spent using print media including reading and being read to.
[c] Includes all sport activities such as basketball, soccer, swimming, running or bicycling.
[d] Includes activities such as singing, camping, taking music lessons, fishing, and boating.
[e] Includes activities such as playing board games, doing puzzles, talking on the phone, and relaxing.
N = Sample size.

Source: Vanderwater et al., 2004.

Table 16-78. Annual Average Time Spent (Hours/Day) on Various Activities According to Age, Race, Ethnicity, Marital Status, and Educational Level (ages 15 years and over)

Characteristic	Personal care [a]	Eating and Drinking [b]	Household Activities [c]	Purchasing Goods and Services [d]	Caring for and Helping Household Members [e]	Caring for and Helping Non-Household Members [f]	Working on Work-related Activities [g]	Educational Activities [h]	Organizational Civic and Religious Activities [i]	Leisure and Sports [j]	Telephone Calls, Mail, and E-mail [k]	Other Activities not Elsewhere Classified [l]
Age (years)												
15+	9.41	1.23	1.79	0.81	0.53	0.21	3.75	0.49	0.30	5.09	0.19	0.21
15 to 19	10.30	1.07	0.76	0.56	0.15	0.21	1.39	3.29	0.34	5.40	0.33	0.22
20 to 24	9.64	1.21	1.05	0.67	0.51	0.20	4.23	0.80	0.21	5.03	0.19	0.24
25 to 34	9.31	1.19	1.55	0.81	1.07	0.12	4.77	0.39	0.16	4.30	0.14	0.17
35 to 44	9.12	1.18	1.87	0.87	0.98	0.19	4.96	0.15	0.30	4.09	0.13	0.16
45 to 54	9.10	1.17	1.97	0.82	0.36	0.24	5.06	0.09	0.29	4.52	0.17	0.20
55 to 64	9.19	1.31	2.11	0.91	0.16	0.28	3.80	0.04	0.39	5.41	0.18	0.20
65 to 74	9.68	1.44	2.64	0.93	0.13	0.30	0.94	0.05	0.38	6.97	0.24	0.29
75+	9.83	1.50	2.32	0.80	0.12	0.21	0.34	0.06	0.43	7.82	0.30	0.27
Gender												
Male	9.21	1.25	1.33	0.64	0.33	0.18	4.53	0.45	0.29	5.47	0.12	0.20
Female	9.59	1.22	2.23	0.96	0.71	0.24	3.02	0.53	0.31	4.72	0.26	0.22
Race/Ethnicity												
White	9.30	1.28	1.85	0.81	0.53	0.21	3.76	0.47	0.29	5.09	0.18	0.21
Black	10.08	0.87	1.38	0.75	0.46	0.20	3.54	0.43	0.37	5.49	0.25	0.18
Hispanic/Latino	9.67	1.18	1.85	0.77	0.60	0.15	3.92	0.69	0.23	4.63	0.13	0.18
Marital Status												
Married	9.12	1.28	2.09	0.88	0.75	0.21	4.08	0.11	0.33	4.79	0.14	0.21
Other	9.75	1.18	1.43	0.72	0.25	0.22	3.34	0.94	0.27	5.45	0.25	0.20
Education												
< High School grad	9.86	1.10	2.38	0.80	0.50	0.20	2.57	0.04	0.25	6.01	0.10	0.17
HS grad, no college	9.42	1.19	2.05	0.76	0.46	0.25	3.58	0.07	0.28	5.57	0.15	0.21
Some college	9.21	1.24	1.94	0.92	0.58	0.23	4.25	0.22	0.29	4.76	0.19	0.18
BS or higher	8.94	1.41	1.77	0.91	0.71	0.18	4.72	0.22	0.37	4.33	0.22	0.23

[a] Includes sleeping, bathing, dressing, health-related self care, and personal and private activities.
[b] Includes time spent eating or drinking (except when identified as part of work or volunteer activity); does not include time spent purchasing meals, snacks, or beverages.
[c] Includes housework, cooking, yard care, pet care, vehicle maintenance and repair, home maintenance, repair, decoration, and renovation.
[d] Includes purchase of consumer goods, professional (e.g., banking, legal, medical, real estate) and personal care services (e.g., hair salons, barbershops, day spas, tanning salons), household services (e.g., housecleaning, lawn care and landscaping, pet care, dry cleaning, vehicle maintenance, construction), and government services (e.g., applying for food stamps, government required licenses or paying fines).
[e] Includes time spent caring or helping to care for child or adult household member (e.g., physical care, playing with children, reading to child or adult, attending to health care needs, dropping off, picking up or waiting for children).
[f] Includes time spent caring or helping to care for child or adult who is not a household member (e.g., physical care, playing with children, reading to child or adult, attending to health care needs, dropping off, picking up or waiting for children). Does not include activities done through a volunteer organization.
[g] Includes time spent as part of the job, income-generating activities, or job search activities. Also includes travel time for work-related activities.
[h] Includes taking classes, doing research and homework, registering for classes, and before and after school extra-curricular activities, except sports.
[i] Includes time spent volunteering for or through civic obligations (e.g., jury duty, voting, attending town hall meetings), or through participating in religious or spiritual activities (e.g., church choir, youth groups, praying).
[j] Includes sports, exercise, and recreation. This category is broken down into subcategories for the 15 to 19 years old age category.
[k] Includes telephone use, mail and e-mail. Does not include communications related to purchase of goods and services or those related to work or volunteering.
[l] Includes residual activities that could not be coded or where information was missing.

Source: USDL (2007).

Table 16-79. Annual Average Time Use by the U.S. Civilian Population, Ages 15 Years and Older

Activity	Hours/day				
	Total	Male	Female	Weekday	Weekends and Holidays
Personal Care [a]	9.41	9.21	9.59	9.12	10.08
sleeping	8.63	8.56	8.69	8.33	9.32
Eating and Drinking [b]	1.23	1.25	1.22	1.18	1.37
Household Activities [c]	1.79	1.33	2.23	1.66	2.11
housework	0.61	0.25	0.95	0.57	0.70
food preparation/cleanup	0.53	0.29	0.75	0.51	0.57
lawn and garden care	0.20	0.26	0.14	0.16	0.27
household management	0.13	0.11	0.14	0.12	0.15
Purchasing Goods and Services [d]	0.81	0.64	0.96	0.76	0.93
consumer goods purchase	0.40	0.29	0.51	0.34	0.53
professional/personal goods purchase	0.09	0.06	0.11	0.10	0.04
Caring for and Helping Household Members [e]	0.53	0.33	0.71	0.56	0.45
caring for household children	0.41	0.24	0.57	0.43	0.37
Caring for and Helping Non-Household Members [f]	0.21	0.18	0.24	0.19	0.26
caring for non-household adults	0.07	0.07	0.08	0.06	0.11
Working on Work-related Activities [g]	3.75	4.53	3.02	4.77	1.36
working	3.40	4.10	2.74	4.33	1.23
Educational Activities [h]	0.49	0.45	0.53	0.63	0.16
attending classes	0.30	0.29	0.32	0.42	0.04
homework and research	0.15	0.12	0.17	0.16	0.10
Organizational Civic and Religious Activities [i]	0.30	0.29	0.31	0.20	0.53
religious and spiritual activities	0.12	0.11	0.13	0.04	0.30
volunteering (organizational and civic activities)	0.13	0.13	0.13	0.13	0.15
Leisure and Sports [j]	5.09	5.47	4.72	4.54	6.37
socializing and communicating	0.76	0.71	0.80	0.60	1.11
watching TV	2.58	2.80	2.36	2.35	3.10
sports, exercise, recreation	0.28	0.38	0.18	0.26	0.33
Telephone Calls, Mail, and E-mail [k]	0.19	0.12	0.26	0.20	0.17
Other Activities not Elsewhere Classified [l]	0.21	0.20	0.22	0.20	0.22

[a] Includes sleeping, bathing, dressing, health-related self care, and personal and private activities.
[b] Includes time spent eating or drinking (except when identified as part of work or volunteer activity); does not include time spent purchasing meals, snacks, or beverages.
[c] Includes housework, cooking, yard care, pet care, vehicle maintenance and repair, home maintenance, repair, decoration, and renovation.
[d] Includes purchase of consumer goods, professional (e.g., banking, legal, medical, real estate) and personal care services (e.g., hair salons, barbershops, day spas, tanning salons), household services (e.g., housecleaning, lawn care and landscaping, pet care, dry cleaning, vehicle maintenance, construction), and government services (e.g., applying for food stamps, government required licenses or paying fines).
[e] Includes time spent caring or helping to care for child or adult household member (e.g., physical care, playing with children, reading to child or adult, attending to health care needs, dropping off, picking up or waiting for children).
[f] Includes time spent caring or helping to care for child or adult who is not a household member (e.g., physical care, playing with children, reading to child or adult, attending to health care needs, dropping off, picking up or waiting for children). Does not include activities done through a volunteer organization.
[g] Includes time spent as part of the job, income-generating activities, or job search activities. Also includes travel time for work-related activities.
[h] Includes taking classes, doing research and homework, registering for classes, and before and after school extra-curricular activities, except sports.
[i] Includes time spent volunteering for or through civic obligations (e.g., jury duty, voting, attending town hall meetings), or through participating in religious or spiritual activities (e.g., church choir, youth groups, praying).
[j] Includes sports, exercise, and recreation. This category is broken down into subcategories for the 15 to 19 years old age category.
[k] Includes telephone use, mail and e-mail. Does not include communications related to purchase of goods and services or those related to work or volunteering.
[l] Includes residual activities that could not be coded or where information was missing.

Source: USDL (2007).

Table 16-80. Mean Time Use (hours/day) by Children, Ages 15 to 19 Years

Activity	hours/day		
	Male	Female	All
Personal Care[a]	10.26	10.34	10.30
Eating and Drinking[b]	1.02	1.11	1.07
Household Activities[c]	0.61	0.92	0.76
Purchasing Goods and Services[d]	0.38	0.74	0.56
Caring for and Helping Household Members[e]	0.10	0.19	0.15
Caring for and Helping Non-Household Members[f]	0.20	0.23	0.21
Working on Work-related Activities[g]	1.53	1.24	1.39
Educational Activities[h]	3.08	3.51	3.29
Organizational Civic and Religious Activities[i]	0.34	0.33	0.34
Leisure and Sports[j]	6.02	4.75	5.40
total leisure and sports – weekdays	-	-	4.85
total leisure and sports – weekends	-	-	6.68
sports, exercise, recreation – weekdays	-	-	0.58
sports, exercise, recreation – weekends/holidays	-	-	0.69
socializing and communicating – weekdays	-	-	0.76
socializing and communicating, - weekends/holidays	-	-	1.32
watching TV – weekdays	-	-	1.96
watching TV – weekends/holidays	-	-	2.45
reading – weekdays	-	-	0.11
reading – weekends/holidays	-	-	0.11
relaxing, thinking – weekdays	-	-	0.15
relaxing, thinking – weekends/holidays	-	-	0.13
playing games, computer use for leisure – weekdays	-	-	0.69
playing games, computer use for leisure – weekends/holidays	-	-	1.00
other sports/leisure including travel – weekdays	-	-	0.61
other sports/leisure including travel – weekends/holidays	-	-	0.98
Telephone Calls, Mail, and E-mail[k]	0.24	0.42	0.33
Other Activities not Elsewhere Classified[l]	0.23	0.21	0.22

[a] Includes sleeping, bathing, dressing, health-related self care, and personal and private activities.
[b] Includes time spent eating or drinking (except when identified as part of work or volunteer activity); does not include time spent purchasing meals, snacks, or beverages.
[c] Includes housework, cooking, yard care, pet care, vehicle maintenance and repair, home maintenance, repair, decoration, and renovation.
[d] Includes purchase of consumer goods, professional (e.g., banking, legal, medical, real estate) and personal care services (e.g., hair salons, barbershops, day spas, tanning salons), household services (e.g., housecleaning, lawn care and landscaping, pet care, dry cleaning, vehicle maintenance, construction), and government services (e.g., applying for food stamps, government required licenses or paying fines).
[e] Includes time spent caring or helping to care for child or adult household member (e.g., physical care, playing with children, reading to child or adult, attending to health care needs, dropping off, picking up or waiting for children).
[f] Includes time spent caring or helping to care for child or adult who is not a household member (e.g., physical care, playing with children, reading to child or adult, attending to health care needs, dropping off, picking up or waiting for children). Does not include activities done through a volunteer organization.
[g] Includes time spent as part of the job, income-generating activities, or job search activities. Also includes travel time for work-related activities.
[h] Includes taking classes, doing research and homework, registering for classes, and before and after school extra-curricular activities, except sports.
[i] Includes time spent volunteering for or through civic obligations (e.g., jury duty, voting, attending town hall meetings), or through participating in religious or spiritual activities (e.g., church choir, youth groups, praying).
[j] Includes sports, exercise, and recreation. This category is broken down into subcategories for the 15 to 19 years old age category.
[k] Includes telephone use, mail and e-mail. Does not include communications related to purchase of goods and services or those related to work or volunteering.
[l] Includes residual activities that could not be coded or where information was missing.

Source: U.S. DL, 2007.

Table 16-81. Mean Time Spent (minutes/day) in Moderate-to-Vigorous Physical Activity (Children Only)

Age (years)	Weekday Mean (SD)			Weekend Mean (SD)		
	Boys	Girls	Both	Boys	Girls	Both
9	190.8(53.2)	173.3(46.4)	181.8(50.6)	184.3(68.6)	173.3(64.3)	178.6(66.6)
11	133.0(42.9)	115.6(36.3)	124.1(40.6)	127.1(59.5)	112.6(53.2)	119.7(56.8)
12	105.3(40.2)	86.0(32.5)	95.6(37.8)	93.4(55.3)	73.9(45.8)	83.6(51.7)
15	58.2(31.8)	38.7(23.6)	49.2(29.9)	43.2(38.0)	25.5(23.3)	35.1(33.3)

SD = Standard deviation.

Source: Nader et al., 2008.

Table 16-82. Occupational Tenure of Employed Individuals[a] by Age and Sex

Age Group (years)	Median Tenure (years)		
	All Workers	Men	Women
16-24	1.9	2.0	1.9
25-29	4.4	4.6	4.1
30-34	6.9	7.6	6.0
35-39	9.0	10.4	7.0
40-44	10.7	13.8	8.0
45-49	13.3	17.5	10.0
50-54	15.2	20.0	10.8
55-59	17.7	21.9	12.4
60-64	19.4	23.9	14.5
65-69	20.1	26.9	15.6
70 and older	21.9	30.5	18.8
Total	6.6	7.9	5.4

[a] Working population = 109.1 million persons.

Source: Carey, 1988.

Table 16-83. Occupational Tenure for Employed Individuals[a] Grouped by Sex and Race

Race	Median Tenure (Years)		
	All Individuals	Men	Women
White	6.7	8.3	5.4
Black	5.8	5.8	5.8
Hispanic	4.5	5.1	3.7

[a] Working population = 109.1 million persons.

Source: Carey, 1988.

Table 16-84. Occupational Tenure for Employed Individuals[a] Grouped by Sex and Employment Status

Employment Status	Median Tenure (Years)		
	All Individuals	Men	Women
Full-Time	7.2	8.4	5.9
Part-Time	3.1	2.4	3.6

[a] Working population = 109.9 million persons.

Source: Carey, 1988.

Table 16-85. Occupational Tenure of Employed Individuals[a] Grouped by Major Occupational Groups and Age

Occupational Group	Total[b]	Median Tenure (years) Age Group					
		16-24	25-34	35-44	45-54	55-64	65+
Executive, Administrative, and Managerial	8.4	2.4	5.6	10.1	15.1	17.9	26.3
Professional Specialty	9.6	2.0	5.7	12.0	18.2	25.6	36.2
Technicians and Related Support	6.9	2.2	5.7	10.9	17.7	20.8	22.2
Sales Occupations	5.1	1.7	4.7	7.7	10.5	15.5	21.6
Administrative Support, including Clerical	5.4	2.1	5.0	7.6	10.9	14.6	15.4
Service Occupations	4.1	1.7	4.4	6.9	9.0	10.6	10.4
Precision Production, Craft, and Repair	9.3	2.6	7.1	13.5	19.9	25.7	30.1
Operators, Fabricators, and Laborers	5.5	1.7	4.6	9.1	13.7	18.1	14.7
Farming, Forestry, and Fishing	10.4	2.9	7.9	13.5	20.7	30.5	39.8

[a] Working population = 109.1 million persons.
[b] Includes all workers 16 years and older

Source: Carey, 1988.

Table 16-86. Voluntary Occupational Mobility Rates for Workers[a] Age 16 Years and Older

Age Group (years)	Occupational Mobility Rate[b] (Percent)
16-24	12.7
25-34	6.6
35-44	4.0
45-54	1.9
55-64	1.0
64 and older	0.3
Total, age 16 and older	5.3

[a] Working population = 109.1 million persons.

[b] Occupational mobility rate = percentage of persons employed in an occupation who had voluntarily entered it from another occupation.

Source: Carey, 1990.

Table 16-87. Descriptive Statistics for Residential Occupancy Period (years)															
			Percentiles											2nd Largest Value	
	N[a]	Mean	5th	10th	25th	50th	75th	90th	95th	98th	99th	99.5th	99.8th	99.9th		Max.
Both genders	500,000	11.7	2	2	3	9	16	26	33	41	47	51	55	59	75	87
Males only	244,274	11.1	2	2	4	8	15	24	31	39	44	48	53	56	73	73
Females only	255,726	12.3	2	2	5	9	17	28	35	43	49	53	58	61	75	87

[a] = Number of simulated persons.

Source: Johnson and Capel, 1992.

Table 16-88. Descriptive Statistics for Both Genders by Current Age

Current age, years	Residential occupancy period (years)						
	Mean	Percentile					
		25	50	75	90	95	99
3	6.5	3	5	8	13	17	22
6	8.0	4	7	10	15	18	22
9	8.9	5	8	12	16	18	22
12	9.3	5	9	13	16	18	23
15	9.1	5	8	12	16	18	23
18	8.2	4	7	11	16	19	23
21	6.0	2	4	8	13	17	23
24	5.2	2	4	6	11	15	25
27	6.0	3	5	8	12	16	27
30	7.3	3	6	9	14	19	32
33	8.7	4	7	11	17	23	39
36	10.4	5	8	13	21	28	47
39	12.0	5	9	15	24	31	48
42	13.5	6	11	18	27	35	49
45	15.3	7	13	20	31	38	52
48	16.6	8	14	22	32	39	52
51	17.4	9	15	24	33	39	50
54	18.3	9	16	25	34	40	50
57	19.1	10	17	26	35	41	51
60	19.7	11	18	27	35	40	51
63	20.2	11	19	27	36	41	51
66	20.7	12	20	28	36	41	50
69	21.2	12	20	29	37	42	50
72	21.6	13	20	29	37	43	53
75	21.5	13	20	29	38	43	53
78	21.4	12	19	29	38	44	53
81	21.2	11	20	29	39	45	55
84	20.3	11	19	28	37	44	56
87	20.6	10	18	29	39	46	57
90	18.9	8	15	27	40	47	56
All ages	11.7	4	9	16	26	33	47

Source: Johnson and Capel, 1992.

Table 16-89. Residence Time of Owner/Renter Occupied Units	
Year household moved into unit	Total occupied units (numbers in thousands)
2005-2009	33,543
2000-2004	28,695
1995-1999	15,120
1990-1994	9,631
1985-1989	6,459
1980-1984	3,703
1975-1979	4,412
1970 - 1974	2,979
1960 -1969	3,661
1950-1959	1,892
1940-1949	460
1939 or earlier	137
	Total 110,692

Source: U.S. Bureau of the Census, 2008a.

Table 16-90. Percent of Householders Living in Houses for Specified Ranges of Time, and Statistics for Years Lived in Current Home

Years lived in current home	Percent of total households
0-4	30.3
5-9	25.9
10-14	13.7
15-19	8.7
20-24	5.8
25-29	3.3
30-34	4.0
35-44	2.7
45-54	3.3
55-64	1.7
65-74	0.4
>75	0.1
	Total[a] 99.9

Statistics for Years Lived in Current Home

N	Mean[b]	50th Percentile[b]	90th Percentile[b]	95th Percentile[b]	99h Percentile[b]
110,692	13	8	32	46	62

[a] Total does not equal 100 due to rounding errors.

[b] The mean, 50th and 90th percentiles were calculated for the number of years lived in current house by apportioning the total sample size (110,692 households) to the indicated percentile associated with the applicable range of years lived in the current home, assuming an even distribution.

Source: Adapted from U.S. Bureau of the Census, 2008a.

Table 16-91. Values and Their Standard Errors for Average Total Residence Time, T, for Each Group in Survey[a]

Households	Average total residence time T (years)	S.D. S_T	Average current residence T_{CR} (years)	Households (percent) 1985	1987
All households	4.55 ± 0.60	8.68	10.56±0.10	100.0	100.0
Renters	2.35±0.14	4.02	4.62±0.08	36.5	36.0
Owners	11.36±3.87	13.72	13.96±0.12	63.5	64.0
Farms	17.31±13.81	18.69	18.75±0.38	2.1	1.9
Urban	4.19±0.53	8.17	10.07±0.10	74.9	74.5
Rural	7.80±1.17	11.28	12.06±0.23	25.1	25.5
Northeast region	7.37±0.88	11.48	12.64±0.12	21.2	20.9
Midwest region	5.11±0.68	9.37	11.15±0.10	25.0	24.5
South region	3.96±0.47	8.03	10.12±0.08	34.0	34.4
West region	3.49±0.57	6.84	8.44±0.11	19.8	20.2

[a] Values of the average current residence time, T_{CR}, are given for comparison.

Source: Israeli and Nelson, 1992.

Table 16-92. Total Residence Time, t (years), Corresponding to Selected Values of R(t)[a] by Housing Category

R(t) =	0.05	0.1	0.25	0.5	0.75
All households	23.1	12.9	3.7	1.4	0.5
Renters	8.0	5.2	2.6	1.2	0.5
Owners	41.4	32.0	17.1	5.2	1.4
Farms	58.4	48.3	26.7	10.0	2.4
Urban	21.7	10.9	3.4	1.4	0.5
Rural	32.3	21.7	9.1	3.3	1.2
Northeast region	34.4	22.3	7.5	2.8	1.0
Midwest region	25.7	15.0	4.3	1.6	0.6
South region	20.7	10.8	3.0	1.2	0.4
West region	17.1	8.9	2.9	1.2	0.4

[a] R(t) = fraction of households living in the same residence for t years or more.

Source: Israeli and Nelson, 1992.

Table 16-93. Summary of Residence Time of Recent Home Buyers (1993)

Number of years lived in previous house	Percent of Respondents
1 year or less	2
2-3	16
4-7	40
8-9	10
10 years or more	32

Source: NAR, 1993.

Table 16-94. Tenure in Previous Home (Percentage Distribution)

	1987	1989	1991	1993
	Percent			
One year or less	5	8	4	2
2-3 Years	25	15	21	16
4-7 Years	36	22	37	40
8-9 Years	10	11	9	10
10 or More Years	24	34	29	32
Total	100	100	100	100
	Years			
Median	6	6	6	6

Source: NAR, 1993.

Table 16-95. Number of Miles Moved (Percentage Distribution)

Miles	All Buyers	First-Time Buyer	Repeat Buyer	New Home Buyer	Existing Home Buyer
	Percent				
Less than 5 miles	29	33	27	23	31
5 to 9 miles	20	25	16	18	20
10 to 19 miles	18	20	17	20	17
20 to 34 miles	9	11	8	12	9
35 to 50 miles	2	2	2	2	3
51 to 100 miles	5	2	6	6	4
Over 100 miles	17	6	24	19	16
Total	100	100	100	100	100
	Miles				
Median	9	8	11	11	8
Mean	200	110	270	230	190

Source: NAR, 1993.

Table 16-96. General Mobility, by Race and Hispanic Origin, Region, Sex, Age, Educational Attainment, Marital Status, Nativity, Tenure, and Poverty Level: 2006 to 2007
(Numbers in thousands)

	Total	Mover		Same county		Different county, same state		Different state, same division		Different division, same region		Different region		Abroad	
Population	N	N	% (of total)	N	% (of movers)	N	% (of movers)	N	% (of movers)	N	% (of movers)	N	% (of movers)	N	% (of movers)
Total 1+ years	292,749	38,681	13%	25,192	65%	7,436	19%	1,446	4%	968	3%	2,448	6%	1,191	3%
Gender															
Male	143,589	19,457	14%	12,579	65%	3,693	19%	771	4%	505	3%	1,220	6%	689	4%
Female	149,160	19,224	13%	12,613	66%	3,743	19%	675	4%	463	2%	1,228	6%	502	3%
Age															
1 to 4 years	16,455	3,217	20%	2,188	68%	577	18%	117	4%	81	3%	184	6%	72	2%
5 to 9 years	19,830	3,161	16%	2,092	66%	614	19%	121	4%	73	2%	179	6%	81	3%
10 to 14 years	20,444	2,517	12%	1,735	69%	441	18%	92	4%	62	2%	139	6%	47	2%
15 to 17 years	13,297	1,465	11%	1,057	72%	224	15%	50	3%	22	2%	75	5%	37	3%
18 to 19 years	7,873	1,330	17%	898	68%	252	19%	40	3%	25	2%	68	5%	47	4%
20 to 24 years	20,532	5,516	27%	3,623	66%	1,069	19%	168	3%	157	3%	320	6%	179	3%
25 to 29 years	20,666	5,316	26%	3,335	63%	1,061	20%	219	4%	136	3%	339	6%	226	4%
30 to 34 years	19,202	3,767	20%	2,374	63%	789	21%	140	4%	106	3%	221	6%	137	4%
35 to 39 years	20,907	2,962	14%	1,877	63%	587	20%	104	4%	84	3%	187	6%	121	4%
40 to 44 years	21,856	2,456	11%	1,567	64%	480	20%	102	4%	60	2%	178	7%	68	3%
45 to 49 years	22,643	1,963	9%	1,362	69%	304	15%	74	4%	42	2%	131	7%	49	2%
50 to 54 years	20,819	1,612	8%	1,119	69%	292	18%	55	3%	42	3%	76	5%	27	2%
55 to 59 years	18,221	1,171	6%	706	60%	258	22%	57	5%	37	3%	86	7%	27	2%
60 to 61 years	6,093	381	6%	212	56%	82	22%	30	8%	9	2%	39	10%	10	3%
62 to 64 years	7,877	386	5%	201	52%	98	25%	19	5%	1	0%	49	13%	18	5%
65 to 69 years	10,629	496	5%	286	58%	110	22%	16	3%	5	1%	63	13%	16	3%
70 to 74 years	8,369	357	4%	179	50%	79	22%	24	7%	17	5%	43	12%	15	4%
75 to 79 years	7,567	233	3%	153	66%	41	18%	4	2%	6	3%	21	9%	7	3%
80 to 84 years	5,513	219	4%	121	55%	53	24%	10	5%	4	2%	26	12%	5	2%
85+ years	3,958	159	4%	108	68%	24	15%	2	1%	-	-	22	14%	3	2%
Educational Attainment															
Not a high school graduate	27,742	3,458	12%	2,431	70%	575	17%	103	3%	33	1%	137	4%	178	5%
High school graduate	61,490	6,435	10%	4,398	68%	1,207	19%	221	3%	145	2%	353	5%	112	2%
Some college or AA degree	49,243	5,534	11%	3,475	63%	1,167	21%	206	4%	145	3%	411	7%	130	2%
Bachelor's degree	36,658	4,062	11%	2,290	56%	910	22%	231	6%	124	3%	336	8%	172	4%
Prof or graduate degree	19,184	1,985	10%	1,004	51%	399	20%	97	5%	102	5%	246	12%	137	7%
Persons age 1-24	98,431	17,205	17%	11,593	67%	3,177	18%	589	3%	419	2%	965	6%	462	3%

Table 16-96. Table 16-96. General Mobility, by Race and Hispanic Origin, Region, Sex, Age, Educational Attainment, Marital Status, Nativity, Tenure, and Poverty Level: 2006 to 2007
(Numbers in thousands)
(continued)

	Total	Mover		Same county		Different county, same state		Different state, same division		Different division, same region		Different region		Abroad	
Population	N[a]	N	% (of total)	N	% (of movers)	N	% (of movers)	N	% (of movers)	N	% (of movers)	N	% (of movers)	N	% (of movers)
Marital Status															
Married, spouse present	12,1390	10,671	9%	6,434	60%	2,220	21%	502	5%	338	3%	808	8%	369	3%
Married, spouse absent	3,472	805	23%	501	62%	90	11%	31	4%	11	1%	73	9%	98	12%
Widowed	13,920	802	6%	533	66%	136	17%	34	4%	8	1%	68	8%	22	3%
Divorced	22,867	3,483	15%	2,369	68%	702	20%	93	3%	69	2%	200	6%	50	1%
Separated	5,047	1,246	25%	911	73%	213	17%	29	2%	16	1%	57	5%	19	2%
Never married	69,324	12,779	18%	8,429	66%	2,442	19%	427	3%	310	2%	739	6%	433	3%
Persons age 1-14	56,730	8,895	16%	6,015	68%	1,632	18%	330	4%	216	2%	502	6%	200	2%
Nativity															
Native	255,501	33,023	13%	21,603	65%	6,671	20%	1,279	4%	904	3%	2,180	7%	387	1%
Foreign born	37,248	5,658	15%	3,589	63%	765	14%	167	3%	64	1%	268	5%	804	14%
Naturalized US citizen	14,525	1,161	8%	768	66%	212	18%	41	4%	31	3%	76	7%	31	3%
Not a US citizen	22,723	4,497	20%	2,821	63%	553	12%	126	3%	33	1%	192	4%	772	17%
Tenure															
Owner-occupied housing unit	207,774	13,760	7%	8,467	62%	2,881	21%	595	4%	408	3%	1,027	7%	381	3%
Renter-occupied housing unit	81,351	24,228	30%	1,6353	67%	4,374	18%	806	3%	547	2%	1,371	6%	776	3%
No cash renter-occupied housing unit	3,624	694	19%	372	54%	181	26%	45	6%	13	2%	49	7%	33	5%
Poverty Status															
Below 100% of poverty	35,924	8,777	24%	6,041	69%	1,484	17%	270	3%	166	2%	392	4%	423	5%
100% to 149% of poverty	26,183	4,705	18%	3,312	70%	832	18%	128	3%	84	2%	215	5%	136	3%
150% of poverty and above	23,0642	25,199	11%	15,839	63%	5,120	20%	1,048	4%	718	3%	1,841	7%	632	3%

\- Represents zero or rounds to zero.
[a] N=Number of respondents.

Source: U.S. Bureau of the Census (2008b).

Table 16-97. Distance of Intercounty Move[a], by Sex, Age, Race and Hispanic Origin, Educational Attainment, Marital Status, Nativity, Tenure, Poverty Status, Reason for Move, and State of Residence 1 Year Ago: 2006 to 2007
(Numbers in thousands)

	Total	Less than 50 miles		50 to 199 miles		200 to 499 miles		500 miles or more	
Population	N	N	%	N	%	N	%	N	%
Intercounty Movers 1+ years	12,299	5,149	42%	2,582	21%	1,802	15%	2,765	22%
Sex									
Male	6,190	2,554	41%	1,324	21%	894	14%	1,418	23%
Female	6,109	2,595	42%	1,258	21%	909	15%	1,347	22%
Age									
Under 16 years	2,809	1,230	44%	520	19%	455	16%	603	21%
16 to 19 years	629	279	44%	148	24%	82	13%	120	19%
20 to 24 years	1,714	720	42%	436	25%	185	11%	373	22%
25 to 29 years	1,755	792	45%	347	20%	215	12%	400	23%
30 to 44 years	3,040	1,295	43%	618	20%	458	15%	669	22%
45 to 64 years	1,782	633	36%	408	23%	312	18%	429	24%
65 to 74 years	357	128	36%	68	19%	66	18%	95	27%
75+ years	213	71	33%	37	17%	30	14%	76	36%
Race and Hispanic Origin									
White alone	9,730	4,049	42%	2,064	21%	1,382	14%	2,234	23%
Black or African American alone	1,626	729	45%	285	18%	320	20%	293	18%
Asian alone	515	205	40%	120	23%	51	10%	138	27%
All remaining single races and all race combinations[b]	427	166	39%	113	26%	49	11%	99	23%
White alone, not Hispanic or Latino	8,290	3,527	43%	1,697	20%	1,156	14%	1,910	23%
Hispanic or Latino[c]	1,575	578	37%	401	25%	232	15%	364	23%
White alone or in combination with one or more other races	9,986	4,161	42%	2,130	21%	1,405	14%	2,290	23%
Black or African American alone or in combination with one or more other races	1,733	777	45%	312	18%	329	19%	315	18%
Asian alone or in combination with one or more other races	573	223	39%	146	25%	59	10%	144	25%

Table 16-97. Distance of Intercounty Move[a], by Sex, Age, Race and Hispanic Origin, Educational Attainment, Marital Status, Nativity, Tenure, Poverty Status, Reason for Move, and State of Residence 1 Year Ago: 2006 to 2007 (continued)
(Numbers in thousands.)

	Total	Less than 50 miles		50 to 199 miles		200 to 499 miles		500 miles or more	
Population	N	N	%	N	%	N	%	N	%
Educational Attainment									
Not a high school graduate	848	390	46%	197	23%	126	15%	135	16%
High school graduate	1,926	776	40%	414	21%	351	18%	385	20%
Some college or AA degree	1,929	836	43%	376	19%	254	13%	463	24%
Bachelor's degree	1,601	651	41%	340	21%	210	13%	400	25%
Prof. or graduate degree	844	268	32%	151	18%	140	17%	286	34%
Persons age 1-24	5,151	2,229	43%	1,104	21%	721	14%	1,096	21%
Marital Status									
Married, spouse present	3,868	1,500	39%	834	22%	560	14%	975	25%
Married, spouse absent	206	57	28%	44	21%	31	15%	74	36%
Widowed	246	78	32%	60	24%	45	18%	63	26%
Divorced	1,065	493	46%	221	21%	158	15%	193	18%
Separated	316	146	46%	57	18%	66	21%	47	15%
Never married	3,917	1,691	43%	867	22%	517	13%	843	22%
Persons age 1-14	2,680	1,184	44%	500	19%	426	16%	570	21%
Nativity									
Native	11,034	4,627	42%	2,299	21%	1,646	15%	2,462	22%
Foreign born	1,265	523	41%	283	22%	156	12%	303	24%
Naturalized U.S. citizen	361	156	43%	63	17%	45	12%	96	27%
Not a US citizen	904	367	41%	220	24%	111	12%	206	23%
Tenure									
Owner-occupied housing unit	4,912	2,083	42%	950	19%	742	15%	1,137	23%
Renter-occupied housing unit	7,099	2,962	42%	1,554	22%	1,019	14%	1,564	22%
No cash renter-occupied housing unit	288	104	36%	78	27%	41	14%	64	22%
Poverty Status									
Below 100% of poverty	2,313	967	42%	576	25%	353	15%	417	18%
100% to 149% of poverty	1,258	625	50%	245	19%	176	14%	212	17%
150% of poverty and above	8,728	3,558	41%	1,761	20%	1,274	15%	2,136	24%

Table 16-97. Distance of Intercounty Move[a], by Sex, Age, Race and Hispanic Origin, Educational Attainment, Marital Status, Nativity, Tenure, Poverty Status, Reason for Move, and State of Residence 1 Year Ago: 2006 to 2007 (continued)
(Numbers in thousands.)

	Total	Less than 50 miles		50 to 199 miles		200 to 499 miles		500 miles or more	
Population	N	N	%	N	%	N	N	%	N
State of Residence 1 Year Ago									
Same state	7,436	4,741	64%	2,059	28%	627	8%	9	0%
Different state	4,862	408	8%	524	11%	1,175	24%	2,756	57%

[a] The estimated distance in miles of an intercounty move is measured from the county of previous residence's geographic population centroid to the county of current residence's geographic population centroid.
[b] Includes American Indian and Alaska Native alone, Native Hawaiian and Other Pacific Islander alone, and Two or More Races.
[c] Hispanics or Latinos may be of any race.

Source: U.S. Bureau of the Census (2008b)

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17 CONSUMER PRODUCTS

17.1 INTRODUCTION

17.1.1 Background

Consumer products may contain toxic or potentially toxic chemical constituents to which people may be exposed as a result of their use. For example, household cleaners can contain ammonia, alcohols, acids, and/or organic solvents which may pose health concerns. Potential routes of exposure to consumer products or chemicals released from consumer products during use include ingestion, inhalation, and dermal contact. These household consumer products include cleaners, solvents, and paints. Non-users, including children, can be passively exposed to chemicals in these products. Since people spend a large amount of time indoors, the use of household chemicals in the indoor environment can be a principal source of exposure (Franklin, 2008).

Very little information is available on the exact way the different kinds of products are used by consumers, including the many ways in which these products are handled, the frequency and duration of contact, and the measures consumers may take to minimize exposure/risk (Steenbekkers, 2001). In addition, the factors that influence these behaviors are not well studied, but some studies have shown there is a large variation in behavior between persons (Steenbekkers, 2001).

This chapter presents information on the amount of product used, frequency of use, and duration of use for various consumer products typically found in consumer households. All tables that present information for these consumer products are located at the end of this chapter.

17.1.2 Additional Sources of Information

There are several sources of information on data relevant to consumer products. These sources are summarized below:

The National Library of Medicine Household Products Database is a consumer guide that provides information on the potential health effects of chemicals contained in more than 7,000 common household products used inside and around the home. Although this database does not provide exposure factor information, it contains information on chemical ingredients and their percentages in consumer products, which products contain specific chemical ingredients, acute and chronic effects of chemical ingredients, and manufacturer information. These data could be useful when conducting an exposure assessment for a specific chemical/active ingredient. The product categories are: auto products, inside the home, pesticides, landscape/yard, personal care, home maintenance, arts and crafts, pet care, and home office. The database can be searched by product name, product type, manufacturer, and ingredient. This database can be found at http://hpd.nlm.nih.gov. Table 17-1 provides a list of household consumer products found in some U.S. households (U.S. EPA, 1987). It should be noted, however, that this list was compiled by U.S. EPA in 1987 and consumer use of some products listed may have changed (e.g., aerosol product use has declined). Therefore, the reader is referred to the National Library of Medicine database as a source of more current information.

The U.S. EPA Source Ranking Database (SRD) is another source of information on consumer products, but does not provide data on frequency of use. SRD can be used to perform systematic screening-level reviews of more than 12,000 potential indoor pollution sources to identify high-priority product and material categories for further evaluation. It also can be used to identify products that contain a specific chemical. Information on the SRD can be found at:
http://www.epa.gov/oppt/exposure/pubs/srd.htm.

The Soaps and Detergents Association (SDA) developed a peer-reviewed document that presents methodologies and specific exposure information that can be used for screening-level risk assessments from exposures to high production volume chemicals. The document addresses the use of consumer products, including laundry, cleaning, and personal care products. It includes data for daily frequency of use, and amount of product used. The data used were compiled from a number of sources including cosmetic associations and data from the SDA. The document entitled "Exposure and Risk Screening Methods for Consumer Product Ingredients" can be found on the SDA website under: http://www.cleaning101.com/files/Exposure_and_Risk_Screening_Methods_for_Consumer_Product_Ingredients.pdf.

The reader is also referred to a document developed by the U.S. EPA, Office of Toxic Substances: *Standard Scenarios for Estimating Exposure to Chemical Substances During Use of Consumer Products - Volumes I and II* (U.S. EPA, 1986). This document presents data and supporting information required to assess consumer exposure to constituents in household cleaners and components of adhesives. Information presented includes a description of standard scenarios selected to represent upper bound exposures for each product. Values are also presented for parameters that are needed to estimate exposure for defined exposure routes and pathways assumed for each scenario.

An additional reference is the Simmons Market Research Bureau (SMRB), "Simmons Study of Media and Markets." This document provides an example of available marketing data that may be useful in assessing exposure to selected products. The report is published biannually. Data are collected on the buying habits of the U.S. populations over the past 12 months for over 1,000 consumer products. Data are presented on frequency of use, total number of buyers in each use category, and selected demographics. The consumer product data are presented according to the "buyer" and not necessarily according to the "user" (actively exposed person). Therefore, it may be necessary to adjust the data to reflect potential uses. The reports are available for purchase from the Simmons Market Research Bureau. Table 17-2 presents a list of product categories in the "Simmons Study of Media and Markets" for which information is available.

It should be noted that this chapter does not provide an exhaustive treatment of all consumer products, but rather provides some background and data that can be utilized in an exposure assessment. Also, the data presented may not capture information needed to assess the highly exposed population (e.g., consumers who use commercial/ industrial strength products at home). The studies presented in the following sections represent readily available surveys for which data were collected on the frequency and duration of use and amount of use of cleaning products, painting products, household solvent products, cosmetic and other personal care products, household equipment, pesticides, and tobacco. The studies have been classified as either key or relevant based on their applicability to exposure assessment needs.

17.2 RECOMMENDATIONS

Due to the large range and variation among consumer products and their exposure pathways, it is not feasible to recommend specific exposure values as has been done in other chapters of this handbook. The user is referred to the information provided by the references of this chapter to derive appropriate exposure factors. The following sections of this chapter provide summaries of data from surveys involving the use of consumer products.

17.3 CONSUMER PRODUCTS USE STUDIES

17.3.1 CTFA, 1983 - Cosmetic, Toiletry, and Fragrance Association, Inc. - Summary of Results of Surveys of the Amount and Frequency of Use of Cosmetic Products by Women

The Cosmetic, Toiletry, and Fragrance Association Inc. (CTFA, 1983), a major manufacturer and a market research bureau, conducted surveys to obtain information on frequency of use of various cosmetic products. Three surveys were conducted to collect data on the frequency of use of various cosmetic products and selected baby products. In the first of these three surveys CTFA (1983) conducted a one-week prospective survey of 47 female employees and relatives of employees between the ages of 13 and 61 years. In the second survey, a cosmetic manufacturer conducted a retrospective survey of 1,129 of its customers. The third survey was conducted by a market research bureau which sampled 19,035 female consumers nationwide over a 9½ month period. Of the 19,035 females interviewed, responses from only 9,684 females were tabulated (CTFA, 1983). The third survey was designed to reflect the sociodemographic (i.e., age, income, etc) characteristics of the entire U.S. population. The respondents in all three surveys were asked to record the number of times they used the various products in a given time period (i.e., a week, a day, a month, or a year).

To obtain the average frequency of use for each cosmetic product, responses were averaged for each product in each survey. Thus, the averages were calculated by adding the reported number of uses per given time period for each product, dividing by the total number of respondents in the survey, and then dividing again by the number of days in the given time period (CTFA, 1983). The average frequency of use of cosmetic products was determined for both "users" and "non-users." The frequency of use of baby products was determined among "users" only. The upper 90th percentile frequency of use values were determined by eliminating the top ten percent most extreme frequencies of use. Therefore, the highest remaining frequency of use was recorded as the upper 90th percentile value. Table 17-3 presents the amount of product used per application (grams) and the average and 90th percentile frequency of use per day for baby products and various cosmetic products for all the surveys.

An advantage of the frequency data obtained from the third survey (market research bureau) is that the sample population was more likely to be representative of the U.S. population. Another advantage of the third dataset is that the survey was conducted over a longer period of time when compared with the other two frequency datasets. Also, the study provided empirical data which will be useful in generating more accurate estimates of consumer exposure to cosmetic products. In contrast to the large market research bureau survey, the CTFA employee survey is very small and both that survey and the cosmetic company survey are likely to be biased toward high end users. Therefore, data from these two surveys should be used with caution. The data in this study were not tabulated by age and the data are more than 20 years old.

17.3.2 Westat, 1987a - Household Solvent Products: A National Usage Survey

Westat (1987a) conducted a nationwide survey to determine consumer exposure to common household products believed to contain methylene chloride or its substitutes (carbon tetrachloride, trichloroethane, trichloroethylene, perchloroethylene, and 1,1,1,2,2,2- trichlorotrifluoroethane). The survey methodology was comprised of three phases. In the first phase, the sample population was generated by using a random digit dialing (RDD) procedure. Using this procedure, telephone numbers of households were randomly selected by utilizing an unbiased, equal probability of selection method, known as the "Waksberg Method" (Westat, 1987a). After the respondents in the selected households (18 years and older) agreed to participate in the survey, the second phase was initiated. It involved a mailout of questionnaires and product pictures to each respondent. In the third phase, a telephone follow-up call was made to those respondents who did not respond to the mailed questionnaire within a 4-week period. The same questionnaire was administered over the telephone to participants who did not respond to the mailed questionnaire. Of the 6,700 individuals contacted for the survey, 4,920 individuals either responded to the mailed questionnaire or to a telephone interview (a response rate of 73 percent). Survey questions included how often the products were used in the last 12 months; when they were last used; how much time was spent using a product (per occasion or year), and the time the respondent remained in the room after use; how much of a product was used per occasion or year; and what protective measures were used (Westat, 1987a).

Thirty-two categories of common household products were included in the survey and are presented in Table 17-4. Tables 17-4, 17-5, 17-6, and 17-7 provide means, medians, and percentile rankings for the following variables: frequency of use, exposure time, amount of use, and time exposed after use.

An advantage of this study is that the random digit dialing procedure (Waksberg Method) used in identifying participants for this survey enabled a diverse selection of a representative, unbiased sample of the U.S. population (Westat 1987a). Also, empirical data on consumer household product use is provided. However, a limitation associated with this study is that the data generated were based on recall behavior. Another limitation is that extrapolation of these data to long-term use patterns may be difficult and the data are more than 20 years old.

17.3.3 Westat, 1987b - National Usage Survey of Household Cleaning Products

Westat (1987b) collected usage data from a nationwide survey to assess the magnitude of exposure of consumers to various products used when performing certain household cleaning tasks. The survey was conducted between the middle of November, 1985 to the middle of January, 1986. Telephone interviews were conducted with 193 households. According to Westat (1987b), the resulting response rate for this survey was 78 percent. The Waksberg method discussed previously in the Westat (1987a) study was also used in randomly selecting telephone numbers employed in the Westat (1987b) survey. The survey was designed to obtain information on cleaning activities performed in the interior of the home during the previous year. The person who did the majority of the cleaning in the kitchen and bathroom areas of each household was interviewed. Of those respondents, the primary cleaner was female in 160 households (83 percent) and male in 30 households (16 percent); the sex of the respondents in three remaining households was not ascertained (Westat, 1987b). Data obtained from the survey included the frequency of performing 14 different cleaning tasks; the amount of time (duration) spent at each task; the cleaning product most frequently used; the type of product (liquid, powder, aerosol or spray pump) used; and the protective measures taken during cleaning such as wearing rubber gloves or having a window open or an exhaust fan on (Westat, 1987b).

The survey data are presented in Tables 17-8 through 17-12. Table 17-8 presents the mean and median total exposure time of use for each cleaning task and the product type preferred for each task. The percentile rankings for the total time exposed to the products used for 14 cleaning tasks are presented in Table 17-9. The mean and percentile rankings of the frequency in performing each task are presented in Table 17-10. Table 17-11 shows the mean and percentile rankings for exposure time per event of performing household tasks. The mean and percentile rankings for total number of hours spent per year using the top 10 product groups are presented in Table 17-12.

Westat (1987b) randomly selected a subset of 30 respondents from the original survey and reinterviewed them during the first two weeks of March, 1986 as a reliability check on the recall data obtained from the original phone survey. Frequency and duration data for 3 of the original 14 cleaning tasks were obtained from the reinterviews. In a second effort to validate the phone survey, 50 respondents of the original phone survey participated in a four-week diary study (between February and March, 1986) of 8 of the 14 cleaning tasks originally studied. The diary approach assessed the validity of using a one-time telephone survey to determine usual cleaning behavior (Westat, 1987b). The data (i.e., frequency and duration) obtained from the reinterviews and the diary approach were lower than the data from the original telephone survey. The data from the reinterviews and the diary approach were more consistent with each other. Westat (1987b) attributed the significant differences in the data obtained from these surveys to seasonal changes rather than methodological problems.

A limitation of this survey is evident from the reliability and validity check of the data conducted by Westat (1987b). The data obtained from the telephone survey may reflect heavier seasonal cleaning because the survey was conducted during the holidays (November through January). Therefore, usage data obtained in this study may be biased and may represent upper bound estimates. Another limitation of this study is the small size of the sample population. An advantage of this survey is that the RDD procedure (Waksberg Method) used provides unbiased results of sample selection and reduces the number of unproductive calls. Another advantage of this study is that it provides empirical data on frequency and duration of consumer use, thereby eliminating best judgment or guesswork.

17.3.4 Westat, 1987c - National Household Survey of Interior Painters

Westat (1987c) conducted a study between November, 1985 and January, 1986 to obtain usage information to estimate the magnitude of exposure of consumers to different types of painting and painting related products used while painting the interior of the home. Seven-hundred and seventy-seven households were sampled to determine whether any household member had painted the interior of the home during the last 12 months prior to the survey date. Of the sampled households, 208 households (27 percent) had a household member who had painted during the last 12 months. Based on the households with primary painters, the response rate was 90 percent (Westat, 1987c). The person in each household who did most of the interior painting during the last 12 months was interviewed over the telephone. The RDD procedure (Waksberg Method) previously described in Westat (1987a) was used to generate sample blocks of telephone numbers in this survey. Questions were asked on frequency and time spent for interior painting activities; the amount of paint used; and protective measures used (i.e., wearing gloves, hats, and masks or keeping a window open) (Westat, 1987c). Fifty-three percent of the primary painters in the households interviewed were male, 46 percent were female, and the sex of the remaining 1 percent was not ascertained. Three types of painting products were used in this study; latex paint, oil-based paint, and wood stains and varnishes. Of the respondents, 94.7 percent used latex paint, 16.8 percent used oil-based paint, and 20.2 percent used wood stains and varnishes.

Data generated from this survey are summarized in Tables 17-13, 17-14, and 17-15. Table 17-13 presents the mean, standard deviation, and percentile rankings for the total exposure time for painting activity by paint type. Table 17-14 presents the mean and median exposure time for the painting activity per occasion for each paint type. A "painting occasion" is defined as a time period from start to cleanup (Westat 1987c). Table 17-14 also presents the frequency and percentile rankings of painting occasions per year. Table 17-15 presents the total amount of paint used by interior painters.

In addition, 30 respondents from the original survey were reinterviewed in April 1986, as a reliability check on the recall data obtained from the original painting survey. There were no significant differences between the data obtained from the reinterviews and the original painting survey (Westat, 1987c).

An advantage of this survey, based on the reliability check conducted by Westat (1987c), is the stability in the painting data obtained. Another advantage of this survey is that the response rate was high (90 percent), therefore, minimizing non-response bias. Also, the Waksberg Method employed provides an unbiased equal probability method of RDD. A limitation of the survey is the data are based on 12-month recall and may not accurately reflect long-term use patterns.

17.3.5 Abt, 1992 - Methylene Chloride Consumer Use Study Survey Findings

As part of a plan to assess the effectiveness of labeling of consumer products containing methylene chloride, Abt conducted a telephone survey of nearly five thousand households (Abt, 1992). The survey was conducted in April and May of 1991. Three classes of products were included: paint strippers, non-automotive spray paint, and adhesive removers. The survey paralleled a 1986 consumer use survey sponsored jointly by Abt and the U.S. EPA.

The survey was conducted to estimate the percent of the U.S. adult population using paint remover, adhesive remover, and non-automotive spray paint. In addition, an estimate of the population using these products containing methylene chloride was determined. A survey questionnaire was developed to collect product usage data and demographic data. The survey sample was generated using a RDD technique.

A total of 4,997 product screener interviews were conducted for the product interview sections. The number of respondents were: 381 for paint strippers, 58 for adhesive removers, and 791 for non-automotive spray paint. Survey responses were weighted to allow estimation at the level of the total U.S. population (Abt, 1992). A follow-up mail survey was also conducted using a short questionnaire. Respondents who had used the product in the past year or had purchased the product in the past 2 years and still had the container were asked to respond to the questionnaire (Abt, 1992). Of the mail questionnaires (527) sent out, 259 were returned. The questionnaire responses included 67 on paint strippers, 6 on adhesive removers, and 186 on non-automotive spray paint. Results of the survey are presented in Tables 17-16 through 17-21 (N's are unweighted). Data are presented for recent users, who were defined as persons who have used the product within the last year of the survey or who have purchased the product in the past 2 years.

Abt (1992) found the following results:

- Compared to the 1986 findings, a significantly smaller proportion of current survey respondents used a paint stripper, spray paint, or adhesive remover.
- The proportion of the population who used the three products recently (within the past year) decreased substantially.
- Those who used the products reported a significantly longer time since their last use.
- For all three products, the reported amount used per year was significantly higher in the current survey.

An advantage of this survey is that the survey population was large and the survey responses were weighted to represent the U.S. population. In addition, the survey was designed to collect data for frequency of product use and amount of product used by gender. Limitations of the survey are that the information may be dated and data were generated based on recall behavior. Extrapolation of these data to accurately reflect long-term use patterns may be difficult.

17.3.6 U.S. EPA, 1996 - National Human Activity Pattern Survey (NHAPS)

U.S. EPA (1996) collected data on the duration and frequency of selected activities and the time spent in selected microenvironments via 24-hour diaries as part of the National Human Activity Pattern Survey (NHAPS). More than 9,000 individuals from various age groups in 48 contiguous states participated in NHAPS including 2000 children. The survey was conducted between October 1992 and September 1994. Individuals were interviewed to categorize their 24-hour routines (diaries) and/or to answer follow-up questions that were related to exposure events. Demographic, including socioeconomic (gender, age, race, education, etc.), geographic (census region, state, etc.), and temporal (day of week, month, season) data were included in the study. Data were collected for a maximum of 82 possible microenvironments and 91 different activities.

As part of the survey, data were also collected on duration and frequency of use of selected consumer products. Tables 17-22 through 17-30 present data on the number of minutes that survey respondents spent in activities working with or being near certain consumer products, including: microwave ovens, freshly applied paints; household cleaning agents such as scouring powders or ammonia; floor wax, furniture wax, or shoe polish; glue; solvents, fumes, or strong smelling chemicals; stain or spot removers; gasoline, diesel-powered equipment, or automobiles; and pesticides, bug sprays, or bug strips. Table 17-31 through 17-35 present data on the number of respondents in these age categories that used fragrances, aerosol sprays, humidifiers, and pesticides (professionally-applied and consumer-applied). Because the age categories used by the study authors did not coincide with the standardized age categories recommended in U.S. EPA (2005) and used elsewhere in this handbook, the source data from NHAPS on pesticide use (professionally applied and consumer-applied) were re-analyzed by U.S. EPA to generate data for the standardized age categories. Data for subsets of the first year of life (e.g., 1 to 2 months, 3 to 5 months, etc.) were not available.

As discussed in previous chapters of this handbook that used NHAPS as a data source, the primary advantage of NHAPS is that the data were collected for a large number of individuals and the survey was designed to be representative of the U.S. general population. However, due to the wording of questions in the survey, precise data were not available for consumers who spent more than 60 or 120 minutes (depending on the activity) using some consumer products. This prevents accurate characterization of the high end of the distribution and may also introduce error into the calculation of the mean. One limitation is that the adult data was not broken down into finer age categories.

17.3.7 Bass et al., 2001 - What's Being Used at Home: A Household Pesticide Survey

Bass et al. (2001) conducted a survey to assess the use of pesticide products in homes with children in March 1999. The study obtained information on what pesticides were used, where they were used, and how frequently they were used. A total of 107 households in Arizona that had a least one child less than ten years of age in the household, and had used a pesticide within the last six months, were surveyed (Bass et al., 2001). The survey population was predominantly female Hispanic and represented a survey response rate of approximately 74 percent. Study participants were selected by systematic random sampling. Pesticide use was assessed by a one-on-one interview in the home. Survey questions pertained to household pesticides used inside the house for insect control and outside the house for the control of weeds in the garden and to repel animals from the garden. As part of the interview, information was gathered on the frequency of use.

Table 17-36 presents information on the type, characteristics, and frequency of pesticide use, as well as information on the demographics of the survey population. A total of 148 pesticide products were used in the 107 households surveyed. Respondents had used pesticides in the kitchen, bathroom, floors, baseboards, and cabinets with dishes or cookware. The frequency of use data showed the following: about 32 percent of the households used pesticides once per week or more; about 44 percent used the products once per month or once in three months; and about 19 percent used the products once in six months or once per year (Bass et al., 2001).

Although this study was limited to a selected area in Arizona, it provides useful information on the frequency of use of pesticides among households with children. This may be useful for populations in similar geographical locations where site-specific data are not available. However, these data are the result of a community-based survey and are not representative of the U.S. general population.

17.3.8 Weegels and van Veen, 2001 - Variation of Consumer Contact with Household Products: A Preliminary Investigation

Weegels and van Veen (2001) conducted a survey to determine consumer exposure to common household products that are used once a day or every other day. Thirty households including, 10 families with children, 10 couples, 9 individuals, and 1 household of 6 adults. Households were recruited through the Usability Panel of the School of Industrial Design and through public notices and pamphlets.

Three types of products were studied, dishwashing detergent, all-purpose cleaners, and hair styling products. Three activities in which these products are commonly used were studied in more detail: dishwashing, toilet cleaning, and styling hair. In-home observations, dairies, and measurement of amount of use were used to collect data. Subjects were visited in the home and videotaped performing the above activities. After three weeks, subjects were again visited in the home and videotaped performing activities, diaries were collected, and amount of product used was measured.

The survey data are presented in Table 17-37. During toilet cleaning 22 of 29 subjects observed used at least two different products (e.g., toilet cleaner, all-purpose cleaner, and/or abrasive cleaner). The large variation in duration of toilet cleaner was due to the diverse ways in which toilet cleaner was used: some subjects left the toilet cleaner to soak overnight, some left it in the bowl while cleaning the remainder of the toilet, other flushed the toilet immediately after cleaning. The authors noted that the findings of the study suggest that "individuals have a consistent way of using a product for a particular activity, but there is a large variety in product usage among consumers, with relations among frequency, durations and amount. If this conclusion is confirmed by future research, it suggests that there will be people who exhibit high-end use of products and will, most likely follow their own routine, which may have consequences for the definition of worst-case use of consumer products."

An advantage of this study is that the empirical data generated during this study provides more accurate calculations of exposure than studies relaying on recall data. A limitation of the study is the small study population (30 households). Another limitation is that the short duration (three weeks) may not accurately reflect long-term or seasonal usage patterns.

17.3.9 Loretz et al., 2005 - Exposure Data for Cosmetic Products: Lipstick, Body Lotion, and Face Cream

Loretz et al. (2005) conducted a nationwide survey to estimate the usage (i.e., frequency of application and amount used per application) of lipstick, body lotion, and face cream. The study was conducted in 2000 and included 360 study subjects recruited in ten U.S. cities (Atlanta, Georgia; Boston, Massachusetts; Chicago, Illinois; Denver, Colorado; Houston, Texas; Minneapolis, Minnesota; St. Louis, Missouri; San Bernadino, California; Tampa, Florida; and Seattle, Washington). The survey participants were women, ages 19-65 years, who regularly used the products of interest. Typical cosmetic formulations of the three product types were weighed and provided to the women for use over a two-week period. Subjects recorded information on product usage (e.g., whether the product was used, number of applications, time of applications) on a daily basis in a diary provided to them. At the end of the two-week period, unused portions of product were returned and weighed. The amount of product used was estimated as the difference between the weight of product at the beginning and end of the survey period. Of the 360 subjects recruited, 86.4 percent, 83.3 percent, and 85.6 percent completed the study and returned the diaries for lipstick, body lotion, and face cream, respectively (Loretz et al., 2005).

The survey data are presented in Table 17-38 and 17-39. Table 17-38 provides the mean, median, and standard deviations for the frequency of use. Table 17-39 provides distribution data for the total amount applied, the average amount applied per use day, and the average amount applied per application.

An advantage of this study is that the survey population covered a diverse geographical area of the U.S. and was not based on recall data. A limitation of the study is that the short duration (two weeks) may not accurately reflect long-term usage patterns. Another limitation is that the study only included women who already used the products; therefore, the usage patterns are not representative of the entire female population. Also, the data are not presented by age group.

17.3.10 Loretz et al., 2006 - Exposure Data for Personal Care Products: Hairspray, Spray Perfume, Liquid Foundation, Shampoo, Body Wash, and Solid Antiperspirant

Loretz et al. (2006) conducted a nationwide survey to determine the usage (i.e., frequency of use and amount used) of hairspray, spray perfume, liquid foundation, shampoo, body wash, and solid antiperspirant. The survey was similar to that described by Loretz et al. (2005). This study was conducted in 2000/2001. A total of 360 women were recruited from ten U.S. cities (Atlanta, Georgia; Boston, Massachusetts; Chicago, Illinois; Denver, Colorado; Houston, Texas; Minneapolis, Minnesota; St. Louis, Missouri; San Bernadino, California; Tampa, Florida; and Seattle, Washington). The survey participants were women, ages 19-65 years old, who regularly used the test products. Subjects kept daily records on product usage (whether the product was used, number of applications, time of applications) in a diary. For spray perfume, liquid foundation, and body wash, subjects recorded the body area(s) where these products were applied. For shampoo, subjects recorded information on their hair type (length, thickness, oiliness, straight or curly, and color treated or not). At the end of the two week period, unused portions of products were returned and weighed. Of the 360 subjects recruited per product, the study was completed by 329 participants for hairspray, 327 for spray perfume, 326 for liquid foundation, and 340 participants for shampoo, body wash, and solid antiperspirant.

The survey data are presented in Tables 17-40 through 17-42. Table 17-40 provides the minimum, maximum, mean, and standard deviations for the frequency of use. Table 17-41 provides percentile values for the amount of product applied per application. Table 17-42 provides distribution data for the amount applied per use day.

An advantage of this study is that the survey population covered a diverse geographical range of the U.S. and did not rely on recall data. A limitation of the study is that the short duration (two weeks) may not accurately reflect long-term usage patterns. Another limitation is that the study only included women who already used these products; therefore, the usage patterns are not entirely representative of the entire female population. Also, the data are not presented by age group.

17.3.11 Hall et al, 2007 - European consumer exposure to cosmetic products, a framework for conducting population exposure assessments.

European cosmetic manufacturers constructed a probabilistic European population model of exposure for six cosmetic products: body lotion, deodorant/antiperspirant, lipstick, facial moisturizer, shampoo, and toothpaste (Hall et al., 2007). Data were collected using both market information databases and a controlled product use study from 44,100 households and 18,057 individual consumers to create a sample of the 249 million inhabitants of the 15 counties in the European Union. Tables 17-43 through 17-50 show the amount consumed in grams/day. The study found an inverse correlation between frequency of product use and quantity used per application for body lotion, facial moisturizer, toothpaste and shampoo and so cautioned against calculating daily exposure to these products by multiplying the maximum frequency value by the maximum quantity per event value.

The advantage of this study is that it included a large sample size. However, behaviors and activities in the European population may not be representative of the U.S. population and results were not broken out by age groups.

17.3.12 Loretz et al., 2008 - Exposure Data for Cosmetic Products: Facial Cleanser, Hair Conditioner, and Eye Shadow

Loretz et al. (2008) used the data from a study conducted in 2005 to estimate frequency of use and usage amount for facial cleanser, hair conditioner, and eye shadow. The study was conducted in a similar manner as Loretz et al. (2005; 2006). A total of 360 women, ages 18 to 69 years of age, were recruited by telephone to provide diary records of product use over a two-week period. The study subjects were representative of four U.S. Census regions (Northeast, Midwest, South, and West). A total of 295, 297, and 299 completed the study for facial cleanser, hair conditioner, and eye shadow, respectively.

The participants recorded daily in a diary whether the product was used that day, the number of applications, and the time of application(s) over a two-week period. Products were weighed at the start and completion of the study to determine the amount used. A statistical analysis of the data was conducted to provide summary distributions of use patterns, including number of applications, amount used per day, and amount of product used per application for each product. Data on the number of applications per use day are provided in Table 17-51. The average amounts of product applied per use day are shown in Table 17-52, and the average amounts of product applied per application are shown in Table 17-53.

The advantages of this study are that it is representative of the U.S. female population for users of the products studied, it provides data for frequency of use and amount used, and it provides distribution data. The limitations of the study are that the data were not provided by age group. In addition, the participants were regular users of the product, so the amount applied and the frequency of use may be higher than for other individuals who may use the products. According to Loretz et al. (2008) "variability in amount used by the different subjects is high, but consistent with the data from other cosmetic and personal care studies." The authors also noted that it was not clear if the high-end users of products represented true usage.

17.3.13 Sathyanarayana et al., 2008 - Baby Care Products; Possible Sources of Infant Phthalate Exposure

Sathyanarayana et al. (2008) investigated dermal exposure to phthalates via the dermal application of personal care products. The study was conducted on 163 infants born between the year 2000 and 2005. The products studied were baby lotion, baby powder, baby shampoo, diaper cream, and baby wipes. Infants were recruited through Future Families, a multicenter pregnancy cohort study, at prenatal clinics in Los Angeles, California; Minneapolis, Minnesota; and Columbia, Missouri. Although the study was designed to assess exposure to phthalates, the authors collected information on the percentage of the total participants that used the baby products. Data were collected from questionnaire responses of the mothers and at study visits. The characteristics and the percent of the population using the studied baby products are shown in Table 17-54. Of the 163 infants studied, 94 percent of the participants used baby wipes and 54 percent used infant shampoo.

The advantages of this study are that it specifically targeted consumer products used by children. The percent of the study population using these products was captured and the data were collected from a diverse ethnic population. The limitations are that these data may not be entirely representative of the U.S. population because the study population was from only three states and the sample size was small.

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Table 17-1. Consumer Products Commonly Found in Some U.S. Households[a]

Consumer Product Category	Consumer Product
Cosmetics Hygiene Products	• Adhesive bandages • Bath additives (liquid) • Bath additives (powder) • Cologne/perfume/aftershave • Contact lens solutions • Deodorant/antiperspirant (aerosol) • Deodorant/antiperspirant (wax and liquid) • Depilatories • Facial makeup • Fingernail cosmetics • Hair coloring/tinting products • Hair conditioning products • Hairsprays (aerosol) • Lip products • Mouthwash/breath freshener • Sanitary napkins and pads • Shampoo • Shaving creams (aerosols) • Skin creams (non-drug) • Skin oils (non-drug) • Soap (toilet bar) • Sunscreen/suntan products • Talc/body powder (non-drug) • Toothpaste • Waterless skin cleaners
Household Furnishings	• Carpeting • Draperies/curtains • Rugs (area) • Shower curtains • Vinyl upholstery, furniture
Garment Conditioning Products	• Anti-static spray (aerosol) • Leather treatment (liquid and wax) • Shoe polish • Spray starch (aerosol) • Suede cleaner/polish (liquid and aerosol) • Textile water-proofing (aerosol)
Household Maintenance Products	• Adhesive (general) (liquid) • Bleach (household) (liquid) • Bleach (see laundry) • Candles • Cat box litter • Charcoal briquets • Charcoal lighter fluid • Drain cleaner (liquid and powder) • Dishwasher detergent (powder) • Dishwashing liquid • Fabric dye (DIY)b • Fabric rinse/softener (liquid) • Fabric rinse/softener (powder) • Fertilizer (garden) (liquid) • Fertilizer (garden) (powder) • Fire extinguishers (aerosol) • Floor polish/wax (liquid) • Food packaging and packaged food • Furniture polish (liquid) • Furniture polish (aerosol) • General cleaner/disinfectant (liquid) • General cleaner (powder) • General cleaner/disinfectant (aerosol and pump) • General spot/stain remover (liquid) • General spot/stain remover (aerosol and pump) • Herbicide (garden-patio) (liquid and aerosol) • Insecticide (home and garden) (powder) • Insecticide (home and garden) (aerosol and pump) • Insect repellent (liquid and aerosol) • Laundry detergent/bleach (liquid) • Laundry detergent (powder) • Laundry pre-wash/soak (powder) • Laundry pre-wash/soak (liquid) • Laundry pre-wash/soak (aerosol and pump) • Lubricant oil (liquid) • Lubricant (aerosol) • Matches • Metal polish • Oven cleaner (aerosol) • Pesticide (home) (solid) • Pesticide (pet dip) (liquid) • Pesticide (pet) (powder) • Pesticide (pet) (aerosol) • Pesticide (pet) (collar) • Petroleum fuels (home (liquid and aerosol) • Rug cleaner/shampoo (liquid and aerosol) • Rug deodorizer/freshener (powder) • Room deodorizer (solid) • Room deodorizer (aerosol) • Scouring pad • Toilet bowl cleaner • Toiler bowl deodorant (solid) • Water-treating chemicals (swimming pools)

Table 17-1. Consumer Products Commonly Found in Some U.S. Households[a] (continued)

Consumer Product Category	Consumer Product	
Home Building/Improvement Products (DIY)[b]	• Adhesives, specialty (liquid) • Ceiling tile • Caulks/sealers/fillers • Dry wall/wall board • Flooring (vinyl) • House Paint (interior) (liquid) • House Paint and Stain (exterior) (liquid) • Insulation (solid) • Insulation (foam)	• Paint/varnish removers • Paint thinner/brush cleaners • Patching/ceiling plaster • Roofing • Refinishing products (polyurethane, varnishes, etc.) • Spray paints (home) (aerosol) • Wall paneling • Wall paper • Wall paper glue
Automobile-related Products	• Antifreeze • Car polish/wax • Fuel/lubricant additives • Gasoline/diesel fuel • Interior upholstery/components, synthetic	• Motor oil • Radiator flush/cleaner • Automotive touch-up paint (aerosol) • Windshield washer solvents
Personal Materials	• Clothes/shoes • Diapers/vinyl pants • Jewelry • Printed material (colorprint, newsprint, photographs)	• Sheets/towels • Toys (intended to be placed in mouths)

[a] A subjective listing based on consumer use profiles.
[b] DIY = Do It Yourself.

Source: U.S. EPA, 1987.

Table 17-2. List of Product Categories in the "Simmons Study of Media and Markets"

The volumes included in the Media series are as follows:	
M1	Publications: Total Audiences
M2	Publications: Qualitative Measurements And In-Home Audiences
M3	Publications: Duplication Of Audiences
M4	Multi-Media Audiences: Adults
M5	Multi-Media Audiences: Males
M6	Multi-Media Audiences: Females and Mothers
M7	Business To Business
M8	Multi-Media Reach and Frequency and Television Attentiveness & Special Events
The following volumes are included in the Product series:	
P1	Automobiles, Cycles, Trucks & Vans
P2	Automotive Products & Services
P3	Travel
P4	Banking, Investments, Insurance, Credit Cards & Contributions, Memberships & Public Activities
P5	Games & Toys, Children's & Babies' Apparel & Specialty Products
P6	Computers, Books, Discs, Records, Tapes, Stereo, Telephones, TV & Video
P7	Appliances, Garden Care, Sewing & Photography
P8	Home Furnishings & Home Improvements
P9	Sports & Leisure
P10	Restaurants, Stores & Grocery Shopping
P11	Direct Mail & Other In-Home Shopping, Yellow Pages, Florist, Telegrams, Faxes & Greeting Cards
P12	Jewelry, Watches, Luggage, Writing Tools & Men's Apparel
P13	Women's Apparel
P14	Distilled Spirits, Mixed Drinks, Malt Beverages, Wine & Tobacco Products
P15	Coffee, Tea, Cocoa, Milk, Soft Drinks, Juices & Bottled Water
P16	Dairy Products, Desserts, Baking & Bread Products
P17	Cereals & Spreads, Rice, Pasta, Pizza, Mexican Foods, Fruits & Vegetables
P18	Soup, Meat, Fish, Poultry, Condiments & Dressings
P19	Chewing Gum, Candy, Cookies & Snacks
P20	Soap, Laundry, Paper Products & Kitchen Wraps
P21	Household Cleaners, Room Deodorizers, Pest Controls & Pet Foods
P22	Health Care Products & Remedies
P23	Oral Hygiene Products, Skin Care, Deodorants & Drug Stores
P24	Hair Care, Shaving Products & Fragrances
P25	Women's Beauty Aids, Cosmetics & Personal Products
P26	Relative Volume of Consumption

Table 17-3. Amount and Frequency of Use of Various Cosmetic and Baby Products

Product Type	Amount of Product Per Application[a] (grams)	Average Frequency of Use (per day)			Upper 90th Percentile Frequency of Use (per day)		
		Survey Type			Survey Type		
		CTFA	Cosmetic Co.	Market[b] Research Bureau	CTFA	Cosmetic Co.	Market Research Bureau
Hair Conditioners	12.4	0.4	0.40	0.27	1.0	1.0	0.86
Hair Sprays	–	0.25	0.55	0.32	1.0	1.0	1.0
Hair Rinses	12.7	0.064	0.18	–	0.29	1.0	–
Shampoos	16.4	0.82	0.59	0.48	1.0	1.0	1.0
Tonics and Dressings	2.9	0.073	0.021	–	0.29	0.14[e]	–
Wave Sets	2.6	0.003[h]	0.040	–	–[h]	0.14	–
Dentifrices	–	1.62	0.67	2.12	2.6	2.0	4.0
Mouthwashes	–	0.42	0.62	0.58	1.86	1.14	1.5
Breath Fresheners	–	0.052	0.43	0.46	0.14	1.0	0.57
Nail Basecoats	0.2	0.052	0.13	–	0.29	0.29	–
Cuticle Softeners	0.7	0.040	0.10	–	0.14	0.29	–
Nail Creams & Lotions	0.6	0.070	0.14	–	0.29	0.43	–
Nail Extenders	–	0.003	0.013	–	0.14[e]	0.14[e]	–
Nail Polish & Enamel	0.3	0.16	0.20	0.07	0.71	0.43	1.0
Nail Polish & Enamel Remover	3.1	0.088	0.19	–	0.29	0.43	–
Nail Undercoats	–	0.049	0.12	–	0.14	0.29	–
Bath Soaps	2.6	1.53	0.95	–	3.0	1.43	–
Underarm Deodorants	0.5	1.01	0.80	1.10	1.29	1.29	2.0
Douches	–	0.013	0.089	0.085	0.14[e]	0.29	0.29
Feminine Hygiene Deodorants	–	0.021	0.084	0.05	1.0[e]	0.29	0.14
Cleansing Products (cold creams, cleansing lotions liquids & pads)	1.7	0.63	0.80	0.54	1.71	2.0	1.5
Depilatories	–	0.0061	0.051	0.009	0.016	0.14	0.033
Face, Body & Hand Preps (excluding shaving preps)	3.5	0.65	–	1.12	2.0	–	2.14
Foot Powder & Sprays	–	0.061	0.079	–	0.57[e]	0.29	–
Hormones	–	0.012	0.028	–	0.57[e]	0.14[e]	–
Moisturizers	0.5	0.98	0.88	0.63	2.0	1.71	1.5
Night Skin Care Products	1.3	0.18	0.50	–	1.0	1.0	–
Paste Masks (mud packs)	3.7	0.027	0.20	–	0.14	0.43	–
Skin Lighteners	–	–	0.024	–	–[d]	0.14[d]	–
Skin Fresheners & Astringents	2.0	0.33	0.56	–	1.0	1.43	–
Wrinkle Smoothers (removers)	0.4	0.021	0.15	–	1.0[d]	1.0	–
Facial Cream	0.6	0.0061	–	–	0.0061	–	–
Permanent Wave	101	0.003	–	0.001	0.0082	–	0.005
Hair Straighteners	0.2	0.0007	–	–	0.005[d]	–	–

Table 17-3. Amount and Frequency of Use of Various Cosmetic and Baby Products (continued)

Product Type	Amount of Product Per Application[a] (grams)	Average Frequency of Use (per day)			Upper 90th Percentile Frequency of Use (per day)		
		Survey Type			Survey Type		
		CTFA	Cosmetic Co.	Market[b] Research Bureau	CTFA	Cosmetic Co.	Market Research Bureau
Hair Dye	–	0.001	–	0.005	0.004[d]	–	0.014
Hair Lighteners	–	0.0003	–	–	0.005[d]	–	–
Hair Bleaches	–	0.0005	–	–	0.02[d]	–	–
Hair Tints	–	0.0001	–	–	0.005[d]	–	–
Hair Rinse (coloring)	–	0.0004	–	–	0.02[d]	–	–
Shampoo (coloring)	–	0.0005	–	–	0.02[d]	–	–
Hair Color Spray	–	–	–	–	–[d]	–	–
Shave Cream	1.73	–	–	0.082	–	–	0.36

[a] Values reported are the averages of the responses reported by the twenty companies interviewed.
[b] The averages shown for the Market Research Bureau are not true averages - this is due to the fact that in many cases the class of most frequent users were indicated by "1 or more" also ranges were used in many cases, i.e., "10-12." The average, therefore, is underestimated slightly. The "1 or more" designation also skew the 90th percentile figures in many instances. The 90th percentile values may, in actuality, be somewhat higher for many products.
[c] Average usage among users only for baby products.
[d] Usage data reflected "entire household" use for both baby lotion and baby oil.
[e] Fewer than 10% of individuals surveyed used these products. Value listed is lowest frequency among individuals reporting usage. In the case of wave sets, skin lighteners, and hair color spray, none of the individuals surveyed by the CTFA used this product during the period of the study.
[f] Usage data reflected "entire household" use.
[g] Usage data reflected total bath product usage.
[h] None of the individuals surveyed reported using this product.
– Indicates no data available.

Source: CTFA, 1983.

Products	Mean	SD	Percentile Rankings for Frequency of Use/Year										
			Min	1	5	10	25	50	75	90	95	99	Max
Spray Shoe Polish	10.28	20.10	1.00	1.00	1.00	1.00	2.00	4.00	8.00	24.30	52.00	111.26	156.00
Water Repellents/Protectors	3.50	11.70	1.00	1.00	1.00	1.00	1.00	2.00	3.00	6.00	10.00	35.70	300.00
Spot Removers	15.59	43.34	1.00	1.00	1.00	1.00	2.00	3.00	10.00	40.00	52.00	300.00	365.00
Solvent-Type Cleaning Fluids or Degreasers	16.46	44.12	1.00	1.00	1.00	1.00	2.00	4.00	12.00	46.00	52.00	300.00	365.00
Wood Floor and Paneling Cleaners	8.48	20.89	1.00	1.00	1.00	1.00	NA	2.00	6.00	24.00	50.00	56.00	350.00
TypeWriter Correction Fluid	40.00	74.78	1.00	1.00	1.00	2.00	4.00	12.00	40.00	100.00	200.00	365.00	520.00
Adhesives	8.89	26.20	1.00	1.00	1.00	1.00	2.00	3.00	6.00	15.00	28.00	100.00	500.00
Adhesive Removers	4.22	12.30	1.00	1.00	1.00	1.00	1.00	1.00	3.00	6.00	16.80	100.00	100.00
Silicone Lubricants	10.32	25.44	1.00	1.00	1.00	1.00	2.00	3.00	10.00	20.00	46.35	150.00	300.00
Other Lubricants (excluding Automotive)	10.66	25.46	1.00	1.00	1.00	1.00	2.00	4.00	10.00	20.00	50.00	100.00	420.00
Specialized Electronic Cleaners (for TVs, Etc.)	13.41	38.16	1.00	1.00	1.00	1.00	2.00	3.00	10.00	24.00	52.00	224.50	400.00
Latex Paint	3.93	20.81	1.00	1.00	1.00	1.00	1.00	2.00	4.00	6.00	10.00	30.00	800.00
Oil Paint	5.66	23.10	1.00	1.00	1.00	1.00	1.00	1.00	3.00	6.00	12.00	139.20	300.00
Wood Stains, Varnishes, and Finishes	4.21	12.19	1.00	1.00	1.00	1.00	1.00	2.00	4.00	7.00	12.00	50.80	250.00
Paint Removers/Strippers	3.68	9.10	1.00	1.00	1.00	1.00	4.00	2.00	3.00	6.00	11.80	44.56	100.00
Paint Thinners	6.78	22.10	0.03	0.03	0.10	0.23	1.00	2.00	4.00	12.00	23.00	100.00	352.00
Aerosol Spray Paint	4.22	15.59	1.00	1.00	1.00	1.00	1.00	2.00	4.00	6.10	12.00	31.05	365.00
Primers and Special Primers	3.43	8.76	1.00	1.00	1.00	1.00	1.00	1.00	3.00	6.00	10.00	50.06	104.00
Aerosol Rust Removers	6.17	9.82	1.00	1.00	1.00	1.00	1.00	2.00	6.00	15.00	24.45	50.90	80.00
Outdoor Water Repellents (for Wood or Cement)	2.07	3.71	1.00	1.00	1.00	1.00	1.00	2.00	2.00	3.00	5.90	12.00	52.00
Glass Frostings, Window Tints, and Artificial Snow	2.78	21.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	27.20	365.00
Engine Degreasers	4.18	13.72	1.00	1.00	1.00	1.00	1.00	2.00	3.25	6.70	12.00	41.70	300.00
Carburetor Cleaners	3.77	7.10	1.00	1.00	1.00	1.00	1.00	2.00	3.00	6.00	12.00	47.28	100.00
Aerosol Spray Paints for Cars	4.50	9.71	1.00	1.00	1.00	1.00	1.00	2.00	4.00	10.00	15.00	60.00	100.00
Auto Spray Primers	6.42	33.89	1.00	1.00	1.00	1.00	1.00	2.00	3.75	10.00	15.00	139.00	500.00
Spray Lubricant for Cars	10.31	30.71	1.00	1.00	1.00	1.00	2.00	3.00	6.00	20.00	40.00	105.60	365.00
Transmission Cleaners	2.28	3.55	1.00	NA	1.00	1.00	1.00	1.00	2.00	3.00	9.00	NA	26.00
Battery Terminal Protectors	3.95	24.33	1.00	1.00	1.00	1.00	1.00	2.00	2.00	4.00	6.55	41.30	365.00
Brake Quieters Cleaners	3.00	6.06	1.00	NA	1.00	1.00	1.00	2.00	2.00	6.00	10.40	NA	52.00
Gasket Remover	2.50	4.39	1.00	NA	1.00	1.00	1.00	1.00	2.00	5.00	6.50	NA	30.00
Tire/Hubcap Cleaners	11.18	18.67	1.00	1.00	1.00	1.00	2.00	4.00	12.00	30.00	50.00	77.00	200.00
Ignition and Wire Dryers	3.01	5.71	1.00	1.00	1.00	1.00	1.00	2.00	3.00	5.00	9.70	44.52	60.00

Table 17-4. Frequency of Use for Household Solvent Products (users-only)

NA= Not Available

Source: Westat, 1987a

Table 17-5. Exposure Time of Use for Household Solvent Products (users-only)

Products	Mean (min)	SD	Percentile Rankings for Duration of Use (minutes)										
			Min	1	5	10	25	50	75	90	95	99	Max
Spray Shoe Polish	7.49	9.60	0.02	0.03	0.25	0.50	2.00	5.00	10.00	18.00	30.00	60.00	60.00
Water Repellents/Protectors	14.46	24.10	0.02	0.08	0.50	1.40	3.00	10.00	15.00	30.00	60.00	120.00	480.00
Spot Removers	10.68	22.36	0.02	0.03	0.08	0.25	2.00	5.00	10.00	30.00	30.00	120.00	360.00
Solvent-Type Cleaning Fluids or Degreasers	29.48	97.49	0.02	0.03	1.00	2.00	5.00	15.00	30.00	60.00	120.00	300.00	1,800.00
Wood Floor and Paneling Cleaners	74.04	128.43	0.02	1.00	5.00	10.00	20.00	30.00	90.00	147.00	240.00	480.00	2,700.00
TypeWriter Correction Fluid	7.62	29.66	0.02	0.02	0.03	0.03	0.17	1.00	2.00	10.00	32.00	120.00	480.00
Adhesives	15.58	81.80	0.02	0.03	0.08	0.33	1.00	4.25	10.00	30.00	60.00	180.00	2,880.00
Adhesive Removers	121.20	171.63	0.03	0.03	1.45	3.00	15.00	60.00	120.00	246.00	480.00	960.00	960.00
Silicone Lubricants	10.42	29.47	0.02	0.03	0.08	0.17	0.50	2.00	10.00	20.00	45.00	180.00	360.00
Other Lubricants (excluding Automotive)	8.12	32.20	0.02	0.03	0.05	0.08	0.50	2.00	5.00	15.00	30.00	90.00	900.00
Specialized Electronic Cleaners (for TVs, Etc.)	9.47	45.35	0.02	0.03	0.08	0.17	0.50	2.00	5.00	20.00	30.00	93.60	900.00
Latex Paint	295.08	476.11	0.02	1.00	22.50	30.00	90.00	180.00	360.00	480.00	810.00	2,880.00	5,760.00
Oil Paint	194.12	345.68	0.02	0.51	15.00	30.00	60.00	12.00	240.00	480.00	579.00	1,702.80	5,760.00
Wood Stains, Varnishes, and Finishes	117.17	193.05	0.02	0.74	5.00	10.00	30.00	60.00	120.00	140.00	360.00	720.00	280.00
Paint Removers/Strippers	125.27	286.59	0.02	0.38	5.00	5.00	20.00	60.00	120.00	240.00	420.00	1,200.00	4,320.00
Paint Thinners	39.43	114.85	0.02	0.08	1.00	2.00	5.00	10.00	30.00	60.00	180.00	480.00	2,400.00
Aerosol Spray Paint	39.54	87.79	0.02	0.17	2.00	5.00	10.00	20.00	45.00	60.00	120.00	300.00	1,800.00
Primers and Special Primers	91.29	175.05	0.05	0.24	3.00	5.00	15.00	30.00	120.00	240.00	360.00	981.60	1,920.00
Aerosol Rust Removers	18.57	48.54	0.02	0.05	0.17	0.25	2.00	5.00	20.00	60.00	60.00	130.20	720.00
Outdoor Water Repellents (for Wood or Cement)	104.94	115.36	0.02	0.05	5.00	15.00	30.00	60.00	120.00	240.00	300.00	480.00	960.00
Glass Frostings, Window Tints, and Artificial Snow	29.45	48.16	0.03	0.14	2.00	3.00	5.00	15.00	30.00	60.00	96.00	268.80	360.00
Engine Degreasers	29.29	48.14	0.02	0.95	2.00	5.00	10.00	15.00	30.00	60.00	120.00	180.00	900.00
Carburetor Cleaners	13.57	23.00	0.02	0.08	0.33	1.00	3.00	7.00	15.00	30.00	45.00	120.00	300.00
Aerosol Spray Paints for Cars	42.77	71.39	0.03	0.19	1.00	3.00	10.00	20.00	60.00	120.00	145.00	360.00	900.00
Auto Spray Primers	51.45	86.11	0.05	0.22	2.00	5.00	10.00	27.50	60.00	120.00	180.00	529.20	600.00
Spray Lubricant for Cars	9.90	35.62	0.02	0.03	0.08	0.17	1.00	5.00	10.00	15.00	30.00	120.00	720.00
Transmission Cleaners	27.90	61.44	0.17	NA	0.35	1.80	5.00	15.00	30.00	60.00	60.00	NA	450.00
Battery Terminal Protectors	9.61	18.15	0.03	0.04	0.08	0.23	1.00	5.00	10.00	20.00	30.00	120.00	180.00
Brake Quieters/Cleaners	23.38	36.32	0.07	NA	0.50	1.00	5.00	15.00	30.00	49.50	120.00	NA	240.00
Gasket Remover	23.57	27.18	0.33	NA	0.50	2.00	6.25	15.00	30.00	60.00	60.00	NA	180.00
Tire/Hubcap Cleaners	22.66	23.94	0.08	0.71	3.00	5.00	10.00	15.00	30.00	60.00	60.00	120.00	240.00
Ignition and Wire Dryers	7.24	8.48	0.02	0.02	0.08	0.47	1.50	5.00	10.00	15.00	25.50	48.60	60.00

NA= Not Available

Source: Westat, 1987a

Table 17-6. Amount of Products Used for Household Solvent Products (users-only)

Products	Mean (ounces/year)	SD	Percentile Rankings for Amount of Products Used (ounces/yr)										
			Min.	1	5	10	25	50	75	90	95	99	Max
Spray Shoe Polish	9.90	17.90	0.04	0.20	0.63	1.00	2.00	4.50	10.00	24.00	36.00	99.36	180.00
Water Repellents/Protectors	11.38	22.00	0.04	0.47	0.98	1.43	2.75	6.00	12.00	24.00	33.00	121.84	450.00
Spot Removers	26.32	90.10	0.01	0.24	0.60	1.00	2.00	5.50	16.00	48.00	119.20	384.00	1,600.00
Solvent-Type Cleaning Fluids or Degreasers	58.30	226.97	0.04	0.50	2.00	3.00	6.50	16.00	32.00	96.00	192.00	845.00	5,120.00
Wood Floor and Paneling Cleaners	28.41	57.23	0.03	0.80	2.45	3.50	7.00	14.00	30.00	64.00	96.00	204.40	1,144.00
TypeWriter Correction Fluid	4.14	13.72	0.01	0.02	0.06	0.12	0.30	0.94	2.40	8.00	18.00	67.44	181.80
Adhesives	7.49	55.90	0.01	0.02	0.05	0.12	0.35	1.00	3.00	8.00	20.00	128.00	1,280.00
Adhesive Removers	34.46	96.60	0.25	0.29	1.22	2.80	6.00	10.88	32.00	64.00	138.70	665.60	1,024.00
Silicone Lubricants	12.50	27.85	0.02	0.20	0.69	1.00	2.25	4.50	12.00	24.00	41.20	192.00	312.00
Other Lubricants (excluding Automotive)	9.93	44.18	0.01	0.18	0.30	0.52	1.00	2.25	8.00	18.00	32.00	128.00	1,280.00
Specialized Electronic Cleaners (for TVs, Etc.)	9.48	55.26	0.01	0.05	0.13	0.25	0.52	2.00	6.00	12.65	24.00	109.84	1,024.00
Latex Paint	371.27	543.86	0.03	4.00	12.92	32.00	64.00	256.00	384.00	857.60	1,280.00	2,560.00	6,400.00
Oil Paint	168.92	367.82	0.02	0.33	4.00	8.00	25.20	64.00	148.48	384.00	640.00	1,532.16	5,120.00
Wood Stains, Varnishes, and Finishes	65.06	174.01	0.12	1.09	4.00	4.00	8.00	16.00	64.00	128.00	256.00	768.00	3,840.00
Paint Removers/Strippers	63.73	144.33	0.64	1.50	4.00	8.00	16.00	32.00	64.00	128.00	256.00	512.00	2,560.00
Paint Thinners	69.45	190.55	0.03	0.45	3.10	4.00	8.00	20.48	64.00	128.00	256.00	640.00	3,200.00
Aerosol Spray Paint	30.75	52.84	0.02	0.75	2.01	3.25	7.00	13.00	32.00	65.00	104.00	240.00	1,053.00
Primers and Special Primers	68.39	171.21	0.01	0.09	1.30	3.23	8.00	16.00	60.00	128.00	256.00	867.75	1,920.00
Aerosol Rust Removers	18.21	81.37	0.09	0.25	1.00	1.43	2.75	8.00	13.00	32.00	42.60	199.80	1,280.00
Outdoor Water Repellents (for Wood or Cement)	148.71	280.65	0.01	0.37	3.63	8.00	16.00	64.00	128.00	448.00	640.00	979.20	3,200.00
Glass Frostings, Window Tints, and Artificial Snow	13.82	14.91	1.00	1.40	2.38	3.25	6.00	12.00	14.00	28.00	33.00	98.40	120.00
Engine Degreasers	46.95	135.17	0.04	1.56	4.00	6.00	12.00	16.00	36.00	80.00	160.00	480.00	2,560.00
Carburetor Cleaners	22.00	50.60	0.10	0.50	1.50	3.00	5.22	12.00	16.00	39.00	75.00	212.00	672.00
Aerosol Spray Paints for Cars	44.95	89.78	0.04	0.14	1.50	3.00	6.12	16.00	48.00	100.80	156.00	557.76	900.00
Auto Spray Primers	70.37	274.56	0.12	0.77	3.00	4.00	9.00	16.00	48.00	128.00	222.00	1,167.36	3840.00
Spray Lubricant for Cars	18.63	54.74	0.08	0.40	0.96	1.00	2.75	6.00	15.50	36.00	64.00	240.00	864.00
Transmission Cleaners	35.71	62.93	2.00	NA	3.75	4.00	8.00	15.00	32.00	77.00	140.00	NA	360.00
Battery Terminal Protectors	16.49	87.84	0.12	0.13	0.58	1.00	2.00	4.00	8.00	15.00	24.60	627.00	1,050.00
Brake Quieters/Cleaners	11.72	13.25	0.50	NA	1.00	2.00	3.02	8.00	14.25	32.00	38.60	NA	78.00
Gasket Remover	13.25	22.35	0.50	NA	1.00	1.00	3.75	7.75	16.00	24.00	58.40	NA	160.00
Tire/Hubcap Cleaners	31.58	80.39	0.12	0.50	1.82	3.00	6.00	12.00	28.00	64.00	96.00	443.52	960.00
Ignition and Wire Dryers	9.02	14.59	0.13	0.32	1.09	1.50	3.00	6.00	10.75	16.00	20.55	113.04	120.00

NA= Not Available

Source: Westat, 1987a

Table 17-7. Time Exposed After Duration of Use for Household Solvent Products (users-only)

Products	Mean (min)	SD	Percentile Rankings for Time Exposed After Duration of Use (minutes)											
			Min.	1	5	10	25	50	75	90	95	99	Max
Spray Shoe Polish	31.40	80.50	0.00	0.00	0.00	0.00	0.00	5.00	20.00	120.00	120.00	480.00	720.00
Water Repellents/Protectors	37.95	111.40	0.00	0.00	0.00	0.00	0.00	3.00	20.00	120.00	240.00	480.00	1,800.00
Spot Removers	43.65	106.97	0.00	0.00	0.00	0.00	1.00	5.00	30.00	120.00	240.00	480.00	1,440.00
Solvent-Type Cleaning Fluids or Degreasers	33.29	90.39	0.00	0.00	0.00	0.00	0.00	3.00	28.75	60.00	180.00	480.00	1,440.00
Wood Floor and Paneling Cleaners	96.75	192.88	0.00	0.00	0.00	0.00	5.00	30.00	120.00	240.00	480.00	1,062.00	1,440.00
TypeWriter Correction Fluid	124.70	153.46	0.00	0.00	1.00	5.00	30.00	60.00	180.00	360.00	480.00	600.00	1,800.00
Adhesives	68.88	163.72	0.00	0.00	0.00	0.00	1.00	10.00	60.00	180.00	360.00	720.00	2,100.00
Adhesive Removers	94.12	157.69	0.00	0.00	0.00	0.00	1.75	20.00	120.00	360.00	480.00	720.00	720.00
Silicone Lubricants	30.77	107.39	0.00	0.00	0.00	0.00	0.00	0.00	10.00	60.00	180.00	480.00	1,440.00
Other Lubricants (excluding Automotive)	47.45	127.11	0.00	0.00	0.00	0.00	0.00	2.00	30.00	120.00	240.00	485.40	1,440.00
Specialized Electronic Cleaners (for TVs, Etc.)	117.24	154.38	0.00	0.00	0.00	1.00	10.00	60.00	180.00	300.00	480.00	720.00	1,440.00
Latex Paint	91.38	254.61	0.00	0.00	0.00	0.00	0.00	5.00	60.00	240.00	480.00	1,440.00	2,880.00
Oil Paint	44.56	155.19	0.00	0.00	0.00	0.00	0.00	0.00	30.00	120.00	240.00	480.00	2,880.00
Wood Stains, Varnishes, and Finishes	48.33	156.44	0.00	0.00	0.00	0.00	0.00	1.00	30.00	120.00	240.00	694.00	2,880.00
Paint Removers/Strippers	31.38	103.07	0.00	0.00	0.00	0.00	0.00	0.00	20.00	60.00	180.00	541.20	1,440.00
Paint Thinners	32.86	105.62	0.00	0.00	0.00	0.00	0.00	0.00	15.00	60.00	180.00	480.00	1,440.00
Aerosol Spray Paint	12.70	62.80	0.00	0.00	0.00	0.00	0.00	0.00	1.00	30.00	60.00	260.50	1,440.00
Primers and Special Primers	22.28	65.57	0.00	0.00	0.00	0.00	0.00	0.00	10.00	60.00	120.00	319.20	720.00
Aerosol Rust Removers	15.06	47.58	0.00	0.00	0.00	0.00	0.00	0.00	5.00	60.00	60.00	190.20	600.00
Outdoor Water Repellents (for Wood or Cement)	8.33	43.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	58.50	309.60	420.00
Glass Frostings, Window Tints, and Artificial Snow	137.87	243.21	0.00	0.00	0.00	0.00	3.00	60.00	180.00	360.00	480.00	1,440.00	1,800.00
Engine Degreasers	4.52	24.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.50	120.00	360.00
Carburetor Cleaners	7.51	68.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	30.00	120.60	1,800.00
Aerosol Spray Paints for Cars	10.71	45.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.50	60.00	282.00	480.00
Auto Spray Primers	11.37	45.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	77.25	360.00	360.00
Spray Lubricant for Cars	4.54	30.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	15.00	70.20	420.00
Transmission Cleaners	5.29	29.50	0.00	NA	0.00	0.00	0.00	0.00	0.00	5.00	22.50	NA	240.00
Battery Terminal Protectors	3.25	17.27	0.00	NA	0.00	0.00	0.00	0.00	0.00	2.90	15.00	120.00	180.00
Brake Quieters/Cleaners	10.27	30.02	0.00	NA	0.00	0.00	0.00	0.00	0.00	30.00	120.00	NA	120.00
Gasket Remover	27.56	58.54	0.00	NA	0.00	0.00	0.00	0.00	12.50	120.00	180.00	NA	240.00
Tire/Hubcap Cleaners	1.51	20.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.00	480.00
Ignition and Wire Dryers	6.39	31.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	30.00	216.60	240.00

NA= Not Available

Source: Westat, 1987a

Table 17-8. Total Exposure Time of Performing Task and Product Type Used by Task for Household Cleaning Products

Tasks	Mean (hrs/year)	Median (hrs/year)	Product Type Used	Percent of Preference
Clean Bathroom Sinks and Tubs	44	26	Liquid	29%
			Powder	44%
			Aerosol	16%
			Spray pump	10%
			Other	1%
Clean Kitchen Sinks	41	18	Liquid	31%
			Powder	61%
			Aerosol	2%
			Spray pump	4%
			Other	2%
Clean Inside of Cabinets (such as kitchen)	12	5	Liquid	68%
			Powder	12%
			Aerosol	2%
			Spray pump	16%
			Other	2%
Clean Outside of Cabinets	21	6	Liquid	61%
			Powder	8%
			Aerosol	16%
			Spray pump	13%
			Other	2%
Wipe Off Kitchen Counters	92	55	Liquid	67%
			Powder	13%
			Aerosol	2%
			Spray pump	15%
			Other	3%
Thoroughly Clean Counters	24	13	Liquid	56%
			Powder	21%
			Aerosol	5%
			Spray pump	17%
			Other	1%
Clean Bathroom Floors	20	9	Liquid	70%
			Powder	21%
			Aerosol	2%
			Spray pump	4%
			Other	3%
Clean Kitchen Floors	31	14	Liquid	70%
			Powder	27%
			Aerosol	2%
			Spray pump	1%
			Other	-
Clean Bathroom or Other Tilted or Ceramic Walls	16	9	Liquid	37%
			Powder	18%
			Aerosol	17%
			Spray pump	25%
			Other	3%

Table 17-8. Total Exposure Time of Performing Task and Product Type Used by Task for Household Cleaning Products (continued)

Tasks	Mean (hrs/year)	Median (hrs/year)	Product Type Used	Percent of Preference
Clean Outside of Windows	13	6	Liquid	27%
			Powder	2%
			Aerosol	6%
			Spray pump	65%
			Other	-
Clean Inside of Windows	18	6	Liquid	24%
			Powder	1%
			Aerosol	8%
			Spray pump	66%
			Other	2%
Clean Glass Surfaces Such as Mirrors & Tables	34	13	Liquid	13%
			Powder	1%
			Aerosol	8%
			Spray pump	76%
			Other	2%
Clean Outside of Refrigerator and Other Appliances	27	13	Liquid	48%
			Powder	3%
			Aerosol	7%
			Spray pump	38%
			Other	4%
Clean Spots or Dirt on Walls or Doors Finishes	19	8	Liquid	46%
			Powder	15%
			Aerosol	4%
			Spray pump	30%
			Other	4%

\- Indicates value is less than 1%

Source: Westat, 1987b.

Table 17-9. Percentile Rankings for Total Exposure Time in Performing Household Tasks								
	Percentile Rankings for Total Exposure Time Performing Task (hrs/yr)							
Tasks	Min	10th	25th	50th	75th	90th	95th	Max
Clean Bathroom Sinks and Tubs	0.4	5.2	13	26	52	91.3	121.7	365
Clean Kitchen Sinks	0.3	3.5	8.7	18.3	60.8	97.6	121.7	547.5
Clean Inside of Kitchen Cabinets	0.2	1	2	4.8	12	32.5	48	208
Clean Outside of Cabinets	0.1	1	2	6	17.3	36	78.7	780
Wipe Off Kitchen Counters	1.2	12	24.3	54.8	91.5	231.2	456.3	912.5
Thoroughly Clean Counters	0.2	1.8	6	13	26	52	94.4	547.5
Clean Bathroom Floors	0.1	2	4.3	8.7	26	36.8	71.5	365
Clean Kitchen Floors	0.5	4.3	8.7	14	26	52	97	730
Clean Bathroom or Other Tilted or Ceramic Walls	0.2	1	3	8.7	26	36	52	208
Clean Outside of Windows	0.1	1.5	2	6	11.5	24	32.6	468
Clean Inside of Windows	0.2	1.2	3	6	19.5	36	72	273
Clean Glass Surfaces Such as Mirrors & Tables	0.2	1.7	6	13	26	60.8	104	1460
Clean Outside Refrigerator and Other Appliances	0.1	1.8	4.3	13	30.4	91.3	95.3	365
Clean Spots or Dirt on Walls or Doors	0.1	0.6	2	8	24	52	78	312
Source: Westat, 1987b.								

Table 17-10. Mean Percentile Rankings for Frequency of Performing Household Tasks

Tasks	Mean	Percentile Rankings							
		Min	10th	25th	50th	75th	90th	95th	Max
Clean bathroom sinks and tubs	3 x/week	0.2 x/week	1 x/week	1 x/week	2 x/week	3.5 x/week	7 x/week	7 x/week	42 x/week
Clean kitchen sinks	7 x/week	0 x/week	1 x/week	2 x/week	7 x/week	7 x/week	15 x/week	21 x/week	28 x/week
Clean inside of cabinets such as those in the kitchen	9 x/year	1 x/year	1 x/year	1 x/year	2 x/year	12 x/year	12 x/year	52 x/year	156 x/year
Clean outside of cabinets	3 x/month	0.1 x/month	0.1 x/month	0.3 x/month	1 x/month	4 x/month	4 x/month	22 x/month	30 x/month
Wipe off counters such as those in the kitchen	2 x/day	0 x/day	0.4 x/day	1 x/day	1 x/day	3 x/day	4 x/day	6 x/day	16 x/day
Thoroughly clean counters	8 x/month	0.1 x/month	0.8 x/month	1 x/month	4 x/month	4 x/month	30 x/month	30 x/month	183 x/month
Clean bathroom floors	6 x/month	0.2 x/month	1 x/month	2 x/month	4 x/month	4 x/month	13 x/month	30 x/month	30 x/month
Clean kitchen floors	6 x/month	0.1 x/month	1 x/month	2 x/month	4 x/month	4 x/month	13 x/month	30 x/month	30 x/month
Clean bathroom or other tiled or ceramic walls	4 x/month	0.1 x/month	0.2 x/month	1 x/month	2 x/month	4 x/month	9 x/month	13 x/month	30 x/month
Clean outside of windows	5 x/year	1 x/year	1 x/year	1 x/year	2 x/year	4 x/year	12 x/year	12 x/year	156 x/year
Clean inside of windows	10 x/year	1 x/year	1 x/year	2 x/year	4 x/year	12 x/year	24 x/year	52 x/year	156 x/year
Clean other glass surfaces such as mirrors and tables	7 x/month	0.1 x/month	1 x/month	2 x/month	4 x/month	4 x/month	17 x/month	30 x/month	61 x/month
Clean outside of refrigerator and other appliances	10 x/month	0.2 x/month	1 x/month	2 x/month	4 x/month	13 x/month	30 x/month	30 x/month	61 x/month
Clean spots or dirt on walls or doors	6 x/month	0.1 x/month	0.2 x/month	0.3 x/month	1 x/month	4 x/month	13 x/month	30 x/month	152 x/month

Source: Westat, 1987b.

17-11. Mean and Percentile Rankings for Exposure Time Per Event of Performing Household Tasks									
Tasks	Mean (minutes/event)	Percentile Rankings (minutes/event)							
		Min	10th	25th	50th	75th	90th	95th	Max
Clean bathroom sinks and tubs	20	1	5	10	15	30	45	60	90
Clean kitchen sinks	10	1	2	3	5	10	15	20	480
Clean inside of cabinets such as those in the kitchen	137	5	24	44	120	180	240	360	2,880
Clean outside of cabinets	52	1	5	15	30	60	120	180	330
Wipe off counters such as those in the kitchen	9	1	2	3	5	10	15	30	120
Thoroughly clean counters	25	1	5	10	15	30	60	90	180
Clean bathroom floors	16	1	5	10	15	20	30	38	60
Clean kitchen floors	30	2	10	15	20	30	60	60	180
Clean bathroom or other tiled or ceramic walls	34	1	5	15	30	45	60	120	240
Clean outside of windows	180	4	30	60	120	240	420	480	1,200
Clean inside of windows	127	4	20	45	90	158	300	381	1,200
Clean other glass surfaces such as mirrors and tables	24	1	5	10	15	30	60	60	180
Clean outside of refrigerator and other appliances	19	1	4	5	10	20	30	45	240
Clean spots or dirt on walls or doors	50	1	5	10	20	60	120	216	960
Source: Westat, 1987b.									

Table 17-12. Total Exposure Time for Ten Product Groups Most Frequently Used for Household Cleaning[a]									
Products	Mean (hrs/yr)	Percentile Rankings of Total Exposure Time (hrs/yr)							
		Min	10th	25th	50th	75th	90th	95th	Max
Dish Detergents	107	0.2	6	24	56	134	274	486	941
Glass Cleaners	67	0.4	3	12	29	62	139	260	1,508
Floor Cleaners	52	0.7	4	7	22	52	102	414	449
Furniture Polish	32	0.1	0.3	1	12	36	101	215	243
Bathroom Tile Cleaners	47	0.5	2	8	17	48	115	287	369
Liquid Cleansers	68	0.2	2	9	22	52	122	215	2,381
Scouring Powders	78	0.3	9	17	35	92	165	281	747
Laundry Detergents	66	0.6	8	14	48	103	174	202	202
Rug Cleaners/Shampoos	12	0.3	0.3	0.3	9	26	26	26	26
All Purpose Cleaners	64	0.3	4	9	26	77	174	262	677

[a] The data in Table 17-11 above reflect only the 14 tasks included in the survey. Therefore, many of the durations reported in the table underestimate the hours of the use of the product group. For example, use of dish detergents to wash dishes is not included.

Source: Westat, 1987b.

Table 17-13. Total Exposure Time of Painting Activity of Interior Painters (hours)

Types of Paint	Mean (hrs)	Std. dev.	Percentile Rankings for Duration of Painting Activity (hrs)							
			Min.	10	25	50	75	90	95	Max.
Latex	12.2	11.3	1	3	4	9	15	24	40	248
Oil-based	10.7	15.6	1	1.6	3	6	10	21.6	65.6	72
Wood Stains and Varnishes	8.6	10.9	1	1	2	4	9.3	24	40	42

Source: Westat, 1987c.

Table 17-14. Exposure Time of Interior Painting Activity/Occasion (hours) and Frequency of Occasions Spent Painting Per Year

	Duration of Painting/Occasion (hrs)		Frequency of Occasions Spent Painting/Year		Percentile Rankings for Frequency of Occasions Spent Painting							
Types of Paint	Mean	Median	Mean	Std. dev.	Min	10	25	50	75	90	95	Max.
Latex	3.0	3	4.2	5.5	1	1	2	3	4	9	10	62
Oil-based	2.1	3	5.1	12.0	1	1	1	2	4	8	26	72
Wood Stains and Varnishes	2.2	2	4.0	4.9	1	1	1	2	4	9	20	20

Source: Westat, 1987c.

Table 17-15. Amount of Paint Used by Interior Painters

Types of Paint	Median (gallons)	Mean (gallons)	Std. dev.	Percentile Rankings for Amount of Paint Used (gallons)							
				Min	10	25	50	75	90	95	Max.
Latex	3.0	3.9	4.6	0.1	1	2	3	5	8	10	50
Oil-based	2.0	2.6	3.0	0.1	0.3	0.5	2	3	7	12	12
Wood Stains and Varnishes	0.8	0.9	0.8	0.1	0.1	0.3	0.8	1	2	2	4.3

Source: Westat, 1987c.

Table 17-16. Frequency of Use and Amount of Product Used for Adhesive Removers

	No. of Times Used Within the Last 12 Months N=58	Minutes Using N=52	Minutes in Room After Using[a] N=51	Minutes in Room After Using[b] N=5	Amount Used in Past Year (Fluid oz.) N=51	Amount per Use (Fluid oz.) N=51
Mean	1.66	172.87	13.79	143.37	96.95	81.84
Standard deviation	1.67	304.50	67.40	169.31	213.20	210.44
Minimum Value	1.00	5.00	0.00	5.00	13.00	5.20
1st Percentile	1.00	5.00	0.00	5.00	13.00	5.20
5th Percentile	1.00	10.00	0.00	5.00	13.00	6.50
10th Percentile	1.00	15.00	0.00	5.00	16.00	10.67
25th Percentile	1.00	29.50	0.00	20.00	16.00	16.00
Median Value	1.00	120.00	0.00	120.00	32.00	26.00
75th Percentile	2.00	240.00	0.00	420.00	96.00	64.00
90th Percentile	3.00	480.00	0.00	420.00	128.00	128.00
95th Percentile	5.00	1,440.00	120.00	420.00	384.00	192.00
99th Percentile	12.00	1,440.00	420.00	420.00	1,280.00	1,280.00
Maximum Value	12.00	1,440.00	420.00	1,440.00	1,280.00	1,280.00

[a] Includes those who did not spend anytime in the room after use.
[b] Includes only those who spent time in the room.

Source: Abt, 1992.

Table 17-17. Adhesive Remover Usage by Gender

	Gender	
	Male N=25	Female N=33
Mean number of months since last time adhesive remover was used - includes all respondents. (Unweighted N=240)	35.33	43.89
Mean number of uses of product in the past year.	1.94	1.30
Mean number of minutes spent with the product during last use.	127.95	233.43
Mean number of minutes spent in the room after last use of product. (Includes all recent users)	19.76	0
Mean number of minutes spent in the room after last use of product. (Includes only those who did not leave immediately)	143.37	0
Mean ounces of product used in the past year.	70.48	139.71
Mean ounces of product used per use in the past year.	48.70	130.36

Source: Abt, 1992.

Table 17-18. Frequency of Use and Amount of Product Used for Spray Paint

	No. of Times Used Within the Last 12 Months N=775	Minutes Using N=786	Minutes in Room After Using[a] N=791	Minutes in Room After Using[b] N=35	Amount Used in Past Year (Fluid oz.) N=778	Amount per Use (Fluid oz.) N=778
Mean	8.23	40.87	3.55	65.06	83.92	19.04
Standard deviation	31.98	71.71	22.03	70.02	175.32	25.34
Minimum Value	1.00	1.00	0.00	1.00	13.00	0.36
1st Percentile	1.00	1.00	0.00	1.00	13.00	0.36
5th Percentile	1.00	3.00	0.00	1.00	13.00	3.47
10th Percentile	1.00	5.00	0.00	10.00	13.00	6.50
25th Percentile	1.00	10.00	0.00	15.00	13.00	9.75
Median Value	2.00	20.00	0.00	30.00	26.00	13.00
75th Percentile	4.00	45.00	0.00	60.00	65.00	21.67
90th Percentile	11.00	90.00	0.00	120.00	156.00	36.11
95th Percentile	20.00	120.00	0.00	120.00	260.00	52.00
99th Percentile	104.00	360.00	120.00	300.00	1,170.00	104.00
Maximum Value	365.00	960.00	300.00	300.00	1,664.00	312.00

[a] Includes those who did not spend anytime in the room after use.
[b] Includes only those who spent time in the room.

Source: Abt, 1992.

Table 17-19. Spray Paint Usage by Gender

	Gender	
	Male N=405	Female N=386
Mean number of months since last time spray paint was used - includes <u>all</u> respondents. (Unweighted N=1724)	17.39	26.46
Mean number of uses of product in the past year.	10.45	4.63
Mean number of minutes spent with the product during last use.	40.87	40.88
Mean number of minutes spent in the room after last use of product. (Includes all recent users)	5.49	0.40
Mean number of minutes spent in the room after last use of product. (Includes only those who did not leave immediately)	67.76	34.69
Mean ounces of product used in the past year.	103.07	59.99
Mean ounces of product used per use in the past year.	18.50	19.92

Source: Abt, 1992.

Table 17-20. Frequency of Use and Amount of Product Used for Paint Removers/Strippers

	No. of Times Used Within the Last 12 Months N=316	Minutes Using N=390	Minutes in Room After Using[a] N=390	Minutes in Room After Using[b] N=39	Amount Used in Past Year (Fluid oz.) N=307	Amount per Use (Fluid oz.) N=307
Mean	3.54	144.59	12.96	93.88	142.05	64.84
Standard deviation	7.32	175.54	85.07	211.71	321.73	157.50
Minimum Value	1.00	2.00	0.00	1.00	15.00	0.35
1st Percentile	1.00	5.00	0.00	1.00	15.00	2.67
5th Percentile	1.00	15.00	0.00	1.00	16.00	8.00
10th Percentile	1.00	20.00	0.00	3.00	16.00	10.67
25th Percentile	1.00	45.00	0.00	10.00	32.00	16.00
Median Value	2.00	120.00	0.00	60.00	64.00	32.00
75th Percentile	3.00	180.00	0.00	120.00	128.00	64.00
90th Percentile	6.00	360.00	10.00	180.00	256.00	128.00
95th Percentile	12.00	480.00	60.00	420.00	384.00	192.00
99th Percentile	50.00	720.00	180.00	1,440.00	1,920.00	320.00
Maximum Value	70.00	1,440.00	1,440.00	1,440.00	3,200.00	2,560.00

[a] Includes those who did not spend anytime in the room after use.
[b] Includes only those who spent time in the room.

Source: Abt, 1992.

Table 17-21. Paint Stripper Usage by Gender

	Gender	
	Male N=156	Female N=162
Mean number of months since last time paint stripper was used - includes all respondents. (Unweighted N=1724)	32.07	47.63
Mean number of uses of product in the past year.	3.88	3.01
Mean number of minutes spent with the product during last use.	136.70	156.85
Mean number of minutes spent in the room after last use of product. (Includes all recent users)	15.07	9.80
Mean number of minutes spent in the room after last use of product. (Includes only those who did not leave immediately)	101.42	80.15
Mean ounces of product used in the past year.	160.27	114.05
Mean ounces of product used per use in the past year.	74.32	50.29

Source: Abt, 1992.

Table 17-22. Number of Minutes Spent Using Any Microwave Oven (minutes/day)

Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	62	0	0	0	1	1	2	5	10	15	20	30	30
5 to 11 years	141	0	0	0	1	2	3	5	10	15	30	30	60
12 to 17 years	1,686	0	0	1	2	3	5	10	15	25	45	60	121
18 to 64 years	375	0	0	1	2	3	5	10	20	30	60	60	70
> 64 years	62	0	0	0	1	1	2	5	10	15	20	30	30

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; N = doer sample size; percentiles are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-23. Number of Minutes Spent in Activities Working With or Near Freshly Applied Paints (minutes/day)													
Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	7	3	3	3	3	5	15	121	121	121	121	121	121
5 to 11 years	12	5	5	5	15	20	45	120	120	121	121	121	121
12 to 17 years	20	0	0	0.5	3	8	45	75	121	121	121	121	121
18 to 64 years	212	0	0	1	2	11	60	121	121	121	121	121	121
> 64 years	764	20	0	0	0	3	18	90	121	121	121	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; N = doer sample size; percentiles are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-24. Number of Minutes Spent in Activities Working With or Near Household Cleaning Agents Such as Scouring Powders or Ammonia (minutes/day)													
Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	21	0	0	0	0	5	10	15	20	30	121	121	121
5 to 11 years	26	1	1	2	2	3	5	15	30	30	30	30	30
12 to 17 years	41	0	0	0	0	2	5	10	40	60	60	60	60
18 to 64 years	672	0	0	1	2	5	10	20	60	121	121	121	121
> 64 years	127	0	0	0	1	3	5	15	30	60	120	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; N = doer sample size; percentiles are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-25. Number of Minutes Spent in Activities (at home or elsewhere) Working With or Near Floorwax, Furniture Wax or Shoe Polish (minutes/day)													
Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	13	0	0	0	5	10	15	20	60	121	121	121	121
5 to 11 years	21	0	0	2	2	3	5	10	35	60	120	120	120
12 to 17 years	15	0	0	0	1	2	10	25	45	121	121	121	121
18 to 64 years	238	0	0	2	3	5	15	30	120	121	121	121	121
> 64 years	34	0	0	0	2	5	10	20	35	121	121	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; N = doer sample size; percentiles are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-26. Number of Minutes Spent in Activities Working With or Near Glue (minutes/day)

Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	6	0	0	0	0	30	30	30	50	50	50	50	50
5 to 11 years	36	2	2	3	5	5	12.5	25	30	60	120	120	120
12 to 17 years	34	0	0	1	2	5	10	30	30	60	120	120	120
18 to 64 years	207	0	0	0	1	5	20	90	121	121	121	121	121
> 64 years	10	0	0	0	0	0	4	60	121	121	121	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; N = doer sample size; percentiles are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-27. Number of Minutes Spent in Activities Working With or Near Solvents, Fumes or Strong Smelling Chemicals (minutes/day)

Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	7	0	0	0	0	1	5	60	121	121	121	121	121
5 to 11 years	16	0	0	0	2	5	5	17.5	45	70	70	70	70
12 to 17 years	38	0	0	0	0	5	10	60	121	121	121	121	121
18 to 64 years	407	0	0	1	2	5	30	121	121	121	121	121	121
> 64 years	21	0	0	0	0	2	5	15	121	121	121	121	121

Note: A Value of "121" for number of minutes signifies that more than 120 minutes were spent; N = doer sample size; percentiles are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-28. Number of Minutes Spent in Activities Working With or Near Stain or Spot Removers (minutes/day)

Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	3	0	0	0	0	0	0	3	3	3	3	3	3
5 to 11 years	3	3	3	3	3	3	5	5	5	5	5	5	5
12 to 17 years	7	0	0	0	0	5	15	35	60	60	60	60	60
18 to 64 years	87	0	0	0	0	2	5	15	60	121	121	121	121
> 64 years	9	0	0	0	0	2	3	15	121	121	121	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; N = doer sample size; percentiles are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-29. Number of Minutes Spent in Activities Working With or Near Gasoline or Diesel-powered Equipment, Besides Automobiles (minutes/day)

Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	14	0	0	0	1	5	22.5	120	121	121	121	121	121
5 to 11 years	12	1	1	1	3	7.5	25	50	60	60	60	60	60
12 to 17 years	25	2	2	5	5	13	35	120	121	121	121	121	121
18 to 64 years	312	0	0	1	3	15	60	121	121	121	121	121	121
> 64 years	26	2	2	2	3	10	25	90	121	121	121	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; N = doer sample size; percentiles are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-30. Number of Minutes Spent in Activities Working With or Near Pesticides, Including Bug Sprays or Bug Strips (minutes/day)

Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	6	1	1	1	1	3	10	15	20	20	20	20	20
5 to 11 years	16	0	0	0	0	1.5	7.5	30	121	121	121	121	121
12 to 17 years	10	0	0	0	0	2	2.5	40	121	121	121	121	121
18 to 64 years	190	0	0	0	1	2	10	88	121	121	121	121	121
> 64 years	764	31	0	0	0	02	5	15	60	121	121	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; N = doer sample size; percentiles are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-31. Number of Respondents Using Cologne, Perfume, Aftershave or Other Fragrances at Specified Daily Frequencies

Age Group	Total N	Number of Times Used in a Day				
		1 to 2	3 to 5	6 to 9	10+	Don't Know
5 to 11 years	26	24	2	*	*	*
12 to 17 years	144	133	9	*	1	1
18 to 64 years	1,735	1,635	93	3	1	3
> 64 years	285	277	8	0	0	0

* = Missing Data.
N = Number of respondents.

Source: U.S. EPA, 1996.

Table 17-32. Number of Respondents Using Any Aerosol Spray Product for Personal Care Item Such as Deodorant or Hair Spray at Specified Daily Frequencies

Age Group	Total N	Number of Times Used in a Day									
		1	2	3	4	5	6	7	10	10+	Don't Know
1 to 4 years	40	30	9	0	0	1	0	0	0	0	0
5 to 11 years	75	57	14	1	1	1	1	0	0	0	0
12 to 17 years	103	53	31	12	4	1	0	0	1	1	0
18 to 64 years	1,071	724	263	39	15	13	1	1	2	8	5
> 64 years	175	141	27	4	0	0	0	0	0	1	2

N = Number of respondents.

Source: U.S. EPA, 1996.

Table 17-33. Number of Respondents Using a Humidifier at Home

Age Group	Total N	Frequency				
		Almost Every Day	3-5 Times a Week	1-2 Times a Week	1-2 Times a Month	Don't Know
1 to 4 years	111	33	16	7	53	2
5 to 11 years	88	18	10	12	46	2
12 to 17 years	83	21	7	5	49	1
18 to 64 years	629	183	77	70	287	12
> 64 years	120	42	10	10	53	5

N = Number of respondents.

Source: U.S. EPA, 1996.

Table 17-34. Number of Respondents Indicating that Pesticides Were Applied by a Professional at Home to Eradicate Insects, Rodents, or Other Pests at Specified Frequencies

Age Group	Total N	Frequency (number of times over a six-month period that pesticides were applied by a professional)					
		None	1 to 2	3 to 5	6 to 9	10+	Don't Know
<1 year	15	9	4	1	1	0	0
1 to <2 years	23	13	5	3	1	1	0
2 to <3 years	32	9	15	5	3	0	0
3 to <6 years	80	51	22	5	2	0	0
6 to <11 years	106	59	22	7	17	1	0
11 to <16 years	115	68	35	4	6	0	2
16 to <21 years	87	40	36	2	5	1	3
18 to 64 years	1,264	660	387	89	97	15	16
> 64 years	243	146	55	15	19	3	5

N = Number of respondents.

Source: U.S. EPA re-analysis of NHAPS (U.S. EPA, 1996) data.

Table 17-35. Number of Respondents Reporting Pesticides Applied by the Consumer at Home to Eradicate Insects, Rodents, or Other Pests at Specified Frequencies

Age Group	Total N	Frequency (number of times over a six-month period that pesticides were applied by a resident)					
		None	1 to 2	3 to 5	6 to 9	10+	Don't Know
<1 year	15	4	8	2	0	1	0
1 to <2 years	23	11	10	1	0	1	0
2 to <3 years	32	18	9	2	2	1	0
3 to <6 years	80	26	35	18	1	0	0
6 to <11 years	106	37	49	14	1	4	1
11 to <16 years	115	37	50	18	4	6	0
16 to <21 years	87	36	33	9	4	4	1
18 to 64 years	1,264	473	477	192	48	55	19
> 64 years	243	94	85	31	15	9	9

N = Number of respondents.

Source: U.S. EPA re-analysis of NHAPS (U.S. EPA, 1996) data.

Table 17-36. Household Demographics, and Pesticide Types, Characteristics, and Frequency of Pesticide Use

	Number[a]	Percent[a]
Survey Population Demographics		
Gender		
Female	90	84.1
Male	17	15.9
Language of Interview		
Spanish	72	67.3
English	35	32.7
Reading Skills		
Able to read English	71	66.4
Able to read Spanish	95	88.8
Number in household		
2-3 people	25	23.3
4-5 people	59	55.1
6-8 people	23	21.4
Children under 10 years		
1 child	37	34.6
2 children	45	42.1
3 to 5 children	25	23.3
Type of home		
Single family detached	75	70.1
Multi-family	9	8.4
Trailer/mobile home	9	8.4
Single-family attached	8	7.5
Apartment/other	4	3.7
Pets		
Pets kept in household	55	51.4
Pesticides used on pets	22	40.0
Pesticide Use		
Type of pesticide		
Insecticide	135	91.2
Rodenticide	10	6.8
Herbicide	3	2.0
Storage of pesticide		
Kitchen	67	45.3
Garage/shed	30	20.3
Laundry/washroom	14	9.4
Other, inside home	11	7.4
Other, outside home	7	4.7
Bathroom	7	4.7
Basement	4	2.7
Closet	4	2.7
Storage precautions		
Child-resistant container	83	56.1
Pesticide locked away	55	37.2
Storage risks		
< 4 feet from ground	72	48.6
Kept near food	5	3.4
Kept near dishes/cookware	5	3.4
Disposal		
Throw it away	132	89.2
Wrap in separate container, throw away	10	6.8
Other	5	3.4
Frequency of use		
More than once/week	20	13.5
Once/week	27	18.2
Once/month	42	28.4
Once every 3 months	23	15.5
Once every 6 months	16	10.8
Once/year	13	8.8
Time stored in home		
< 6 months	75	50.7
6 to 12 months	24	15.2
12 to 24 months	17	11.5
> 24 months	16	10.8

[a] Totals may not add to 107 participants or 148 products, and percentages may not add to 100 due to some non-responses to survey questions.

Source: Bass et al., 2001.

Table 17-37. Amount and Frequency of Use of Household Products								
Product Type	Overall						Per Subject	
	Mean	SD	Min	Max	Subjects	Events	Min	Max
Dishwashing Liquid								
Frequency of use per day	0.63	0.79	0	5	45	596	0.05	2.29
Duration of contact (mins)	11	5	1	60	45	596	2	35
Amount used per contact (g)	5	3	1	16	13	163	2	10
All-purpose Cleaner								
Frequency of use per day	0.35	0.70	0	4	28	218	0.050	1.82
Duration of contact (mins)	20	22	1	135	28	204	5	60
Amount used per contact (g)	27	30	1	123	12	105	2	74
Toilet Cleaner								
Frequency of use per day	0.28	0.55	0	2	18	105	0.05	1.67
Duration of contact (mins)	74	204	1	1,209	28	101	2[a]	24[a]
Amount used per contact (g)	-	-	-	-	-	-	9	153
Hair Spray								
Frequency of use per day	0.76	0.68	0	3	9	143	0.29	1.76
Amount used per contact (g)	-	-	-	-	-	-	1.0	11.6
Duration of release (s)	11	6	5	25	12	-	-	-
Duration of contact with nebula (s)	23	11	5	41	12	-	-	-
Duration of contact with nebula x g released (s x g)	48	48	5	150	10	-	-	-

[a] Excludes durations over 30 mins
\- Indicates insufficient sample size to estimate average use

Source: Weegels and van Veen, 2001.

Table 17-38. Frequency of Use of Cosmetic Products				
Product Type	N	Number of Applications per Day		
		Mean	Median	SD
Lipstick	311	2.35	2	1.80
Body lotion, hands	308	2.12	2	1.59
Body lotion, arms	308	1.52	1	1.30
Body lotion, feet	308	0.95	1	1.01
Body lotion, legs	308	1.11	1	0.98
Body lotion, neck & throat	308	0.43	0	0.82
Body lotion, back	308	0.26	0	0.63
Body lotion, other	308	0.40	0	0.76
Face cream	300	1.77	2	1.16

N = Number of subjects (women, ages 19 to 65 years).
SD = Standard deviation.

Source: Loretz et al., 2005.

Table 17-39. Amount of Test Product used (grams) for Lipstick, Body Lotion and Face Cream

Summary Statistics	Total Amount Applied	Average[a] Amount Applied per Use Day	Average[b] Amount Applied per Application
Lipstick			
Minimum	0.001	0.000	0.000
Maximum	2.666	0.214	0.214
Mean	0.272	0.024	0.010
SD	0.408	0.034	0.018
Percentiles			
10th	0.026	0.003	0.001
20th	0.063	0.005	0.003
30th	0.082	0.008	0.004
40th	0.110	0.010	0.004
50th	0.147	0.013	0.005
60th	0.186	0.016	0.006
70th	0.242	0.021	0.009
80th	0.326	0.029	0.011
90th	0.655	0.055	0.024
95th	0.986	0.087	0.037
99th	2.427	0.191	0.089
Best Fit Distributions & Parameters[c]	Lognormal Distribution GM = 0.14 GSD = 3.56 P-value (Gof) = 0.01	Lognormal Distribution GM = 0.01 GSD = 3.45 P-value (Gof) <0.01	Lognormal Distribution GM = 0.01 GSD = 3.29 P-value (Gof) <0.01
Body Lotion			
Minimum	0.67	0.05	0.05
Maximum	217.66	36.31	36.31
Mean	103.21	8.69	4.42
SD	53.40	5.09	4.19
Percentiles			
10th	36.74	3.33	1.30
20th	51.99	4.68	1.73
30th	68.43	5.71	2.32
40th	82.75	6.74	2.76
50th	96.41	7.63	3.45
60th	110.85	9.25	4.22
70th	134.20	10.90	4.93
80th	160.26	12.36	6.14

Table 17-39. Amount of Test Product used (grams) for Lipstick, Body Lotion and Face Cream (continued)

Summary Statistics	Total Amount Applied	Average[a] Amount Applied per Use Day	Average[b] Amount Applied per Application
90th	182.67	14.39	8.05
95th	190.13	16.83	10.22
99th	208.50	27.91	21.71
Best Fit Distributions & Parameters[c]	Beta Distribution[c] Alpha = 1.53 Beta = 1.77 Scale = 222.01 P-value (GoF) = 0.06	Gamma Distribution Location = -0.86 Scale = 2.53 Shape = 3.77 P-value (GoF) = 0.37	Lognormal Distribution GM = 3.26 GSD = 2.25 P-value (GoF) = 0.63
Face Cream			
Minimum	0.04	0.00	0.00
Maximum	55.85	42.01	21.01
Mean	22.36	2.05	1.22
SD	14.01	2.90	1.76
Percentiles			
10th	5.75	0.47	0.28
20th	9.35	0.70	0.40
30th	12.83	1.03	0.53
40th	16.15	1.26	0.67
50th	19.86	1.53	0.84
60th	23.79	1.88	1.04
70th	29.31	2.23	1.22
80th	36.12	2.90	1.55
90th	44.58	3.50	2.11
95th	48.89	3.99	2.97
99th	51.29	12.54	10.44
Best Fit Distributions & Parameters[c]	Triangle Distribution Minimum = -1.09 Maximum = 58.71 Likeliest = 7.53 P-value (GoF) = 0.27	Lognormal Distribution[c] GM = 1.39 GSD = 2.58 P-value (GoF) <0.01	Lognormal Distribution[c] GM = 0.80 GSD = 2.55 P-value (GoF) = 0.02

[a] Derived as the ratio of the total amount used to the number of use days.
[b] Derived as the ratio of the total amount used to the total number of applications during the survey.
[c] None of the tested distributions provided a good fit.
GM = Geometric mean.
GSD = Geometric standard deviation.
GoF = Goodness of fit.
Note: Data are for women, ages 19 to 65 years.

Source: Loretz et al., 2005.

Table 17-40. Frequency of Use of Personal Care Products

Product Type	N	Average Number of Applications per Use Day[a]			
		Mean	SD	Min	Max
Hairspray (aerosol)	165[b]	1.49	0.63	1.00	5.36
Hairspray (pump)	162	1.51	0.64	1.00	4.22
Liquid Foundation	326	1.24	0.32	1.00	2.00
Spray Perfume	326	1.67	1.10	1.00	11.64
Body wash	340	1.37	0.58	1.00	6.36
Shampoo	340	1.11	0.24	1.00	2.14
Solid antiperspirant	340	1.30	0.40	1.00	4.00

[a] Derived as the ratio of the number of applications to the number of use days.
[b] Subjects who completed the study but did not report their number of applications were excluded.
N = Number of subjects (women, ages 18 to 65 years).
SD = Standard deviation.

Source: Loretz et al., 2006.

Table 17-41. Average Amount of Product Applied per Application[a] (grams)

Summary Statistics	Hairspray (aerosol)	Hairspray (pump)	Spray Perfume	Liquid Foundation	Shampoo	Body Wash	Solid Antiperspirant
N	163[b]	161[b]	310[b]	321[b]	340	340	340
Mean	2.58	3.64	0.33	0.54	11.76	11.3	0.61
SD	2.26	3.50	0.41	0.52	8.77	6.9	0.56
Minimum	0.05	0.00	0.00	0.00	0.39	1.1	0.00
Maximum	14.08	21.44	5.08	2.65	67.89	58.2	5.55
Percentiles							
10th	0.66	0.70	0.06	0.08	3.90	4.6	0.14
20th	0.94	1.01	0.10	0.14	5.50	5.8	0.22
30th	1.26	1.59	0.13	0.19	6.78	7.1	0.30
40th	1.56	2.14	0.18	0.26	8.27	8.5	0.37
50th	1.83	2.66	0.23	0.36	9.56	9.5	0.45
60th	2.38	3.43	0.28	0.48	11.32	11.4	0.55
70th	2.87	3.84	0.36	0.63	13.29	13.4	0.69
80th	3.55	5.16	0.49	0.86	16.07	16.0	0.89
90th	5.33	7.81	0.68	1.23	22.59	21.1	1.25
95th	7.42	10.95	0.94	1.70	27.95	24.3	1.67
97.5th	8.77	14.68	1.25	2.07	35.65	28.4	2.15
99th[c]	11.30	15.52	1.73	2.36	51.12	35.1	2.52
Best fit distributions and parameters	Lognormal Distribution	Lognormal Distribution	Lognormal Distribution	Lognormal Distribution	Lognormal	Gamma	Lognormal Distribution
	GM = 1.84 GSD = 2.40	GM = 2.44 GSD = 2.67	GM = 0.21 GSD = 3.01	GM = 0.33 GSD = 2.99	GM = 9.32 GSD = 2.02	Location = 0.51 Scale = 3.92 Shape = 2.76	GM = 0.43 GSD = 2.37
P-value (Kolmogorov-Smirnov)	0.06	0.07	0.077	0.041	0.1328	0.486	0.339

a Derived as the ratio of the total amount used to the total number of applications.
b Subjects who completed the study, but did not report their number of applications, or who did not return the unused portion of the product, were excluded.
c Estimate does not meet the minimum sample size criteria (N=800) as set by the National Center for Health Statistics. For upper percentile (>75), the minimum sample size (N) satisfies the following rule: n[8/(1-p)]. http://www/cdc.gov/nchs/about/major/nhanes/nhanes3/nh3gui.pdf.
N = Number of subjects (women, ages 19 to 65 years).
GM = Geometric mean.
GSD = Geometric standard Deviation.

Source: Loretz et al., 2006.

Table 17-42. Average Amount of Product Applied per Use Day[a] (grams)

Summary Statistics	Hairspray (aerosol)	Hairspray (pump)	Spray Perfume	Liquid Foundation	Shampoo	Body Wash	Solid Antiperspirant
N	163[b]	161[b]	310[b]	321[b]	340	340	340
Mean	3.57	5.18	0.53	0.67	12.80	14.5	0.79
SD	3.09	4.83	0.57	0.65	9.11	8.5	0.78
Minimum	0.05	0.00	0.00	0.00	0.55	1.3	0.00
Maximum	18.25	24.12	5.08	3.00	67.89	63.4	5.55
Percentiles							
10th	0.84	0.91	0.08	0.10	4.12	5.7	0.17
20th	1.35	1.48	0.12	0.16	5.80	7.6	0.29
30th	1.65	2.33	0.19	0.23	7.32	9.3	0.38
40th	2.23	2.66	0.26	0.30	9.09	10.9	0.46
50th	2.71	3.74	0.34	0.45	10.75	12.9	0.59
60th	3.30	4.71	0.45	0.58	12.82	14.8	0.70
70th	3.89	5.67	0.61	0.76	14.73	17.4	0.86
80th	4.86	7.38	0.81	1.04	17.61	20.7	1.08
90th	7.73	12.22	1.45	1.76	23.63	25.5	1.70
95th	9.89	15.62	1.77	2.18	29.08	29.1	2.32
97.5th	13.34	19.41	1.86	2.40	36.46	35.6	3.33
99th[c]	15.05	23.98	2.01	2.70	51.12	43.5	4.42
Best fit distributions and parameters	Lognormal Distribution	Lognormal Distribution	Lognormal Distribution	Lognormal Distribution	Lognormal	Gamma	Lognormal Distribution
	GM = 2.57 GSD = 2.37	GM = 3.45 GSD = 2.70	GM = 0.30 GSD = 3.36	GM = 0.40 GSD = 3.10	Location = 0.38 Scale = 5.79 Shape = 2.15	Location = 0.67 Scale = 4.89 Shape = 2.84	GM = 0.56 GSD = 2.41
P-value (Kolmogorov-Smirnov)	0.05	0.05	0.075	0.047	0.8208	0.760	0.293

[a] Derived as the ratio of the total amount used to the total number of applications.
[b] Subjects who completed the study, but did not report their number of applications, or who did not return the unused portion of the product, were excluded.
[c] Estimate does not meet the minimum sample size criteria (N=800) as set by the National Center for Health Statistics. For upper percentile (>75), the minimum sample size (N) satisfies the following rule: n[8/(1-p)]. http://www/cdc.gov/nchs/about/major/nhanes/nhanes3/nh3gui.pdf.
N = Number of subjects (women, ages 19 to 65 years).
GM = Geometric mean.
GSD = Geometric standard Deviation.

Source: Loretz et al., 2006.

Table 17-43. Body Lotion Exposure for Consumers Only (Males and Females).				
Value	Amount (g/day)	Stdev	Amount (mg/kg/day)	Stdev
Mean	4.543	0.012	67.869	0.228
Std	2.707	0.013	43.866	0.307
Median	4.556	0.023	64.265	0.369
Minimum	0.005	0.000	0.043	0.003
Maximum	21.081	1.264	401.371	46.215
Percentile				
p01	0.005	0.000	0.079	0.003
p02.5	0.017	0.000	0.250	0.011
p05	0.556	0.008	8.066	0.191
p10	1.129	0.006	15.055	0.293
p20	1.948	0.018	27.535	0.330
p30	2.907	0.024	40.763	0.359
p40	3.737	0.027	53.072	0.357
p50	4.556	0.023	64.265	0.369
p60	5.246	0.023	75.114	0.374
p70	5.898	0.021	86.751	0.404
p80	6.645	0.024	101.024	0.495
p90	7.822	0.033	123.227	0.715
p92	8.183	0.038	130.177	0.868
p94	8.651	0.042	139.085	0.968
p95	8.951	0.047	144.797	1.072
p96	9.326	0.054	151.892	1.211
p97.5	10.191	0.081	167.036	1.559
p98	10.655	0.096	174.414	1.768
p99	12.261	0.155	198.018	2.888
p99.5	13.893	0.221	222.667	4.420
p99.9	16.991	0.413	282.959	10.304
Source: Hall et al., 2007.				

Table 17-44. Deodorant/Antiperspirant Spray Exposure for Consumers Only (Males and Females) – Under Arms Only.

Value	Amount (g/day)	Stdev	Amount (mg/kg/day)	Stdev
Mean	3.478	0.007	49.07	0.13
Std	2.051	0.009	31.00	0.22
Median	3.153	0.012	43.52	.019
Minimum	0.045	0.005	0.59	0.10
Maximum	23.663	1.724	379.03	63.23
Percentile				
p01	0.228	0.012	3.08	0.13
p02.5	0.373	0.008	5.08	0.12
p05	0.598	0.011	8.23	0.16
p10	1.135	0.014	15.31	0.20
p20	1.951	0.012	25.75	0.17
p30	2.425	0.010	32.38	0.17
p40	2.796	0.011	37.96	0.17
p50	3.153	0.012	43.52	0.19
p60	3.548	0.013	49.73	0.22
p70	4.049	0.015	57.50	0.27
p80	4.804	0.019	68.59	0.32
p90	6.095	0.029	87.79	0.49
p92	6.477	0.031	93.94	0.58
p94	6.955	0.037	101.93	0.71
p95	7.262	0.040	107.01	0.81
p96	7.645	0.047	113.29	0.91
p97.5	8.537	0.064	126.91	1.24
p98	9.005	0.076	133.46	1.40
p99	10.451	0.107	154.31	1.98
p99.5	11.628	0.132	175.01	2.80
p99.9	13.843	0.277	222.53	7.29

Source: Hall et al., 2007.

Table 17-45. Deodorant/Antiperspirant Spray Exposure for Consumers Only (Males and Females) Using Product Over Torso and Under Arms

Value	Amount (g/day)	Stdev	Amount (mg/kg/day)	Stdev
Mean	3.732	0.008	52.47	0.14
Std	2.213	0.010	32.94	0.23
Median	3.383	0.012	46.66	0.20
Minimum	0.044	0.005	0.59	0.10
Maximum	24.662	2.057	389.12	66.91
Percentile				
p01	0.239	0.014	3.19	0.14
p02.5	0.384	0.009	5.30	0.15
p05	0.639	0.015	8.80	0.18
p10	1.214	0.015	16.47	0.23
p20	2.078	0.013	27.71	0.18
p30	2.580	0.012	34.76	0.17
p40	2.986	0.011	40.73	0.18
p50	3.383	0.012	46.66	0.20
p60	3.819	0.014	53.26	0.21
p70	4.364	0.016	61.50	0.27
p80	5.156	0.021	73.25	0.35
p90	6.543	0.030	93.70	0.53
p92	6.969	0.036	100.24	0.60
p94	7.505	0.042	108.70	0.73
p95	7.839	0.048	114.08	0.81
p96	8.263	0.053	120.73	0.92
p97.5	9.213	0.069	135.17	1.24
p98	9.711	0.080	142.13	1.42
p99	11.263	0.117	164.14	2.31
p99.5	12.544	0.157	186.13	3.14
p99.9	14.898	0.300	235.47	7.01

Source: Hall et al., 2007.

Table 17-46. Deodorant/Antiperspirant Non-Spray for Consumers Only (Males and Females)				
Value	Amount (g/day)	Stdev	Amount (mg/kg/day)	Stdev
Mean	0.898	0.002	12.95	0.04
Std	0.494	0.002	7.34	0.05
Median	0.820	0.003	11.77	0.05
Minimum	0.000	0.000	0.00	0.00
Maximum	4.528	0.300	73.91	7.48
Percentile				
p01	0.064	0.002	0.90	0.04
p02.5	0.123	0.004	1.75	0.05
p05	0.221	0.004	3.12	0.06
p10	0.363	0.003	5.08	0.05
p20	0.509	0.003	7.26	0.05
p30	0.617	0.003	8.85	0.05
p40	0.718	0.003	10.30	0.05
p50	0.820	0.003	11.77	0.05
p60	0.934	0.004	13.36	0.05
p70	1.068	0.004	15.25	0.07
p80	1.238	0.005	17.77	0.08
p90	1.509	0.007	22.08	0.12
p92	1.598	0.008	23.51	0.14
p94	1.722	0.010	25.37	0.17
p95	1.806	0.011	26.57	0.19
p96	1.912	0.013	28.05	0.21
p97.5	2.134	0.016	31.18	0.28
p98	2.233	0.017	32.67	0.32
p99	2.515	0.025	37.25	0.48
p99.5	2.771	0.033	41.93	0.72
p99.9	3.426	0.088	52.79	1.63
Source: Hall et al., 2007.				

Table 17-47. Lipstick Exposure for Consumers Only (Females)				
Value	Amount (mg/kg/day)	Stdev	Amount (mg/kg/day)	Stdev
Mean	24.61	0.17	0.39	0.00
Std	24.05	0.25	0.40	0.01
Median	17.11	0.18	0.26	0.00
Minimum	0.13	0.04	0.00	0.00
Maximum	217.53	26.01	3.88	0.55
Percentile				
p01	0.57	0.04	0.01	0.00
p02.5	1.00	0.07	0.02	0.00
p05	1.68	0.07	0.03	0.00
p10	2.95	0.07	0.04	0.00
p20	5.69	0.11	0.09	0.00
p30	9.20	0.14	0.14	0.00
p40	12.93	0.15	0.20	0.00
p50	17.11	0.18	0.26	0.00
p60	22.37	0.24	0.34	0.00
p70	29.43	0.33	0.46	0.01
p80	39.70	0.47	0.62	0.01
p90	56.53	0.66	0.90	0.01
p92	61.66	0.72	0.98	0.01
p94	68.29	0.86	1.10	0.02
p95	72.51	0.95	1.17	0.02
p96	77.78	1.08	1.26	0.02
p97.5	89.08	1.34	1.46	0.03
p98	94.46	1.52	1.55	0.03
p99	110.98	2.06	1.84	0.04
p99.5	126.71	2.93	2.13	0.06
p99.9	160.06	6.33	2.78	0.14
Source: Hall et al., 2007.				

Table 17-48. Facial Moisturizer Exposure for Consumers Only (Males and Females)				
Value	Amount (g/day)	Stdev	Amount (mg/kg/day)	Stdev
Mean	0.906	0.003	13.62	0.05
Std	0.533	0.004	8.63	0.08
Median	0.851	0.004	12.42	0.06
Minimum	0.001	0.000	0.02	0.00
Maximum	4.751	0.380	92.75	11.80
Percentile				
p01	0.055	0.002	0.73	0.04
p02.5	0.079	0.004	1.13	0.03
p05	0.138	0.001	1.89	0.04
p10	0.261	0.004	3.67	0.06
p20	0.472	0.004	6.63	0.05
p30	0.603	0.003	8.66	0.05
p40	0.721	0.003	10.51	0.06
p50	0.851	0.004	12.42	0.06
p60	0.990	0.004	14.47	0.07
p70	1.131	0.004	16.78	0.07
p80	1.289	0.005	19.65	0.10
p90	1.536	0.007	24.14	0.14
p92	1.617	0.008	25.57	0.17
p94	1.727	0.010	27.46	0.19
p95	1.801	0.012	28.68	0.22
p96	1.897	0.014	30.23	0.25
p97.5	2.129	0.022	33.73	0.35
p98	2.251	0.027	35.52	0.43
p99	2.653	0.043	41.63	0.71
p99.5	3.040	0.057	48.23	1.08
p99.9	3.714	0.108	63.35	2.62

Source: Hall et al., 2007.

Table 17-49. Shampoo Exposure for Consumers Only (Males and Females)

Value	Amount (g/day)	Stdev	Amount (mg/kg/day)	Stdev
Mean	6.034	0.014	85.888	0.223
Std	3.296	0.015	48.992	0.278
Median	5.503	0.020	77.895	0.294
Minimum	0.344	0.036	3.826	0.461
Maximum	29.607	0.669	528.361	65.887
Percentile				
p01	1.071	0.000	12.781	0.148
p02.5	1.268	0.023	16.367	0.181
p05	1.482	0.024	21.059	0.182
p10	2.178	0.019	29.737	0.269
p20	3.236	0.016	44.415	0.242
p30	3.843	0.019	55.58	0.253
p40	4.777	0.023	66.502	0.27
p50	5.503	0.020	77.895	0.294
p60	6.416	0.022	90.255	0.332
p70	7.390	0.026	104.537	0.373
p80	8.597	0.028	122.6	0.461
p90	10.456	0.039	150.488	0.642
p92	11.013	0.054	159.046	0.73
p94	11.721	0.041	169.939	0.846
p95	12.181	0.063	176.768	0.922
p96	12.705	0.064	185.092	1.08
p97.5	13.765	0.073	202.349	1.396
p98	14.194	0.091	210.49	1.551
p99	15.637	0.110	235.613	2.142
p99.5	16.992	0.149	260.624	3.009
p99.9	20.397	0.443	320.47	6.689

Source: Hall et al., 2007.

Table 17-50. Toothpaste Exposure for Consumers Only (Males and Females)				
Value	Amount (g/day)	Stdev	Amount (mg/kg/day)	Stdev
Mean	2.092	0.001	29.85	0.04
Std	0.577	0.001	10.34	0.05
Median	2.101	0.003	28.67	0.06
Minimum	0.069	0.012	0.93	0.18
Maximum	4.969	0.159	98.77	8.19
Percentile				
p01	0.777	0.011	10.14	0.14
p02.5	1.049	0.006	13.34	0.08
p05	1.204	0.004	15.47	0.06
p10	1.370	0.003	17.96	0.06
p20	1.591	0.003	21.29	0.05
p30	1.790	0.003	23.94	0.05
p40	1.958	0.003	26.32	0.06
p50	2.101	0.003	28.67	0.06
p60	2.237	0.003	31.15	0.06
p70	2.383	0.003	34.00	0.07
p80	2.551	0.003	37.62	0.08
p90	2.749	0.003	43.29	0.12
p92	2.809	0.004	45.03	0.14
p94	2.895	0.005	47.23	0.16
p95	2.960	0.006	48.61	0.17
p96	3.052	0.008	50.27	0.20
p97.5	3.323	0.010	53.70	0.25
p98	3.447	0.015	55.28	0.26
p99	3.760	0.006	60.12	0.39
p99.5	3.956	0.026	64.77	0.52
p99.9	4.303	0.049	74.84	1.10
Source: Hall et al., 2007.				

Table 17-51. Average Number of Applications Per Use Day[a]			
Summary Statistics	Facial Cleanser (Lathering and Non-Lathering)	Hair Conditioner	Eye Shadow
N	295	297	299
Mean	1.6	1.1	1.2
SD	0.52	0.19	0.33
Minimum	1.0	1.0	1.0
Maximum	3.2	2.4	2.7
Percentiles			
10th	1.0	1.0	1.0
20th	1.0	1.0	1.0
30th	1.2	1.0	1.0
40th	1.4	1.0	1.1
50th	1.7	1.0	1.1
60th	1.9	1.0	1.1
70th	2.0	1.0	1.2
80th	2.0	1.1	1.4
90th	2.2	1.2	1.7
95th	2.4	1.4	2.0
97.5th	2.9[b]	1.8[b]	2.2[b]
99th[b]	3.1[b]	2.1[b]	2.5[b]

[a] Derived as the ratio of the number of applications to the number of use days.
[b] Estimate does not meet the minimum sample size criteria (n=800) as set by the National Center for Health Statistics. For upper percentile (>0.75), the minimum sample size (n) satisfies the following rule: n [8/(1-p.] http://www/cdc/gov/nchs/about/major/nhanes/nhanes3/nh3gui.pdf.
N = Number of subjects (women, ages 18 to 69 years).
SD = Standard deviation.

Source: Loretz et al., 2008.

Table 17-52. Average Amount of Product Applied Per Use Day (grams)[a]					
Summary Statistics	Facial Cleanser (Lathering and Non-Lathering)	Facial Cleanser (Lathering)	Facial Cleanser (Non-Lathering)	Hair Conditioner	Eye shadow
N	295	174	121	297	299
Mean	4.06	4.07	4.05	13.77	0.04
SD	2.78	2.87	2.67	11.50	0.11
Minimum	0.33	0.33	0.83	0.84	0.001
Maximum	16.70	15.32	16.70	87.86	0.74
Percentiles					
10th	1.41	1.23	1.50	3.71	0.003
20th	1.79	1.72	1.94	5.54	0.005
30th	2.18	2.15	2.22	6.95	0.007
40th	2.66	2.64	2.80	8.73	0.009
50th	3.25	3.19	3.33	10.62	0.010
60th	3.86	3.84	3.88	12.61	0.013
70th	4.62	4.71	4.59	15.54	0.017
80th	6.24	6.33	5.92	20.63	0.025
90th	8.28	8.24	8.40	28.20	0.052
95th	9.93	10.50	9.37[b]	33.19	0.096
97.5th	10.71[b]	11.47[b]	10.26[b]	45.68[b]	0.525[b]
99th[b]	12.44[b]	13.07[b]	15.29[b]	60.20[b]	0.673[b]
Best fit distributions and parameters	Lognormal distribution	Lognormal distribution	Lognormal distribution	Lognormal distribution	Lognormal distribution
	GM = 3.26	GM = 3.21	GM = 3.35	GM = 10.28	GM = 0.01
	GSD = 1.12	GSD = 2.03	GSD = 1.86	GSD - 2.20	GSD = 3.61
P-value (Chi-square test)	0.1251	0.4429	0.4064	0.8595	<0.0001

[a] Derived as the ratio of the total amount used to the number of use days.
[b] Estimate does not meet the minimum sample size criteria (n=800) as set by the National Center for Health Statistics. For upper percentile (>0.75), the minimum sample size (n) satisfies the following rule: n [8/(1-p)]. http://www/cdc.gov/nchs/about/major/nhanes/nhanes3/nh3gui.pdf.

N = Number of subjects (women, ages 18 to 69 years).
GM = Geometric mean.
GSD = Geometric standard deviation.

Source: Loretz et al., 2008.

Table 17-53. Average Amount of Product Applied Per Application (grams)[a]

Summary Statistics	Facial Cleanser (Lathering and Non-Lathering)	Facial Cleanser (Lathering)	Facial Cleanser (Non-Lathering)	Hair Conditioner	Eye Shadow
N	295	174	121	297	299
Mean	2.57	2.56	2.58	13.13	0.03
SD	1.78	1.78	1.77	11.22	0.10
Minimum	0.33	0.33	0.57	0.84	0.0004
Maximum	14.61	10.67	14.61	87.86	0.69
Percentiles					
10th	0.92	0.83	1.10	3.48	0.003
20th	1.32	1.26	1.35	5.34	0.004
30th	1.57	1.55	1.59	6.71	0.006
40th	1.85	1.84	1.89	8.26	0.007
50th	2.11	2.11	2.15	10.21	0.009
60th	2.50	2.50	2.51	12.24	0.011
70th	2.94	2.96	2.96	14.54	0.015
80th	3.47	3.56	3.40	18.88	0.022
90th	4.81	5.10	4.52	27.32	0.041
95th	5.89	6.37	5.11[b]	32.43	0.096
97.5th	7.16[b]	7.77[b]	6.29[b]	45.68[b]	0.488[b]
99th[b]	9.44[b]	9.61[b]	15.46[b]	60.20[b]	0.562[b]
Best fit distributions and parameters	Extreme value	Gamma	Extreme value	Lognormal distribution	Lognormal distribution
	Mode = 1.86	Loc = 0.28	Mode = 1.92	GM = 9.78	GM = 0.01
	Scale = 1.12	Scale = 1.29	Scale = 1.03	GSD = 2.20	GSD = 3.59
P-value (Chi-square test)	0.0464	0.6123	0.5219	0.9501	<0.0001

[a] Derived as the ratio of the total amount used to the total number of applications.
[b] Estimate does not meet the minimum sample size criteria (n=800) as set by the National Center for Health Statistics. For upper percentile (>0.75), the minimum sample size (n) satisfies the following rule: n [8/(1-p)]. http://www/cdc.gov/nchs/about/major/nhanes/nhanes3/nh3gui.pdf.
N = Number of subjects (women, ages 18 to 69 years).
GM = Geometric mean.
SD = Geometric standard deviation.

Source: Loretz et al., 2008.

Table 17-54. Characteristics of the Study Population and the Percent Using Selected Baby Care Products	
Characteristic	Sample Number (percent)
Number of Participants	
Los Angeles, California	43 (26)
Minneapolis, Minnesota	77 (47)
Columbia, Missouri	43 (26)
Gender	
Male	84 (52)
Female	79 (48)
Age (months)	
2-8	42 (26)
9-16	82 (50)
17-24	30 (18)
24-28	9 (6)
Infant Weight (kg)	
≤10	84 (52)
> 10	79 (48)
Race	
White	131 (80)
Hispanic/Latino	17 (10)
Native American	3 (2)
Asian	8 (5)
Black	4 (3)
Product Use	Percent Using
Baby Lotion	36
Baby Shampoo	54
Baby Powder	14
Diaper Cream	33
Baby Wipes	94
Source: Sathyanarayana et al., 2008.	

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18. LIFETIME

18.1 INTRODUCTION

The length of an individual's life is an important factor to consider when evaluating cancer risk because the dose estimate is averaged over an individual's lifetime. Since the averaging time is found in the denominator of the dose equation, a shorter lifetime would result in a higher potential risk estimate, and conversely, a longer life expectancy would produce a lower potential risk estimate.

The recommendations for life expectancy are provided in the next section, along with a summary of the confidence rating for this recommendation. The recommended values are based on one key study identified by the U.S. EPA for this factor. Following the recommendations, the key study is summarized.

18.2 RECOMMENDATIONS

Current data suggest that 78 years would be an appropriate value to reflect the average life expectancy of the general population and is the recommended value. If gender is a factor considered in the assessment, note that the average life expectancy value for females is higher than for males. It is recommended that the assessor use the appropriate value of 75 years for males or 80 years for females, based on life expectancy data from 2005. (U.S. National Center for Health Statistics, 2008). If race is a consideration in assessing exposure for individuals, note that the life expectancy is longer for Whites than for Blacks. Therefore, assessors are encouraged to use values that most reflect the exposed population. Tables 18-1 and 18-2 present the recommendations and confidence ratings for life expectancy, respectively.

This recommended value is different than the 70 years commonly assumed for the general population in U.S. EPA risk assessments. The Integrated Risk Information System (IRIS) does not use a 70-year lifetime assumption in the derivation of RfCs and RfDs, cancer slope factors or unit risks. Therefore, using a value different than 70 years will not result in an inconsistency with the toxicity data.

Table 18-1. Recommended Values for Expectation of Life at Birth: 2005

Population	Life Expectancy years
Total	78
Males	75
Females	80

Source: U.S. National Center for Health Statistics, 2008.

Table 18-2. Confidence in Lifetime Expectancy Recommendations		
Considerations	Rationale	Rating
Soundness		High
Adequacy of Approach	Data presented in the section are from the U.S. Bureau of the Census publication on the American Community Survey (ACS).	
Minimal (or defined) Bias	There are no apparent biases.	
Applicability and Utility		High
Exposure Factor of Interest	The study was designed to provide United States communities socioeconomic and demographic profiles, which includes a demographic assessment of life expectancy.	
Representativeness	The data are representative of the U.S. population.	
Currency	The study was published in 2008 and discusses life expectancy trends from 1970 to 2005. The study has also made projections for 2010 until the year 2020.	
Data Collection Period	Data were collected in 2005.	
Clarity and Completeness		High
Accessibility	The study is widely available to the public (Census data).	
Reproducibility	Results can be reproduced by analyzing Census data.	
Quality Assurance	Information on ensuring data quality are available publicly.	
Variability and Uncertainty		Medium
Variability in Population	Data were averaged by gender and race but only for Blacks and Whites; no other nationalities were represented within the section.	
Uncertainty	Data were based on death certificates filed in the 50 states in the U.S. and District of Columbia. Projections are made based on models that estimate probability of dying.	
Evaluation and Review		High
Peer Review	Data are published and have received extensive peer review.	
Number and Agreement of Studies	Data presented in the section are from the U.S. Bureau of the Census publication. Recommendation was based on only one study, but it is widely accepted.	
Overall Rating		**High**

18.3 KEY LIFETIME STUDY

18.3.1 Combination of Data Compiled by the Census Bureau

Statistical data on life expectancy are published annually by the U.S. Department of Commerce in the publication: "Statistical Abstract of the United States." The latest year for which statistics are available is 2005. Available data on life expectancies for various subpopulations born in the years 1970 to 2005 are presented in Table 18-3. These data are based on information from all death certificates filed in the 50 states and the District of Columbia (NCHS, 2008).

Data for 2005 show that the life expectancy for an average person born in the United States is 77.8 years (U.S. Bureau of the Census, 2008). The average life expectancy for males in 2005 was 75.2 years, and 80.4 years for females. Whereas the gap between males and females was about 7 years in 1970, it has now narrowed to about 5 years. Table 18-3 also indicates that life expectancy for white males and females is consistently longer than for Black males and females. Table 18-4 presents data for expectation of life for persons who were at a specific age in year 2005. These data are available by age, gender, and race and may be useful for deriving exposure estimates based on the age of a specific subpopulation. The data show that expectation of life is longer for females and for Whites.

18.4 REFERENCES FOR CHAPTER 18

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Table 18-3. Expectation of Life at Birth, 1970 to 2005, and Projections, 2010 to 2020 (years)[a]

YEAR		TOTAL			WHITE			BLACK		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
1970		70.8	67.1	74.7	71.7	68.0	75.6	64.1	60.0	68.3
1975		72.6	68.8	76.6	73.4	69.5	77.3	66.8	62.4	71.3
1980		73.7	70.0	77.4	74.4	70.7	78.1	68.1	63.8	72.5
1982		74.5	70.8	78.1	75.1	71.5	78.7	69.4	65.1	73.6
1983		74.6	71.0	78.1	75.2	71.6	78.7	69.4	65.2	73.5
1984		74.7	71.1	78.2	75.3	71.8	78.7	69.5	65.3	73.6
1985		74.7	71.1	78.2	75.3	71.8	78.7	69.3	65.0	73.4
1986		74.7	71.2	78.2	75.4	71.9	78.8	69.1	64.8	73.4
1987		74.9	71.4	78.3	75.6	72.1	78.9	69.1	64.7	73.4
1988		74.9	71.4	78.3	75.6	72.2	78.9	68.9	64.4	73.2
1989		75.1	71.7	78.5	75.9	72.5	79.2	68.8	64.3	73.3
1990		75.4	71.8	78.8	76.1	72.7	79.4	69.1	64.5	73.6
1991		75.5	72.0	78.9	76.3	72.9	79.6	69.3	64.6	73.8
1992		75.8	72.3	79.1	76.5	73.2	79.8	69.6	65.0	73.9
1993		75.5	72.2	78.8	76.3	73.1	79.5	69.2	64.6	73.7
1994		75.7	72.4	79.0	76.5	73.3	79.6	69.5	64.9	73.9
1995		75.8	72.5	78.9	76.5	73.4	79.6	69.6	65.2	73.9
1996		76.1	73.1	79.1	76.8	73.9	79.7	70.2	66.1	74.2
1997		76.5	73.6	79.4	77.2	74.3	79.9	71.1	67.2	74.7
1998		76.7	73.8	79.5	77.3	74.5	80.0	71.3	67.6	74.8
1999		76.7	73.9	79.4	77.3	74.6	79.9	71.4	67.8	74.7
2000		77.0	74.3	79.7	77.6	74.9	80.1	71.9	68.3	75.2
2001		77.2	74.4	79.8	77.7	75.0	80.2	72.2	68.6	75.5
2002		77.3	74.5	79.9	77.7	75.1	80.3	72.3	68.8	75.6
2003		77.4	74.7	80.0	77.9	75.3	80.4	72.6	68.9	75.9
2004		77.8	75.2	80.4	78.3	75.7	80.8	73.1	69.5	76.3
2005		77.8	75.2	80.4	78.3	75.7	80.8	73.2	69.5	76.5
Projections[a]	2010	78.3	75.7	80.8	78.9	76.5	81.3	73.8	70.2	77.2
	2015	78.9	76.4	81.4	79.5	77.1	81.8	75.0	71.4	78.2
	2020	79.5	77.1	81.9	80.0	77.7	82.4	76.1	72.6	79.2

[a] Based on middle mortality assumptions; for details, see source: U.S. Census Bureau, 2008.

Source: U.S. National Center for Health Statistics, 2008.

Table 18-4. Expectation of Life by Race, Sex, and Age: 2005

Age in 1990 (years)	Total[a]	Expectation of Life in Years			
		White		Black	
		Male	Female	Male	Female
At Birth	77.8	75.7	80.8	69.5	76.5
1	77.4	75.2	80.2	69.6	76.4
2	76.4	74.2	79.2	68.7	75.5
3	75.4	73.3	78.3	67.7	74.5
4	74.5	72.3	77.3	66.7	73.5
5	73.5	71.3	76.3	65.7	72.5
6	72.5	70.3	75.3	64.8	71.6
7	71.5	69.3	74.3	63.8	70.6
8	70.5	68.3	73.3	62.8	69.6
9	69.5	67.3	72.3	61.8	68.6
10	68.5	66.3	71.3	60.8	67.6
11	67.5	65.3	70.3	59.8	66.6
12	66.5	64.3	69.4	58.8	65.6
13	65.6	63.4	68.4	57.9	64.6
14	64.6	62.4	67.4	56.9	63.7
15	63.6	61.4	66.4	55.9	62.7
16	62.6	60.4	65.4	55.0	61.7
17	61.7	59.5	64.4	54.0	60.7
18	60.7	58.5	63.4	53.1	59.7
19	59.7	57.6	62.5	52.2	58.8
20	58.8	56.6	61.5	51.2	57.8
21	57.8	55.7	60.5	50.3	56.8
22	56.9	54.8	59.6	49.4	55.9
23	56.0	53.9	58.6	48.6	54.9
24	55.0	52.9	57.6	47.7	53.9
25	54.1	52.0	56.6	46.8	53.0
26	53.1	51.1	55.7	45.9	52.0
27	52.2	50.1	54.7	45.0	51.1
28	51.2	49.2	53.7	44.1	50.1
29	50.3	48.3	52.7	43.2	49.1
30	49.3	47.3	51.8	42.3	48.2
31	48.4	46.4	50.8	41.4	47.3
32	47.4	45.4	49.8	40.5	46.3
33	46.5	44.5	48.9	39.6	45.4
34	45.5	43.6	47.9	38.8	44.4

Table 18-4. Expectation of Life by Race, Sex, and Age: 2005 (continued)

Age in 1990 (years)	Expectation of Life in Years				
	Total[a]	White		Black	
		Male	Female	Male	Female
35	44.6	42.6	46.9	37.9	43.5
36	43.6	41.7	46.0	37.0	42.6
37	42.7	40.8	45.0	36.1	41.6
38	41.8	39.8	44.1	35.2	40.7
39	40.8	38.9	43.1	34.3	39.8
40	39.9	38.0	42.2	33.4	38.9
41	39.0	37.1	41.2	32.6	38.0
42	38.0	36.2	40.3	31.7	37.1
43	37.1	35.3	39.3	30.8	36.2
44	36.2	34.4	38.4	30.0	35.3
45	35.3	33.5	37.5	29.2	34.4
46	34.4	32.6	36.5	28.3	33.6
47	33.5	31.7	35.6	27.5	32.7
48	32.7	30.8	34.7	26.7	31.9
49	31.8	30.0	33.8	26.0	31.0
50	30.9	29.1	32.9	25.2	30.2
51	30.0	28.3	32.0	24.4	29.4
52	29.2	27.4	31.1	23.7	28.6
53	28.3	26.6	30.2	23.0	27.8
54	27.5	25.8	29.3	22.3	27.0
55	26.7	24.9	28.4	21.6	26.2
56	25.8	24.1	27.5	20.9	25.4
57	25.0	23.3	26.7	20.2	24.6
58	24.2	22.5	25.8	19.5	23.8
59	23.4	21.7	25.0	18.9	23.0
60	22.6	20.9	24.1	18.2	22.3
61	21.8	20.2	23.3	17.6	21.5
62	21.0	19.4	22.4	17.0	20.8
63	20.2	18.7	21.6	16.4	20.1
64	19.5	17.9	20.8	15.8	19.4
65	18.7	17.2	20.0	15.2	18.7
70	15.2	13.8	16.2	12.4	15.3
75	12.0	10.7	12.8	10.0	12.3
80	9.2	8.1	9.7	7.9	9.7

[a] Includes other races not shown separately.

Source: U.S. Census Bureau, 2009, based on data from the National Center for Health Statistics.

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19. RESIDENTIAL BUILDING CHARACTERISTICS

19.1 INTRODUCTION

Unlike previous chapters in this handbook which focus on human behavior or characteristics that affect exposure, this chapter focuses on residence characteristics. Assessment of exposure in residential settings requires information on the availability of the chemical(s) of concern at the point of exposure, characteristics of the structure and microenvironment that affect exposure, and human presence within the residence. The purpose of this chapter is to provide data that are available on residence characteristics that affect exposure in an indoor environment. Source-receptor relationships in residential exposure scenarios can be complex due to interactions among sources, and transport/transformation processes that result from chemical-specific and building-specific factors.

There are many factors that effect indoor air exposures. Indoor air models generally require data on several parameters. This chapter focuses on two parameters, surface area/volume and air exchange rates. Other factors that affect indoor air quality are furnishings, siting, weather, ventilation and infiltration, environmental control systems, material durability, and building structure.

Figure 19-1 illustrates the complex factors that must be considered when conducting exposure assessments in a residential setting. In addition to sources within the building, chemicals of concern may enter the indoor environment from outdoor air, soil, gas, water supply, tracked-in soil, and industrial work clothes worn by the residents. Indoor concentrations are affected by loss mechanisms, also illustrated in Figure 19-1, involving chemical reactions, deposition to and re-emission from surfaces, and transport out of the building. Particle-bound chemicals can enter indoor air through resuspension. Indoor air concentrations of gas-phase organic chemicals are affected by the presence of reversible sinks formed by a wide range of indoor materials. In addition, the activity of human receptors greatly affects their exposure as they move from room to room, entering and leaving the exposure scene.

Inhalation exposure assessments in residential and other indoor settings are modeled by considering the building as an assemblage of one or more well-mixed zones. A zone is defined as one room, a group of interconnected rooms, or an entire building. At this macroscopic level, well-mixed perspective forms the basis for interpretation of measurement data as well as simulation of hypothetical scenarios. Exposure assessment models on a macroscopic level incorporate important physical factors and processes. These well-mixed, macroscopic models have been used to perform indoor air quality simulations (Axley, 1989), as well as indoor air exposure assessments (McKone, 1989; Ryan, 1991). Nazaroff and Cass (1986) and Wilkes et al. (1992) have used code-intensive computer programs featuring finite difference or finite element numerical techniques to model mass balance. A simplified approach using desk top spreadsheet programs has been used by Jennings et al. (1985). U.S. EPA has created two useful indoor air quality models: the *Indoor Air Quality Building and Assessment Model* (I-BEAM) estimates indoor air quality in commercial buildings and the *Multi-Chamber Concentration and Exposure Model* (MCCEM) estimates average and peak indoor air concentration of chemicals released from residences.

Section 19.3 of this chapter summarizes existing data on building characteristics (volumes, surface areas, mechanical systems, and types of foundations). Section 19.4 summarizes transport phenomena that affect chemical transport (airflow, chemical-specific deposition and filtration, and soil tracking). Section 19.5 provides information on various types of indoor sources associated with airborne exposure and soil/house dust sources. Section 19.6 summarizes advanced concepts.

Major air transport pathways for airborne substances in residences include the following:

- Air exchange - Air leakage through windows, doorways, intakes and exhausts, and "adventitious openings" (i.e., cracks and seams) that combine to form the leakage configuration of the building envelope plus natural and mechanical ventilation;
- Interzonal airflows - Transport through doorways, ductwork, and service chaseways that interconnect rooms or zones within a building; and
- Local circulation - Convective and advective air circulation and mixing within a room or within a zone.

The distribution of airflows across the building envelope that contribute to air exchange and the interzonal airflows along interior flowpaths is determined by the interior pressure distribution. The forces causing the airflows are temperature differences, the actions of wind, and mechanical ventilation systems. Basic concepts have been reviewed by ASHRAE (1993). Indoor-outdoor and room-to-room temperature differences create density differences that help determine basic patterns of air motion. During the heating season, warmer indoor air tends to rise to exit the building at upper levels by stack action. Exiting air is replaced at lower levels by an influx of colder outdoor air. During the cooling season, this pattern is reversed: stack forces during the cooling season are generally not as strong as in the heating season because the indoor-outdoor temperature differences are not pronounced.

In examining a data base of air leakage measurements, Sherman and Dickerhoff (1996) observed that houses built prior to 1980 showed a clear increase in leakage with increasing age and were leakier, on average, than newer houses. They further observed that the post-1980 houses did not show any trend in leakiness with age.

The position of the neutral pressure level (i.e., the point where indoor-outdoor pressures are equal) depends on the leakage configuration of the building envelope. The stack effect arising from indoor-outdoor temperature differences is also influenced by the partitioning of the building interior. When there is free communication between floors or stories, the building behaves as a single volume affected by a generally rising current during the heating season and a generally falling current during the cooling season. When vertical communication is restricted, each level essentially becomes an independent zone. As the wind flows past a building, regions of positive and negative pressure (relative to indoors) are created within the building; positive pressures induce an influx of air, whereas negative pressures induce an outflow. Wind effects and stack effects combine to determine a net inflow or outflow.

The final element of indoor transport involves the actions of mechanical ventilation systems that circulate indoor air through the use of fans. Mechanical ventilation systems may be connected to heating/cooling systems that, depending on the type of building, recirculate thermally treated indoor air or a mixture of fresh air and recirculated air. Mechanical systems also may be solely dedicated to exhausting air from a designated area, as with some kitchen range hoods and bath exhausts, or to recirculating air in designated areas as with a room fan. Local air circulation also is influenced by the movement of people and the operation of local heat sources.

19.2 RECOMMENDATIONS

Table 19-1 presents the recommended values for house volume and air exchange rate. Tables 19-2 and 19-3 provide the confidence in recommendations for house volume and air exchange rate, respectively. Studies or analyses described in this chapter were used in selecting recommended values for residential volume and air exchange rate. Air exchange rate data presented in the studies are extremely limited. Therefore, the confidence recommendation has been assigned a "low" overall rating and these values should be used with caution. Both central and lower percentile values are provided. These two parameters -- volume and air exchange rate -- can be used by exposure assessors in modeling indoor-air concentrations as one of the inputs to exposure estimation. Other inputs to the modeling effort include rates of indoor pollutant generation and losses to (and, in some cases, re-emissions from) indoor sinks. Other things being equal (i.e., holding constant the pollutant generation rate and effect of indoor sinks), lower values for either the indoor volume or the air exchange rate will result in higher indoor-air concentrations. Thus, values near the lower end of the distribution (e.g., 10th percentile) for either parameter are appropriate in developing conservative estimates of exposure.

For the volume of a residence, the 2007 American Housing Survey – AHS - (US Census Bureau, 2008) indicates a median housing unit is 401 m^3 assuming an eight foot ceiling. This median value is recommended as a central estimate residential volume. The 2005 Residential Energy Consumption Survey (RECS) data indicates a 493 m^3 average living space (U.S. DOE, 2005). The Versar (1990) Perfluorocarbon Tracer – (PFT) database found a mean value of 369 m^3 (see Table 19-4). The difference between these values reflects changes in the definitions of floorspace between the most recent and earlier RECS. The 25th percentile -- 209 m^3 for 1995 RECS survey or 225 m^3 for PFT database, averaging 217 m3 across the two studies -- is recommended as the lower percentile value.

For the residential air exchange rate, the median value of 0.45 air changes per hour (ACH) from the PFT database (see Table 19-14) is recommended as a typical value (Koontz and Rector, 1995). The arithmetic mean is not preferred because it is influenced fairly heavily by extreme values at the upper tail of the distribution. For a conservative value, the 10th percentile for the PFT database -- 0.18 ACH -- is recommended (Table 19-14).

There are some uncertainties in, or limitations on, the distribution for volumes and air exchange rates that are presented in this chapter. For example, the RECS and AHS measured floor area rather than total volume. The PFT database did not base its measurements on sample that was statistically representative of the national housing stock. PFT has been found to underpredict seasonal average air exchange by 20 to 30 percent Sherman (1989). Using PFT to determine air exchange can produce significant errors when conditions in the measurement scene greatly deviate from idealizations calling for constant, well-mixed conditions. Principal concerns focus on the effects of naturally varying air exchange and the effects of temperature in the permeation source. Some researchers have found that failing to use a time-weighted average temperature can greatly affect air exchange rates estimates (Leaderer et al., 1985). A final difficulty in estimating air exchange rates for any particular zone results from interconnectedness of multi-zone models and the affect of neighboring zones as demonstrated by Sinden (1978) and Sandberg (1984).

Indoor air quality models typically are not software products that can be purchased as "off-the-shelf" items. Most existing software models are research tools that have been developed for specific purposes and are being continuously refined by researchers. Leading examples of indoor air models implemented as software products are as follows:

- CONTAM – CONTAM was developed at the National Institute of Standards and Technology (NIST) with support from U.S. EPA and the U.S. Department of Energy (DOE) (Axley, 1988; Grot, 1991; Walton, 1993);

- IAQX – The Indoor Air Quality and Inhalation Exposure model is a Windows-based simulation software package developed by U.S. EPA (Price et al, 2003).

- CPIEM -- The California Population Indoor Exposure Model was developed for the California Air Resources Board (Price et al, 2003).

- TEM -- The Total Exposure Model was developed with support from U.S. EPA and the US Air Force (Price et al, 2003).

- RISK -- RISK was developed by the Indoor Environment Management Branch of the U.S. EPA National Risk Management Research Laboratory (Price et al, 2003).

- TRIM – The Total Risk Integrated Methodology is an ongoing modeling project of EPA's Office of Air Quality Planning and Standards (Price et al, 2003).

- TOXLT/TOXST -- The Toxic Modeling System Long-Term was developed along with the release of the new version of the U.S. EPA's Industrial Source Complex (ISC2) Dispersion Models (Price, 2001).

- MIAQ – The Multi-Chamber Indoor Air Quality Model was developed for the California Institute of Technology and Lawrence Berkeley National Laboratory (Price, 2003)

- MCCEM -- the Multi-Chamber Consumer Exposure Model was developed for U.S EPA Office of Pollution Prevention and Toxics (EPA/OPPT) (GEOMET, 1989; Koontz and Nagda, 1991); and

- THERdbASE -- the Total Human Exposure Relational Data Base and Advanced Simulation Environment software was developed by researchers at the Harry Reid Center for Environmental Studies at University Nevada, Las Vegas (UNLV) (Pandian et al., 1993).

Table 19-1. Recommendations - Residential Parameters		
Volume of Residence	401 m^3 (central estimate)[a]	217 m^3 (lower percentile)[b]
Air Exchange Rate	0.45 ACH (central estimate)[c]	0.18 ACH (lower percentile)[d]

[a] Average value presented in Table 19-7 recommended for use as a central estimate..
[b] Mean of two 25th percentile values (Table 19-4) - recommended to be used as a lower percentile estimate.
[c] Median value recommended to be used as a central estimate (Table 19-14).
[d] 10^{th} percentile value recommended to be used as a lower percentile value (Table 19-14).

Table 19-2. Confidence in House Volume Recommendations

General Assessment Factors	Rationale	Rating
Soundness		
Adequacy of Approach	All the studies were based on primary data. For the RECS survey, volumes were estimated assuming an 8 ft. ceiling height. The effect of this assumption has been tested by Murray (1996) and found to be insignificant.	Medium
Minimal (or defined) Bias	Selection of residences was random for RECS.	
Applicability and Utility		
Exposure Factor of Interest	The focus of the studies was on estimating house volume as well as other factors.	
Representativeness	Residences in the U.S. were the focus of the studies. The sample sizes used in the studies were fairly large, although only 1 study (RECS) was representative of the whole U.S. Not all samples were selected at random; however, RECS samples were selected at random. RECS sample is representative of the U.S.	Medium
Currency	Measurements in the PFT database were taken between 1982-1987. The most recent RECS survey was conducted in 2005.	
Data Collection Period	Not applicable.	
Clarity and Completeness		
Accessibility	Papers are widely available from peer review journals.	
Reproducibility	Direct measurements were made.	High
Quality Assurance	Not applicable.	
Variability and Uncertainty		
Variability in Population	Distributions are presented by housing type and regions; although some of the sample sizes for the subcategories were small.	Medium
Uncertainty	Some measurement error may exist since surface areas were estimated using the assumption of 8 ft. ceiling height.	
Evaluation and Review		
Peer Review	All studies are from peer reviewed literature.	Medium
Number and Agreement of Studies	There are 4 studies. There is relatively good agreement among researchers.	
Overall Rating	.	**Medium**

Table 19-3. Confidence in Air exchange Rate Recommendations		
General Assessment Factors	Rationale	Rating
Soundness		
Adequacy of Approach	All the studies were based on primary data. Although the PFT technology is a U.S.EPA standard method (Method IP-4A), it has some major limitations (e.g., uniform mixing assumption).	Medium
Minimal (or defined) Bias	Bias may result since the selection of residences was not random.	
Applicability and Utility		
Exposure Factor of Interest	The focus of the studies was on estimating air exchange rates as well as other factors.	
Representativeness	Residences in the U.S. were the focus of the PFT database, but sample was not representative of the U.S. The sample sizes used in the studies were fairly large, although not representative of the whole U.S. Not all samples were selected at random.	Medium
Currency	Measurements in the PFT database were taken between 1982-1987.	
Data Collection Period	Only short term data were collected; some residences were measured during different seasons; however, long term air exchange rates are not well characterized.	
Clarity and Completeness		
Accessibility	Papers are widely available from government reports and peer review journals.	
Reproducibility	Precision across repeat analyses has been documented to be acceptable.	Medium
Quality Assurance	Not applicable.	
Variability and Uncertainty		
Variability in Population	Distributions are presented by U.S. regions, seasons, and climatic regions; although some of the sample sizes for the subcategories were small and not representative of U.S. The utility is limited.	Low
Uncertainty	Some measurement error may exist.	
Evaluation and Review		
Peer Review	The studies appear in peer reviewed literature.	
Number and Agreement of Studies	There are 4 studies; however . Three of the studies are based on the same PFT database The database contains results of 20 projects of varying scope	Medium
Overall Rating		**Low**

19.3 BUILDING CHARACTERISTICS STUDIES

19.3.1 Volumes of Residence Studies

19.3.1.1 *Versar, 1990 - Database on Perfluorocarbon Tracer (PFT) Ventilation Measurements*

A database of time-averaged air exchange and interzonal airflow measurements in more than 4,000 residences has been compiled by Versar (1990) (see Section 19.4.2). These data were collected between 1982 and 1987. The residences that appear in this database are not a random sample of U.S. homes; however, they do represent a compilation of homes visited in about 100 different field studies, some of which involved random sampling. In each study, the house volumes were directly measured or estimated. The collective homes visited in these field projects are not geographically balanced; a large fraction of these homes are located in southern California. Statistical weighting techniques were applied in developing estimates of nationwide distributions (see Section 19.4.2) to compensate for the geographic imbalance. The Versar (1990) Perfluorocarbon Tracer – (PFT) database found a mean value of 369 m^3 (see Table 19-4). These data were compared to the results of the residential volume distributions form the 1995 Residential Energy Consumption Survey (RECS) (Thompson, 1995). The arithmetic means from the two sources are identical (369 cubic meters). The medians (50th percentiles) are very similar: 310 cubic meters for the RECS data, and 321 cubic meters for the PFT database. The 25th percentile values were 209 m^3 for 1995 RECS survey and 225 m^3 for PFT database, (Table 19-4). Cumulative frequency distributions from the two sources (Figure 19-2) also are quite similar, especially between the 50th and 75th percentiles.

19.3.1.2 *Murray, 1996 - Analysis of RECS and PFT Databases*

Using a database from the 1993 RECS and an assumed ceiling height of 8 feet, Murray (1996) estimated a mean residential volume of 382 m^3 using RECS estimates of heated floor space. This estimate is slightly different from the mean of 369 m^3 given in Table 19-4. Murray's (1996) sensitivity analysis indicated that when a fixed ceiling height of 8 feet was replaced with a randomly varying height with a mean of 8 feet, there was little effect on the standard deviation of the estimated distribution. From a separate analysis of the PFT database, based on 1,751 individual household measurements, Murray (1996) estimated an average volume of 369 m^3, the same as previously given in Table 19-4. In performing this analysis, the author carefully reviewed the PFT database in an effort to use each residence only once, for those residences thought to have multiple PFT measurements.

19.3.1.3 *U.S. DOE, 2005 - Residential Energy Consumption Survey (RECS)*

Measurement surveys have not been conducted to directly characterize the range and distribution of volumes for a random sample of U.S. residences. Related data, however, are regularly collected through the U.S. DOE's RECS (U.S. DOE, 2005). In addition to collecting information on energy use, this triennial survey collects data on housing characteristics including direct measurements of total and heated floor space for buildings visited by survey specialists. For the most recent survey (2005), a multistage probability sample of 4,381 residences was surveyed, representing 111 million housing units nationwide. The 2005 survey response rate was 77.1 percent. Volumes were estimated from the RECS measurements by multiplying the heated floor space area by an assumed ceiling height of 8 feet.

Results for residential volume distributions from the 2005 RECS are presented in Tables 19-5 and 19-6. Table 19-5 provides information on average estimated residential volumes according to housing type and ownership. The predominant housing type--single-family detached homes--also had the largest average volume (Table 19-5). Multifamily units and mobile homes had volumes averaging about half that of single-family detached homes, with single-family attached homes about halfway between these extremes. Within each category of housing type, owner-occupied residences averaged about 50 percent greater volume than rental units. Data on the relationship of residential volume to year of construction are provided in Table 19-6 and indicate a slight decrease in residential volumes between 1950 and 1979, followed by an increasing trend. A ceiling height of 8 feet was assumed in estimating the average volumes, whereas there may have been some time-related trends in ceiling height. The average house volume for all types of units for all years was estimated to be 492 m^3.

19.3.1.4 U.S. Census Bureau, 2008 – American Housing Survey for the United States: 2007

The American Housing Survey (AHS) is conducted by the Bureau of the Census for the Department of Housing and Urban Development (HUD). It collects data on the Nation's housing, including apartments, single-family homes, mobile homes, vacant housing units, household characteristics, housing quality, foundation type, drinking water source, equipment and fuels, and housing unit size. National data are collected in odd numbered years, and data for each of 47 selected Metropolitan Areas are collected about every six years. The national sample includes about 55,000 housing units. Each metropolitan area samples 4,100 or more housing units. The AHS returns to the same housing units year after year to gather data. AHS lists the number of residential single detached and manufactured/mobile homes in the U.S. within various categories including seasonal, year-round occupied, and new in the last four years (Table 19-7). Assuming an 8 foot ceiling, these units have a median size of 401 m^3; however, these values do not include multifamily units.

19.3.2 Room Volume, Surface Area, Products and Materials

19.3.2.1 Room Volume

Volumes of individual rooms are dependent on the building size and configuration, but summary data are not readily available. The exposure assessor is advised to define specific rooms, or assemblies of rooms, that best fit the scenario of interest. Most models for predicting indoor-air concentrations specify airflows in cubic meters per hour and, correspondingly, express volumes in cubic meters. A measurement in cubic feet can be converted to cubic meters by multiplying the value in cubic feet by 0.0283 m^3/ft^3. For example, a bedroom that is 9 feet wide by 12 feet long by 8 feet high has a volume of 864 cubic feet or 24.5 cubic meters. Similarly, a living room with dimensions of 12 feet wide by 20 feet long by 8 feet high has a volume of 1920 cubic feet or 54.3 cubic meters, and a bathroom with dimensions of 5 feet by 12 feet by 8 feet has a volume of 480 cubic feet or 13.6 cubic meters.

Murray (1996) analyzed the distribution of selected residential zones (i.e., a series of connected rooms) using the PFT database. The author analyzed the "kitchen zone" and the "bedroom zone" for houses in the Los Angeles area that were labeled in this manner by field researchers, and "basement," "first floor," and "second floor" zones for houses outside of Los Angeles for which the researchers labeled individual floors as zones. The kitchen zone contained the kitchen in addition to any of the following associated spaces: utility room, dining room, living room and family room. The bedroom zone contained all the bedrooms plus any bathrooms and hallways associated with the bedrooms. The following summary statistics (mean ± standard deviation) were reported by Murray (1996) for the volumes of the zones described above: 199 ± 115 m^3 for the kitchen zone, 128 ± 67 m^3 for the bedroom zone, 205 ± 64 m^3 for the basement, 233 ± 72 m^3 for the first floor, and 233 ± 111 m^3 for the second floor.

19.3.2.2 Surface Areas

The surface areas of floors are commonly considered in relation to the room or house volume, and their relative loadings are expressed as a surface area-to-volume, or loading ratio. Table 19-8 provides the basis for calculating loading ratios for typical-sized rooms. Constant features in the examples are: a room width of 12 feet and a ceiling height of 8 feet (typical for residential buildings), or a ceiling height 12 feet (typical for commercial buildings). The loading ratios for the 8-foot ceiling height range from 0.98 m^2m^{-3} to 2.18 m^2m^{-3} for wall areas and from 0.36 m^2m^{-3} to 0.44 m^2m^{-3} for floor area. In comparison, ASTM Standard E 1333 (ASTM, 1990), for large-chamber testing of formaldehyde levels from wood products, specifies the following loading ratios: (1) 0.95 m^2m^{-3} for testing plywood (assumes plywood or paneling on all four walls of a typical size room); and (2) 0.43 m^2m^{-3} for testing particleboard (assumes that particleboard decking or underlayment would be used as a substrate for the entire floor of a structure).

19.3.2.3 Products and Materials

Table 19-9 presents examples of assumed amounts of selected products and materials used in constructing or finishing residential surfaces (Tucker, 1991). Products used for floor surfaces include adhesive, varnish and wood stain; and materials used for walls include paneling, painted gypsum board, and wallpaper. Particleboard and chipboard are commonly used for interior furnishings such as shelves or cabinets, but could also be used for decking or underlayment. It should be noted that numbers presented in Table 19-9 for surface area are based on typical values for residences, and they are presented as examples. In contrast to the concept of loading ratios presented above (as a surface area), the numbers in Table 19-9 also are not scaled to any particular residential volume. In some cases, it may be preferable for the exposure assessor to use professional judgment in combination with the loading ratios given above. For example, if the exposure scenario involves residential carpeting, either as an indoor source or as an indoor sink, then the ASTM loading ratio of 0.43 m^2m^{-3} for floor materials could be multiplied by an assumed residential volume and assumed fractional coverage of carpeting to derive an estimate of the surface area. More specifically, a residence with a volume of 300 m^3, a loading ratio of 0.43 m^2m^{-3} and coverage of 80% would have 103 m^2 of carpeting. The estimates discussed here relate to macroscopic surfaces; the true surface area for carpeting, for example, would be considerably larger because of the nature of its fibrous material.

19.3.3 Mechanical System Configurations

Mechanical systems for air movement in residences can affect the migration and mixing of pollutants released indoors and the rate of pollutant removal. Three types of mechanical systems are: (1) systems associated with heating and air conditioning (HAC); (2) systems whose primary function is providing localized exhaust; and (3) systems intended to increase the overall air exchange rate of the residence.

Portable space heaters intended to serve a single room, or a series of adjacent rooms, may or may not be equipped with blowers that promote air movement and mixing. Without a blower, these heaters still have the ability to induce mixing through convective heat transfer. If the heater is a source of combustion pollutants, as with unvented gas or kerosene space heaters, then the combination of convective heat transfer and thermal buoyancy of combustion products will result in fairly rapid dispersal of such pollutants. The pollutants will disperse throughout the floor where the heater is located and to floors above the heater, but will not disperse to floors below.

Central forced-air HAC systems are common in many residences. Such systems, through a network of supply/return ducts and registers, can achieve fairly complete mixing within 20 to 30 minutes (Koontz et al., 1988). The air handler for such systems is commonly equipped with a filter (see Figure 19-3) that can remove particle-phase contaminants. Further removal of particles, via deposition on various room surfaces (see Section 19.4.4), is accomplished through increased air movement when the air handler is operating.

Figure 19-3 also distinguishes forced-air HAC systems by the return layout in relation to supply registers. The return layout shown in the upper portion of the figure is the type most commonly found in residential settings. On any floor of the residence, it is typical to find one or more supply registers to individual rooms, with one or two centralized return registers. With this layout, supply/return imbalances can often occur in individual rooms, particularly if the interior doors to rooms are closed. In comparison, the supply/return layout shown in the lower portion of the figure by design tends to achieve a balance in individual rooms or zones. Airflow imbalances can also be caused by inadvertent duct leakage to unconditioned spaces such as attics, basements, and crawl spaces. Such imbalances usually depressurize the house, thereby increasing the likelihood of contaminant entry via soil-gas transport or through spillage of combustion products from vented fossil-fuel appliances such as fireplaces and gas/oil furnaces.

Mechanical devices such as kitchen fans, bathroom fans, and clothes dryers are intended primarily to provide localized removal of unwanted heat, moisture, or odors. Operation of these devices tends to increase the air exchange rate between the indoors and outdoors. Because local exhaust devices are designed to be near certain indoor sources, their effective removal rate for locally generated pollutants is greater than would be expected from the dilution effect of increased air exchange. Operation of these devices also tends to depressurize the house, because replacement air usually is not provided to balance the exhausted air.

An alternative approach to pollutant removal is one which relies on an increase in air exchange to dilute pollutants generated indoors. This approach can be accomplished using heat recovery ventilators (HRVs) or energy recovery ventilators (ERVs). Both types of ventilators are designed to provide balanced supply and exhaust airflows and are intended to recover most of the energy that normally is lost when additional outdoor air is introduced. Although ventilators can provide for more rapid dilution of internally generated pollutants, they also increase the rate at which outdoor pollutants are brought into the house. A distinguishing feature of the two types is that ERVs provide for recovery of latent heat (moisture) in addition to sensible heat. Moreover, ERVs typically recover latent heat using a moisture-transfer device such as a desiccant wheel. It has been observed in some studies that the transfer of moisture between outbound and inbound air streams can result in some re-entrainment of indoor pollutants that otherwise would have been exhausted from the house (Andersson et al., 1993). Inadvertent air communication between the supply and exhaust air streams can have a similar effect.

Most homes in the U.S. have some kind of central heating and air conditioning system. Those with central air conditioning constitute 62% of the home in the U.S. (U.S. Census Bureau, 2008).

Studies quantifying the effect of mechanical devices on air exchange using tracer-gas measurements are uncommon and typically provide only anecdotal data. The common approach is for the expected increment in the air exchange rate to be estimated from the rated airflow capacity of the device(s). For example, if a device with a rated capacity of 100 cubic feet per minute (cfm), or 170 cubic meters per hour, is operated continuously in a house with a volume of 400 cubic meters, then the expected increment in the air exchange rate of the house would be 170 $m^3 h^{-1}$ / 400 m^3, or approximately 0.4 air changes per hour.

19.3.4 Type of Foundation

The type of foundation of a residence is of interest in residential exposure assessment. It provides some indication of the number of stories and house configuration, and provides an indication of the relative potential for soil-gas transport. For example, such transport can occur readily in homes with enclosed crawl spaces. Homes with basements provide some resistance, but still have numerous pathways for soil-gas entry. By comparison, homes with crawl spaces open to the outside have significant opportunities for dilution of soil gases prior to transport into the house. Using data from the 2007 AHS, of total housing units in the US, 32% have a basement under the entire building, 10% have a basement under part of the building, 24% have a crawl space, and 32% are on a concrete slab (U.S. DOE, 2005).

19.3.4.1 *Lucas et al., 1992 - National Residential Radon Survey*

The estimated percentage of homes with a full or partial basement according to the National Residential Radon Survey of 5,700 households nationwide was 45 percent (Table 9-10) (Lucas et al., 1992). The National Residential Radon Survey provides data for more refined geographical areas, with a breakdown by the 10 U.S. EPA Regions. The New England region (i.e., U.S. EPA Region 1), which includes Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont, had the highest prevalence of basements (93 percent). The lowest prevalence (4 percent) was for the South Central region (i.e., U.S. EPA Region 6), which includes Arkansas, Louisiana, New Mexico, Oklahoma, and Texas. Table 19-11 presents the States associated with each Census Region and U.S EPA Region.

19.3.4.2 *U.S. DOE (2005) - Housing Characteristics 2005 - Residential Energy Consumption Survey (RECS)*

The most recent RECS (described in Section 19.3.1) was administered in 2005 to over 4,381 households (U.S. DOE, 2005). The type of information requested by the survey questionnaire included the type of foundation for the residence (i.e., basement, enclosed crawl space, crawl space open to outside or concrete slab). This information was not obtained for multifamily structures with five or more dwelling units or for mobile homes. Table 19-12 presents estimates from the survey of the percentage of residences with each foundation type, by census region, and for the entire U.S. The percentages can add to more than 100 percent because some residences have more than one type of foundation; for example, most split-level structures have a partial basement combined with some crawlspace that typically is enclosed.

The data in Table 19-12 indicate that 40.5 percent of residences nationwide have a basement. It also shows that a large fraction of homes have concrete slabs (45.9 percent). There are also variations by census region. For example, around 70 percent of the residences in the Northeast and Midwest regions have basements. In the South and West regions, the predominant foundation type is concrete slab. Table 19-11 illustrates the four Census Regions.

19.4 TRANSPORT RATES STUDIES

19.4.1 Air Exchange Rates

Air exchange is the balanced flow into and out of a building, and is composed of three processes: (1) infiltration - air leakage through random cracks, interstices, and other unintentional openings in the building envelope; (2) natural ventilation - airflows through open windows, doors, and other designed openings in the building envelope; and (3) forced or mechanical ventilation - controlled air movement driven by fans. For nearly all indoor exposure scenarios, air exchange is treated as the principal means of diluting indoor concentrations. The air exchange rate is generally expressed in terms of air changes per hour (ACH, with units of h^{-1}), the ratio of the airflow ($m^3 h^{-1}$) to the volume (m^3).

No measurement surveys have been conducted to directly evaluate the range and distribution of residential air exchange rates. Although a significant number of air exchange measurements have been carried out over the years, there has been a diversity of protocols and study objectives. Since the early 1980s, however, an inexpensive perfluorocarbon tracer (PFT) technique has been used to measure time-averaged air exchange and interzonal airflows in thousands of occupied residences using essentially similar protocols (Dietz et al., 1986). The PFT technique utilizes miniature permeation tubes as tracer emitters and passive samplers to collect the tracers. The passive samplers are returned to the laboratory for analysis by gas chromatography. These measurement results have been compiled to allow various researchers to access the data (Versar, 1990).

19.4.1.1 *Nazaroff et al., 1988 - Radon Entry via Potable Water*

Nazaroff et al. (1988) aggregated the data from two studies conducted earlier using tracer-gas decay. At the time these studies were conducted, they were the largest U.S. studies to include air exchange measurements. The first (Grot and Clark, 1981) was conducted in 255 dwellings occupied by low-income families in 14 different cities. The geometric mean ± standard deviation for the air exchange measurements in these homes, with a median house age of 45 years, was 0.90 ± 2.13 ACH. The second study (Grimsrud et al., 1983) involved 312 newer residences, with a median age of less than 10 years. Based on measurements taken during the heating season, the geometric mean ± standard deviation for these homes was 0.53 ± 1.71 ACH. Based on an aggregation of the two distributions with proportional weighting by the respective number of houses studied, Nazaroff et al. (1988) developed an overall distribution with a geometric mean of 0.68 ACH and a geometric standard deviation of 2.01.

19.4.1.2 *Versar, 1990 - Database of PFT Ventilation Measurements*

The residences included in the PFT database do not constitute a random sample across the United States. They represent a compilation of homes visited in the course of about 100 separate field-research projects by various organizations, some of which involved random sampling and some of which involved judgmental or fortuitous sampling. The larger projects in the PFT database are summarized in Table 19-13, in terms of the number of measurements (samples), states where, and months when, samples were taken, and summary statistics for their respective distributions of measured air exchange rates. For selected projects (Lawrence Berkeley Laboratory, Research Triangle Institute - RTI, Southern California - SOCAL), multiple measurements were taken for the same house, usually during different seasons. A large majority of the measurements are from the SOCAL project that was conducted in Southern California. The means of the respective studies generally range from 0.2 to 1.0 ACH, with the exception of two California projects--RTI2 and SOCAL2. Both projects involved measurements in Southern California during a time of year (July) when windows would likely be opened by many occupants.

19.4.1.3 *Koontz and Rector, 1995 - Estimation of Distributions for Residential Air Exchange Rates*

In analyzing the composite data from various projects (2,971 measurements), Koontz and Rector (1995) assigned weights to the results from each state to compensate for the geographic imbalance in locations where PFT measurements were taken. The results were weighted in such a way that the resultant number of cases would represent each state in proportion to its share of occupied housing units, as determined from the 1990 U.S. Census of Population and Housing.

Summary statistics from the Koontz and Rector (1995) analysis are shown in Table 19-14, for the country as a whole and by census regions. Based on the statistics for all regions combined, the authors suggested that a 10th percentile value of 0.18 ACH would be appropriate as a conservative estimator for air exchange in residential settings, and that the 50th percentile value of 0.45 ACH would be appropriate as a typical air exchange rate. In applying conservative or typical values of air exchange rates, it is important to realize the limitations of the underlying data base. Although the estimates are based on thousands of measurements, the residences represented in the database are not a random sample of the United States housing stock. The sample population is not balanced in terms of geography or time of year. Statistical techniques were applied to compensate for some of these imbalances. In addition, PFT measurements of air exchange rates assume uniform mixing of the tracer within the building. This is not always so easily achieved. Furthermore, the degree of mixing can vary from day to day and house to house because of the nature of the factors controlling mixing (e.g., convective air monitoring driven by weather, and type and operation of the heating system). The relative placement of the PFT source and the sampler can also cause variability and uncertainty. It should be noted that sampling is typically done in a single location in a house which may not represent the average from that house. In addition, very high and very low values of air exchange rates based on PFT measurements have greater uncertainties than those in the middle of the distribution. Despite such limitations, the estimates in Table 19-14 are believed to represent the best available information on the distribution of air exchange rates across United States residences throughout the year.

19.4.1.4 *Murray and Burmaster, 1995 - Residential Air Exchange Rates in the United States: Empirical and Estimated Parametric Distributions by Season and Climatic Region*

Murray and Burmaster (1995) analyzed the PFT database using 2,844 measurements (essentially the same cases as analyzed by Koontz and Rector (1995), but without the compensating weights). These authors summarized distributions for subsets of the data defined by climate region and season. The coldest region was defined as having 7,000 or more heating degree days, the colder region as 5,500-6,999 degree days, the warmer region as 2,500-5,499 degree days, and the warmest region as fewer than 2,500 degree days. The months of December, January and February were defined as winter, March, April and May were defined as spring, and so on. The results of Murray and Burmaster (1995) are summarized in Table 19-15. Neglecting the summer results in the colder regions which have only a few observations, the results indicate that the highest air exchange rates occur in the warmest climate region during the summer. As noted earlier, many of the measurements in the warmer climate region were from field studies conducted in Southern California during a time of year (July) when windows would tend to be open in that area. Data for this region in particular should be used with caution since other areas within this region tend to have very hot summers and residences use air conditioners, resulting in lower air exchange rates. The lowest rates generally occur in the colder regions during the fall (Table 19-15).

19.4.2 Infiltration Models

A variety of mathematical models exist for prediction of air infiltration rates in individual buildings. A number of these models have been reviewed, for example, by Liddament and Allen (1983), and by Persily and Linteris (1984). Basic principles are concisely summarized in the ASHRAE Handbook of Fundamentals (ASHRAE, 1993). These models have a similar theoretical basis; all address indoor-outdoor pressure differences that are maintained by the actions of wind and stack (temperature difference) effects. The models generally incorporate a network of airflows where nodes representing regions of different pressure are interconnected by leakage paths. Individual models differ in details such as the number of nodes they can treat or the specifics of leakage paths (e.g., individual components such as cracks around doors or windows versus a combination of components such as an entire section of a building). Such models are not easily applied by exposure assessors, however, because the required inputs (e.g., inferred leakage areas, crack lengths) for the model are not easy to gather.

Another approach for estimating air infiltration rates is developing empirical models. Such models generally rely on collection of infiltration measurements in a specific building under a variety of weather conditions. The relationship between the infiltration rate and weather conditions can then be estimated through regression analysis, and is usually stated in the following form:

$$A = L\left(0.006\Delta T \frac{0.03}{C} U^{1.5}\right) \qquad \text{(Eqn 19-1)}$$

where:

A = air infiltration rate (h^{-1})
T_i = indoor temperature (°C)
T_o = outdoor temperature (°C)
U = windspeed (ms^{-1})
n is an exponent with a value typically between 1 and 2
a, b and c are parameters to be estimated

Relatively good predictive accuracy usually can be obtained for individual buildings through this approach. However, exposure assessors often do not have the information resources required to develop parameter estimates for making such predictions.

A reasonable compromise between the theoretical and empirical approaches has been developed in the model specified by Dietz et al. (1986). The model, drawn from correlation analysis of environmental measurements and air infiltration data, is formulated as follows

$$A = L\left(0.006\Delta T \frac{0.03}{C} U^{1.5}\right) \qquad \text{(Eqn 19-2)}$$

where:

A = average air changes per hour or infiltration rate, h-1
L = generalized house leakiness factor (1 < L < 5)
C = terrain sheltering factor (1 < C < 10)
ΔT = indoor-outdoor temperature difference (C°)
U = windspeed (ms-1)

The value of L is greater as house leakiness increases and the value of C is greater as terrain sheltering (reflects shielding of nearby wind barrier) increases. Although the above model has not been extensively validated, it has intuitive appeal and it is possible for the user to develop reasonable estimates for L and C with limited guidance. Historical data from various U.S. airports are available for estimation of the temperature and windspeed parameters. As an example application, consider a house that has central values of 3 and 5 for L and C, respectively. Under conditions where the indoor temperature is 20°C (68°F), the outdoor temperature is 0°C (32°F) and the windspeed is 5 ms^{-1}, the predicted infiltration rate for that house would be 3 (0.006 x 20 + 0.03/5 x 51.5), or 0.56 air changes per hour. This prediction applies under the condition that exterior doors and windows are closed, and does not include the contributions, if any, from mechanical systems (see Section 19.3.3). Occupant behavior, such as opening windows, can, of course, overwhelm the idealized effects of temperature and wind speed.

19.4.3 Deposition and Filtration

Deposition refers to the removal of airborne substances to available surfaces that occurs as a result of gravitational settling and diffusion, as well as electrophoresis and thermophoresis. Filtration is driven by similar processes, but is confined to material through which air passes. Filtration is usually a matter of design, whereas deposition is a matter of fact.

19.4.3.1 Deposition

The deposition of particulate matter and reactive gas-phase pollutants to indoor surfaces is often stated in terms of a characteristic deposition velocity ($m\ h^{-1}$) allied to the surface-to-volume ratio ($m^2\ m^{-3}$) of the building or room interior, forming a first order loss rate (h^{-1}) similar to that of air exchange. Theoretical considerations specific to indoor environments have been summarized in comprehensive reviews by Nazaroff and Cass (1989) and Nazaroff et al. (1993).

For airborne particles, deposition rates depend on aerosol properties (size, shape, density) as well as room factors (thermal gradients, turbulence, surface geometry). The motions of larger particles are dominated by gravitational settling; the motions of smaller particles are subject to convection and diffusion. Consequently, larger particles tend to accumulate more rapidly on floors and up-facing surfaces while smaller particles may accumulate on surfaces facing in any direction. Figure 19-4 illustrates the general trend for particle deposition across the size range of general concern for inhalation exposure (<10 µm). The current thought is that theoretical calculations of deposition rates are likely to provide unsatisfactory results due to knowledge gaps relating to near-surface air motions and other sources of inhomogeneity (Nazaroff et al., 1993).

19.4.3.1.1 *Thatcher and Layton, 1995 - Deposition, Resuspension, and Penetration of Particles Within a Residence*

Thatcher and Layton (1995) evaluated removal rates for indoor particles in four size ranges (1-5, 5-10, 10-25, and >25 µm) in a study of one house occupied by a family of four. These values are listed in Table 19-16. In a subsequent evaluation of data collected in 100 Dutch residences, Layton and Thatcher (1995) estimated settling velocities of 2.7 m h^{-1} for lead-bearing particles captured in total suspended particulate matter (TSP) samples.

19.4.3.1.2 *Wallace, 1996 - Indoor Particles: A Review*

In a major review of indoor particles, Wallace (1996) cited overall particle deposition rates for respirable ($PM_{2.5}$), inhalable (PM_{10}), and coarse (difference between PM_{10} and $PM_{2.5}$) size fractions determined from U.S. EPA's PTEAM study. These values, listed in Table 19-17, were derived from measurements conducted in nearly 200 residences.

19.4.3.2 Filtration

A variety of air cleaning techniques have been applied to residential settings. Basic principles related to residential-scale air cleaning technologies have been summarized in conjunction with reporting early test results (Offerman et al., 1984). General engineering principles are summarized in ASHRAE (1988). In addition to fibrous filters integrated into central heating and air conditioning systems, extended surface filters and High Efficiency Particle Arrest (HEPA) filters as well as electrostatic systems are available to increase removal efficiency. Free-standing air cleaners (portable and/or console) are also being used. Product-by-product test results reported by Hanley et al. (1994); Shaughnessy et al. (1994); and Offerman et al. (1984) exhibit considerable variability across systems, ranging from ineffectual (< 1% efficiency) to nearly complete removal.

19.4.4 Interzonal Airflows

Residential structures consist of a number of rooms that may be connected horizontally, vertically, or both horizontally and vertically. Before considering residential structures as a detailed network of rooms, it is convenient to divide them into one or more zones. At a minimum, each floor is typically defined as a separate zone. For indoor air exposure assessments, further divisions are sometimes made within a floor, depending on (1) locations of specific contaminant sources and (2) the presumed degree of air communication among areas with and without sources.

Defining the airflow balance for a multiple-zone exposure scenario rapidly increases the information requirements as rooms or zones are added. As shown in Figure 19-5, a single-zone system (considering the entire building as a single well-mixed volume) requires only two airflows to define air exchange. Further, because air exchange is balanced flow (air does not "pile up" in the building, nor is a vacuum formed), only one number (the air exchange rate) is needed. With two zones, six airflows are needed to accommodate interzonal airflows plus air exchange; with three zones, twelve airflows are required. In some cases, the complexity can be reduced using judicious (if not convenient) assumptions. Interzonal airflows connecting nonadjacent rooms can be set to zero, for example, if flow pathways do not exist. Symmetry also can be applied to the system by assuming that each flow pair is balanced.

19.4.5 House Dust and Soil Loadings

House dust is a complex mixture of biologically-derived material (animal dander, fungal spores, etc.), particulate matter deposited from the indoor aerosol, and soil particles brought in by foot traffic. House dust may contain VOCs (see, for example, Wolkoff and Wilkins, 1994; Hirvonen et al., 1995), pesticides from imported soil particles as well as from direct applications indoors (see, for example, Roberts et al., 1991), and trace metals derived from outdoor sources (see, for example, Layton and Thatcher, 1995). The indoor abundance of house dust depends on the interplay of deposition from the airborne state, resuspension due to various activities, direct accumulation, and infiltration.

In the absence of indoor sources, indoor concentrations of particulate matter are significantly lower than outdoor levels. For some time, this observation supported the idea that a significant fraction of the outdoor aerosol is filtered out by the building envelope. More recent data, however, have shown that deposition (incompletely addressed in earlier studies) accounts for the indoor-outdoor contrast, and outdoor particles smaller than 10 µm aerodynamic diameter penetrate the building envelope as completely as nonreactive gases (Wallace, 1996).

19.4.5.1 *Roberts et al., 1991 - Development and Field Testing of a High Volume Sampler for Pesticides and Toxics in Dust*

Dust loadings, reported by Roberts et al. (1991) were also measured in conjunction with the Non-Occupational Pesticide Exposure Study (NOPES). In this study house dust was sampled from a representative grid using a specially constructed high-volume surface sampler (HVS2). The surface sampler collection efficiency was verified in conformance with ASTM F608 (ASTM, 1989). The data summarized in Table 19-18 were collected from carpeted areas in volunteer households in Florida encountered during the course of NOPES. Seven of the nine sites were single-family detached homes, and two were mobile homes. The authors noted that the two houses exhibiting the highest dust loadings were only those homes where a vacuum cleaner was not used for housekeeping.

19.4.5.2 *Thatcher and Layton, 1995 - Deposition, Resuspension and Penetration of Particles Within a Residence*

Relatively few studies have been conducted at the level of detail needed to clarify the dynamics of indoor aerosols. One intensive study of a California residence (Thatcher and Layton, 1995), however, provides instructive results. Using a model-based analysis for data collected under controlled circumstances, the investigators verified penetration of the outdoor aerosol and estimated rates for particle deposition and resuspension (Table 19-19). The investigators stressed that normal household activities are a significant source of airborne particles larger than 5 µm. During the study, they observed that just walking into and out of a room could momentarily double the concentration. The airborne abundance of submicrometer particles, on the other hand, was unaffected by either cleaning or walking.

Mass loading of floor surfaces (Table 19-20) was measured in the study of Thatcher and Layton (1995) by thoroughly cleaning the house and sampling accumulated dust, after one week of normal habitation. Methodology, validated under ASTM F608 (ASTM, 1989), showed fine dust recovery efficiencies of 50 percent with new carpet and 72 percent for linoleum. Tracked areas showed consistently higher accumulations than untracked areas, confirming the importance of tracked-in material. Differences between tracked areas upstairs and downstairs show that tracked-in material is not readily transported upstairs. The consistency of untracked carpeted areas throughout the house, suggests that, in the absence of tracking, particle transport processes are similar on both floors.

19.5 SOURCES

Product- and chemical-specific mechanisms for indoor sources can be described using simple emission factors to represent instantaneous releases, as well as constant releases over defined time periods; more complex formulations may be required for time-varying sources. Guidance documents for characterizing indoor sources within the context of the exposure assessment process are limited (see, for example, Jennings et al., 1987; Wolkoff, 1995). Fairly extensive guidance exists in the technical literature, however, provided that the exposure assessor has the means to define (or estimate) key mechanisms and chemical-specific parameters. Basic concepts are summarized below for the broad source categories that relate to airborne contaminants, waterborne contaminants, and for soil/house dust indoor sources.

19.5.1 Source Descriptions for Airborne Contaminants

Table 19-21 summarizes simplified indoor source descriptions for airborne chemicals for direct discharge sources (e.g., combustion, pressurized propellant products), as well as emanation sources (e.g., evaporation from "wet" films, diffusion from porous media), and transport-related sources (e.g., infiltration of outdoor air contaminants, soil gas entry).

Direct-discharge sources can be approximated using simple formulas that relate pollutant mass released to characteristic process rates. Combustion sources, for example, may be stated in terms of an emission factor, fuel content (or heating value), and fuel consumption (or carrier delivery) rate. Emission factors for combustion products of general concern (e.g., CO, NO_x) have been measured for a number of combustion appliances using room-sized chambers (see, for example, Relwani et al., 1986). Other direct-discharge sources would include volatiles released from water use and from pressurized consumer products. Resuspension of house dust (see Section 19.4.3.1) would take on a similar form by combining an activity-specific rate constant with an applicable dust mass.

Diffusion-limited sources (e.g., carpet backing, furniture, flooring, dried paint) represent probably the greatest challenge in source characterization for indoor air quality. Vapor-phase organics dominate this group, offering great complexity because (1) there is a fairly long list of chemicals that could be of concern, (2) ubiquitous consumer products, building materials, coatings, and furnishings contain varying amounts of different chemicals, (3) source dynamics may include nonlinear mechanisms, and (4) for many of the chemicals, emitting as well as non-emitting materials evident in realistic settings may promote reversible and irreversible sink effects. Very detailed descriptions for diffusion-limited sources can be constructed to link specific properties of the chemical, the source material, and the receiving environment to calculate expected behavior (see, for example, Schwope et al., 1992; Cussler, 1984). Validation to actual circumstances, however, suffers practical shortfalls because many parameters simply cannot be measured directly.

The exponential formulation listed in Table 19-32 was derived based on a series of papers generated during the development of chamber testing methodology by U.S. EPA (Dunn, 1987; Dunn and Tichenor, 1988; Dunn and Chen, 1993). This framework represents an empirical alternative that works best when the results of chamber tests are available. Estimates for the initial emission rate (E_o) and decay factor (k_s) can be developed for hypothetical sources from information on pollutant mass available for release (M) and supporting assumptions.

Assuming that a critical time period (t_c) coincides with reduction of the emission rate to a critical level (E_c) or with the release of a critical fraction of the total mass (M_c), the decay factor can be estimated by solving either of these relationships:

$$\frac{E_c}{E_0} e^{k_s\ t_c} \text{ or } \frac{M_c}{M} e^{k_s\ t_c} \qquad \text{(Eqn 19-3)}$$

The critical time period can be derived from product-specific considerations (e.g., equating drying time for a paint to 90 percent emissions reduction). Given such an estimate for k_s, the initial emission rate can be estimated by integrating the emission formula to infinite time under the assumption that all chemical mass is released:

$$M\int_0^\infty E_0\, e^{k_s t} dt \; \frac{E_0}{k_s} \qquad \text{(Eqn 19-4)}$$

The basis for the exponential source algorithm has also been extended to the description of more complex diffusion-limited sources. With these sources, diffusive or evaporative transport at the interface may be much more rapid than diffusive transport from within the source material, so that the abundance at the source/air interface becomes depleted, limiting the transfer rate to the air. Such effects can prevail with skin formation in "wet" sources like stains and paints (see, for example, Chang and Guo, 1992). Similar emission profiles have been observed with the emanation of formaldehyde from particleboard with "rapid" decline as formaldehyde evaporates from surface sites of the particleboard over the first few weeks. It is then followed by a much slower decline over ensuing years as formaldehyde diffuses from within the matrix to reach the surface (see, for example, Zinn et al., 1990).

Transport-based sources bring contaminated air from other areas into the airspace of concern. Examples include infiltration of outdoor contaminants, and soil gas entry. Soil gas entry is a particularly complex phenomenon, and is frequently treated as a separate modeling issue (Little et al., 1992; Sextro, 1994). Room-to-room migration of indoor contaminants would also fall under this category, but this concept is best considered using the multiple-zone model.

19.5.2 Source Descriptions for Waterborne Contaminants

Residential water supplies may convey chemicals to which occupants can be exposed through ingestion, dermal contact, or inhalation. These chemicals may appear in the form of contaminants (e.g., trichloroethylene) as well as naturally-occurring byproducts of water system history (e.g., chloroform, radon). Among indoor water uses, showering, bathing and handwashing of dishes or clothes provide the primary opportunities for dermal exposure. The escape of volatile chemicals to the gas phase associates water use with inhalation exposure. The exposure potential for a given situation will depend on the source of water, the types and extents of water uses, and the extent of volatilization of specific chemicals. Primary types of residential water use (summarized in Section 19.4.5) include showering/bathing, toilet use, clothes washing, dishwashing, and faucet use (e.g., for drinking, cooking, general cleaning, or washing hands).

Upper-bounding estimates of chemical release rates from water use can be formulated as simple emission factors by combining the concentration in the feed water (g m^{-3}) with the flow rate for the water use (m^3 h^{-1}), and assuming that the chemical escapes to the gas phase. For some chemicals, however, not all of the chemical escapes in realistic situations due to diffusion-limited transport and solubility factors. For inhalation exposure estimates, this may not pose a problem because the bounding estimate would overestimate emissions by no more than approximately a factor of two. For multiple exposure pathways, the chemical mass remaining in the water may be of importance. Refined estimates of volatile emissions are usually considered under two-resistance theory to accommodate mass transport aspects of the water-air system (see, for example, U.S. EPA 2000; Howard et al., 1999; Moya, 1999; Little, 1992; Andelman, 1990; McKone, 1987). More detailed descriptions of models used to estimate emissions from indoor water sources including shower, bathtub, dishwasher and washing machines are included in U.S. EPA 2000. Release rates are formulated as:

$$S = K_m F_w \left[C_w \frac{C_a}{H} \right] \qquad \text{(Eqn 19-5)}$$

where:

S = chemical release rate (g h^{-1})
K_m = dimensionless mass-transfer coefficient
F_w = water flow rate (m^3 h^{-1})
C_w = concentration in feed water (g m^{-3})
C_a = concentration in air (g m^{-3})
H = dimensionless Henry's Law constant

Because the emission rate is dependent on the air concentration, recursive techniques are required. The mass transfer coefficient is a function of water use characteristics (e.g., water droplet size spectrum, fall distance, water film) and chemical properties (diffusion in gas and liquid phases).

Estimates of practical value are based on empirical tests to incorporate system characteristics into a single parameter (see, for example, Giardino et al., 1990). Once characteristics of one chemical-water use system are known (reference chemical, subscript r), the mass transfer coefficient for another chemical (index chemical, subscript i) delivered by the same system can be estimated using formulations identified in the review by Little (1992):

$$\frac{1}{K}\left(\frac{D_{Li}}{D_{Lr}}\right)^{1/2} = \frac{1}{K_{Lr}}\frac{1}{K_{Gr}}\frac{1}{H}\left(\frac{D_{Gr}}{D_{Gi}}\right)^{2/3}\left(\frac{D_{Li}}{D_{Lr}}\right)^{1/2} \quad \text{(Eqn 19-6)}$$

where:

D_L = liquid diffusivity (m^2 s^{-1})
D_G = gas diffusivity (m^2 s^{-1})
K_L = liquid-phase mass transfer coefficient
K_G = gas-phase mass transfer coefficient
H = dimensionless Henry's Law constant

19.5.3 Soil and House Dust Sources

The rate process descriptions compiled for soil and house dust in Section 19.5.3 provide inputs for estimating indoor emission rates (S_d, g h^{-1}) in terms of dust mass loading (M_d, g m^{-2}) combined with resuspension rates (R_d, h^{-1}) and floor area (A_f, m^2):

$$S^d = M_d R_d A_f \quad \text{(Eqn 19-7)}$$

Because house dust is a complex mixture, transfer of particle-bound constituents to the gas phase may be of concern for some exposure assessments. For emission estimates, one would then need to consider particle mass residing in each reservoir (dust deposit, airborne).

19.6 ADVANCED CONCEPTS

19.6.1 Uniform Mixing Assumption

Many exposure measurements are predicated on the assumption of uniform mixing within a room or zone of a house. Mage and Ott (1994) offers an extensive review of the history of use and misuse of the concept. Experimental work by Baughman et al. (1994) and Drescher et al. (1995) indicates that, for an instantaneous release from a point source in a room, fairly complete mixing is achieved within 10 minutes when convective flow is induced by solar radiation. However, up to 100 minutes may be required for complete mixing under quiescent (nearly isothermal) conditions. While these experiments were conducted at extremely low air exchange rates (<0.1 ACH), based on the results, attention is focused on mixing within a room.

The situation changes if a human invokes a point source for a longer period and remains in the immediate vicinity of that source. Personal exposure in the near vicinity of a source can be much higher than the well-mixed assumption would suggest. A series of experiments conducted by GEOMET (1989) for the U.S. EPA involved controlled point-source releases of carbon monoxide tracer (CO), each for 30 minutes. "Breathing-zone" measurements located within 0.4 m of the release point were ten times higher than for other locations in the room during early stages of mixing and transport.

Similar investigations conducted by Furtaw et al. (1995) involved a series of experiments in a controlled-environment room-sized chamber. Furtaw et al. (1995) studied spatial concentration gradients around a continuous point source simulated by sulfur hexafluoride (SF_6) tracer with a human moving about the room. Average breathing-zone concentrations when the subject was near the source exceeded those several meters away by a factor that varied inversely with the ventilation intensity in the room. At typical room ventilation rates, the ratio of source-proximate to slightly-removed concentration was on the order of 2:1.

19.6.2 Reversible Sinks

For some chemicals, the actions of reversible sinks are of concern. For an initially "clean" condition in the sink material, sorption effects can greatly deplete indoor concentrations. However, once enough of the chemical has been adsorbed, the diffusion gradient will reverse, allowing the chemical to escape. For persistent indoor sources, such effects can serve to reduce indoor levels initially but once the system equilibrates, the net effect on the average concentration of the reversible sink is negligible. Over suitably short time frames, this can also affect integrated exposure. For indoor sources whose emission profile declines with time (or ends abruptly), reversible sinks can serve to extend the emissions period as the chemical desorbs long after direct emissions are finished. Reversible sink effects have been observed for a number of chemicals in the presence of carpeting, wall coverings, and other materials commonly found in residential environments.

Interactive sinks (and models of the processes) are of a special importance; while sink effects can greatly reduce indoor air concentrations, re-emission at lower rates over longer time periods could greatly extend the exposure period of concern. For completely reversible sinks, the extended time could bring the cumulative exposure to levels approaching the sink-free case. Recent publications (Axley et al., 1993; Tichenor et al., 1991) show that first principles provide useful guidance in postulating models and setting assumptions for reversible-irreversible sink models. Sorption/desorption can be described in terms of Langmuir (monolayer) as well as Brunauer-Emmet-Teller (BET, multilayer) adsorption.

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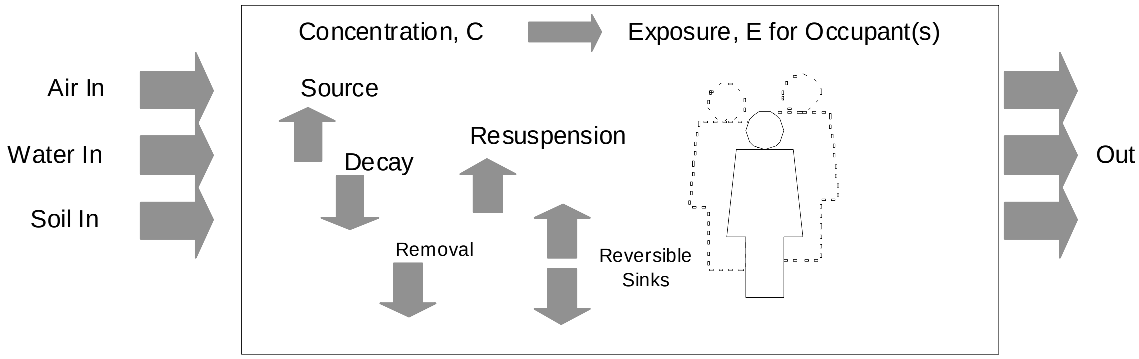

Figure 19-1. Elements of Residential Exposure

Table 19-4. Summary of Residential Volume Distributions in Cubic Meters[a]		
Parameter	RECS Data (1)	PFT Database (2)
Arithmetic Mean	369	369
Standard Deviation	258	209
10th Percentile	147	167
25th Percentile	209	225
50th Percentile	310	321
75th Percentile	476	473
90th Percentile	672	575

[a] In cubic meters.

Sources: (1) Thompson, 1995; (2) Versar, 1990.

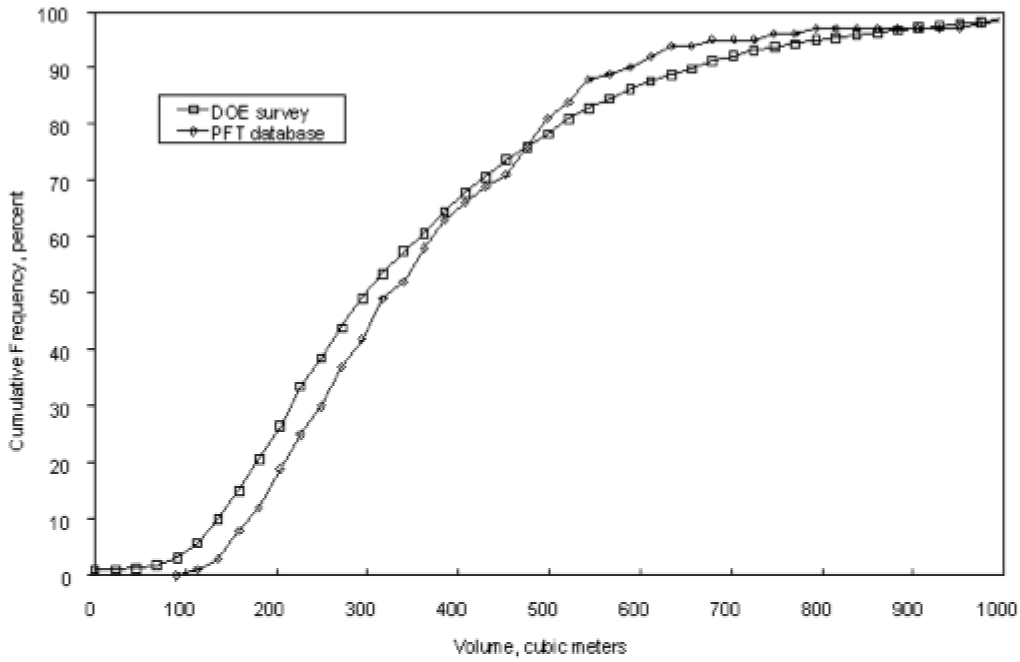

Figure 19-2. Cumulative Frequency Distributions for Residential Volumes

Table 19-5. Average Estimated Volumes of U.S. Residences, by Housing Type and Ownership

	Ownership					
	Owner-Occupied		Rental		All Units	
Housing Type	Volume[a] (m^3)	Percent of Total	Volume[a] (m^3)	Percent Of Total	Volume[a] (m^3)	Percent of Total
Single-Family (Detached)	637	64.1	449	7.2	616	64.9
Single-Family (Attached)	544	4.2	313	3.1	440	6.8
Multifamily (2-4 units)	363	1.8	211	5.3	247	7.0
Multifamily (5+ Units)	253	2.3	189	13.0	198	15.0
Mobile Home	249	5.7	196	1.1	240	6.2
All Types	586	78.1	269	29.7	492	100.0

[a] Volumes calculated from floor areas assuming a ceiling height of 8 feet. Excludes floorspace in unheated garages. The total average square footage per housing unit for the 2001 RECS was reported as 1,975 square feet. This figure excluded unheated garages and for most housing units, living space in attics. The average total square footage for housing units in the 2005 RECS, reported in this table is 2,171 square feet, includes attic living space for all housing units. The only available figures that permit comparison of total square footage for both survey years would exclude all garage floorspace and attic floorspace in all housing units--for 2001 the total square footage was 2,005 and for 2005 the total was 2,029 square feet.

Source: Adapted from U.S. DOE, 2005.

Table 19-6. Residential Volumes in Relation to Year of Construction

	Volume[a] (m^3)	Percent of Total
Year of Construction		
Before 1940	527	13.2
1940 to 1949	464	6.7
1950 to 1959	465	11.3
1960 to 1969	446	11.3
1970 to 1979	422	17.0
1980 to 1989	451	16.7
1990 to 1999	567	15.6
2000 to 2005	640	8.3
All Years	492	100.0

[a] Volumes calculated from floor areas assuming a ceiling height of 8 feet. Excludes floorspace in unheated garages. The total average square footage per housing unit for the 2001 RECS was reported as 1,975 square feet. This figure excluded unheated garages and for most housing units, living space in attics. The average total square footage for housing units in the 2005 RECS, reported in this table is 2,171 square feet, includes attic living space for all housing units. The only available figures that permit comparison of total square footage for both survey years would exclude all garage floorspace and attic floorspace in all housing units--for 2001 the total square footage was 2,005 and for 2005 the total was 2,029 square feet.

Source: U.S. DOE, 2005.

Table 19-7. Number of Residential Single Detached and Manufactured/mobile Homes by Volume

Housing Units	Total housing units	Seasonal	Year-round: Total	Year-round: Owner occupied	Year-round: Renter occupied	New units in last 4 years	Manufactured/ mobile homes
Total all housing units	128,203	4,402	123,801	75,647	35,045	7,188	8,705
Total single detached and manufactured/mobile homes	89,111	3,384	85,727	67,931	10,423	5,485	8,705
Less than 113.3 m^3	1,004	232	773	361	269	34	344
113.3 to 169.7 m^3	2,725	510	2,215	1,108	712	27	973
169.9 to 226.3 m^3	6,443	602	5,841	3,605	1,466	95	1,830
226.5 to 339.6 m^3	20,725	711	20,015	14,864	3,305	570	2,661
339.8 to 452.8 m^3	20,061	457	19,604	16,220	1,973	1,107	1,138
453.1 to 566.1 m^3	13,960	260	13,700	11,957	914	1,137	280
566.3 to 679.4 m^3	7,320	108	7,212	6,438	320	714	103
679.6 to 905.9 m^3	6,845	103	6,742	6,028	271	820	47
906 or more m^3	4,285	68	4,217	3,708	212	546	138
Not reported (includes don't know)	5,742	334	5,409	3,642	981	434	1,193
Median	400.7	255.5	405.3	425.0	304.5	521.9	252.6

Source: American Housing Survey (2007) (converted from ft^2, assumes 8 foot ceiling).

Table 19-8. Dimensional Quantities for Residential Rooms

Nominal Dimensions	Length (m)	Width (m)	Height (m)	Volume (m^3)	Wall Area (m^2)	Floor Area (m^2)	Total Area (m^2)
Eight Foot Ceiling							
12'x15'	4.6	3.7	2.4	41	40	17	74
12'x12'	3.7	3.7	2.4	33	36	13	62
10'x12'	3.0	3.7	2.4	27	33	11	55
9'x12'	2.7	3.7	2.4	24	31	10	51
6'x12'	1.8	3.7	2.4	16	27	7	40
4'x12'	1.2	3.7	2.4	11	24	4	32
Twelve Foot Ceiling							
12'x15'	4.6	3.7	3.7	61	60	17	94
12'x12'	3.7	3.7	3.7	49	54	13	80
10'x12'	3.0	3.7	3.7	41	49	11	71
9'x12'	2.7	3.7	3.7	37	47	10	67
6'x12'	1.8	3.7	3.7	24	40	7	54
4'x12'	1.2	3.7	3.7	16	36	4	44

Table 19-9. Examples of Products and Materials Associated with Floor and Wall Surfaces in Residences

Material Sources	Assumed Amount of Surface Covered[a]
Silicone caulk	0.2 m^2
Floor adhesive	10.0 m^2
Floor wax	50.0 m^2
Wood stain	10.0 m^2
Polyurethane wood finish	10.0 m^2
Floor varnish or lacquer	50.0 m^2
Plywood paneling	100.0 m^2
Chipboard	100.0 m^2
Gypsum board	100.0 m^2
Wallpaper	100.0 m^2

[a] Based on typical values for a residence.

Source: Adapted from Tucker, 1991.

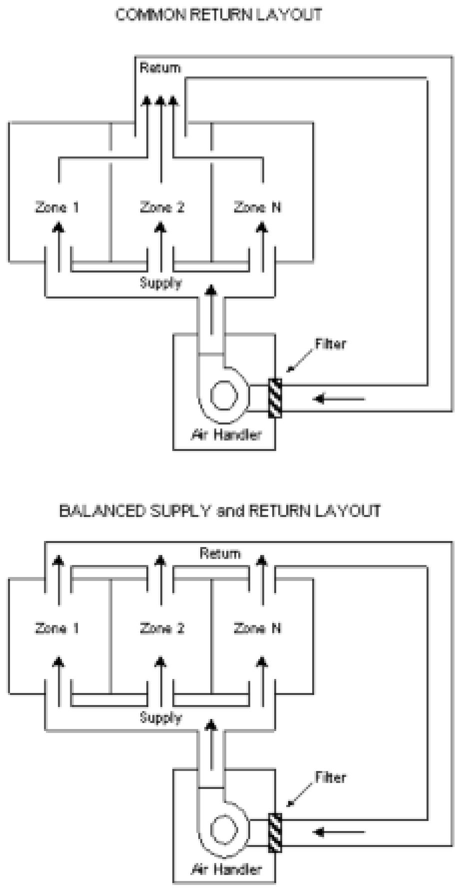

Figure 19-3. Configuration for Residential Forced-air Systems

Table 19-10. Percent of Residences with Basement, by Census Region and U.S. EPA Region

Census Region	U.S. EPA Region	Percent of Residences with Basements
Northeast	1	93.4
Northeast	2	55.9
Northeast	3	67.9
South	4	19.3
Midwest	5	73.5
South	6	4.1
Midwest	7	75.3
West	8	68.5
West	9	10.3
West	10	11.5
	All Regions	45.2

Source: Lucas et al., 1992.

Table 19-11. States Associated with U.S. EPA Regions and Census Regions

U.S. EPA Regions			
Region 1	Region 4	Region 6	Region 9
Connecticut	Alabama	Arkansas	Arizona
Maine	Florida	Louisiana	California
Massachusetts	Georgia	New Mexico	Hawaii
New Hampshire	Kentucky	Oklahoma	Nevada
Rhode Island	Mississippi	Texas	
Vermont	North Carolina		Region 10
	South Carolina	Region 7	Alaska
Region 2	Tennessee	Iowa	Idaho
New Jersey		Kansas	Oregon
New York	Region 5	Missouri	Washington
	Illinois	Nebraska	
Region 3	Indiana		
Delaware	Michigan	Region 8	
District of Columbia	Minnesota	Colorado	
Maryland	Ohio	Montana	
Pennsylvania	Wisconsin	North Dakota	
Virginia		South Dakota	
West Virginia		Utah	
		Wyoming	
US Bureau of Census Regions			
Northeast Region	Midwest Region	South Region	West Region
Connecticut	Illinois	Alabama	Alaska
Maine	Indiana	Arkansas	Arizona
Massachusetts	Iowa	Delaware	California
New Hampshire	Kansas	District of Columbia	Colorado
New Jersey	Michigan	Florida	Hawaii
New York	Minnesota	Georgia	Idaho
Pennsylvania	Missouri	Kentucky	Montana
Rhode island	Nebraska	Louisiana	Nevada
Vermont	North Dakota	Maryland	New Mexico
	Ohio	Mississippi	Oregon
	South Dakota	North Carolina	Utah
	Wisconsin	Oklahoma	Washington
		South Carolina	Wyoming
		Tennessee	
		Texas	
		Virginia	
		West Virginia	

Table 19-12. Percent of Residences with Certain Foundation Types by Census Region			
Census Region	Percent of Residences[a]		
	With Basement	With Crawlspace	With Concrete Slab
Northeast	73.1	18.8	24.4
Midwest	67.7	27.2	30.4
South	19.0	29.6	58.5
West	17.2	37.1	61.8
All Regions	40.5	28.7	45.9

[a] Percentage may add to more than 100 percent because more than one foundation type may apply to a given residence.

Source: U.S. DOE, 2005.

Table 19-13. Summary of Major Projects Providing Air Exchange Measurements in the PFT Database

Project Code	State	Month(s)[a]	Number of Measurements	Mean Air Exchange Rate	SD[b]	Percentiles				
						10th	25th	50th	75th	90th
ADM	CA	5-7	29	0.70	0.52	0.29	0.36	0.48	0.81	1.75
BSG	CA	1,8-12	40	0.53	0.30	0.21	0.30	0.40	0.70	0.90
GSS	AZ	1-3,8-9	25	0.39	0.21	0.16	0.23	0.33	0.49	0.77
FLEMING	NY	1-6,8-12	56	0.24	0.28	0.05	0.12	0.22	0.29	0.37
GEOMET1	FL	1,6-8,10-12	18	0.31	0.16	0.15	0.18	0.25	0.48	0.60
GEOMET2	MD	1-6	23	0.59	0.34	0.12	0.29	0.65	0.83	0.92
GEOMET3	TX	1-3	42	0.87	0.59	0.33	0.51	0.71	1.09	1.58
LAMBERT1	ID	2-3,10-11	36	0.25	0.13	0.10	0.17	0.23	0.33	0.49
LAMBERT2	MT	1-3,11	51	0.23	0.15	0.10	0.14	0.19	0.26	0.38
LAMBERT3	OR	1-3,10-12	83	0.46	0.40	0.19	0.26	0.38	0.56	0.80
LAMBERT4	WA	1-3,10-12	114	0.30	0.15	0.14	0.20	0.30	0.39	0.50
LBL1	OR	1-4,10-12	126	0.56	0.37	0.28	0.35	0.45	0.60	1.02
LBL2	WA	1-4,10-12	71	0.36	0.19	0.18	0.25	0.32	0.42	0.52
LBL3	ID	1-5,11-12	23	1.03	0.47	0.37	0.73	0.99	1.34	1.76
LBL4	WA	1-4,11-12	29	0.39	0.27	0.14	0.18	0.36	0.47	0.63
LBL5	WA	2-4	21	0.36	0.21	0.13	0.19	0.30	0.47	0.62
LBL6	ID	3-4	19	0.28	0.14	0.11	0.17	0.26	0.38	0.55
NAHB	MN	1-5,9-12	28	0.22	0.11	0.11	0.16	0.20	0.24	0.38
NYSDH	NY	1-2,4,12	74	0.59	0.37	0.28	0.37	0.50	0.68	1.07
PEI	MD	3-4	140	0.59	0.45	0.15	0.26	0.49	0.83	1.20
PIERCE	CT	1-3	25	0.80	1.14	0.20	0.22	0.38	0.77	2.35
RTI1	CA	2	45	0.90	0.73	0.38	0.48	0.78	1.08	1.52
RTI2	CA	7	41	2.77	2.12	0.79	1.18	2.31	3.59	5.89
RTI3	NY	1-4	397	0.55	0.37	0.26	0.33	0.44	0.63	0.94
SOCAL1	CA	3	551	0.81	0.66	0.29	0.44	0.66	0.94	1.43
SOCAL2	CA	7	408	1.51	1.48	0.35	0.59	1.08	1.90	3.11
SOCAL3	CA	1	330	0.76	1.76	0.26	0.37	0.48	0.75	1.11
UMINN	MN	1-4	35	0.36	0.32	0.17	0.20	0.28	0.40	0.56
UWISC	WI	2-5	57	0.82	0.76	0.22	0.33	0.55	1.04	1.87

[a] 1 = January, 2 = February, etc.
[b] Standard deviation

Source: Adapted from Versar, 1990.

Table 19-14. Summary Statistics for Air Exchange Rates (air changes per hour-ACH), by Region					
	West Region	North Central Region	Northeast Region	South Region	All Regions
Arithmetic Mean	0.66	0.57	0.71	0.61	0.63
Arithmetic Standard Deviation	0.87	0.63	0.60	0.51	0.65
Geometric Mean	0.47	0.39	0.54	0.46	0.46
Geometric Standard Deviation	2.11	2.36	2.14	2.28	2.25
10th Percentile	0.20	0.16	0.23	0.16	0.18
50th Percentile	0.43	0.35	0.49	0.49	0.45
90th Percentile	1.25	1.49	1.33	1.21	1.26
Maximum	23.32	4.52	5.49	3.44	23.32

Source: Koontz and Rector, 1995.

Table 19-15. Distributions of Residential Air Exchange Rates[a] by Climate Region and Season

Climate Region	Season	Sample Size	Arithmetic Mean	Standard Deviation	Percentiles				
					10th	25th	50th	75th	90th
Coldest	Winter	161	0.36	0.28	0.11	0.18	0.27	0.48	0.71
	Spring	254	0.44	0.31	0.18	0.24	0.36	0.53	0.80
	Summer	5	0.82	0.69	0.27	0.41	0.57	1.08	2.01
	Fall	47	0.25	0.12	0.10	0.15	0.22	0.34	0.42
Colder	Winter	428	0.57	0.43	0.21	0.30	0.42	0.69	1.18
	Spring	43	0.52	0.91	0.13	0.21	0.24	0.39	0.83
	Summer	2	1.31	-	-	-	-	-	-
	Fall	23	0.35	0.18	0.15	0.22	0.33	0.41	0.59
Warmer	Winter	96	0.47	0.40	0.19	0.26	0.39	0.58	0.78
	Spring	165	0.59	0.43	0.18	0.28	0.48	0.82	1.11
	Summer	34	0.68	0.50	0.27	0.36	0.51	0.83	1.30
	Fall	37	0.51	0.25	0.30	0.30	0.44	0.60	0.82
Warmest	Winter	454	0.63	0.52	0.24	0.34	0.48	0.78	1.13
	Spring	589	0.77	0.62	0.28	0.42	0.63	0.92	1.42
	Summer	488	1.57	1.56	0.33	0.58	1.10	1.98	3.28
	Fall	18	0.72	1.43	0.22	0.25	0.42	0.46	0.74

[a] In air changes per hour

\- Few oberservations for summer results in colder regions. Data not available.

Source: Murray and Burmaster, 1995.

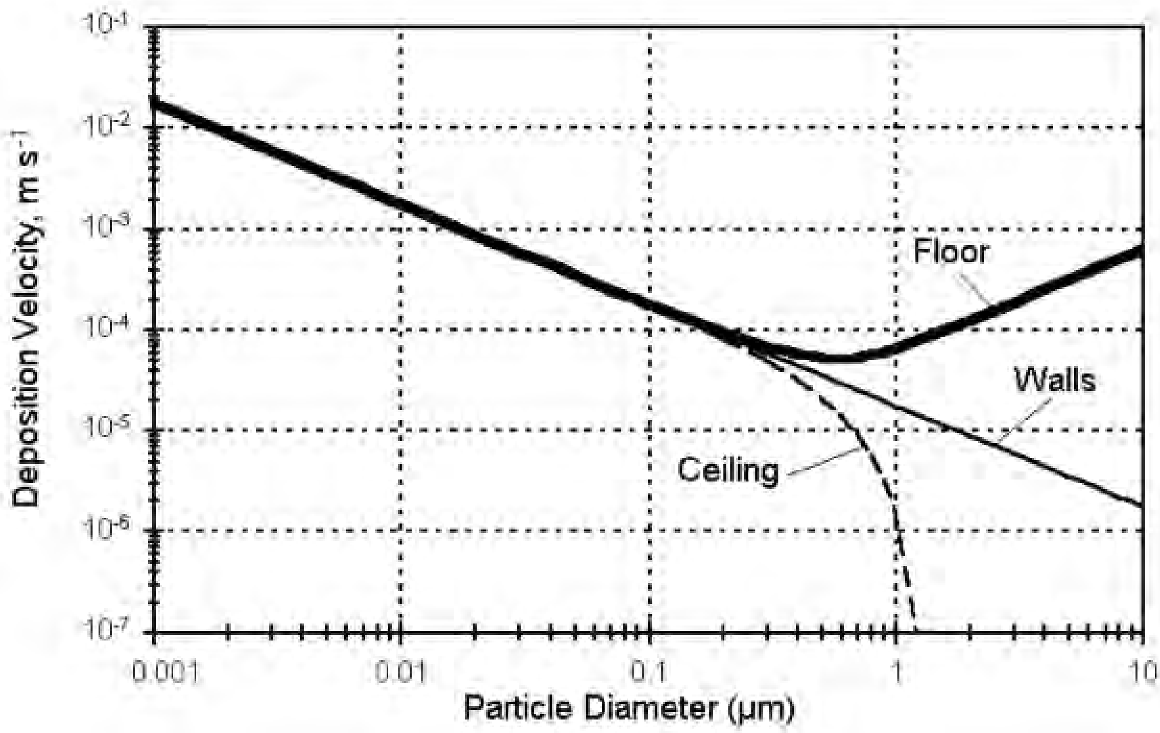

Figure 19-4. Idealized Patterns of Particle Deposition Indoors

Source: Adapted from Nazaroff and Cass, 1989.

Table 19-16. Particle Deposition During Normal Activities	
Particle Size Range	Particle Removal Rate (h^{-1})
1-5	0.5
5-10	1.4
10-25	2.4
>25	4.1
Source: Adapted from Thatcher and Layton, 1995.	

Table 19-17. Deposition Rates for Indoor Particles	
Size Fraction	Deposition Rate
$PM_{2.5}$	0.39 h^{-1}
PM_{10}	0.65 h^{-1}
Coarse	1.0 h^{-1}
Source: Adapted from Wallace, 1996.	

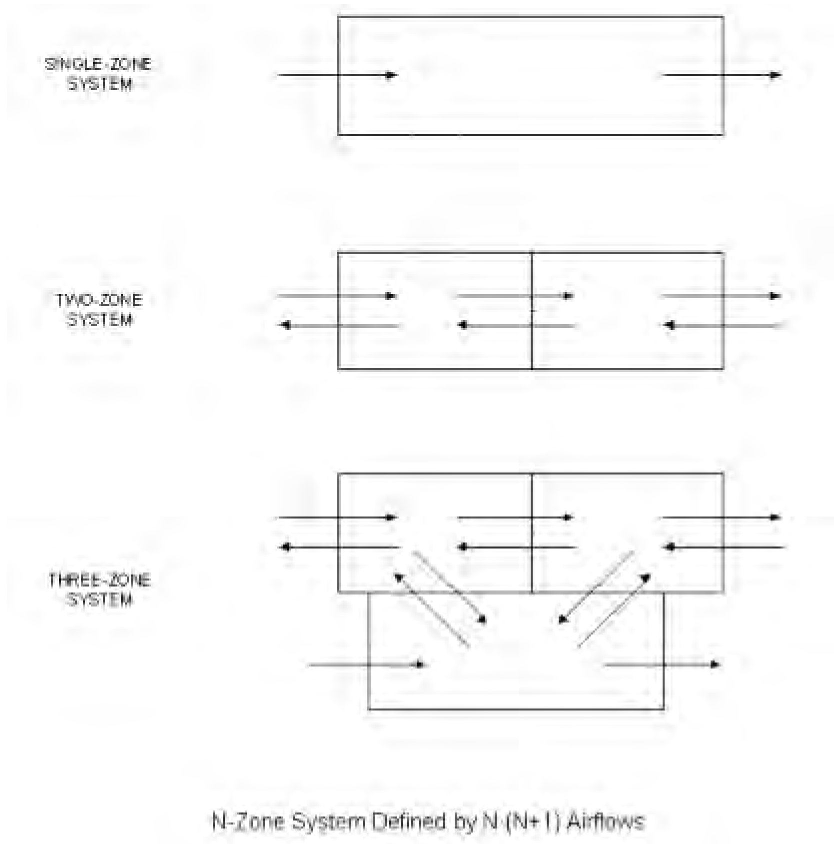

Figure 19-5. Air Flows for Multiple-zone Systems

Table 19-18. Total Dust Loading for Carpeted Areas		
Household	Total Dust Load ($g\text{-}m^{-2}$)	Fine Dust (<150 μm) Load ($g\text{-}m^{-2}$)
1	10.8	6.6
2	4.2	3.0
3	0.3	0.1
4	2.2; 0.8	1.2; 0.3
5	1.4; 4.3	1.0; 1.1
6	0.8	0.3
7	6.6	4.7
8	33.7	23.3
9	812.7	168.9

Source: Adapted from Roberts et al., 1991.

Table 19-19. Particle Deposition and Resuspension During Normal Activities		
Particle Size Range (μm)	Particle Deposition Rate (h^{-1})	Particle Resuspension Rate (h^{-1})
0.3-0.5	(not measured)	9.9×10^{-7}
0.6-1	(not measured)	4.4×10^{-7}
1-5	0.5	1.8×10^{-5}
5-10	1.4	8.3×10^{-5}
10-25	2.4	3.8×10^{-4}
>25	4.1	3.4×10^{-5}

Source: Adapted from Thatcher and Layton, 1995.

Table 19-20. Dust Mass Loading After One Week Without Vacuum Cleaning	
Location in Test House	Dust Loading ($g\text{-}m^{-2}$)
Tracked area of downstairs carpet	2.20
Untracked area of downstairs carpet	0.58
Tracked area of linoleum	0.08
Untracked area of linoleum	0.06
Tracked area of upstairs carpet	1.08
Untracked area of upstairs carpet	0.60
Front doormat	43.34

Source: Adapted from Thatcher and Layton, 1995.

Table 19-21. Simplified Source Descriptions for Airborne Contaminants		
Description	Components	Dimensions
Direct Discharge		
Combustion	$E_f H_f M_f$	g h^{-1}
	E_f = emission factor	g J^{-1}
	H_f = fuel content	J mol^{-1}
	M_f = fuel consumption rate	mol h^{-1}
Volume Discharge	$Q_p C_p \varepsilon$	g h^{-1}
	Q_p = volume delivery rate	$m^3 h^{-1}$
	C_p = concentration in carrier	g m^{-3}
	ε = transfer efficiency	g g^{-1}
Mass Discharge	$M_p w_e \varepsilon$	g h^{-1}
	M_p = mass delivery rate	g h^{-1}
	w_e = weight fraction	g g^{-1}
	ε = transfer efficiency	g g^{-1}
Diffusion Limited		
	$(D_f \delta^{-1})(C_s - C_i)A_i$	g h^{-1}
	D_f = diffusivity	$m^2 h^{-1}$
	δ^{-1} = boundary layer thickness	m
	C_s = vapor pressure of surface	g m^{-3}
	C_i = room concentration	g m^{-3}
	A_i = area	m^2
Exponential	$A_i E_o e^{-k t}$	g h^{-1}
	A_i = area	m^2
	E_o = initial unit emission rate	g $h^{-1} m^{-2}$
	k = emission decay factor	h^{-1}
	t = time	h
Transport		
Infiltration	$Q_{ii} C_i$	g h^{-1}
Interzonal	Q_{ii} = air flow from zone j	$m^3 h^{-1}$
Soil Gas	C_i = air concentration in zone j	g m^{-3}

GLOSSARY OF TERMS

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Absorbed dose - In exposure assessment, the amount of a substance that penetrates an exposed organism's absorption barriers (e.g. skin, lung tissue, gastrointestinal tract) through physical or biological processes. The term is synonymous with internal dose.

Activity pattern data - Information on human activities used in exposure assessments. These may include a description of the activity, frequency of activity, duration spent performing the activity, and the microenvironment in which the activity occurs.

Acute exposure - A single exposure to a toxic substance which may result in severe biological harm or death. Acute exposures are usually characterized as lasting no longer than a day, as compared to longer, continuing exposure over a period of time.

Adherence factor - The amount of a material (e.g., soil) that adheres to the skin per unit of surface area.

Activity pattern (time use) data - Information on activities in which various individuals engage, length of time spent performing various activities, locations in which individuals spend time and length of time spent by individuals within those various environments.

Agricultural commodity - Used by U.S. EPA to mean plant (or animal) parts consumed by humans as food. When such items are raw or unprocessed, they are referred to as "raw agricultural commodities."

Air exchange rate - Rate of air leakage through windows, doorways, intakes and exhausts, and "adventitious openings" (i.e., cracks and seams) that combine to form the leakage configuration of the building envelope plus natural and mechanical ventilation.

All water sources - Includes water from all supply sources such as community water supply (i.e., tap water), bottled water, etc.

Analytical uncertainty propagation - Examining how uncertainty in individual parameters affects the overall uncertainty of the exposure assessment.

Anthropometric - The study of human body measurements for use in anthropological classification and comparison.

As-consumed intake - Intake rate based on the weight of the food in the form that it is consumed (e.g., cooked or prepared).

Assessment - A determination or appraisal of possible consequences resulting from an analysis of data.

Average Daily Dose (ADD) - Dose rate averaged over a pathway-specific period of exposure expressed as a daily dose on a per-unit-body-weight basis. The ADD is used for exposure to chemicals with non-carcinogenic non-chronic effects. The ADD is usually expressed in terms of mg/kg-day or other mass/mass-time units.

Benchmark Dose or Concentration - A dose or concentration that produces a predetermined change in response rate of an adverse effect (called the benchmark response or BMR) compared to background.

Best Tracer Method (BTM) - Method for estimating soil ingestion that allows for the selection of the most recoverable tracer for a particular subject or group of subjects. Selection of the best tracer is made on the basis of the food/soil (F/S) ratio.

Bias - A systematic error inherent in a method or caused by some feature of the measurement system.

Bioavailability - The rate and extent to which an agent can be absorbed by an organism and is available for metabolism or interaction with biologically significant receptors. Bioavailability involves both release from a medium (if present) and absorption by an organism.

Biokinetic model comparison - A methodology that compares direct measurements of a biomarker such as blood or urine levels of a toxicant with predictions from a biokinetic model.

Biomarker model comparison - A methodology that compares results from a biokinetic exposure model to biomarker measurements children blood. The method is used to confirm assumptions about ingested soil and dust quantities in this handbook.

Basal Metabolic Rate (BMR) - Minimum level of energy required to maintain normal body functions.

Body Mass Index (BMI) - The ratio of weight and height squared.

Bootstrap - A statistical method of resampling data use to estimate variance and bias of an estimator and provide confidence intervals for parameters.

Bounding estimate - An estimate of exposure, dose, or risk that is higher or lower than that incurred by the person with the highest or lowest exposure, dose, or risk in the population being assessed. Bounding estimates are useful in developing statements that exposures, doses, or risks are "not greater than" or "less than" the estimated value, because assumptions are used which define the likely bounding conditions.

Central tendency exposure - A measure of the middle or the center of an exposure distribution. The mean is the most commonly used measure of central tendency.

Chronic exposure - Repeated exposure by the oral, dermal, or inhalation route for more than approximately 10% of the life span in humans (more than approximately 90 days to 2 years in typically used laboratory animal species).

Chronic intake - The long term period over which a substance crosses the outer boundary of an organism without passing an absorption barrier.

Classical statistical methods - Estimating the population exposure distribution directly, based on measured values from a representative sample**.**

Coating - Method used to measure skin surface area, in which either the whole body or specific body regions are coated with a substance of known density and thickness.

Community water - Includes tap water ingested from community or municipal water supply.

Comparability - The ability to describe likenesses and differences in the quality and relevance of two or more data sets.

Concentration - Amount of a material or agent dissolved or contained in unit quantity in a given medium or system.

Confidence intervals - An estimated range of values with a given probability of including the population parameter of interest. The range of values is usually based on the results of a sample that estimated the mean and the sampling error or standard error.

Consumer-only intake rate - The average quantity of food consumed per person in a population composed only of individuals who ate the food item of interest during a specified period.

Contaminant concentration - Contaminant concentration is the concentration of the contaminant in the medium (air, food, soil, etc.) contacting the body and has units of mass/volume or mass/mass.

Creel study - A study in which fishermen are interviewed while fishing.

Cumulative exposure - Exposure via mixtures of contaminants both indoors and outdoors. Exposure may also occur through more than one pathway. New directions in risk assessments in U.S. EPA put more emphasis on total exposures via multiple pathways.

Deposition - The removal of airborne substances to available surfaces that occurs as a result of gravitational settling and diffusion, as well as electrophoresis and thermophoresis.

Dermal absorption - A route of exposure by which substances can enter the body through the skin.

Dermal adherence - The loading of a substance onto the outer surface of the skin.

Diary study - Survey in which individuals are asked to record food intake, activities, or other factors in a diary which is later used to evaluate exposure factors associated with specific populations.

Direct water ingestion - Consumption of plain water as a beverage. It does not include water used for preparing beverages such as coffee or tea.

Distribution - A set of values derived from a specific population or set of measurements that represents the range and array of data for the factor being studied.

Doers - Survey respondents who report participating in a specified activity.

Dose - The amount of a substance available for interaction with metabolic processes or biologically significant receptors after crossing the outer boundary of an organism. The potential dose is the amount ingested, inhaled, or applied to the skin. The applied dose is the amount of a substance presented to an absorption barrier and available for absorption (although not necessarily having yet crossed the outer boundary of the organism). The absorbed dose is the amount crossing a specific absorption barrier (e.g., the exchange boundaries of skin, lung, and digestive tract) through uptake processes. Internal dose is a more general term denoting the amount absorbed without respect to specific absorption barriers or exchange boundaries. The amount of a chemical available for interaction by any particular organ or cell is termed the delivered dose for that organ or cell.

Dose rate - Dose per unit time.

Dose-response assessment - Analysis of the relationship between the total amount of an agent administered to, taken up by, or absorbed by an organism, system, or (sub)population and the changes developed in that organism, system, or (sub)population in reaction to that agent, and inferences derived from such an analysis with respect to the entire population. Dose-response assessment is the second of four steps in risk assessment.

Dose-response curve- Graphical presentation of a dose-response relationship.

Dose-response relationship - The resulting biological responses in an organ or organism expressed as a function of a series of doses.

Dressed weight - The portion of the harvest brought into kitchens for use, including bones for particular species.

Drinking water - All fluids consumed by individuals to satisfy body needs for internal water.

Dry weight intake rates - Intake rates that are based on the weight of the food consumed after the moisture content has been removed.

Dust Ingestion - Consumption of dust that results from various behaviors including, but not limited to, mouthing objects or hands, eating dropped food, consuming dust directly, or inhaling dust that passes from the respiratory system into the gastrointestinal tract.

Effect - Change in the state or dynamics of an organism, system, or (sub) population caused by exposure to an agent.

Employer tenure - The length of time a worker has been with the same employer.

Energy expenditures - The amount of energy expended by an individual during activities.

Exposure - Contact of a chemical, physical, or biological agent with the outer boundary of an organism. Exposure is quantified as the concentration of the agent in the medium in contact integrated over the time duration of the contact.

Exposure assessment - The determination or estimation (qualitative or quantitative) of the magnitude, frequency, or duration, and route or exposure.

Exposure concentration - The concentration of a chemical in its transport or carrier medium at the point of contact.

Exposure duration - Length of time over which contact with the contaminant lasts.

Exposure event - The occurrence of continuous contact between an agent and a target.

Exposure frequency - The number of exposure events in an exposure duration.

Exposure loading - The exposure mass divided by the exposure surface area. For example, a dermal exposure measurement based on a skin wipe sample, expressed as a mass of residue per skin surface area, is an exposure loading.

Exposure pathway - The physical course a chemical takes from the source to the organism exposed.

Exposure route - The way a chemical pollutant enters an organism after contact, e.g., by ingestion, inhalation, or dermal absorption.

Exposure scenario - A set of facts, assumptions, and interferences about how exposure takes place that aids the exposure assessor in evaluating estimating, or quantifying exposures.

Fate - Pattern of distribution of an agent, its derivatives, or metabolites in an organism, system, compartment, or (sub)population of concern as a result of transport, partitioning, transformation, or degradation.

General population - The total of individuals inhabiting an area or making up a whole group.

Geometric mean - The n^{th} root of the product of n values.

Geophagy - A form of soil ingestion involving the intentional ingestion of earths, usually associated with cultural practices.

Hazard - Inherent property of an agent or situation having the potential to cause adverse effects when an organism, system, or (sub)population is exposed to that agent.

Hazard assessment - A process designed to determine the possible adverse effects of an agent or situation to which an organism, system, or (sub)population could be exposed. The process typically includes hazard identification, dose-response evaluation and hazard characterization. The process focuses on the hazard, in contrast to risk assessment, where exposure assessment is a distinct additional step.

High end exposure - An estimate of individual exposure or dose for those persons at the upper end of an exposure or dose distribution, conceptually above the 90^{th} percentile, but not higher than the individual in the population who has the highest exposure or dose.

Homegrown/home produced foods - Fruits and vegetables produced by home gardeners, meat and dairy products derived form consumer-raised livestock, game meat, and home caught fish.

Human Equivalent Concentration or Dose: The human concentration (for inhalation exposure) or dose (for other routes of exposure) of an agent that is believed to induce the same magnitude of toxic effect as the experimental animal species concentration or dose. This adjustment may incorporate toxicokinetic information on the particular agent, if available, or use a default procedure, such as assuming that daily oral doses experienced for a lifetime are proportional to body weight raised to the 0.75 power.

Indirect water ingestion - Includes water added during food preparation, but not water intrinsic to purchased foods. Indirect water includes for example, water used to prepare baby formulas, cake mix, and concentrated orange juice.

Indoor settled dust - Particles in building interiors that have settled onto objects, surfaces, floors, and carpeting. These particles may include soil particles that have been tracked into the indoor environment from outdoors.

Inhalation dosimetry - Process of measuring or estimating inhaled dose.

Inhalation unit risk - The upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 μg/m^3 in air for a lifetime.

Inhaled dose - The amount of an inhaled substance that is available for interaction with metabolic processes or biologically significant receptors after crossing the outer boundary of an organism.

Insensible water loss - Evaporative water losses that occur during breastfeeding. Corrections are made to account for insensible water loss when estimating breast milk intake using the test weighing method.

Intake - The process by which a substance crosses the outer boundary of an organism without passing an absorption barrier (e.g., through ingestion or inhalation).

Intake rate - Rate of inhalation, ingestion, and dermal contact depending on the route of exposure. For ingestion, the intake rate is simply the amount of food containing the contaminant of interest that an individual ingests during some specific time period (units of mass/time). For inhalation, the intake rate is the rate at which contaminated air is inhaled. Factors that affect dermal exposure are the amount of material that comes into contact with the skin, and the rate at which the contaminant is absorbed.

Inter-individual variability - Variations between individuals in terms of human characteristics such as age or body weight, or behaviors such as location, activity patterns, and ingestion rates.

Internal dose - The amount of a substance penetrating across absorption barriers (the exchange boundaries) of an organism, via either physical or biological processes (synonymous with absorbed dose).

Interzonal air flows - Transport of air through doorways, ductwork, and service chaseways that interconnect rooms or zones within a building.

Intra-individual variability - Fluctuations in an individual's physiologic (e.g., body weight), or behavioral characteristics (e.g., ingestion rates or activity patterns).

Key study - A study that is useful for deriving exposure factors.

Lead isotope ratio methodology - A method that measures different lead isotopes in children's blood and/or urine, food, water, and house dust and compares the ratio of these isotopes to infer sources of lead exposure that may include dust or other environmental exposures.

Lifestage - A distinguishable time frame in an individual's life characterized by unique and relatively stable behavioral and/or physiological characteristics that are associated with development and growth.

Lifetime Average Daily Dose (LADD) - Dose rate averaged over a lifetime. The LADD is used for compounds with carcinogenic or chronic effects. The LADD is usually expressed in terms of mg/kg-day or other mass/mass-time units.

Limiting Tracer Method (LTM) - Method for evaluating soil ingestion that assumes that the maximum amount of soil ingested corresponds with the lowest estimate from various tracer elements.

Local circulation - Convective and adjective air circulation and mixing within a room or within a zone.

Long-term exposure - Repeated exposure for more than 30 days, up to approximately 10% of the life span in humans (more than 30 days).

Lowest-Observed-Adverse-Effect Level (LOAEL): The lowest exposure level at which there are biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control group.

Margin of safety - For some experts, margin of safety has the same meaning as margin of exposure, while for others, margin of safety means the margin between the reference dose and the actual exposure.

Mass-balance/tracer techniques - Method for evaluating soil intake that accounts for both inputs and outputs of tracer elements. Tracers in soil, food, medicine and other ingested items as well as in feces and urine are accounted for.

Mean value - Simple or arithmetic average of a range of values, computed by dividing the total of all values by the number of values.

Measurement error - A systematic error arising from inaccurate measurement (or classification) of subjects on the study variables.

Measurement end-point - Measurable (ecological) characteristic that is related to the valued characteristic chosen as an assessment point.

Median value - The value in a measurement data set such that half the measured values are greater and half are less.

Metabolic Equivalent of Work (MET) - A dimensionless energy expenditure metric used to represent an activity level.

Microenvironment - Surroundings that can be treated as homogeneous or well characterized in the concentrations of an agent (e.g., home, office, automobile, kitchen, store).

Model uncertainty - Uncertainty regarding gaps in scientific theory required to make predictions on the basis of causal inferences.

Moisture content - The portion of foods made up by water. The percent water is needed for converting food intake rates and residue concentrations between whole weight and dry weight values.

Monte Carlo technique - A repeated random sampling from the distribution of values for each of the parameters in a generic (exposure or dose) equation to derive an estimate of the distribution of (exposures or doses in) the population.

Mouthing behavior - Activities in which objects, including fingers, are touched by the mouth or put into the mouth except for eating and drinking, and includes licking, sucking, chewing, and biting.

Non-dietary ingestion - Ingestion of non-food substances, typically resulting from the mouthing of hands and objects.

No-Observed-Adverse-Effect-Level (NOAEL) - The highest exposure level at which there are no biologically significant increases in the frequency or severity of adverse effect between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered adverse or precursors of adverse effects.

Occupational mobility - An indicator of the frequency at which workers change from one occupation to another.

Occupational tenure - The cumulative number of years a person worked in his or her current occupation, regardless of number of employers, interruptions in employment, or time spent in other occupations.

Outdoor settled dust - Particles that have settled onto outdoor objects and surfaces due to either wet or dry deposition.

Oxygen consumption (VO_2) - The rate at which oxygen is used by tissues.

Parameter uncertainty - Uncertainty regarding some parameter.

Pathway - The physical course a chemical or pollutant takes from the source to the organism exposed.

Per capita intake rate - The average quantity of food consumed per person in a population composed of both individuals who ate the food during a specified time period and those that did not.

Pica - Pica behavior is the repeated eating of non-nutritive substances, whereas soil-pica is a form of soil ingestion that is characterized by the recurrent ingestion of unusually high amounts of soil (i.e., on the order of 1,000 - 5,000 milligrams per day or more).

Plain tap water - Excludes tap water consumed in the form of juices and other beverages containing tap water.

Population mobility - An indicator of the frequency at which individuals move from one residential location to another.

Population risk descriptor - An assessment of the extent of harm to the population being addressed. It can be either an estimate of the number of cases of a particular effect that might occur in a population (or population segment), or a description of what fraction of the population receives exposures, doses, or risks greater than a specified value.

Potential dose - The amount of a chemical contained in material ingested, air breathed, or bulk material applied to the skin.

Poverty/income ratio - Ratio of reported family income to federal poverty level.

Precision - A measure of the reproducibility of a measured value under a given set of circumstances.

Preparation losses - Net cooking losses, which include dripping and volatile losses, post cooking losses, which involve losses from cutting, bones, excess fat, scraps and juices, and other preparation losses which include losses from paring or coring.

Primary data/analysis - Information gathered from observations or measurements of a phenomena or the surveying of respondents.

Probabilistic uncertainty analysis - Technique that assigns a probability density function to each input parameter, then randomly selects values from each of the distributions and inserts them into the exposure equation. Repeated calculations produce a distribution of predicted values, reflecting the combined impact of variability in each input to the calculation. Monte Carlo is a common type of probabilistic Uncertainty analysis.

Questionnaire/survey response - A "question and answer" data collection methodology conducted via in-person interview, mailed questionnaire, or questions administered in a test format in a school setting.

Random samples - Samples selected from a statistical population such that each sample has an equal probability of being selected.

Range - The difference between the largest and smallest values in a measurement data set.

Ready-to-feed - Infant and baby products (formula, juices, beverages, baby food), and table foods that do not need to have water added to them prior to feeding.

Real-time hand recording - Method by which trained observers manually record information on children's behavior.

Reasonable maximum exposure (or worst case) - A semiquantitative term referring to the lower portion of the high end of the exposure, dose, or risk distribution. As a semiquantitative term, it should refer to a range that can conceptually be described as above the 90^{th} percentile in the distribution, but below the 98^{th} percentile.

Recreational/sport fishermen - Individuals who catch fish as part of a sporting or recreational activity and not for the purpose of providing a primary source of food for themselves or for their families.

Reference Concentration (RfC) - An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, LOAEL, or benchmark concentration, with uncertainty factors generally applied to reflect limitations of the data used. Generally used in EPA's noncancer health assessments. Durations include acute, short-term, subchronic, and chronic.

Reference Dose (RfD) - An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, LOAEL, or benchmark dose, with uncertainty factors generally applied to reflect limitations of the data used. Generally used in EPA's noncancer health assessments. Durations include acute, short-term, subchronic, and chronic.

Relevant study - Studies that are applicable or pertinent, but not necessarily the most important to derive exposure factors.

Representativeness - The degree to which a sample is, or samples are, characteristic of the whole medium, exposure, or dose for which the samples are being used to make inferences.

Residential occupancy period - The time between a person moving into a residence and the time the person moves out or dies.

Residential volume - The volume (m3) of the structure in which and individual resides and may be exposed to airborne contaminants.

Risk - The probability of an adverse effect in an organism, system, or (sub)population caused under specified circumstances by exposure to an agent.

Risk assessment - A process intended to calculate or estimate the risk to a given target organism, system, or (sub)population, including the identification of attendant uncertainties, following exposure to a particular agent, taking into account the inherent characteristics of the agent of concern as well as the characteristics of the specific target system. The risk assessment process includes four steps: hazard identification, hazard characterization (related term: Dose-response assessment), exposure assessment, and risk characterization. It is the first component in a risk analysis process.

Risk characterization - The qualitative and, wherever possible, quantitative determination, including attendant uncertainties, of the probability of occurrence of known and potential adverse effects of an agent in a given organism, system, or (sub)population, under defined exposure conditions. Risk characterization is the fourth step in the risk assessment process.

Risk communication - Interactive exchange of information about (health or environmental) risks among risk assessors, managers, news media, interested groups, and the general public.

Route - The way a chemical or pollutant enters an organism after contact, e.g., by ingestion, inhalation, or dermal absorption.

Sample - A small part of something designed to show the nature or quality of the whole. Exposure-related measurements are usually samples of environmental or ambient media, exposures of a small subset of a population for a short time, or biological samples, all for the purpose of inferring the nature and quality of parameters important to evaluating exposure.

Scenario uncertainty - Uncertainty regarding missing or incomplete information needed to fully define exposure and dose.

Screening-level assessment - An exposure assessment that examines exposures that would fall on or beyond the high end of the expected exposure distribution.

Secondary data/analysis - The reanalysis of data collected by other individuals or group; an analysis of data for purposes other than those for which the data were originally collected.

Sensitivity analysis - Process of changing one variable while leaving the others constant to determine its effect on the output. This procedure fixes each uncertain quantity at its credible lower and upper bounds (holding all others at their nominal values, such as medians) and computes the results of each combination of values. The results help to identify the variables that have the greatest effect on exposure estimates and help focus further information-gathering efforts.

Serving sizes - The quantities of individual foods consumed per eating occasion. These estimates may be useful for assessing acute exposures.

Short-term exposure - Repeated exposure for more than 24 hours, up to 30 days.

Soil - Particles of unconsolidated mineral and/or organic matter from the earth's surface that are located outdoors, or are used indoors to support plant growth.

Soil adherence - The quantity of soil that adheres to the skin and from which chemical contaminants are available for uptake at the skin surface.

Soil ingestion - The intentional or unintentional consumption of soil, resulting from various behaviors including, but not limited to, mouthing, contacting dirty hands, eating dropped food, or consuming soil directly. Soil-pica is a form of soil ingestion that is characterized by the recurrent ingestion of unusually high amounts of soil (i.e., on the order of 1,000 - 5,000 milligrams per day or more). Geophagy is also a form of soil ingestion defined as the intentional ingestion of earths and is usually associated with cultural practices.

Spatial variability - Variability across location, whether long- or short-term.

Subsistence fishermen - Individuals who consume fresh caught fish as a major source of food.

Surface area - Coating, triangulation, and surface integration are direct measurement techniques that have been used to measure total body surface area and the surface area of specific body parts. Consideration has been given for differences due to age, gender, and race. Surface integration is performed by using a planimeter and adding the areas.

Surface integration - Method used to measure skin surface area in which a planimeter is used to measure areas of the skin, and the areas of various surfaces are summed.

Survey response methodology - Responses to survey questions are analyzed. This methodology includes questions asked of children directly, or their care givers, about behaviors affecting exposures.

Tap water from food manufacturing - Water used in industrial production of foods.

Temporal variability - Variability over time, whether long- or short-term.

Threshold - Dose or exposure concentration of an agent below which a stated effect is not observed or expected to occur.

Time-averaged exposure - The time-integrated exposure divided by the exposure duration. An example is the daily average exposure of an individual to carbon monoxide. (Also called timeweighted average exposure.)

Total tap water - Water consumed directly from the tap as a beverage or used in the preparation of foods and beverages (i.e., coffee, tea, frozen juices, soups, etc.).

Total fluid intake - Consumption of all types of fluids including tapwater, milk, soft drinks, alcoholic beverages, and water intrinsic to purchased foods.

Total water - Water from tap water and non tap water sources including water contained in food.

Tracer-element studies - Soil ingestion studies that use trace elements found in soil and poorly metabolized in the human gut as indicators of soil intake.

Triangulation - Method used to measure skin surface area in which areas of the body are marked into geometric figures, then their linear dimensions are calculated.

Uncertainty - Uncertainty represents a lack of knowledge about factors affecting exposure or risk and can lead to inaccurate or biased estimates of exposure. The types of uncertainty include: scenario, parameter, and model.

Upper percentile - Values in the upper tail (i.e., between 90th and 99.9th percentile) of the distribution of values for a particular exposure factor. Values at the upper end of the distribution of values for a particular set of data.

Uptake - The process by which a substance crosses an absorption barrier and is absorbed into the body.

Usual dietary intakes - Refers to the long-term average daily intake by an individual.

Variability - Variability arises from true heterogeneity across people, places or time and can affect the precision of exposure estimates and the degree to which they can be generalized. The types of variability include: spatial, temporal, and inter-individual.

Ventilation Rate (VR) - Alternative term for inhalation rate or breathing rate. Usually measured as minute volume, i.e. volume (liters) of air exhaled per minute.

Video transcription - Method by which trained videographers tape a child's activities and subsequently extract data manually with computer software.

Wet-weight intake rates - Intake rates that are based on the wet (or whole) weight of the food consumed. This in contrast to dry-weight intake rates.

Glossary entries adapted from:

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