7. DERMAL EXPOSURE FACTORS

7.1. INTRODUCTION

Dermal exposure can occur during a variety of activities in different environmental media and microenvironments [U.S. Environmental Protection Agency (U.S. EPA), (2004, 1992a, b)]. These include:

- water (e.g., bathing, washing, swimming);
- soil (e.g., outdoor recreation, gardening, construction);
- sediment (e.g., wading, fishing);
- other liquids (e.g., use of commercial products);
- vapors/fumes/gases (e.g., use of commercial products); and
- other solids or residues (e.g., soil/dust or chemical residues on carpets, floors, counter tops, outdoor surfaces, or clothing).

Exposure via the dermal route may be estimated in various ways, depending on the exposure media and scenario of interest. For example, dermal exposure to contaminants in soil, sediment, or dust may be evaluated using information on the concentration of contaminant in these materials in conjunction with information on the amount of material that adheres to the skin per unit surface area and the total area of skin surface exposed. An approach for estimating dermal exposure to contaminants in liquids uses information on the concentration of contaminant in the liquid in conjunction with information on the film thickness of liquid remaining on the skin after contact. When assessing dermal exposure to water (e.g., bathing or swimming) or to vapors and fumes, the concentration of chemical in water or vapor with the total exposed skin surface area may be considered. An approach for estimating exposure to surface residues is to use information on the rate of transfer of chemical residues to the skin as a result of contact with the surfaces. Dermal exposure also may result from leaching of chemicals that are impregnated in materials that come into contact with skin. For example, Snodgrass (1992) evaluated transfer of pesticides from treated clothing onto the skin. For information on various methods used to estimate dermal exposure, refer to *Guidelines for Exposure Assessment (U.S. EPA, 1992b)*, *Dermal Exposure Assessment: Principles and Applications (U.S. EPA, 1992a)*, and *Dermal Exposures Assessment: A Summary of EPA Approaches* (U.S. EPA, 2007a). Additional scenario-specific information on dermal exposure assessment is available in *Risk Assessment Guidance for Superfund (RAGS) Part E* (U.S. EPA, 2004), *Standard Operating Procedures for Residential Pesticide Exposure Assessment, draft (U.S. EPA, 2009)*, and *Methods for Assessing Exposure to Chemical Substances: Volume 7, Methods for Assessing Consumer Exposure to Chemical Substances* (U.S. EPA, 1987). In general, these methods for estimating dermal exposure require information on the surface area of the skin that is exposed. Some methods also require information on the adherence of solids to the skin or information on the film thickness of liquids on the skin. Others utilize information on the transfer of residues from contaminated surfaces to the skin surface and/or rate of contact with objects or surfaces. This chapter focuses on measurements of body surface area and non-chemical-specific factors related to dermal exposure (i.e., the deposition of contaminants onto the skin), such as adherence of solids to the skin, film thickness of liquids on the skin, and residue transfer from contaminated surfaces to the skin. However, this chapter only provides recommendations for surface area and solids adherence to skin. According to Riley et al. (2004), numerous factors may affect loading and retention of chemicals on the skin, including the form of the contaminant (particle, liquid, residue), surface characteristics (hard, plush, porous, surface loading, previous transfers), skin characteristics (moisture, age, loading), contact mechanics (pressure, duration, repetition), and environmental conditions (temperature, relative humidity, air exchange). These factors are discussed in this chapter, as reported by the various study authors. Information on other factors that may affect dermal exposure (e.g., contact frequency and duration, and skin thickness) also is provided in this chapter.

Factors that influence dermal uptake (i.e., absorption) and internal dose, including chemical-specific factors, are not provided in this handbook. These include factors such as the concentration of chemical in contact with the skin, weight fraction of chemicals in consumer products, and characteristics of the chemical (i.e., lipophilicity, polarity, volatility, solubility). Also, factors affecting the rate of absorption of the chemical through the skin at the site of application and the amount of chemical delivered to the target organ are not covered in this chapter. Absorption may be affected by the age and condition of the skin, including presence of perspiration (Williams et al., 2005; Williams et al., 2004). Also, the thickness of the stratum corneum (outer layer of the skin) varies over parts of the body and may affect absorption. While not the primary focus of this chapter, some limited information on skin thickness is presented in Section 7.7—Other Factors. For guidance on how to use information on factors needed to assess dermal dose, refer to *Dermal Exposure Assessment: Principles and Applications* (U.S. EPA, 1992a) and *Risk Assessment Guidelines for Superfund (RAGs) Part E* (U.S. EPA, 2004).

Frequency and duration of contact also may affect dermal exposure and dose. Data on dermal contact frequency and duration of hand contact with objects and surfaces are presented in Section 7.7.1 of this chapter. Additional information on consumer products use and activity factors that may affect dermal exposure is presented in Chapters 16 and 17.

Section 7.3 of this chapter provides data on surface area of the human skin. Section 7.4 provides data on adherence of solids to human skin. Information on the film thickness of liquids on the skin is limited. However, studies that estimated film thickness of liquids on the skin are presented in Section 7.5. Section 7.6 presents available information on the transfer of residues from contaminated surfaces to the skin. Section 7.7 provides information on other factors affecting dermal exposure (e.g., frequency and duration of dermal contact with objects and surfaces, and skin thickness).

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. Relevant data on these and other factors also are presented in this chapter to provide added perspective on the state-of-knowledge pertaining to dermal exposure factors.

7.2. RECOMMENDATIONS

7.2.1. Body Surface Area

Table 7-1 summarizes the recommended mean and 95th percentile total body surface area values. For children under 21 years of age, the recommendations for total body surface area are based on the U.S. EPA analysis of 1999–2006 data from the National Health and Nutrition Examination Survey (NHANES). These data 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 7.3.1.3 and Appendix 7A). NHANES (1999–2006) used a statistically based survey design that should ensure that the data are reasonably representative of the general population for each 2-year interval (e.g., 1999 to 2000, 2001 to 2002). Multiple NHANES study years, supplying a larger sample size, were necessary for estimating surface area for children given the multiple stratifications by age. The advantage of using the NHANES data sets to derive the total surface area recommendations is that data are nationally representative and remain the principal source of body-weight and height data collected nationwide from a large number of subjects. Note that differences between the surface area recommendations presented here and those in the previous *Exposure Factors Handbook* (U.S. EPA, 1997) reflect changes in the body weights used in calculating these surface areas. If sex-specific data for children, sex-combined data for adults, or data for statistics other than the mean or 95th percentile are needed, refer to Table 7-9 through Table 7-13 of this chapter.

Table 7-2 presents the recommendations for the percentage of total body surface area represented by individual body parts for children based on data from U.S. EPA (1985) and Boniol et al. (2008) (see Section 7.3.1). The data from Boniol et al. (2008) are used for the recommendations for children greater than 2 years of age because they are based on a larger sample size than those in U.S. EPA (1985) for the same age groups. Because the Boniol et al. (2008) study does not include data for children less than 2 years of age, recommendations for this age group are based on the data from U.S. EPA (1985). It should be noted, however, that the sample size for the percentages of the total body represented by various body parts in this age group is very small. Table 7-2 also provides age-specific body part surface areas (m^2) for children. These values were obtained by multiplying the age-specific mean body part percentages (for males and females combined) by the total body surface areas presented in Table 7-1. If sex-specific data are needed for children equal to or greater than 2 years of age, or if data for additional body parts not summarized in Table 7-2 are needed, refer to Table 7-8. The body part data in this table may be applied to data in Table 7-9 through Table 7-11 to calculate surface area for the various body parts.

The recommendations for surface area of adult body parts are based on the U.S. EPA Analysis of NHANES 2005–2006 data and algorithms from U.S. EPA (1985). The U.S. EPA Analysis of the NHANES data was used to develop recommendations for body parts because the data are nationally representative and based on a large number of subjects. Table 7-2 presents the data for adult males and adult females (21+ years of age). If sex-combined data for adults or data for statistics other than the mean and 95th percentile are needed, refer to Table 7-12 and Table 7-13. These tables 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% of the skin surface is exposed (U.S. EPA, 1992a). More recent guidance recommends assuming 100% 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 only occurs to 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 or chemical residues on surfaces 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. Also, surface area of the body and body weight are highly correlated (Phillips et al., 1993). The relationship between these factors, therefore, should be considered when selecting body weights for use with the surface area data for estimating dermal exposure.

7.2.2. Adherence of Solids to Skin

The adherence factor (AF) describes the amount of solid 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. Refer to the activities described in Table 7-19 to select those that best represent the exposure scenarios of concern and use the corresponding adherence values from Table 7-20. Table 7-19 also lists the age ranges covered by each study. This may be used as a general guide to the ages covered by these data.

Table 7-4 summarizes recommended mean AF values according to common activities. The key studies used to develop the recommendations for adherence of solids to skin are those based on field studies in which specific activities relevant to dermal exposure were evaluated (compared to relevant studies that evaluated adherence in controlled laboratory trials using sieved or standardized soil). Insufficient data were available to develop activity-specific distributions or probability functions for these studies. 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).

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:

$$AF_{wtd} = \frac{(AF_1)(SA_1) + (AF_2)(SA_2) + \ldots (AF_i)(SA_i)}{SA_1 + SA_2 + \ldots SA_i} \qquad \text{(Eqn. 7-1)}$$

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% of the arms, and lower legs may be assumed to represent 40% 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 (1992a) 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, 1992a). The rate of solids accumulation on skin over time has not been well studied but probably occurs fairly quickly. Therefore, prorating the adherence values for exposure time periods of less than 1 day is not recommended.

Table 7-5 shows the confidence ratings for these AF recommendations. 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 also should be noted that the skin-adherence studies on which these recommendations are based have generally 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 used for the recommendations.

7.2.3. Film Thickness of Liquids on Skin

The film thickness of liquids on skin represents the amount of material that remains on the skin after contact with a liquid (e.g., consumer product such as cleaning solution or soap). The data on film thickness of liquids on the hand are limited, and recommended values are not provided in this chapter. Refer to Section 7.5 for a description of the available data that may be used to assess dermal contact with liquid using the film thickness approach.

7.2.4. Residue Transfer

Several studies have developed methods for quantifying the rates of transfer of chemical residues to the skin of individuals performing activities on contaminated surfaces. These studies have been conducted primarily for the purpose of estimating exposure to pesticides. Section 7.6 describes studies that have estimated residue transfer to human skin. Because use of residue transfer depends on the specific conditions under which exposure occurs (e.g., activity, contact surfaces, age), general recommendations are not provided. Instead, refer to Section 7.6 for a description of the available data from which appropriate values may be selected.

Table 7-1. Recommended Values for Total Body Surface Area, for Children (sexes combined) and Adults by Sex

Age Group	Mean (m²)	95th Percentile (m²)	Multiple Percentiles	Source
Male and Female Children Combined				
Birth to <1 month	0.29	0.34	See Table 7-9, Table 7-10, and Table 7-11 (for sex-specific data)	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 Male				
21 to 30 years	2.05	2.52	See Table 7-9 (for sex-combined data) and Table 7-10	U.S. EPA Analysis of NHANES 2005−2006 data
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 Female				
21 to 30 years	1.81	2.25	See Table 7-9(for sex-combined data) and Table 7-11	U.S. EPA Analysis of NHANES 2005−2006 data
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[a]	Arms[b]	Hands	Legs[c]	Feet	Source
	Mean Percent of Total Surface Area						
Male and Female Children Combined							
Birth to <1 month[d]	18.2	35.7	13.7	5.3	20.6	6.5	U.S. EPA (1985)
1 to <3 months[d]	18.2	35.7	13.7	5.3	20.6	6.5	
3 to <6 months[d]	18.2	35.7	13.7	5.3	20.6	6.5	
6 to <12 months[d]	18.2	35.7	13.7	5.3	20.6	6.5	
1 to <2 years[d]	16.5	35.5	13.0	5.7	23.1	6.3	
2 to <3 years[e]	8.4	41.0	14.4	4.7	25.3	6.3	Boniol et al. (2008) (average of data for males and females)
3 to <6 years[f]	8.0	41.2	14.0	4.9	25.7	6.4	
6 to <11 years[g]	6.1	39.6	14.0	4.7	28.8	6.8	
11 to <16 years[h]	4.6	39.6	14.3	4.5	30.4	6.6	
16 to <21 years[i]	4.1	41.2	14.6	4.5	29.5	6.1	
Adult Male							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 Female							
21+ years	6.2	35.4	12.8	4.8	32.3	6.6	
	Mean Surface Area by Body Part[j] m^2						
Male and Female Children Combined							
Birth to <1 month[d]	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[d]	0.060	0.118	0.045	0.017	0.068	0.021	
3 to <6 months[d]	0.069	0.136	0.052	0.020	0.078	0.025	
6 to <12 months[d]	0.082	0.161	0.062	0.024	0.093	0.029	
1 to <2 years[d]	0.087	0.188	0.069	0.030	0.122	0.033	
2 to <3 years[e]	0.051	0.250	0.088	0.028	0.154	0.038	U.S. EPA Analysis of NHANES 1999−2006 data and Boniol et al. (2008)
3 to <6 years[f]	0.061	0.313	0.106	0.037	0.195	0.049	
6 to <11 years[g]	0.066	0.428	0.151	0.051	0.311	0.073	
11 to <16 years[h]	0.073	0.630	0.227	0.072	0.483	0.105	
16 to <21 years[i]	0.075	0.759	0.269	0.083	0.543	0.112	
Adult Male							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 Female							
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[a]	Arms[b]	Hands	Legs[c]	Feet	Source
	95th Percentile Surface Area by Body Part[k] m^2						
Male and Female Children Combined							
Birth to <1 month[d]	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[d]	0.069	0.136	0.052	0.020	0.078	0.025	
3 to <6 months[d]	0.080	0.157	0.060	0.023	0.091	0.029	
6 to <12 months[d]	0.093	0.182	0.070	0.027	0.105	0.033	
1 to <2 years[d]	0.101	0.217	0.079	0.035	0.141	0.038	
2 to <3 years[e]	0.059	0.287	0.101	0.033	0.177	0.044	U.S. EPA Analysis of NHANES 1999−2006 data and Boniol et al. (2008)
3 to <6 years[f]	0.076	0.391	0.133	0.046	0.244	0.061	
6 to <11 years[g]	0.090	0.586	0.207	0.070	0.426	0.100	
11 to <16 years[h]	0.095	0.816	0.295	0.093	0.626	0.136	
16 to <21 years[i]	0.096	0.960	0.340	0.105	0.687	0.142	
Adult Male							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 Female							
21+ years	0.121	0.850	0.266	0.106	0.764	0.146	

a For children, ages 2 to <21 years, data from Boniol et al. (2008) for the neck, bosom, shoulders, abdomen, back, genitals, and buttocks were combined to represent the trunk.

b For children, ages 2 to <21 years, data from Boniol et al. (2008) for the upper and lower arms were combined to represent the arms.

c For children, ages 2 to <21 years, data from Boniol et al. (2008) for the thigh and legs were combined to represent the legs.

d Percentages based on a small number of observations for this age group.

e Based on data for 2 year olds from Boniol et al. (2008).

f Based on data for 4 year olds from Boniol et al. (2008).

g Based on average of data for 6, 8, and 10 year olds from Boniol et al. (2008).

h Based on average of data for 12 and 14 year olds from Boniol et al. (2008).

i Based on average of data for 16 and 18 year olds from Boniol et al. (2008).

j Children's values calculated as mean percentage of body part times mean total body surface area.

k Children's values 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 large sample sizes; sample size varied with age. Body-part percentages for children <2 years of age were based on direct measurements from a very small number of subjects (*N* = 4). Percentages for children ≥2 years were based on 2,050 children; adult values were based on 89 adults.	
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 for a large sample of the population.	
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. Body part percentages for children <2 years of age were based on direct measurements from a very small number of subjects (*N* = 4). Percentages for children ≥2 years were based on 2,050 children from various states in the United States and are assumed to be representative of U.S. children; adult values were based on 89 adults.	
Currency	The U.S. EPA analysis used the most current NHANES data to generate surface area data using algorithms based on older direct measurements. The data on body part percentages were dated. However, the age of the percentage data is not expected to affect its utility if the percentages are applied to total surface area data that has been updated based on the most recent NHANES body-weight and height data.	
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.	

Table 7-3. Confidence in Recommendations for Body Surface Area (continued)		
General Assessment Factors	Rationale	Rating
Clarity and Completeness		Medium
Accessibility	The U.S. EPA analysis of the NHANES data is unpublished, but used the same methodology as that described in the 1997 *Exposure Factors Handbook* (U.S. EPA, 1997). U.S. EPA (1985) is a U.S. EPA-published report. Boniol et al. (2008) is a published paper.	
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.	
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 for some ages, there is uncertainty in the body part percentage estimates for these age groups.	
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, but used the same methodology as that described in the 1997 *Exposure Factors Handbook* (U.S. EPA, 1997).	
Number and Agreement of Studies	There is one key study for total surface area and two key studies 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/cm^2					
Children						
Residential (indoors)[a]	-	0.0041	0.011	0.0035	0.010	Holmes et al. (1999)
Daycare (indoors and 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. (1996b)
Indoor sports[d]	-	0.0019	0.0063	0.0020	0.0022	Kissel et al. (1996b)
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. (1996b)
Playing in sediment[g]	0.040	0.17	0.49	0.70	21	Shoaf et al. (2005b)
Adults						
Outdoor sports[h]	0.0314	0.0872	0.1336	0.1223	-	Holmes et al. (1999); Kissel et al. (1996b)
Activities with soil[i]	0.0240	0.0379	0.1595	0.0189	0.1393	Holmes et al. (1999); Kissel et al. (1996b)
Construction activities[j]	0.0982	0.1859	0.2763	0.0660	-	Holmes et al. (1999)
Clamming[k]	0.02	0.12	0.88	0.16	0.58	Shoaf et al. (2005a)

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 one 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).

f Based on weighted average of geometric mean soil loadings of 2 groups of children (age 9 to 14 years; N = 12) 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.

k Based on geometric mean soil loadings of 18 adults (ages 33 to 63 years) clamming in tidal flats.

\- = 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. All three studies were conducted by researchers from a laboratory where a similar methodology was used. This may limit the representativeness of the data in terms of a wider population.	
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.	

Table 7-5. Confidence in Recommendations for Solids Adherence to Skin (continued)		
General Assessment Factors	Rationale	Rating
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

Surface area of the skin can be determined by 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 (Du Bois and Du Bois, 1989; Gehan and George, 1970; Boyd, 1935). 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. Appendix 7A presents a discussion and comparison of formulas. The key studies on body surface area that are presented in Section 7.3.1 are based on these formulas, as well as weight and height data from NHANES.

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*

U.S. EPA (1985) summarized the direct measurements of the surface area of adults' and children's body parts provided by Boyd (1935) and USDA (1969) as a percentage of total surface area. Table 7-6 presents these percentages. 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 in the analysis of body parts, 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, 1999–2006 [CDC (2006); see Section 7.3.1.3].

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 Du Bois and Du Bois (1989) and SPS to obtain the standard error (U.S. EPA, 1985).

Regression equations were developed for specific body parts using the Du Bois and Du Bois (1989) formula and using the surface area of various body parts provided by Boyd (1935) and USDA (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. *Boniol et al. (2008)—Proportion of Skin Surface Area of Children and Young Adults from 2 to 18 Years Old*

Boniol et al. (2008) applied measurement data for 87 body parts to a computer model to estimate the surface area of body parts of children. The measurement data were collected in the late 1970s by Snyder et al. (1978) for the purpose of product safety design (e.g., toys and ergonomics) and represent

1,075 boys and 975 girls from various states in the United States. A surface area module of the computer model MAN3D was used to construct models of the human body for children (ages 2, 4, 6, 8, 10, 12, 14, 16, and 18 years) to estimate surface area of 13 body parts for use in treating skin lesions. The body parts included head, neck, bosom, shoulders, abdomen, back, genitals and buttocks, thighs, legs, feet, upper arms, lower arms, and feet. The proportion of the skin surface area of these body parts relative to total surface area was computed. Table 7-8 presents these data for the various ages of male and female children. Except for the head, for which the percentages are much lower in this study than in U.S. EPA (1985), the body part proportions in this study appear to be similar to those presented in U.S. EPA (1985). For example, the proportions for hands range from 4.2 to 4.9% in this study and from 5.0 to 5.9% in U.S. EPA (1985). Because this study provides additional body parts that were not included in the U.S. EPA (1985) study, it is necessary to combine some body parts for the purpose of comparing their results. For example, upper arms and lower arms can be combined to represent total arms, and thighs plus legs can be combined to represent total legs. Upper arms plus lower arms for 4-year-olds from this study represent 14% of the total body surface, compared to 14.2% for arms for 3- to 6-year-olds from U.S. EPA (1985). Thighs plus legs for 2-year-olds from this study represent 25.3% of the total surface, compared to 23.2% for 2- to 3-year-olds from U.S. EPA (1985). Likewise, neck, bosom, shoulders, abdomen, back, and genitals/buttocks can be combined to represent the trunk.

The advantages of this study are that the data represent a larger sample size of children and are more recent than those used in U.S. EPA (1985). This study also provides data for more body parts than U.S. EPA (1985). However, the age groups presented in this study differ from those recommended in U.S. EPA (2005) and used elsewhere in this handbook, and no data are available for children 1 year of age and younger.

7.3.1.3. *U.S. EPA Analysis of NHANES 2005−2006 and 1999–2006 Data*

The U.S. EPA estimated total body surface areas by 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 Centers for Disease Control (CDC) National Center of Health Statistics. The survey's target population is the civilian, non-institutionalized U.S. population. The NHANES 1999–2006 survey was conducted on a nationwide probability sample of approximately 40,000 people 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 non-response to the household interview was 19%, and an additional 4% did not participate in the physical examinations (including body-weight measurements).

The NHANES 1999–2006 survey includes oversampling of low-income persons, adolescents 12 to 19 years of age, 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' Web site (http://www.cdc.gov/nchs/about/major/nhanes/nhanes20052006/faqs05_06.htm#question%2012). For adult estimates, the U.S. EPA utilized NHANES 2005–2006 in its estimates for currency and the same analytical methodology as in the earlier version of the *Exposure Factors Handbook* (U.S. EPA, 1997).

Table 7-9 presents the mean and percentile estimates of total body surface area by age category for males and females combined. Table 7-10 and Table 7-11 present the mean and percentiles of total body surface area by age category for males and females, respectively. Table 7-12 and Table 7-13 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 data sets to derive total 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 less than 2 years of age were based on recumbent length whereas 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*

Murray and Burmaster (1992) generated distributions of total body surface area for men and women ages 18 to 74 years 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: Du Bois and Du Bois (1989), Boyd (1935), U.S. EPA (1985), and Costeff (1966). The formulae of Du Bois and Du Bois (1989), 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 previously. 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 (see Table 7-14). 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%. Body surface area was found to have lognormal distributions for both men and women (see Figure 7-1). It also was found that assuming correlation between height and weight influences the final distribution by less than 1%.

The advantages of this study are that it compared the various formulae for computing surface area and confirmed that the formula used by the U.S. EPA in its analysis—as described in Section 7.3.1.3—is appropriate. This study is considered relevant because the height and weight data used in this analysis predates the height and weight data used in the more recent U.S. EPA analysis (see Section 7.3.1.3).

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 age 0 to 2 years, children age 2.1 to 17.9 years, and adults age 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.

Table 7-15 presents summary statistics for both adults and children. 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 were lognormally distributed. The SA/BW ratios for adults and all ages combined were normally 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 sex and age on SA/BW distribution also was analyzed by classifying the 401 observations by sex 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. *Garlock et al. (1999)—Adult Responses to a Survey of Soil Contact Scenarios*

Garlock et al. (1999) reported on a survey conducted during the summer of 1996. The objective of the study was to evaluate behaviors relevant to dermal contact with soil and dust. Garlock et al. (1999) conducted computer-aided telephone interviews designed to be nationally representative of the U.S. population. The survey response rate was 61.4%, with a sample size of 450. Adult respondents were asked to provide information on what they usually wore while engaging in the following activities during warm or cold weather: gardening, outdoor team sports (e.g., soccer, softball, football), and home construction projects that include digging, as well as whether they washed or bathed following these activities. Information also was collected on frequency and duration of these activities (see Chapter 16). Similar information was collected for children's outdoor activities and is reported in Wong et al. (2000). Using the activity-specific clothing choices reported for each survey participant and body surface area data from U.S. EPA (1985), Garlock et al. (1999) estimated the percentages of adult total body surface areas that would be uncovered for each of the warm weather and cold weather activities (see Table 7-16). The median ranged from 28 to 33% for warm weather activities and 3 to 8% for cold weather activities.

The advantages of this study are that it provides information on the percentage of adult total surface area that may be exposed to soil during a variety of outdoor activities. These data represent outdoor activities only (no data are provided for exposure to indoor surface dusts).

7.3.2.4. *Wong et al. (2000)—Adult Proxy Responses to a Survey of Children's Dermal Soil Contact Activities*

Wong et al. (2000) reported on two national phone surveys that gathered information on activity patterns related to dermal contact with soil. The first [also reported on by Garlock et al. (1999)] was conducted in 1996 using random digit dialing. Information about 211 children was gathered from adults more than 18 years of age. 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 of age, 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 through October) was obtained. The results of this survey indicated 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. Table 7-17 provides these estimates.

The advantage of this study is that it provides information on the percentage of children's bodies exposed to soil. These data reflect exposed skin areas during warm weather for outdoor activities only.

7.3.2.5. *AuYeung et al. (2008)—The Fraction of Total Hand Surface Area Involved in Young Children's Outdoor Hand-to-Mouth Contacts*

AuYeung et al. (2008) videotaped a total of 38 children (20 girls and 18 boys) between the ages of 1 and 6 years while they engaged in unstructured play activities in outdoor residential locations. The data were reviewed, and contact information was recorded according to the objects contacted and the associated contact configurations (e.g., full palm press, closed hand grip, open hand grip, side hand contact, partial palm, fingers only). The fraction of the hand associated with each of the various configuration categories then was estimated for a convenience sample of children and adults using hand traces and handprints consistent with the various contact configurations. Statistical distributions of the fraction of children's total hand surface associated with outdoor contacts were estimated by combining the information on occurrence and configuration of contacts from the videotaped activity study with the data on the fraction of the hand associated with the various contact configurations. Table 7-18 provides the per-contact fractional surface areas for the various types of objects contacted and for all objects combined. For all objects contacted, fractional surface areas ranged from 0.13 to 0.27. AuYeung et al. (2008) suggested that "the majority of children's outdoor contacts with objects involve a relatively small fraction of the hand's total surface area."

The advantage of this study is that it provides information on the fraction of the hand that contacts various surfaces and objects. However, the data are for a relatively small sample size of children (ages 1 to 6 years). Similar data for adults and older children were not provided.

7.4. ADHERENCE OF SOLIDS TO SKIN

Several field studies have been conducted to estimate the adherence of solids to skin. These field studies consider factors such as activity, sex, age, field conditions, and clothing worn. Section 7.4.1 provides information on key studies that measured adherence of solids to skin according to specific activities. Section 7.4.2 provides relevant information. Relevant studies provide additional perspective on adherence, including information on loading per contact event and the effects of soil/dust type, particle size, soil organic and moisture content, skin condition, and contact pressure and duration. This information may be useful for models based on individual contact events.

7.4.1. Key Adherence of Solids to Skin Studies

7.4.1.1. *Kissel et al. (1996b)—Field Measurements of Dermal Soil Loading Attributable to Various Activities: Implications for Exposure Assessment*

Kissel et al. (1996b) 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, 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 feet (Kissel et al., 1996b).

Table 7-19 provides the activities, information on their duration, sample size, and clothing worn by participants. The subjects' body surfaces (forearms, hands, lower legs for all sample groups; faces and/or feet 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 by using allometric models of surface area.

Table 7-20 presents geometric means for post-activity soil adherence by activity and body region for the four groups of volunteers evaluated. 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.

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"). The study was conducted as a follow-up to previous field sampling of soil adherence on individuals participating in various activities (Kissel et al., 1996b). For this round of sampling, soil loading data were collected utilizing the same methods used and described in Kissel et al. (1996b). Table 7-19 presents information regarding the groups studied and their observed activities.

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. Table 7-19 describes the number of children within each day's group and the clothing worn. For the second observation day ("Daycare Kids No. 2"), post-activity 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. The play area was described by the authors as being primarily carpeted. Table 7-19 describes the clothing worn by the children within each day's group.

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 for 1 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 were monitored while cleaning and fixing water mains, jack-hammering, and excavating trenches ("Utility Workers") on 2 days; five participated on the 1st day and four on the 2nd. 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). Table 7-19 describes the clothing worn by these groups.

Table 7-20 summarizes the geometric means and standard deviations (SDs) of the post-activity soil adherence for each group of individuals and for each body part. 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., 1996b). 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. (2005b)—Child Dermal Sediment Loads Following Play in a Tide Flat*

The purpose of the Shoaf et al. (2005b) study was to obtain sediment adherence data for children playing in a tidal flat ("Shoreline Play"). The study was conducted 1 day in late September 2003 at a tidal flat in Jamestown, RI. A total of nine subjects (three females and six males) ages 7 to 12 years participated in the study. Table 7-19 presents information on activity duration, sample size, and clothing worn by participants. Participants' parents completed questionnaires on 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 7-20, were 0.04 (2.9), 0.17 (3.1), 0.49 (8.2), 0.70 (3.6), and 21 (1.9), respectively. Event duration did not appear to be associated with sediment loading on the skin.

The primary advantage of this study is that it provides adherence data specific to children and sediments, which previously had 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 (nine) and sampling during just 1 day and at one location, make extrapolation to other situations uncertain.

7.4.1.4. *Shoaf et al. (2005a)—Adult Dermal Sediment Loads Following Clam Digging in Tide Flats*

The purpose of this study was to obtain sediment adherence data for adults engaged in unscripted clam digging activities in a tidal flat. The study was conducted over three days in late August 2003 at a tide flat near Narragansett, RI. Eighteen subjects (nine females and nine males) ages 33 to 63 years old participated in the study. This study reports direct measurements of sediment loadings on five body parts (face, forearms, hands, lower legs and feet). Pre- and post-activity sediment loading data were collected using skin rinsing techniques. The data from this study are presented along with the other field studies in Table 7-19 (populations and field conditions) and Table 7-20 (soil adherence results). Activity time was found not to be a good indicator of skin loading.

The primary advantage of this study is that it provides adherence data for sediments which had previously been largely unavailable. Results will be useful to risk assessors considering exposure scenarios involving adult activities at a coastal shoreline or tide flat. The limited number of participants (18) and sampling over just 3 days and one location, make extrapolation to other situations uncertain.

7.4.2. Relevant Adherence of Solids to Skin Studies

7.4.2.1. *Harger (1979)—A Model for the Determination of an Action Level for Removal of Curene Contaminated Soil*

U.S. EPA (1992a, 1988, 1987) reported on experimental values for (soil-related) dust adherence as estimated by Harger (1979). According to U.S. EPA (1992a), "these estimates are based on unpublished experiments by Dr. Rolf Hartung (University of Michigan) as reported in a 1979 memorandum from J. Harger to P. Cole (both from Michigan Toxic Substance Control Commission in Lansing, MI). According to this memo, Dr. Hartung measured adherence using his own hands and found: 2.77 mg/cm^2 for kaolin with a SD of 0.66 and $N = 6$; 1.45 mg/cm^2 for potting soil with SD = 0.36 and $N = 6$; and 3.44 mg/cm^2 for sieved vacuum cleaner dust (mesh 80) with SD = 0.80 and $N = 6$. The details of the experimental procedures were not reported. Considering the informality of the study and lack of procedural details, the reliability of these estimates cannot be evaluated." Accordingly, these data are not considered to be key for the purpose of developing recommendations for soil adherence to the skin.

7.4.2.2. *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 house dust having particle sizes ranging from 44 to 833 µm in diameter, fractionated into six size ranges, to estimate the amount that adhered to the palm of the hand of a small adult. The amount of dust that adhered to skin was determined by applying approximately 5 grams of dust for each size fraction, removing excess dust by shaking the hands, and then measuring the difference in weight before and after application. Que Hee et al. (1985) found no relationship between particle size and adherence for house dusts with particle sizes <246 µm. For all six particle sizes, an average of 63 ± 42 percent of applied dust adhered to the palm of the hand. This represents 31.2 ± 16.6 mg of soil. Excluding the two largest size fractions, 58 ± 29% of the applied dust adhered to the hand, representing 28.9 ± 1.9 mg.

The limitation of these data is that they were based on one adult hand and a single house dust sample. Also, the data are for hands only and are not linked to specific activities.

7.4.2.3. *Driver et al. (1989)—Soil Adherence to Human Skin*

Driver et al. (1989) conducted experiments to evaluate the conditions that may affect soil adherence to the skin of adult hands. Both top soils and subsoils of five soil types (Hyde, Chapanoke, Panorama, Jackland, and Montalto) were collected from sites in Virginia. The organic content, clay mineralogy, and particle size distribution of the soils were characterized, and 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 when 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 preweighed amount of soil over the entire surface area of the hands for a period of approximately 30 seconds, followed by removing 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. Driver et al. (1989) 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 was soil type and subtype ($p < 0.001$), but the interaction of soil type and particle size also was significant ($p < 0.01$).

Driver et al. (1989) found statistically significant increases in soil adherence with decreasing particle size, whereas Que Hee et al. (1985) found that different size particles of house dust <246 µm adhered equally well to hands.

The advantages of this study are that it provides additional perspective on the effects of particle size on adherence and that it evaluated several different soil types. However, it is based on data for hands only for a limited number of experimental observations (i.e., one subject). Also, the data are not activity based.

7.4.2.4. *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 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. Lepow et al. (1975) estimated that approximately 0.5 mg of soil adhered to 1 cm^2 of skin. Roels et al. (1980) estimated that 159 mg of soil adhered to the hand of an 11-year-old child. Assuming that approximately 60% (185 cm^2) of the surface area of the hand was sampled, the amount of soil adhering per unit area of skin was estimated to be 0.9 mg/cm^2. Que Hee et al. (1985) estimated that approximately 31.2 mg of housedust adhered to the palm of a small adult. Assuming a hand surface area of 160 cm^2, Sedman (1989) estimated a soil loading of 0.2 mg/cm^2. 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).

This study is considered relevant and not key because it does not provide any new data, but uses data from other studies and various assumptions to estimate soil adherence.

7.4.2.5. *Finley et al. (1994)—Development of a Standard Soil-to-Skin Adherence Probability Density Function for Use in Monte Carlo Analyses of Dermal Exposure*

Using data from several existing studies, Finley et al. (1994) developed probability density functions of soil-to-skin adherence. Finley et al. (1994) reviewed studies that estimated adherence among adults and children based on various gravimetric and hand wiping/rinsing methods. Several of these studies were originally conducted for the purpose of estimating lead exposure from soil contact. By combining data from four studies [Charney et al. (1980); Roels et al. (1980); Gallacher et al. (1984); and Duggan et al. (1985)], Finley et al. (1994) estimated a mean ± standard deviation soil adherence value for children of 0.65 ± 1.2 mg soil/cm^2-skin. (50th percentile = 0.36 and 95th percentile = 2.4 mg soil/cm^2-skin). Using data from three studies [Gallacher et al. (1984); Que Hee et al. (1985); and Driver et al. (1989)], Finley et al. (1994) estimated a mean ± standard deviation soil adherence value for adults of 0.49 ± 0.54 mg soil/cm^2-skin. (50th percentile = 0.06 and 95th percentile = 1.6 mg soil/cm^2-skin). Because the distributions of soil-to-skin adherence were similar for children and adults, Finley et al. (1994) developed a probability density function based on the combined data for children and adults. The probability density function is lognormally distributed with a mean ± standard deviation of 0.52 ± 0.9 mg soil/cm^2-skin (50th percentile = 0.25 and 95th percentile = 1.7 mg soil/cm^2-skin).

The advantage of this study is that it provides distributions of soil adherence for children, adults, and children and adults combined. However, it is based on some older, relevant studies that are not activity- or body-part specific.

7.4.2.6. *Kissel et al. (1996a)—Factors Affecting Soil Adherence to Skin in Hand-Press Trials: Investigation of Soil Contact and Skin Coverage*

Kissel et al. (1996a) conducted soil adherence experiments to evaluate the effect of particle size and soil moisture content on adherence to the skin. Five soil types were obtained in the Seattle, WA, area (sand, two types of loamy sand, sandy loam, and silt loam) and were analyzed to determine composition. Clay content ranged from 0.5 to 7.0%, and organic carbon content ranged from 0.7 to 4.6%. 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 when 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 the total surface area of one hand, 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. For dry soil, mean adherence was the lowest for the largest particle sizes (i.e., >250 µm) of dry soil (0.06 to 0.34 mg/cm^2) and highest for the smallest particle sizes (0.42 to 0.76 mg/cm^2). Adherence values based on moisture content ranged from 0.22 to 0.54 mg/cm^2 for soils with moisture contents of 9% or less, 0.39 to 3.09 mg/cm^2 for soils with moisture contents of 10 to 19%, and 1.64 to 14.8 mg/cm^2 for soils with moisture contents of 21 to 27%.

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.

7.4.2.7. *Holmes et al. (1996)—Investigation of the Influence of Oil on Soil Adherence to Skin*

Holmes et al. (1996) conducted experiments to evaluate differences in adherence of soil to skin based on soil type, moisture content, and the presence of oil (i.e., petroleum contaminants) in the soil. Three soil types (loamy sand, silt loam, and sand) treated with three concentrations (0, 1, and 10%) of motor oil were used, and the experiments were conducted under wet and dry soil conditions. A single subject pressed the right hand, palm down, into a pan containing soil. The soil adhering to the hand was collected by washing and then weighed. For dry soil containing no oil, adherence values ranged from 0.29 mg/cm^2 for sandy soil to 0.59 mg/cm^2 for silt loam. For wet soil containing no oil (13 to 15% moisture), adherence values were 0.25 mg/cm^2 for silt loam, 1.6 mg/cm^2 for sand, and 3.7 mg/cm^2 for loamy sand. According to Holmes et al. (1996), “high concentrations of petroleum contaminants can increase the dermal adherence of soil, but the magnitude of the effect is likely to be modest.”

The advantage of this study is that it provides additional perspective on the factors that affect soil adherence to skin. However, it is based on limited observations (i.e., one subject) for only the hand under experimental conditions (i.e., not activity-based).

7.4.2.8. *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 pre-activity and post-activity 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. Table 7-21 summarizes the parameters describing each of these activities. Before each trial, each participant was washed to obtain a preactivity or background gravimetric measurement.

For wet soil, post-activity 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, post-activity gravimetric measurements for children playing and adults transplanting showed higher soil loading on hands and much lower soil loading on other body surfaces. This also was 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. Kissel et al. (1998) observed geometric means of up to about 3 mg/cm^2 on adults’ hands after the 30-minute pipelaying activity with wet soil. After children played and adults transplanted in wet soil, geometric mean soil loadings were 0.7 and 1.1 mg/cm^2, respectively. 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 the short activity duration.

7.4.2.9. *Rodes et al. (2001)—Experimental Methodologies and Preliminary Transfer Factor Data for Estimation of Dermal Exposure to Particles*

Rodes et al. (2001) conducted a study using the fluorescein-tagged Arizona Test Dust (ATD) as a surrogate for house dust and evaluated particle mass transfer from surfaces to the human skin of three test subjects (one female and two males). Transfers to wet and dry skin from stainless steel, vinyl, and carpeted surfaces that had been preloaded with tagged ATD were quantified. For carpets, experiments were conducted in which particles were either embedded in the carpet fibers or not embedded. Particles were embedded into carpet by dragging a steel cylinder across the carpet after loading. Controlled hand (palm) press experiments were conducted, and the amount of tagged ATD that had transferred to the skin of the palm was measured using fluorometry. Surface loadings that represented typical indoor conditions were used in the study. Rodes et al. (2001) used defined dust fractions (<80 µm) to evaluate the influence of particles size on transfer. For the experiments with wet hands, a surrogate saliva solution was used. The portion of the hand that contacted the material also was estimated.

Dermal transfer factors were calculated as the mass of particles on the hand (µg on hand/cm^2 of dermal contact area) divided by the mass of particles on the surface contacts (µg on surface/cm^2 of surface contact). Table 7-22 shows the dermal transfer factors (based on the mean of left and right hand presses) for the various surface types and hand moisture contents. The results indicate that for dry hands, transfer from smooth surfaces (i.e., stainless steel) was higher than for other materials (58.2 to 76.0%; mean = 69 $\pm$ 9%). Skin moisture content was shown to be a critical factor in the proportion of particles to transfer (wet hands resulted in 100% transfer from stainless steel). As surface roughness increased, transfer tended to decrease, with carpet surfaces having the lowest transfer factors (3.4 to 16.9%). Embedding particles into the carpet significantly reduced particle transfer. Rodes et al. (2001) also observed that “only about 1/3rd of the projected hand surface typically came in contact with the smooth test surfaces during a press….[and] consecutive presses decreased the particle transfer by a factor of three as the skin became loaded, requiring ~100 presses to reach an equilibrium transfer rate.”

The advantage of this study is that it evaluated particle transfer for a variety of surface types and skin conditions. However, a small number of subjects were involved in the study, and Rodes et al. (2001) suggested that when using these data, the similarities and differences in characteristics between ATD and real house dust should be considered.

7.4.2.10. *Edwards and Lioy (2001)—Influence of Sebum and Stratum Corneum Hydration on Pesticide/Herbicide Collection Efficiencies of the Human Hand*

Edwards and Lioy (2001) studied the effects of sebum/sweat and skin hydration on the transfer of pesticide residues in dust to the hands. Under normal conditions, the skin on the hand is covered by a layer of sebum, a mixture of lipids secreted from the sebaceous glands, and sweat that is secreted from sweat ducts. Edwards and Lioy (2001) measured the levels of sebum and moisture on the palm of the hand of one subject prior to conducting hand press experiments using house dust treated with a mixture of four pesticides (atrazine, diazinon, malathion, and chlorpyrifos). The house dust sample was obtained from vacuum cleaner bags and was sieved to <250 µm. The dust was settled onto the sample surfaces and sprayed with the pesticide mixture, and the subject pressed one hand to the surface in a series of trials conducted approximately 1 week apart. The hand was rinsed with solvent to extract any transferred pesticide/dust, and the solution was analyzed for pesticide residues. Transfer efficiencies (percentage) were calculated as the concentration of residues measured in the hand rinse solution divided by the concentration of pesticide on the sampling surface times 100. The results of this study indicated that the transfer efficiencies of two pesticides in dust were negatively correlated with sebum levels (i.e., increased sebum levels resulted in a 13% reduction in atrazine transfer and an 8% reduction in malathion transfer) and transfer efficiencies of two pesticides in dust were negatively correlated with skin hydration [i.e., increased skin moisture resulted in a 7% reduction in diazinon transfer and 5% reduction in chlorpyrifos transfer; Edwards and Lioy (2001)].

The advantage of this study is that it provides additional perspective on factors that can affect adherence of solids to the skin. However, it is considered relevant and not key because the transfer of dust was studied for the hands only and used experimental conditions not based on exposure-related activities.

7.4.2.11. *Choate et al. (2006)—Dermally Adhered Soil: Amount and Particle Size Distribution*

Choate et al. (2006) investigated the soil characteristics that affect particle adherence to human skin. The factors considered included particle size, organic carbon content, and soil moisture. Day-to-day variability and differences based on whether or not hands were washed before contacting the soil also were examined. A total of 108 subjects (1/3 female) between 18 and 30 years of age participated in one or more of a series of soil adherence experiments. Some of the experiments were conducted using clay loam soil collected in Colorado, while others were conducted using silty-clay loam soil collected in Iowa. Soil moisture contents ranged from 1 to 10%. Choate et al. (2006) used either preweighed adhesive tape or hand washing with distilled water to remove and collect soil that had adhered to the palm of subjects' hands after contact with bulk soil under controlled experimental conditions. Removed soil was weighed, and the mass of soil per area of skin surface was calculated for each sample.

Based on the adhesive tape tests, an average of 0.7 mg/cm^2 of the Colorado soil adhered to the hand ($N = 6$ subjects each sampled using the right or left hand on 10–12 study days). There were no significant differences between the left and right hands, but there were "large average variabilities . . . both between subjects on a given day (±52%) and for an individual subject on different days (±50%)." Differences between soil adherence to hands that had or had not been washed prior to soil contact were observed, with hand washing resulting in a lower mean adherence value (0.51 mg/cm^2; $N = 76$) than non-washing (1.1 mg/cm^2; $N = 72$), when soil with a moisture content of 4.7% was used. The authors suggested that this is "probably due to the removal [during washing] of oils from the skin that aid in the adherence of soil particles." Soil adherence for the two types of soils (i.e., from Colorado and Iowa) with low moisture content (i.e., <2%) averaged 0.64 and 0.69 mg/cm^2, compared to 1.47 and 1.36 mg/cm^2 for those with high moisture content (9% to 10%). Large particle fractions of the soils with higher moisture content adhered more readily than those in soils with low or medium moisture content. The "adhered fractions of dry or moderately moist soils with wide distribution of particle sizes generally consist[ed] of particles of diameters <63 µm." The organic carbon content of the soils did not appear to be an important contributor to soil adherence.

The advantage of this study is that it provides additional perspective on factors that affect soil adherence to skin by using a larger number of subjects compared to some of the earlier studies. However, the data are based only on controlled experimental conditions and may not be representative of the specific types of activities in which dermal exposure may occur.

7.4.2.12. *Yamamoto et al. (2006)—Size Distribution of Soil Particles Adhered to Children's Hands*

Yamamoto et al. (2006) conducted both laboratory and field experiments that showed finer soil particles adhered more readily to children's hands than coarse particles. In the laboratory, one female subject pressed her hand into a tray containing reference soil. Her hand then was washed in ultrapure water that was analyzed to determine the size distributions and the amount of soil that had adhered to the hand. Yamamoto et al. (2006) observed that the mode diameter of soil adhering to the hand (22.8 ± 0.0 µm) was less than that of the reference soil (36.9 ± 4.9 µm), indicating that finer particles adhered more efficiently to the hand. The effect of hand moisture was tested by moistening the hand prior to pressing it onto the tray of soil. Yamamoto et al. (2006) observed that while the amount of soil that adhered to the hand increased with hand moisture, the size distributions were not greatly changed.

A separate field experiment was conducted in which ten 4-year-old children (five males and five females) attending a nursery school in Japan participated. After playing in the playground and sandbox for a morning or afternoon, the children's hands were washed in bottles containing 500 mL ultrapure water, and aliquots of the water were analyzed to determine the size distributions and amounts of particles that had adhered to the hands. The particles sizes of soil samples collected from the children's playing area (i.e., playground, field, and sandbox) also were analyzed. The mean, median, and maximum amounts of soil adhering to the children's hands were 26.2, 15.2, and 162.5 mg/hand, respectively. Assuming a surface area of the hand of 210 cm^2, the amounts are equivalent to 0.125, 0.73, and 0.774 mg/cm^2, respectively. Compared to the soil in the children's play area, the soil adhering to the children's hands was composed primarily of the finer particles.

The advantage of this study is that both laboratory and field measurements were used to evaluate particle sizes of soil that adheres to the hands. However, only one subject participated in the laboratory study, and the children's activities in the field portion were not indexed to the amount of time spent performing soil contact activities.

7.4.2.13. *Ferguson et al. (2009a; 2009c; 2009b; 2008)—Soil-Skin Adherence: Computer-Controlled Chamber Measurements*

Ferguson et al. (2009a; 2009c; 2009b; 2008) conducted a series of soil adherence experiments by using a mechanical chamber designed to control and measure pressure and time of contact with surfaces loaded with soil. Adherence of play sand and lawn soil to human cadaver skin and cotton sheet samples was measured after contact with either loaded carpet or aluminum surfaces. Multiple pressure levels (20 to 50 kPa), durations of contact (10 to 50 seconds), and particle sizes (<139.7 µm and $\geq$139.7 to <381.0 µm) were evaluated (Ferguson et al., 2009a; Ferguson et al., 2009b; Beamer et al., 2008). Also, both single- and multiple-contact experiments were conducted (Ferguson et al., 2009c). Soil adherence was estimated by weighing the carpet or aluminum samples loaded with play sand or lawn soil both before and after controlled contacts occurred and calculating the weight differences. Each experiment, using different combinations of pressure, contact duration, particle size, soil type, surface, and contact material, was repeated multiple times. Table 7-23 presents a comparison of the adherence values for contact with carpet and aluminum surfaces. Mean soil to skin adherence from contact with aluminum surfaces (1.18 mg/cm^2) was higher than from carpet (0.71 mg/cm^2). In general, soil transfer increased as pressure increased, and contact durations of 30 seconds or more did not appear to result in higher adherence. For carpets, larger particle size was associated with higher adherence, while smaller particle size was associated with higher adherence from aluminum (Ferguson et al., 2009a), Based on a comparison of data from experiments with multiple contacts, Ferguson et al. (2009c) found that, "on average, 8% of the original transfer amount will transfer during a second contact. Therefore, attaching a soil/adherence transfer of the original magnitude for every contact may result in overestimates for exposure."

The advantages of these studies are that they provide data from controlled experiments in which a variety of conditions were tested. However, a single carpet type was used, and transfer may differ based on carpet type. Also, adherence may be different for different types of soil or house dust, as well as for different skin types and conditions. Differences in the nature of contact and the initial surface soil loadings also may affect adherence.

7.5. FILM THICKNESS OF LIQUIDS ON SKIN

Information on the thickness of liquids on human skin is sometimes used to estimate dermal exposure to contaminants in liquids that come into contact with the skin. For example, these data are used to estimate exposure to consumer products in U.S. EPA's Exposure and Fate Assessment Screening Tool [EFAST; U.S. Environmental Protection Agency (2007b)]. Section 7.5.1 provides the available data on film thickness of liquids on the skin. However, these data are limited; therefore, studies related to this factor have not been categorized as key or relevant in this chapter, and specific recommendations are not provided for this factor.

7.5.1. U.S. EPA (1987)—Methods for Assessing Consumer Exposure to Chemical Substances; and U.S. EPA (1992c)—A Laboratory Method to Determine the Retention of Liquids on the Surface of Hands

U.S. EPA (1992c, 1987) reported on experiments that were conducted to measure the retention of liquids on hands after contact with six different types of liquids (mineral oil, cooking oil, water soluble bath oil, 50:50 oil/water emulsion, water, and 50:50 water ethanol). These liquids were selected because they were non-toxic and represented a range of viscosities and likely retention on the hands. Five exposure conditions were tested to simulate activities in which consumers' hands may be exposed to liquids, including (1) contact with dry skin (initial contact), (2) contact with skin previously exposed to the liquid and still wet (secondary contact), (3) immersion of a hand into a liquid, (4) contact from handling a wet rag, and (5) contact during spill cleanup. For the initial contact scenario, a cloth saturated with liquid was rubbed over the front and back of both clean, dry hands for the first time during an exposure event. For the secondary contact scenario, a cloth saturated with liquid was rubbed over the front and back of both hands for a second time, after as much as possible of the liquid that adhered to skin during the first contact event was removed using a clean cloth. For the immersion scenario, one hand was immersed in a container of liquid and then removed; the liquid was allowed to drip back into the container for 30 seconds (60 seconds for cooking oil). For the scenario involving the handling of a rag, a cloth saturated with liquid was rubbed over the palms of both hands in a manner simulating handling of a wet cloth. For the spill cleanup scenario, a subject used a clean cloth to wipe up 50 mL of liquid poured onto a plastic laminate countertop. For each of the five scenarios, retention was measured immediately after applying the liquid to the hands and after partial and full removal by wiping. Partial wiping was defined as "lightly [wiping with a removal cloth] for 5 seconds (superficially)." Full wiping was defined as "thoroughly and completely as possible within 10 seconds removing as much liquid as possible." Four human subjects were used in the experiments, and multiple replicates (four to six) were conducted for each subject and type of liquid and exposure condition. Retention of liquids on the skin was estimated by taking the difference between the weight of the cloth(s) before and after wiping and dividing by skin surface area. For the immersion scenario, retention was estimated as the weight difference in the immersion container before and after immersion. Film thickness (cm) was estimated as the amount of liquid retained on the skin (g/cm^2) divided by the density of the liquid (g/cm^3) used in the experiment.

Table 7-24 presents the estimated film thickness data from these experiments. Film thickness data may be used with information on the density of a liquid and the weight fraction of the chemical in the liquid to estimate the amount of contaminant retained on the skin (i.e., amount retained on skin [g/cm^2] = film thickness of liquid on skin [cm] × density of liquid [g/cm^3] × weight fraction [unitless]). Dermal exposure (g/event) may be estimated as the amount retained on the skin (g/cm^2) times the skin surface area exposed (cm^2/event).

The advantage of this study is that it provides data for a factor for which information is very limited. Data are provided for various types of liquids under various conditions. However, the data are based on a limited number of observations and may not be representative of all types of exposure scenarios.

7.6. RESIDUE TRANSFER

Several methods have been developed to quantify rates of residue transfer to the human skin of individuals performing activities on treated surfaces. These methods have been used to either develop transfer efficiencies or estimate residue transfer coefficients. Transfer efficiencies are the fraction (or percentage) of surface residues transferred to the skin. Transfer coefficients (cm^2/hour) represent the ratio of the dermal exposure during a specified time period (mg/hour) based on a specific exposure activity (e.g., harvesting a crop or performing indoor or outdoor activities) to the environmental concentration of the pesticide (mg/cm^2). Transfer coefficients are estimated in studies in which environmental residue levels are measured concurrently with exposure levels for particular job functions or activities. These studies have been conducted primarily for the purpose of estimating exposure to pesticides. Exposure levels are typically measured using dosimeter clothing that is worn by study subjects during the conduct of specific activities and then removed and analyzed for pesticide residues. Sometimes biomonitoring studies (i.e., urine analyses) or other methods (e.g., hand wash) are used to estimate exposure levels. Environmental residues are estimated using various techniques, including use of deposition coupons, wipe samples, or a residue collection tool such as a "drag sled" or roller on indoor or outdoor surfaces, as described in U.S. EPA (1998).

Although chemical-specific transfer coefficients are typically preferred for estimating exposure, U.S. EPA (2009) has used data from published and unpublished residue transfer studies to develop some generic activity-specific transfer coefficient assumptions to use in exposure assessments when chemical-specific data are unavailable. Use of these generic transfer coefficients for pesticides is based on the assumption that the transfer of residues to human skin is based primarily on the types of activities being performed rather than on the specific characteristics of the pesticide. This section presents data for published residue transfer studies only (i.e., unpublished data are not included here).

A transfer coefficient, expressed in units of cm^2/hour, is used to estimate exposure to chemical residues by combining it with the environmental concentration (in units of mg/cm^2) and an exposure time in hours/days (e.g., exposure [mg/day] = transfer coefficient [cm^2/hour] × environmental concentration [mg/cm^2] × exposure time [hours/day]). When using transfer co-efficients, it is important to ensure that the residue levels used are consistent with the method for developing the transfer coefficient (e.g., residue levels based on deposition coupons should be used with transfer co-efficients based on deposition coupons; residue levels based on a residue collection tool such as the California Roller should be used with transfer coefficients based on the same type of tool). Information on methods that may be used to estimate transferrable residues from indoor surfaces and dislodgeable residues from turf may be found in Hsu et al. (1990), Geno et al. (1996), Camann et al. (1996), Fortune (1998a, b), and Fortune et al. (2000). U.S. EPA (2009) describes the use of generic transfer coefficients for a variety of activities involving pesticides. Section 7.6.1 discusses the published data on transfer efficiencies and transfer coefficients gathered from the scientific literature. Because residue transfer depends on the specific conditions under which exposure occurs (e.g., activity, contact surfaces, age), the studies described in Section 7.6.1 have not been categorized as key or relevant, and specific recommendations are not provided for this factor.

7.6.1. Residue Transfer Studies

7.6.1.1. *Ross et al. (1990)—Measuring Potential Dermal Transfer of Surface Pesticide Residue Generated From Indoor Fogger Use: An Interim Report*

Ross et al. (1990) utilized choreographed exercise routines to measure the amount of pesticide residues that may be transferred from carpets to adult skin. Five adult volunteers wore dosimeter clothing (i.e., cotton tight, shirt, gloves, and socks) over the skin areas that normally would be exposed and conducted exercise routines for 18.2 minutes in hotel rooms where pesticides (i.e., chlorpyrifos and d-trans-allethrin) were applied (20 minutes total exposure to account for entry and exit from the treated rooms). The exercise routines were performed at times ranging from 0 to 13 hours after pesticide application. The routines included "substantial body contact between the subject and treated carpet" and were "intended to represent a person's day-long (16 hours]) contact with pesticide-treated surfaces in a home in which a total discharge fogger had been used" (Krieger et al., 2000). The dosimeter clothing was assumed to retain the same amount of pesticide as the skin (Krieger et al., 2000). It was collected and analyzed for pesticide residues to estimate the amount of residues that had been transferred from the carpet the skin. Environmental concentrations of the pesticides were measured in the rooms where the exercise routines took place by using gauze coupons placed in the rooms prior to pesticide application.

Ross et al. (1990) found that the transfer of pesticides (i.e., potential dermal exposure) differed according to the body part exposed and declined with time after pesticide application with a rapid decline in pesticide transfer between 6 and 12 hours. Some of the possible factors attributed to this decline were loss of formulation inerts, absorption by or adsorption to the carpet, breakdown to non-detected materials, downward migration into non-contact areas of the carpet or adsorption to dust particles, and volatilization. Table 7-25 provides the mean transfer efficiencies (i.e., percent of pesticide residues transferred to the various body parts from carpet), based on the time after application. These percentages represent the clothing residues divided by the environmental concentrations—based on deposition coupons—times 100 (Ross, 1990).

The study demonstrated the efficacy of using choreographed activities to estimate pesticide residue transfer. A limitation of this study is that the exercise routines used may not be representative of other types of indoor activities.

7.6.1.2. *Ross et al. (1991)—Measuring Potential Dermal Transfer of Surface Pesticide Residue Generated From Indoor Fogger Use: Using the CDFA Roller Method: Interim Report II*

Ross et al. (1991) reported on the use of the California Food and Drug Administration (CDFA) roller to estimate pesticide transfer from carpet. This study was conducted in parallel with the Ross et al. (1990) study. The roller device was tested as a surrogate for human subjects for measuring residue transfer from indoor surfaces. The roller was a 12-kg, foam-covered rolling cylinder equipped with stationary handles. A cotton cloth covered with plastic was placed over a pesticide-treated carpet, and the device was rolled over it 10 times. The cloth then was collected and analyzed for pesticide residues. Environmental residue levels were measured using gauze coupons placed on the carpet prior to pesticide application. Mean gauze dosimeter residues were compared to the amount of material transferred to the roller sheet. The results showed that the carpet roller method transferred 1 to 3% of carpet residue to the roller sheet. As in the 1990 study, pesticide transferability decreased with time and with contact with the treated surface. Using the data from Ross et al. (1990), which involved the collection of pesticide residues on dosimeter clothing worn by human subjects who engaged in choreographed exercise routines, and the roller data from this study, Ross et al. (1991) calculated residue transfer coefficients as the total µg of residues transferred to dosimetry clothing times hours of exposure/µg/cm^2 residue transferred to the roller sheet. Mean transfer coefficients were 200,000 ± 50,000 cm^2/hr for chlorpyrifos and 140,000 ± 30,000 cm^2/hr for d-trans allethrin. Ross et al. (1991) concluded that the use of a carpet roller was a good surrogate for measuring residue transfer.

A limitation of this study is that transfer of surface residues from the carpet to CDFA roller may not be representative of transfer of residues based on various human activities.

7.6.1.3. *Formoli (1996)—Estimation of Exposure of Persons in California to Pesticide Products That Contain Propetamphos*

Formoli (1996) conducted a study to estimate exposure to propetamphos that was applied to carpets. Five adult subjects (two men and three women) wore whole body dosimeters and performed structured exercise routines for 20 minutes on the treated carpet. The subjects' clothing was cut up and analyzed for pesticide residues. Transferable residues also were collected from the carpet by moving a roller device over cotton cloth that was subsequently analyzed for pesticide residues. Using the dermal exposure data from the dosimeters and the transferable residue data from the roller device, Formoli (1996) calculated a transfer coefficient of 43,800 cm^2/hr.

These data are useful because they provide perspective on residue transfer data based on controlled experimental conditions. However, the limitations of this study are that the exercise routines used may not be representative of all types of activities in which transfer of surface residues occurs, and the data are based on a single pesticide and a limited number of observations.

7.6.1.4. *Krieger et al. (2000)—Biomonitoring and Whole Body Dosimetry to Estimate Potential Human Dermal Exposure to Semi-Volatile Chemicals*

Krieger et al. (2000) conducted a study similar to the Ross et al. (1991; 1990) studies. The purpose of the Krieger et al. (2000) study was to compare dermal exposure estimated by four different methods. The methods included (1) measurement of residues deposited onto foil coupons that had been placed on the carpet prior to pesticide application; (2) measurement of residues transferred to cotton cloth using the CDFA roller method, as described by Ross et al. (1991); (3) measurement of residues transferred to whole body cotton dosimeters during structured exercise routines; and (4) analysis of biomonitoring (urine) from subjects who participated in structured activities wearing either cotton whole body dosimeters or swimsuits. A total of 13 subjects wore whole body dosimeters while 21 subjects wore bathing suits. Foggers containing the pesticide chlorpyrifos were discharged from the centers of two identical rectangular meeting rooms at the University of California, Riverside. The rooms were kept unventilated for 2 hours and then were opened with a room divider removed during 30 minutes of ventilation. Surface deposition and dislodgeable residues were measured with three aluminum foil coupons and cotton sheets placed at two, four, and six feet from each fogger. The exercise routines were the same as those used in Ross et al. (1990). Biomonitoring was conducted by collecting four successive 24-hour urine samples from each subject 1 day prior to exposure and 3 days after exposure to chlorpyrifos.

The average amounts of pesticide transferred to the dosimeters were 0.27 µg/cm^2 based on the CDFA roller method and 0.73 µg/cm^2 based on the whole body dosimetry method. These transfer amounts represent 7.5% and 20.2%, respectively, of the average concentration of pesticide on the surface of the carpet (3.6 µg/cm^2) based on the deposition coupons. Calculating the transfer coefficient in the same way as Ross et al. (1991), the mean transfer coefficient would be approximately 154,000 cm^2/hr (13,758 µg of residues transferred to dosimetry clothing per 0.33 hour of exposure/0.27 µg/cm^2 residue transferred to the roller sheet). Using the concentration of residues on the deposition coupons instead of those transferred to the roller cloth as the environmental concentration would give a transfer coefficient of approximately 12,000 cm^2/hr (13,758 µg of residues transferred to dosimetry clothing per 0.33 hour of exposure/3.6 µg/cm^2 residue deposited on the carpet). Absorbed doses and biomonitoring data reported by Krieger et al. (2000) are not summarized because the data are specific to the pesticide (chlorpyrifos) studied. However, the biomonitoring data indicate that "both types of dosimeters [roller cloth and whole body] removed substantially more [pesticide] than was transferred and absorbed by human skin" (Krieger et al., 2000).

The advantage of this study is that it compared estimates of pesticide residue transfer using a variety of methods. However, the results are based on a single pesticide and may not be representative of other chemicals or activities that may result in exposure.

7.6.1.5. *Clothier (2000)—Dermal Transfer Efficiency of Pesticides From New, Vinyl Sheet Flooring to Dry and Wetted Palms*

Clothier (2000) compared the transfer of pesticide residues from vinyl flooring to dry, water-wetted, and saliva-wetted hands. Three different pesticides were used in the study (chlorpyrifos, piperonyl butoxide, and pyrethrin). Three male subjects participated in the study by pressing their hand palm down on the vinyl surface. Prior to performing the hand presses, the hands were either treated with a sample of their own saliva or water or received no pretreatment (dry hands). Transferable residues also were collected using the polyurethane foam (PUF) roller method described by Camann et al. (1996). Deposition coupons also were used to measure the amount of pesticide applied to the flooring. Transfer efficiencies were estimated as the rate of transfer to hands or PUF roller (µg/cm^2) /mean surface loading (µg/cm^2) times 100. Table 7-26 presents the transfer efficiencies from this study. Transfer efficiencies were higher for wetted palms than for dry palms and for the PUF roller than for dry hands.

The advantage of this study is that it provides perspective on the effects of hand moisture on residue transfer. The data are based on three pesticides applied to vinyl surfaces and a limited number of subjects under controlled experimental conditions. However, the data may not reflect transfer associated with other chemicals or activities.

7.6.1.6. *Bernard et al. (2001)—Environmental Residues and Biomonitoring Estimates of Human Insecticide Exposure From Treated Residential Turf*

Bernard et al. (2001) conducted a study similar to those conducted by Ross et al. (1990) and Krieger et al. (2000), except that the exercise routines were conducted on pesticide-treated turf instead of on pesticide-treated carpets. Exposure was measured by analyzing whole body dosimeters worn by female participants during 20 minutes of exercise that occurred approximately 3.5 hours after pesticide had been applied to the turf. Pesticide deposition was estimated by collecting and analyzing cotton coupons present at the time of application. Dislodgeable residues were measured by collecting and rinsing foliage samples in an aqueous solution, and transferable turf residues were estimated using the CDFA roller 0, 1, and 3 days after application. Turf residues based on spray deposition (i.e., coupons), dislodgeable (aqueous wash) residues, and transferable (roller) residues were 12, 3.4, and 0.085 μg/cm^2, respectively. This suggests that dislodgeable residues were approximately 28% of the deposition residues, and transferable residues were less than 1% of the deposition residues. Bernard et al. (2001) estimated that exposures based on transferable residues and those based on whole body dosimetry would be similar because transferable residues based on whole body dosimetry and those based on the roller technique were similar.

This study provides perspective on residue transfer from treated turf. However, the data are for a single pesticide and may not be representative of other chemical substances or exposure conditions.

7.6.1.7. *Cohen Hubal et al. (2005)—Characterizing Residue Transfer Efficiencies Using a Fluorescent Imaging Technique*

Cohen Hubal et al. (2005) used a fluorescent tracer method to evaluate the factors that affect the transfer of residues from indoor surfaces to the hands. The non-toxic fluorescent tracer vitamin B_2 riboflavin was applied to carpet and laminate flooring. Two levels of analyte loading were evaluated in the study (2 μg/cm^2 and 10 μg/cm^2). Three adult subjects participated in a series of controlled experiments in which the hands contacted the treated surfaces using one of two different levels of pressure for one of two different durations. Transfer as a result of multiple sequential contacts also was evaluated. The hands were characterized as dry, moist, or sticky prior to conducting the hand presses on the treated flooring materials. To simulate moist hands, the hands were placed under a cool mist vaporizer for 20 seconds; to simulate sticky conditions, 1.2 grams of Karo Syrup was applied to the hands. Dermal loading on the hands was measured by using a fluorescence imaging system. Transfer efficiencies were estimated by dividing the mass of tracer on the hand per unit surface area (μg/cm^2) divided by the loading of tracer on the carpet or laminate surface (μg/cm^2) times 100. Incremental transfer efficiency was calculated separately for each individual contact, whereas overall transfer efficiency was calculated cumulatively for the series of contacts. Table 7-27 provides the incremental and overall transfer efficiencies based on the hand conditions, the surface type, the surface loading, and the number of contacts. Based on the data in Table 7-27, the mean transfer efficiency after a single contact ranged from 3 to 14% for dry and sticky hands, respectively. According to Cohen Hubal et al. (2005), surface loading and skin condition were important parameters in characterizing transfer efficiency, but duration of contact and pressure did not have a significant effect on transfer.

An advantage of this study is that it uses a tracer method to estimate transfer efficiency from surfaces to human skin. It also provides perspective on various conditions that may affect transfer efficiency. A limitation is that the data may not reflect transfer associated with specific chemicals or activities.

7.6.1.8. *Hubal et al. (2008)—Comparing Surface Residue Transfer Efficiencies to Hands Using Polar and Non-Polar Fluorescent Transfer*

As a follow up to the Cohen Hubal et al. (2005) study, Hubal et al. (2008) conducted a study using a second fluorescent tracer, Uvitex OB, which has different physical-chemical properties than riboflavin. The fluorescent tracer, which was used as a surrogate for pesticide residues, was applied to carpet or laminate surfaces at two different loading levels, and controlled hand transfer experiments were conducted by using various pressures and motions (i.e., press and smudge), numbers of contacts, and different hand conditions (i.e., dry or moist). The mass of tracer transferred to the hands was measured using a fluorescent tracer imaging system. The results indicated that "overall percent transfer ranged from 0.8 to 45.5% for the first contact and 0.6 to 19.4% for the seventh contact," and dermal loadings increased in a near linear fashion through the seventh contact. "Transfer was greater for laminate (over carpet), smudge (over press), and moist (over dry)" (Hubal et al., 2008). For lower surface loadings, dermal transfer increased through the seventh contact, suggesting that multiple contacts may be required to reach an effective equilibrium with the surface.

Similar to the previous study, the advantage of these data is that they are based on tracers and provide information on factors affecting residue transfer. However, the data may or may not accurately reflect transfer for specific chemicals or activities.

7.6.1.9. *Beamer et al. (2009)—Developing Probability Distributions for Transfer Efficiencies for Dermal Exposure*

Beamer et al. (2009) combined data from nine residue transfer studies and developed distributions for three pesticides (chlorpyrifos, pyrethrin I, and piperonyl butoxide) and three surface types (foil, vinyl, and carpet). The studies used for developing these distributions included Hsu et al. (1990), Ross et al. (1991), Camann et al. (1996; 1995), Geno et al. (1996), Fortune (1998a, b), Clothier (2000), and Krieger et al. (2000). Beamer et al. (2009) stratified the data by chemical and surface type. Statistical methods were used to develop the distributions, based on combined data from studies that used different sampling methods, surface concentrations, formulations, sampling time, and skin conditions (i.e., dry or wet). Transfer efficiencies were defined as the amount transferred to skin or a transfer media used as a surrogate for skin divided by the amount of pesticide applied to the surface.

Table 7-28 presents the lognormal parameter values for the three chemicals and three surface types evaluated. The results of statistical analyses indicated that the distributions of transfer efficiencies were statistically different for the surface types and chemicals shown in Table 7-28. Transfer efficiency was highest for foil for all chemicals, followed by vinyl and carpet. For example, the geometric mean transfer efficiencies ranged from 0.01 to 0.02 (i.e., 1 to 2%) for carpet, 0.03 to 0.04 (3 to 4%) for vinyl, and 0.83 to 0.86 (83 to 86%) for foil. According to Beamer et al. (2009), these distributions can be used for modeling transfer efficiencies.

An advantage of this data set is that it uses data from several of the studies described in this chapter to develop distributions for three pesticides and three surface types. However, there is some uncertainty with regard to the representativeness of these data for other chemicals or exposure conditions.

7.7. OTHER FACTORS

7.7.1. Frequency and Duration of Dermal (Hand) Contact

This section provides information from studies that evaluated activities that may affect dermal exposure. This includes information on the frequency and duration of dermal contact with objects and surfaces. Additional information on activities patterns and consumer product use that affect the frequency and duration of dermal contact is provided in Chapters 16 and 17. Information on hand-to-mouth contact frequency in presented in Chapter 4.

7.7.1.1. *Zartarian et al. (1997)—Quantified Dermal Activity Data From a Four-Child Pilot Field Study*

Zartarian et al. (1997) conducted a pilot field study in California in 1993 to estimate children's dermal contact with objects in their environment. Four Mexican American farm worker children ages 2 to 4 years were videotaped to record their activities over a 1-day period. Five to 30% of the children's time was spent outdoors, while the remainder was spent indoors. Videotape data were obtained over 6 to 11 waking hours for the four children (i.e., a total of 33 hours of videotape). The videotapes were translated to provide information about the objects that the children contacted, as well as the frequency and duration of contact. The data indicated that most objects were contacted for approximately 2 to 3 seconds in duration, and hard surfaces and hard toys were touched by children's hands for the longest percent of the time (Zartarian et al., 1997). Table 7-29 provides the average contact frequency for the left and right hands of the four children who participated in the study. Frequency of contact was highest for hard surfaces and hard toys (see Table 7-29).

The advantage of this study is that it was the first in a series of papers that used video-transcription methods to evaluate children's micro-activities relative to potential dermal exposure. However, the number of participants in this study (four children) was small, and the results may not be representative of all U.S. children.

7.7.1.2. *Reed et al. (1999)—Quantification of Children's Hand and Mouthing Activities Through a Videotaping Methodology*

Reed et al. (1999) used a videotaping methodology similar to that used by Zartarian et al. (1997) to quantify the hand contact activities of 30 children in New Jersey. A total of 20 children ages 3 to 6 years were observed in daycare facilities, while an additional 10 children, ages 2 to 5 years were observed in residential settings. Total videotaping time ranged from 3 to 7 hours for the daycare children and 5 to 6 hours for the residential children. Frequency of hand contact with objects and surfaces was quantified by recording touches with clothing, dirt, objects, and smooth or textured surfaces, as observed on video. According to Reed et al. (1999), "comparison of activities of children in home settings and daycare showed that rates of many of the activities did not differ significantly between venues and therefore, data from homes and daycare were combined." Table 7-30 presents the hand contact frequency data for the 30 children observed in this study. High contact frequencies were observed for clothing, objects, other, and smooth surfaces.

The advantages of this study are that more children were observed than in the previous study, and both daycare and residential children were included. However, the children were from a single location and may not be representative of all U.S. children.

7.7.1.3. *Freeman et al. (2001)—Quantitative Analysis of Children's Micro-Activity 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 behaviors that might contribute to exposure via dermal contact or non-dietary ingestion. Of these 168 families, 19 agreed to videotaping of the study children's activities for a period of 4 consecutive hours. The videotaped children ranged in age from 3 to 12 years of age but were divided into four age groups (3 to 4 years, 5 to 6 years, 7 to 8 years, and 10 to 12 years) for the purposes of quantifying microactivities. The frequency of touching clothing, textured surfaces (e.g., carpets and upholstered furniture), smooth surfaces (e.g., wood or plastic furniture, hardwood floor), or objects (e.g., toys, pencils, or other things that could be manipulated) was quantified by observing the behaviors on the videotapes during a 4-hour observation period. Table 7-31 shows the frequency of hand contacts per hour for the 19 children.

An advantage to this study is that it included results for various ages of children. However, the children in this study may not be representative of all U.S. children. Also, the presence of unfamiliar persons following the children with a video camera may have influenced the video-transcription methodology results.

7.7.1.4. *Freeman et al. (2005)—Contributions of Children's Activities to Pesticide Hand Loadings Following Residential Pesticide Application*

Freeman et al. (2005) gathered data on hand contacts with surfaces and objects as part of a study to evaluate pesticide exposure in residential settings. A convenience sample of 10 children between the ages of 24 and 55 months was selected for videotape observation on the 2nd day after their homes were treated with pesticides. The children were videotaped during a 4-hour period (only three children spent time outside the house, with outdoor times ranging from 21 to 57 minutes). The videotapes were transcribed to quantify contact rates in terms of frequency and duration. According to Freeman et al. (2005), "the duration of contact of most contact events was very short (2−3 seconds)," but contact with bottles, food, and objects tended to be somewhat longer (median durations ranged from 4.5 to 7.5 seconds for these items). Table 7-32 presents the right-hand contact rates (contacts per hour) for the various objects and surfaces. High contact items include objects and smooth surfaces.

The advantage of this study is that it provides additional information on hand contact frequency. However, the data are based on a limited number of children and were collected over a relatively short time period. Also, the presence of a video camera may have affected the children's behavior.

7.7.1.5. *AuYeung et al. (2006)—Young Children's Hand Contact Activities; an Observational Study via Videotaping in Primarily Outdoor Residential Settings*

AuYeung et al. (2006) gathered data on children's hand contact activities by videotaping them in outdoor residential settings in 1998–1999. A total of 38 children ages 1 to 6 years from middle class suburban families were recruited from the San Francisco Bay peninsula area to participate in the study. Each child was videotaped during 2 hours of natural (i.e., unstructured) play in an outdoor location (i.e., park, playground, outdoor residential area). Videotapes then were translated using a software package specially designed for this use. Contacts were tabulated for 15 object surface categories and for all non-dietary objects and all objects and surfaces combined. Hourly contact frequency, median duration per contact, and hourly contact duration were calculated for each child for the left hand, right hand, and both hands combined, and summary statistics were developed for all children combined. Table 7-33 provides the data for outdoor locations. According to AuYeung et al. (2006), these data suggest that children have a large number of short-duration contacts with outdoor objects and surfaces. AuYeung et al. (2006) also collected some limited data for indoor locations. These data are based on nine children who were videotaped for 15 minutes or more indoors. Table 7-34 provides summary data for these children.

The advantage of this study is that it provides dermal (hand) contact data for a wide variety of outdoor objects and surfaces. The data for indoor environments were limited, however, and the presence of unfamiliar persons following the children with a video camera may have influenced the video-transcription methodology results.

7.7.1.6. *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) used video observation and transcription methods to assess children's hand contacts with outdoor surfaces as part of a study to assess the relationship between blood level levels and children's activities in urban environments. During the summers of 2000 and 2001, a total of 37 children ages 1 to 5 years were videotaped during 2-hour periods while playing in outdoor urban residential settings. The children were primarily from low-income, Hispanic families. Ko et al. (2007) tabulated surface contacts by reviewing the videotapes and counting the number of times a child's hands touched one of the following surfaces: (1) cement, stone, or steel on the ground (cement); (2) porch floor or porch steps (porch); (3) grass; and (4) bare soil. Distributions of contact frequency (contacts per hour) were developed using the data for the 37 children for the four surface types and for all surfaces combined. According to Ko et al. (2007), the median contact frequency for all surfaces was 81 contacts per hour (geometric mean = 70 contacts per hour), with several children touching surfaces approximately 400 contacts per hour (see Table 7-35).

Similar to the AuYeung et al. (2006) study described in the previous section, the advantage of this study is that it provides data for outdoor dermal (hand) contacts with a variety of objects and surfaces. These surface types are somewhat different from those in AuYeung et al. (2006) but provide additional perspective on contact with outdoor surfaces. As with all studies that use videotape methods, however, the presence of unfamiliar persons following the children with a video camera may have influenced the results.

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

Beamer et al. (2008) conducted a study in which children were videotaped to estimate contacts with objects and surfaces in their environment. A convenience sample of 23 children residing in the farm worker community of Salinas Valley, CA, participated in the study. Participants were 6- to 13-month-old infants and 20- to 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.

Table 7-36 presents the mean and median object and surface contact frequency in events per hour. The most frequently contacted objects included toys (121 contacts per hour) and clothing/towels (114 contacts per hour). The mean frequency of hand contact of all objects and surfaces for both hands combined was 686.3 contacts per hour. Table 7-36 also provides information on the duration of contact with these objects and surfaces in minutes per hour and in seconds per contact.

The advantage of this study is that it included both infants and toddlers. Also, it provided data for a wide variety of objects and surfaces. Differences between the two age groups, as well as sex differences, were observed. As with other video-transcription studies, however, the presence of non-family-member videographers and a video camera may have influenced the children's behavior.

7.7.2. Thickness of the Skin

Although factors that influence dermal uptake (i.e., absorption) and internal dose are not the focus of this chapter, limited information on the physiological characteristics of the skin (i.e., thickness of the skin on various body parts) is presented here to provide some perspective on this topic. It should be noted that this is only one factor that may influence dermal uptake. Others include the condition of the skin (e.g., Williams et al. (2005; 2004), suggested that the presence of perspiration on the skin may affect uptake of contaminants) and chemical-specific factors (e.g., concentration of chemical in contact with the skin and characteristics of the chemical that affect its rate of absorption).

The skin consists of two distinct layers: the epidermis (outermost layer) and dermis. The outermost layer of the epidermis is the stratum corneum or horny layer. Because the stratum corneum serves as the body's outermost boundary, it is the layer where chemical exposures may occur. According to the International Commission on Radiological Protection (ICRP, 1975), the thickness of the stratum corneum of adults is "approximately one-tenth that of the epidermis except for palms [of hands] and soles [of feet] where it may be much thicker." Over most parts of the body, the stratum corneum is estimated to range in thickness from about 13 to 15 µm, but it may vary by region of the body, with the certain parts (e.g., the "horny pads") of the palms and soles being as high as 600 µm (ICRP, 1975). Holbrook and Odland (1974) used electron microscopy to measure the thickness of the stratum corneum from fixed tissues collected from the abdomen, back, forearm, and thigh of six subjects (three men and three women) ages 25 to 31 years old. The mean thicknesses for these four body regions were 8.2, 9.4, 12.9, and 10.9 µm, respectively. Schwindt et al. (1998) estimated thickness using skin at the same four sites in six women with a mean age of 33.2 years. Based on calculations from measurements of transepidermal water loss during tape stripping, mean thicknesses were estimated to be 7.7 ± 1.7, 11.2 ± 2.6, 12.3 ± 3.6, and 13.1 ± 4.7 µm for the abdomen, back, forearm, and thigh, respectively (Schwindt et al., 1998). Using two methods of calculating thickness, Pirot et al. (1998) estimated the thickness of the stratum corneum on the forearms of 13 subjects (2 men and 11 women) between the ages of 23 and 60 years. The mean ± standard deviation values were 11.3 ± 5.1 and 12.6 ± 5.3 µm. Russell et al. (2008) estimated the thickness of the stratum corneum on the forearm to be approximately 10 µm, based on 18 adults (3 men and 15 women) between the ages of 22 and 43 years. Egawa et al. (2007) estimated the stratum corneum thickness on five body parts of 15 Japanese adults (6 men and 9 women) ages 23 to 49 years old. Mean ± standard deviation thicknesses were 16.8 ± 2.8, 21.8 ± 3.6, 22.6 ± 4.3, 29.3 ± 6.8, and 173 ± 37.0 for the cheek, upper arm, forearm, back of hand, and palm of hand, respectively (Egawa et al., 2007).

For newborn infants, the stratum corneum "is extremely thin, but grows rapidly during the first month" (ICRP, 1975). Based on measurements of newborn skin that was fixed in formalin, thickness of the stratum corneum was about 10 µm on the back and about 80 to 140 µm on the sole of the foot of newborns. Based on measurement using non-fixed, fresh, frozen newborn skin, the thickness of the stratum corneum ranged from 10 to 50 µm for portions of the buttocks and abdomen and most other regions of the body except the hands and feet (ICRP, 1975).

7.8. REFERENCES FOR CHAPTER 7

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Table 7-6. Percentage of Total Body Surface Area by Body Part for Children (sexes combined) and Adults by Sex

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
Male and Female Children Combined													
<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	
Male, 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
Female, 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

[a] Sample size = 13.
[b] Sample size = 12.
N = Number of subjects, (M:F = male:female).
Min = Minimum percent.
Max = Maximum percent.

Source: U.S. EPA (1985).

Table 7-7. Summary of Equation Parameters for Calculating Adult Body Surface Area[a]

		Equation for surface areas (m^2)					
Body Part	*N*	a_o	W^{a1}	H^{a2}	P	R^2	SE
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] $SA = a_o W^{a1} H^{a2}$ where: W = Weight in kilograms; H = Height in centimeters; P = Level of significance; R^2 = Coefficient of determination; SA = Surface Area; SE = 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 Proportion (%) of Children's Total Skin Surface Area, by Body Part

	Age (years)								
	2	4	6	8	10	12	14	16	18
	Males								
N	115	118	117	104	124	154	155	100	88
Head	8.4	8.1	7.0	6.0	5.4	4.9	4.3	4.0	3.9
Neck	3.9	3.8	3.2	2.7	2.6	2.3	2.2	2.0	2.0
Bosom	12.3	12.3	12.2	12.2	12.2	12.4	12.3	12.3	12.8
Shoulders	1.9	2.1	1.9	1.9	1.8	1.8	1.8	1.8	1.9
Abdomen	2.7	2.9	2.7	2.8	2.7	2.8	2.8	2.8	2.9
Back	12.9	13.2	13.1	13.1	13.1	13.4	13.4	13.3	13.9
Genitals and Buttocks	7.1	6.9	6.9	6.8	7.1	7.0	7.2	7.2	6.8
Thighs	14.9	15.0	16.2	16.6	17.6	17.4	18.2	18.1	18.3
Legs	10.3	10.3	10.9	11.7	11.8	11.9	11.9	11.9	11.2
Feet	6.5	6.5	6.7	7.2	6.8	7.0	6.6	6.7	6.1
Upper Arms	8.7	8.5	8.6	8.6	8.8	8.7	8.9	9.6	9.6
Lower Arms	5.8	5.6	5.7	5.7	5.5	5.5	5.7	5.8	5.9
Hands	4.5	4.8	4.9	4.7	4.6	4.7	4.7	4.7	4.7
	Females								
N	97	110	126	93	134	133	116	98	68
Head	8.4	7.8	6.9	6.1	5.3	4.8	4.5	4.3	4.3
Neck	3.8	3.6	3.2	2.8	2.5	2.3	2.1	2.1	2.0
Bosom	12.4	12.6	12.4	12.2	12.1	12.0	12.3	13.3	14.3
Shoulders	2.0	2.0	1.9	1.9	1.8	1.8	1.7	1.8	1.8
Abdomen	3.0	2.9	2.8	2.8	2.7	2.7	2.8	2.9	3.0
Back	13.2	13.4	13.2	13.1	13.0	12.9	13.2	13.9	14.1
Genitals and Buttocks	6.8	6.6	6.6	6.6	7.0	7.3	8.0	7.9	8.1
Thighs	14.2	15.6	16.5	18.4	18.4	18.5	18.9	17.8	17.4
Legs	11.2	10.4	11.4	11.3	12.2	12.5	12.1	11.9	11.5
Feet	6.0	6.3	6.6	6.5	6.7	6.5	6.1	6.1	5.6
Upper Arms	8.6	8.4	8.3	8.1	8.4	8.8	8.8	8.6	8.5
Lower Arms	5.6	5.5	5.3	5.5	5.3	5.5	5.3	5.3	5.1
Hands	4.8	4.9	4.9	4.7	4.5	4.5	4.2	4.2	4.4

N = Number of observations.

Note: Sums of columns may equal slightly more or less than 100% due to rounding.

Source: Boniol et al. (2008).

Table 7-9. 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								
			5^{th}	10^{th}	15^{th}	25^{th}	50^{th}	75^{th}	85^{th}	90^{th}	95^{th}
Males and Females Combined											
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	1,159	0.53	0.45	0.46	0.47	0.49	0.53	0.56	0.58	0.59	0.61
2 to <3 years	1,122	0.61	0.52	0.54	0.55	0.57	0.61	0.64	0.67	0.68	0.70
3 to <6 years	2,303	0.76	0.61	0.64	0.66	0.68	0.74	0.81	0.85	0.89	0.95
6 to <11 years	3,590	1.08	0.81	0.85	0.88	0.93	1.05	1.21	1.31	1.36	1.48
11 to <16 years	5,294	1.59	1.19	1.25	1.31	1.4	1.57	1.75	1.86	1.94	2.06
16 to <21 years	4,843	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 7-10. 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, Male

Age Group	*N*	Mean	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
					Male						
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	1,150	0.76	0.61	0.64	0.66	0.69	0.75	0.82	0.86	0.89	0.95
6 to <11 years	1,794	1.09	0.82	0.86	0.89	0.94	1.06	1.21	1.29	1.34	1.46
11 to <16 years	2,593	1.61	1.17	1.23	1.28	1.39	1.60	1.79	1.90	1.99	2.12
16 to <21 years	2,457	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 older	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 7-11. 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
Female											
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	1,153	0.75	0.61	0.64	0.66	0.68	0.74	0.80	0.84	0.88	0.94
6 to <11 years	1,796	1.08	0.80	0.85	0.87	0.92	1.04	1.21	1.33	1.39	1.51
11 to <16 years	2,701	1.57	1.20	1.28	1.34	1.42	1.55	1.69	1.8	1.88	2.00
16 to <21 years	2,386	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 older	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 7-12. Surface Area of Adult Males (21 years and older) in Square Meters

Body Part	Percentile									
	Mean	5th	10th	15th	25th	50th	75th	85th	90th	95th
Adult Males										
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 7-13. Surface Area of Adult Females (21 years and older) in Square Meters

Body Part	Percentile									
	Mean	5th	10th	15th	25th	50th	75th	85th	90th	95th
Adult Females										
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 7-14. Statistical Results for Total Body Surface Area Distributions (m^2), for Adults				
	Males			
	U.S. EPA	Boyd	Du Bois and Du Bois	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
	Females			
	U.S. EPA	Boyd	Du Bois and Du Bois	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).				

Table 7-15. Descriptive Statistics for Surface Area/Body-Weight (SA/BW) Ratios (m^2/kg)

Age (year)	Mean	Range Min–Max	SD	SE	Percentiles						
					5th	10th	25th	50th	75th	90th	95th
Male and Female Combined											
0 to 2	0.064	0.042−0.114	0.011	0.001	0.047	0.051	0.056	0.062	0.072	0.078	0.085
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	0.050	0.059
≥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 7-16. Estimated Percent of Adult Skin Surface Exposed During Outdoor Activities

	Skin Area Exposed (% of total body surface area)			
	N	5th percentile	50th percentile	95th percentile
Gardening				
Cold months	31	3	8	33
Warm months	212	3	33	69
Other Yard Work	73	3	3	31
Cold months	245	8	33	68
Team Sports				
Cold months	26	3	8	33
Warm months	71	14	33	43
Repair/Digging	15	3	3	14
Cold months	65	9	28	67

N = Number of observations.

Source: Garlock et al. (1999).

Table 7-17. Estimated Skin Surface Exposed During Warm Weather Outdoor Activities

	Skin Area Exposed (% of total body surface area)		
	Play	Gardening/Yardwork	Organized Team Sport
Age (year)	<5	5 to 17	5 to 17
N	41	47	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 7-18. Median per Contact Outdoor Fractional Surface Areas of the Hands, by Object, Both Hands Combined

	Animal	Body	Clothes	Fabric	Floor	Food	Footwear	Metal	Non-Dietary Water	Paper	Plastic	Rock /Brick	Toy	Vegetation /Grass	Wood	All Objects
N	12	38	38	19	37	26	30	38	9	27	36	16	37	37	38	38
Minimum	0.02	0.06	0.11	0.05	0.13	0.02	0.02	0.00	0.08	0.02	0.08	0.06	0.08	0.02	0.07	0.13
Maximum	0.27	0.27	0.30	0.30	1.00	1.00	0.25	0.27	1.00	0.30	0.30	0.30	0.27	0.30	0.30	0.27
Mean	0.18	0.15	0.22	0.16	0.24	0.16	0.11	0.14	0.52	0.13	0.17	0.20	0.15	0.17	0.20	0.16
5th percentile	0.04	0.07	0.14	0.11	0.13	0.03	0.03	0.11	0.10	0.03	0.13	0.07	0.13	0.03	0.11	0.13
25th percentile	0.12	0.13	0.19	0.14	0.19	0.05	0.06	0.14	0.19	0.08	0.14	0.18	0.14	0.12	0.15	0.14
50th percentile	0.20	0.16	0.22	0.15	0.24	0.11	0.10	0.14	0.31	0.13	0.15	0.23	0.14	0.16	0.18	0.15
75th percentile	0.24	0.19	0.26	0.15	0.27	0.14	0.14	0.15	1.00	0.17	0.19	0.24	0.15	0.24	0.25	0.17
95th percentile	0.26	0.24	0.30	0.24	0.30	0.80	0.21	0.19	1.00	0.25	0.28	0.28	0.24	0.30	0.30	0.26
95th percentile	0.26	0.26	0.30	0.29	0.75	1.00	0.25	0.26	1.00	0.29	0.30	0.30	0.26	0.30	0.30	0.27

N = Number of subjects.

Source: AuYeung et al. (2008).

Table 7-19. Summary of Field Studies That Estimated Activity-Specific Adherence Rates

Activity	Month	Event[a] (hours)	*N*	M	F	Age (years)	Conditions	Clothing	Study
Indoor									
Tae Kwon Do	Feb.	1.5	7	6	1	8 to 42	Carpeted floor	All in long sleeve-long pants martial arts uniform, sleeves rolled back, barefoot	Kissel et al. (1996b)
Greenhouse Worker	Mar.	5.25	2	1	1	37 to 39	Plant watering, spraying, soil blending, sterilization	Long pants, elbow length short sleeve shirt, no gloves	
Indoor Kid No. 1	Jan.	2	4	3	1	6 to 13	Playing on carpeted floor	3 or 4 short pants, 2 of 4 short sleeves, socks, no shoes	Holmes et al. (1999)
Indoor Kid No. 2	Feb.	2	6	4	2	3 to 13	Playing on carpeted floor	5 of 6 long pants, 5 of 6 long sleeves, socks, no shoes	
Daycare Kid No. 1a	Aug.	3.5	6	5	1	1 to 6.5	Indoors: linoleum surface; Outdoors: grass, bare earth, barked area	4 of 6 long pants, 5 of 6 short sleeves, socks, shoes	
Daycare Kid No. 1b	Aug.	4	6	5	1	1 to 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 Kid No. 2[b]	Sept.	8	5	4	1	1 to 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 Kid No. 3	Nov.	8	4	3	1	1 to 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 to 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. (1996b)
Soccer No. 2	Mar.	1.5	8	0	8	24 to 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 to 34	All weather field (sand-ground tires)	All in short sleeve shirts, shorts, knee socks, shin guards	
Groundskeeper No. 1	Mar.	1.5	2	1	1	29 to 52	Campus grounds, urban horticulture center, arboretum	All in long pants, intermittent use of gloves	
Groundskeeper No. 2	Mar.	4.25	5	3	2	22 to 37	Campus grounds, urban horticulture center, arboretum	All in long pants, intermittent use of gloves	
Groundskeeper No. 3	Mar.	8	7	5	2	30 to 62	Campus grounds, urban horticulture center, arboretum	All in long pants, intermittent use of gloves	

Activity	Month	Event[a] (hours)	*N*	M	F	Age (years)	Conditions	Clothing	Study
Outdoor (continued)									
Groundskeeper No. 4	Aug.	4.25	7	4	3	22 to 38	Campus grounds, urban horticulture center, arboretum	5 of 7 in short sleeve shirts, intermittent use of gloves	Kissel et al. (1996b)
Groundskeeper No. 5	Aug.	8	8	6	2	19 to 64	Campus grounds, urban horticulture center, arboretum	5 of 8 in short sleeve shirts, intermittent use of gloves	
Irrigation Installer	Oct.	3	6	6	0	23 to 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 to 22	Mixed grass-bare wet field	All in short sleeve shirts, shorts, variable sock lengths	
Farmer No. 1	May	2	4	2	2	39 to 44	Manual weeding, mechanical cultivation	All in long pants, heavy shoes, short sleeve shirts, no gloves	
Farmer No. 2	July	2	6	4	2	18 to 43	Manual weeding, mechanical cultivation	2 of 6 short, 4 of 6 long pants, 1 of 6 long sleeve shirt, no gloves	
Reed Gatherer	Aug.	2	4	0	4	42 to 67	Tidal flats	2 of 4 short sleeve shirts/knee length pants, all wore shoes	
Kid-in-Mud No. 1	Sept.	0.17	6	5	1	9 to 14	Lake shoreline	All in short sleeve T-shirts, shorts, barefoot	
Kid-in-Mud No. 2	Sept.	0.33	6	5	1	9 to 14	Lake shoreline	All in short sleeve T-shirts, shorts, barefoot	
Gardener No. 1	Aug.	4	8	1	7	16 to 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)
Gardener No. 2	Aug.	4	7	2	5	26 to 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 to 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	8	7	0	24 to 30	Compacted mixed grass and bare earth field	All short pants, 7 of 8 short or rolled up sleeves, socks, shoes	
Archeologist	July	11.5	7	3	4	16 to 35	Digging with trowel, screening dirt, sorting	6 of 7 short pants, all short sleeves, 3 no shoes or socks, 2 sandals	
Construction Worker	Sept.	8	8	8	0	21 to 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 to 43	Digging (manual and mechanical), rock moving	All long pants, 2 long sleeves, all socks and boots	

Table 7-19. Summary of Field Studies That Estimated Activity-Specific Adherence Rates (continued)

Table 7-19. Summary of Field Studies That Estimated Activity-Specific Adherence Rates (continued)

Activity	Month	Event[a] (hours)	*N*	M	F	Age (years)	Conditions	Clothing	Study
Outdoor (continued)									
Utility Worker No. 1	July	9.5	5	5	0	24 to 45	Cleaning, fixing mains, excavation (backhoe and shovel)	All long pants, short sleeves, socks, boots, gloves sometimes	Holmes et al. (1999)
Utility Worker No. 2	Aug.	9.5	6	6	0	23 to 44	Cleaning, fixing mains, excavation (backhoe and shovel)	All long pants, 5 of 6 short sleeves, socks, boots, gloves sometimes	
Equip. Operator No. 1	Aug.	8	4	4	0	21 to 54	Earth scraping with heavy machinery, dusty conditions	All long pants, 3 of 4 short sleeves, socks, boots, 2 of 4 gloves	
Equip. Operator No. 2	Aug.	8	4	4	0	21 to 54	Earth scraping with heavy machinery, dusty conditions	All long pants, 3 of 4 short sleeves, socks, boots, 1 gloves	
Shoreline Play (children)	Sept.	0.33−1.0	9	6	3	7 to 12	Tidal flat	No shirt or short sleeve T-shirts, shorts, barefoot	Shoaf et al. (2005b)
Clamming (adults)	Aug.	1−2	18	9	9	33 to 63	Tidal flat	T-shirt, shorts, shoes	Shoaf et al. (2005a)

a Event duration.
b Activities were confined to the house.
N = Number of subjects.
M = Males.
F = Females.

Table 7-20. 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 Worker	2	0.043 --	0.0064 --	0.0015 --	0.0050 --	
Indoor Kid No. 1	4	0.0073 1.9	0.0042 1.9	0.0041 2.3		0.012 1.4
Indoor Kid No. 2	6	0.014 1.5	0.0041 2.0	0.0031 1.5		0.0091 1.7
Daycare Kid No. 1a	6	0.11 1.9	0.026 1.9	0.030 1.7		0.079 2.4
Daycare Kid No. 1b	6	0.15 2.1	0.031 1.8	0.023 1.2		0.13 1.4
Daycare Kid No. 2	5	0.073 1.6	0.023 1.4	0.011 1.4		0.044 1.3
Daycare Kid 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	
Groundskeeper No. 1	2	0.15 --	0.005 --		0.0021 --	0.018 --
Groundskeeper No. 2	5	0.098 2.1	0.0021 2.6	0.0010 1.5	0.010 2.0	
Groundskeeper No. 3	7	0.030 2.3	0.0022 1.9	0.0009 1.8	0.0044 2.6	0.0040
Groundskeeper No. 4	7	0.045 1.9	0.014 1.8	0.0008 1.9	0.0026 1.6	0.018 --
Groundskeeper No. 5	8	0.032 1.7	0.022 2.8	0.0010 1.4	0.0039 2.1	
Irrigation Installer	6	0.19 1.6	0.018 3.2	0.0054 1.8	0.0063 1.3	

Table 7-20. 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	0.27	0.36	0.059	
		1.7	1.6	1.7	2.7	
Farmers No. 1	4	0.41	0.059	0.0058	0.018	
		1.6	3.2	2.7	1.4	
Farmers No. 2	6	0.47	0.13	0.037	0.041	
		1.4	2.2	3.9	3.0	
Reed Gatherer	4	0.66	0.036	0.16		0.63
		1.8	2.1	9.2		7.1
Kid-in-Mud No. 1	6	35	11	36		24
		2.3	6.1	2.0		3.6
Kid-in-Mud No. 2	6	58	11	9.5		6.7
		2.3	3.8	2.3		12.4
Gardener No. 1	8	0.20	0.050	0.072	0.058	0.17
		1.9	2.1	--	1.6	--
Gardener No. 2	7	0.18	0.054	0.022	0.047	0.26
		3.4	2.9	2.0	1.6	--
Rugby No. 2	8	0.14	0.11	0.15	0.046	
		1.4	1.6	1.6	1.4	
Rugby No. 3	7	0.049	0.031	0.057	0.020	
		1.7	1.3	1.2	1.5	
Archeologist	7	0.14	0.041	0.028	0.050	0.24
		1.3	1.9	4.1	1.8	1.4
Construction Worker	8	0.24	0.098	0.066	0.029	
		1.5	1.5	1.4	1.6	
Landscape/Rockery	4	0.072	0.030		0.0057	
		2.1	2.1		1.9	
Utility Worker No.1	5	0.32	0.20		0.10	
		1.7	2.7		1.5	
Utility Worker No. 2	6	0.27	0.30		0.10	
		2.1	1.8		1.5	
Equip. Operator No. 1	4	0.26	0.089		0.10	
		2.5	1.6		1.4	
Equip. Operator No. 2	4	0.32	0.27		0.23	
		1.6	1.4		1.7	
Shoreline Play	9	0.49	0.17	0.70	0.04	21
(children)		8.2	3.1	3.6	2.9	1.9
Clamming (adults)	18	0.88	0.12	0.16	0.02	0.58
		17	1.1	4.7	0.10	12

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. (1996b); Holmes et al. (1999); Shoaf et al. (2005a, b).

Table 7-21. Summary of Controlled Greenhouse Trials							
Activity	Ages (years)	Duration (min)	Soil Moisture (%)	Clothing[a]	*N*	Male	Female
Transplanting	Adult	~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	Adult	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).

Table 7-22. Dermal Transfer Factors for Selected Contact Surface Types and Skin Wetness, Using <80 µm Tagged ATD				
Mean surface Loading µg/cm^2	Test Subject[a]	Contact Surface Type[b]	Skin Moisture Level[c]	Dermal Transfer Factor[d]
36.3	F1	SS	Dry	0.760 (0.000)
39.1	M1	SS	Dry	0.716 (NA)
32.0	M1	SS	Damp	1.222 (NA)
45.0	M1	SS	Wet	1.447 (NA)
42.6	M2	SS	Dry	0.582 (0.059)
23.8	M2	SS	Damp	0.970 (NA)
30.6	M2	SS	Wet	1.148 (NA)
30.5	M2	Vinyl	Dry	0.554 (0.052)
32.7	M2	Vinyl	Damp	0.485 (0.068)
38.9 (not embedded)	M2	Carpet	Dry	0.087 (0.000)
36.4 (embedded)	M2	Carpet	Dry	0.034 (0.007)
33.8 (not embedded)	M2	Carpet	Damp	0.190 (0.002)
33.3 (embedded)	M2	Carpet	Damp	0.169 (0.11)

[a] F1 = female subject; M1 and M2 = male subjects.
[b] SS = stainless steel; vinyl linoleum; nylon carpet.
[c] Dry = no added moisture; wet = synthetic saliva moistened (moisture visible but not excessive).
[d] Dermal transfer factor = µg on hand/cm^2 of dermal contact area/µg on surface/cm^2 of surface contact. Based on mean of left and right hand presses. Standard deviation (SD) in parenthesis; NA = not available.

Source: Rodes et al. (2001).

Table 7-23. Comparison of Adherence (mg/cm^2) for Contact With Carpet and Aluminum Surfaces, Averaged Across Pressure, Contact Time, Soil Type, and Soil Particle Size[a]

	Carpet Transfer	Hard Surface (aluminum) Transfer	Combined (carpet/aluminum) Transfer
Mean Soil Adherence	0.37 ± 0.4	0.42 ± 0.6	0.39 ± 0.4
Mean Soil-Skin Adherence	0.71 ± 0.5	1.18 ± 0.4	0.92 ± 0.5
Mean Soil-Cloth Adherence	0.20 ± 0.3	0.15 ± 0.4	0.17 ± 0.4

[a] Soil adherence values averaged across pressure, time, soil type, and soil size.

Source: Ferguson et al. (2009a).

Table 7-24. Film Thickness Values of Selected Liquids Under Various Experimental Conditions (10^{-3}cm)

	Mineral Oil[a]	Cooking Oil[b]	Bath Oil[c]	Oil/ Water[d]	Water[e]	Water/ Ethanol[f]
Initial Contact[g]						
No wipe[h]	1.56	2.25	1.74	2.03	2.34	3.25
Partial wipe[i]	0.62	0.82	0.59	1.55	1.83	2.93
Full wipe[j]	0.27	0.34	0.20	1.38	1.97	3.12
Secondary Contact[k]						
No wipe[h]	1.40	1.87	1.56	1.60	2.05	2.95
Partial wipe[i]	0.47	0.52	0.48	1.19	1.39	2.67
Full wipe[j]	0.06	0.07	0.08	0.92	1.32	2.60
Immersion[l]						
No wipe[h]	11.87	6.55	6.90	9.81	4.99	6.55
Partial wipe[i]	2.00	1.46	1.55	2.42	2.14	2.93
Full wipe[j]	-	-	-	-	-	-
Handling Rag[m]						
No wipe[h]	1.64	1.50	2.04	1.88	2.10	4.17
Partial wipe[i]	0.44	0.34	0.53	1.21	1.48	3.70
Full wipe[j]	0.13	0.01	0.21	0.96	1.37	3.58
Spill Cleanup[n]						
No wipe[h]	1.23	0.73	0.89	1.19	-	-
Partial wipe[i]	0.55	0.51	0.48	1.36	-	-
Full wipe[j]	-	-	-	-	-	-

[a] Density = 0.8720 g/cm^3.
[b] Density = 0.9161 g/cm^3.
[c] Density = 0.8660 g/cm^3.
[d] Density = 0.9357 g/cm^3; 50% water and 50% oil.
[e] Density = 0.9989 g/cm^3.
[f] Density = 0.9297 g/cm^3; 50% water and 50% ethanol.
[g] Initial contact = cloth saturated with liquid was rubbed over the front and back of both clean, dry hands for the first time during an exposure event.
[h] Retention of liquid on the skin was estimated without any intentional removal of liquid by wiping.
[i] Retention was measured after ‘partial’ removal of liquids on the skin by wiping. Partial wiping was defined as “lightly [wiping with a removal cloth] for 5 seconds (superficially).”
[j] Retention was measured after ‘full’ removal of liquids on the skin by wiping. Full wiping was defined as “ thoroughly and completely as possible within 10 seconds removing as much liquid as possible.”
[k] Secondary contact = cloth saturated with liquid was rubbed over the front and back of both hands for a second time, after as much as possible of the liquid that adhered to skin during the first contact event was removed using a clean cloth.
[l] Immersion = one hand immersed in a container of liquid, removed, and liquid allowed to drip back into container for 30 seconds (60 seconds for cooking oil).
[m] Handling rag = cloth saturated with liquid was rubbed over the palms of both hands for the first time during an exposure event in a manner simulating handling of a wet cloth.
[n] Spill cleanup = subject used a clean cloth to wipe up 50 mL of liquid poured onto a plastic laminate countertop.
\- = no data.

Note: Data for mineral oil, cooking oil, and bath oil for initial contact, secondary contact, and immersion from U.S. EPA (1992c). All other data from U.S. EPA (1987).

Source: U.S. EPA (1987) and U.S. EPA (1992c).

Table 7-25. Mean Transfer Efficiencies (%)[a]

Time After Application[b]	Legs (tights)	Torso and Arms (shirt)	Feet (socks)	Hands (gloves)
0 hours				
chlorpyrifos	6.6 ± 1.6	5.6 ± 2.6	32.1 ± 13.4	17.4 ± 8.6
allethrin	5.9 ± 1.5	5.4 ± 2.4	34.3 ± 18.3	22.4 ± 12.6
6 hours				
chlorpyrifos	7.5 ± 4.6	6.3 ± 5.8	33.3 ± 12.9	16.9 ± 11.0
allethrin	5.3 ± 2.0	4.8 ± 2.5	27.1 ± 8.8	17.9 ± 9.1
12.5 hours				
chlorpyrifos	4.0 ± 1.3	3.1 ± 0.5	20.3 ± 3.5	8.1 ± 1.9
allethrin	3.0 ± 0.8	2.8 ± 0.5	13.7 ± 4.7	8.3 ± 2.7

[a] Clothing residue values divided by floor residues and multiplied by 100.
[b] After room was vented.

Source: Ross et al. (1990).

Table 7-26. Transfer Efficiencies (%) for Dry, Water-Wetted, and Saliva-Wetted Palms and PUF Roller

	Dry Palms	Water-Wetted Palms	Saliva-Wetted Palms	PUF Roller
Chlorpyrifos				
Mean	1.53	5.22	4.38	4.19
SD	0.73	3.02	2.83	2.87
Pyrethrin				
Mean	3.64	11.87	8.89	5.66
SD	2.21	7.25	4.66	3.60
Piperonyl Butoxide				
Mean	1.41	4.85	4.06	4.28
SD	0.73	2.95	2.64	3.33

SD = Standard deviation.
PUF = Polyurethane foam.

Source: Clothier (2000).

Table 7-27. Incremental and Overall Surface-to-Hand Transfer Efficiencies (%)							
Contact	Hand Condition			Surface Type		Surface Loading	
	Dry	Moist	Sticky	Carpet	Laminate	High	Low
Incremental transfer %, average (SD)							
1	3.0 (2.7)	7.1 (6.1)	14 (18)	6.4 (7.0)	10 (16)	3.9 (4.0)	13 (16)
2	2.5 (4.0)	7.7 (5.7)	7.5 (18)	8.0 (9.5)	3.6 (13)	3.7 (3.5)	8.1 (16)
3	2.0 (5.4)	4.0 (7.3)	6.9 (7.3)	3.8 (7.2)	4.8 (6.8)	1.7 (1.7)	7.0 (9.0)
4	0.9 (3.1)	1.9 (2.5)	2.3 (8.0)	1.1 (6.3)	2.3 (4.2)	0.9 (1.8)	2.7 (7.4)
5	1.3 (2.2)	1.0 (3.7)	2.0 (5.3)	1.7 (2.4)	1.3 (4.9)	0.3 (1.1)	2.5 (5.0)
Incremental transfer %, average (SD) without sticky hands							
1	3.0 (2.7)	7.1 (6.1)	-	4.9 (5.3	5.2 (4.9)	2.6 (2.1)	7.5 (6.0)
2	2.5 (4.0)	7.7 (5.7)	-	5.8 (6.0)	4.2 (4.9)	2.8 (3.0)	7.3 (6.6)
3	2.0 (5.4)	4.0 (7.3)	-	2.1 (6.4)	4.0 (6.4)	1.4 (1.3)	4.7 (8.8)
4	0.9 (3.1)	1.9 (2.5)	-	0.9 (3.0)	1.9 (2.6)	1.0 (1.8)	1.8 (3.8)
5	1.3 (2.3)	1.0 (3.7)	-	1.6 (1.6)	0.7 (3.8)	0.4 (1.2)	1.9 (3.9)
Overall transfer %, average (SD)							
1	3.0 (2.7)	7.1 (6.1)	14 (18)	6.4 (7.0)	10 (16)	3.9 (4.0)	13 (16)
2	2.8 (2.5)	7.4 (5.2)	11 (9.7)	7.2 (7.6)	6.9 (7.1)	3.8 (3.1)	10 (8.8)
3	2.5 (2.9)	6.2 (4.7)	9.7 (7.6)	6.1 (6.3)	6.2 (6.0)	3.1 (2.2)	9.3 (7.2)
4	2.1 (2.4)	5.3 (4.0)	7.9 (7.0)	5.0 (5.7)	5.4 (5.4)	2.5 (1.7)	8.2 (6.6)
5	1.6 (0.8)	4.2 (3.4)	8.2 (6.9)	4.6 (5.3)	4.6 (5.1)	1.8 (1.0)	7.1 (6.0)
Overall transfer %, average (SD) without sticky hands							
1	3.0 (2.7)	7.1 (6.1)	-	4.9 (5.3)	5.2 (4.9)	2.6 (2.1)	7.5 (6.0)
2	2.8 (2.5)	7.4 (5.2)	-	5.4 (5.0)	4.7 (4.3)	2.7 (2.1)	7.4 (5.3)
3	2.5 (2.9)	6.2 (4.7)	-	4.3 (4.0)	4.4 (4.6)	2.3 (1.4)	6.5 (5.1)
4	2.1 (2.4)	5.3 (4.0)	-	3.3 (3.3)	3.9 (4.0)	1.9 (1.1)	5.7 (4.4)
5	1.6 (0.8)	4.2 (3.4)	-	2.8 (2.4)	2.8 (3.0)	1.4 (0.5)	4.2 (3.2)

SD = Standard deviation.

Source: Cohen Hubal et al. (2005).

Table 7-28. Lognormal Distributions for Modeling Transfer Efficiencies (fraction)[a]

Chemical	Surface	μ	σ	GM	GSD
Chlorpyrifos	Carpet	−4.26	0.54	0.01	1.70
	Vinyl	−3.30	0.85	0.04	2.34
	Foil	−0.15	0.08	0.86	1.08
Pyrethrin I	Carpet	−3.86	0.68	0.02	1.97
	Vinyl	−3.66	0.96	0.03	2.61
	Foil	−0.19	0.10	0.83	1.11
Piperonyl butoxide	Carpet	−4.00	0.51	0.02	1.67
	Vinyl	−3.63	0.81	0.03	2.25

[a] Distributions should be truncated at 1.0.
GM = Geometric mean.
GSD = Geometric standard deviation.

Source: Beamer et al. (2009).

Table 7-29. Hand-to-Object/Surface Contact—Frequency (contacts/hour)

Object/Surface	Left Hand Average[a]	Right Hand Average[a]
Bedding/Towel	13.0	13.8
Carpet/Rug	4.3	6.0
Dirt	5.3	6.5
Food	9.3	9.3
Footwear	2.0	3.0
Grass/Vegetation	6.3	5.0
Hair	4.5	3.5
Hard Floor	10.0	9.5
Hard Surface	36.0	40.3
Hard Toy	27.3	29.3
Paper/Card	8.8	14.5
Plush Toy	4.0	4.0
Upholstered Furniture	17.0	15.5
Water/Beverage	1.3	1.8

[a] Average = mean of average hourly contact rates of 4 children of farm workers, ages 2 to 4 years.

Source: Zartarian et al. (1997).

Table 7-30. Hand-to-Objects/Surfaces—Frequency (contacts/hour)				
Object/Surface	Both Hands[a]			
	Range	Mean	Median	90th Percentile
Clothing	22.8−129.2	66.6	65.0	103.3
Dirt	0−146.3	11.4	0.3	56.4
Object	56.2−312.0	122.9	118.7	175.8
Other[b]	8.3−243.6	82.9	64.3	199.6
Smooth Surface	13.6−190.4	83.7	80.2	136.9
Textured Surface	0.2−68.7	22.1	16.3	52.2

[a] Based on data for 30 children (20 daycare children and 10 residential children) ages 2 to 6 years.
[b] Other includes items such as paper, grass, and pets.

Source: Reed et al. (1999).

Table 7-31. Median (mean ± SD) Hand Contact Frequency With Clothing, Surfaces, or Objects (contacts/hour)[a]				
Age	3 to 4 years	5 to 6 years	7 to 8 years	10 to 12 years
N	3	7	4	5
Touch Clothing	26 (34 ± 21)	22 (26 ± 23)	50 (54 ± 43)	35 (53 ± 66)
Touch Textured Surface	40 (52 ± 61)	20 (32 ± 40)	22 (58 ± 88)	16 (24 ± 31)
Touch Smooth Surface	134 (151 ± 62)	111 (120 ± 77)	120 (155 ± 119)	94 (96 ± 50)
Touch Object	130 (153 ± 108)	117 (132 ± 88)	111 (164 ± 148)	127 (179 ± 126)

[a] Based on 4-hour observation period.
SD = Standard deviation.
N = Number of children observed.

Source: Freeman et al. (2001).

Table 7-32. Hand Contact with Objects/Surfaces—Frequency (contacts/hour)		
Object/Surface	Right Hand[a]	
	Mean (SD)	Median (range)
Bottle	14.6 (17.9)	11.5 (1.3−63.0)
Carpet/Rug	6.3 (9.3)	1.1 (0−23.0)
Clothes	38.0 (16.4)	41.9 (12.8−66.8)
Food	9.2 (6.6)	7.3 (3.0−20.8)
Hair	5.1 (3.6)	4.1 (1.3−11.8)
Hard Floor	9.5 (6.2)	10.3 (1.3−17.5)
Object	97.7 (45.8)	96.8 (25.0−176.4)
Paper	22.9 (18.0)	21.8 (1.3−54.3)
Skin	31.5 (15.3)	26.4 (16.0−63.5)
Smooth Surface	83.9 (38.0)	88.0 (32.0−158.4)
Textured Surface	6.5 (5.7)	4.1 (1.0−20.7)
Upholstered Furniture	20.7 (15.2)	19.3 (6.8−55.5)

[a] Only data for the right hand were reported; data for 10 children, ages 24 to 55 months.
SD = Standard deviation.

Source: Freeman et al. (2005).

Table 7-33. Outdoor Hand Contact With Objects/Surfaces, Children 1 to 6 Years[a]

Object/Surface	Both Hands											
	Range	Mean	Median	95th Percentile	Range	Mean	Median	95th Percentile	Range	Mean	Median	95th Percentile
	Frequency (contacts/hour)				Duration (seconds/contact)				Duration (minutes/hour)			
Animal	0−23.3	2.6	0	13.8	1.5−7	3.2	2.5	6.5	0−2	0.2	0	1.6
Body	17−191.7	74.8	65.1	150.4	1−4	2	2	3.2	0.6−17.8	5	4.1	11.2
Clothes/Towel	17−199.1	73.7	65.7	132	1−5	2.5	2	4.6	1.4−26.3	6.7	4.8	18.2
Fabric	0−31.5	3.7	0.4	14.7	0.5−23.5	5.9	3	15.4	0−6.6	0.7	0	3.9
Floor	0−940.4	65.8	27.9	182.7	0−13	3	2	6.5	0−16.4	4	2.4	12.2
Food	0−88.7	14.5	4.9	56.2	0−28	7.6	6	20.8	0−17.3	3.9	0.4	17
Footwear	0−23.1	3.6	1.5	11.4	0−12	3.3	2.5	8.1	0−5.6	0.5	0	2
Metal	0.6−466.2	58.3	16	206.4	0−109.5	7.3	3	15.8	0−36.3	7.4	3.2	27.3
Non-Dietary Water	0.7.4	0.5	0	2.9	0.5−9	3.3	2	8.2	0−1	0.1	0	0.6
Paper/Wrapper	0−103.8	7.3	1.5	21.4	0−53.5	9.4	4.3	28.1	0−27	1.8	0.4	7.8
Plastic	0−324.6	56.7	47	121.1	1−21.5	5.1	4	12.8	0−26.3	8	6	20.6
Rock/Brick	0−28	2.4	0	10.3	1−9	2.8	2	7.5	0−3.7	0.2	0	1
Toy	0−657.8	161.3	129.4	372.8	0−25.5	6.5	6	13.5	0−63.1	29.8	28.4	57
Vegetation/Grass	0−138.7	40.6	27.8	128.1	0−11	3.7	3	9.1	0−21.5	5.1	2.9	17.9
Wood	0.6−100.9	22.4	12.7	79.8	0−9	3.7	3	8	0−27.8	3.2	1.2	12.8
Non-Dietary Object	225.1−1,512.6	575.3	526.3	889.2	0−5	3	3	4	42.6−101.7	72.9	72.3	94.2
All Objects/Surfaces	229.9−1,517.7	589.8	540.8	889.2	0−5	3	3	4.2	42.6−102.2	76.8	77.5	99.3

[a] Based on 38 children aged 1 to 6 years in parks, playgrounds, and outdoor residential areas in California.

Source: AuYeung et al. (2006).

Table 7-34. Indoor Hand Contact With Objects/Surfaces—Frequency, Children 1 to 6 Years[a] (median contacts/hour)

Object/Surface	Left Hand	Right Hand
Carpet	7.9	8.5
Clothing	41	25.2
Hard Floor	3.2	3.9
Paper	3.8	7.4
Skin	11.6	9.9
Upholstered Furniture	13.1	7.7
Smooth Surface	61.9	62.7
Textured Surfaces	18.2	22.1

[a] Based on 9 children aged 1 to 6 years in indoor residential settings in California.

Source: AuYeung et al. (2006).

Table 7-35. Outdoor Hand Contact With Surfaces—Frequency, Children 1 to 5 Years[a] (contacts/hour)

Object/Surface	Both Hands					
	N	Range	Geometric Mean	SD	Median	90th Percentile
Cement	37	0−240	27	0.59	36	107
Porch	22	0−104	12	0.74	16	86
Grass	34	0−183	8	0.71	7	71
Bare Soil	27	0−81	6	0.67	5	71
All Surfaces	37	3−405	70	0.44	81	193

[a] Based on observations of a total of 37 children aged 1 to 5 years (primarily low-income, Hispanic) in outdoor residential areas in Illinois.

N = Number of subjects.

SD = Standard deviation of log-transformed contacts/hour.

Source: Ko et al. (2007).

Table 7-36. Hand Contact With Objects/Surfaces, Infants and Toddlers[a]

Object/Surface	Both Hands								
	Range	Mean	Median	Range	Mean	Median	Range	Mean	Median
	Frequency (contacts/hour)			Duration (minutes/hour)[b]			Duration (seconds/contact)		
Animal	0.0−4.3	0.2	0.0	0.0−0.2	0.0	0.0	1.5−2.0	1.8	1.8
Body	16.6−147.1	76.8	70.5	1.6−21.9	7.5	5.9	1.0−3.0	2.3	2.0
Clothes/Towel	39.2−237.9	113.8	100.9	4.5−31.0	13.1	12.4	1.0−4.0	2.9	3.0
Fabric	0.0−134.4	45.6	37.6	2.1−21.6	10.3	9.1	2.0−9.0	3.6	3.0
Floor	0.0−594.5	96.0	41.5	0.0−32.2	7.0	4.3	0.5−5.0	2.3	2.5
Food	0.0−170.7	51.8	42.7	0.0−37.1	14.2	12.1	2.0−24.0	7.1	7.0
Footwear	0.0−47.0	7.8	2.4	0.0−7.7	1.1	0.3	1.0−11.0	3.8	3.0
Metal	0.0−52.4	17.3	14.5	0.0−5.2	2.0	1.9	0.8−9.0	3.4	3.0
Non-Dietary Water	0.0−2.6	0.2	0.0	0.0−0.0	0.0	0.0	0.5−1.0	0.8	0.8
Paper/Wrapper	0.0−75.3	18.1	18.7	0.0−13.9	3.7	3.1	1.5−11.5	4.4	4.0
Plastic	10.9−294.9	87.1	76.1	0.9−50.6	13.5	10.9	0.5−8.0	3.8	4.0
Rock/Brick	0.0−17.4	3.4	1.6	0.0−1.8	0.3	0.1	1.0−5.0	2.7	3.0
Toy	28.3−300.4	121.2	98.8	9.8−54.1	25.2	9.8	3.0−11.5	5.8	5.0
Vegetation	0.0−16.3	3.8	0.3	0.0−2.2	0.3	0.0	0.5−4.0	2.7	3.0
Wood	0.0−65.4	24.9	27.2	0.0−10.6	3.5	3.9	1.5−8.0	3.8	3.0
Non-Dietary Object	266.8−1,180.0	600.8	568.7	62.6−106.2	83.1	83.2	2.0−5.0	3.2	3.0
All Objects/Surfaces	303.1−1,206.0	686.3	689.4	76.4−124.1	99.1	100.5	2.0−5.0	3.3	3.0

[a] Based on 23 farm worker children (ages 6 to 26 months) from California.
[b] Hourly contact duration for both hands is the sum of the hourly contact durations for the left and right hands independently.

Source: Beamer et al. (2008).

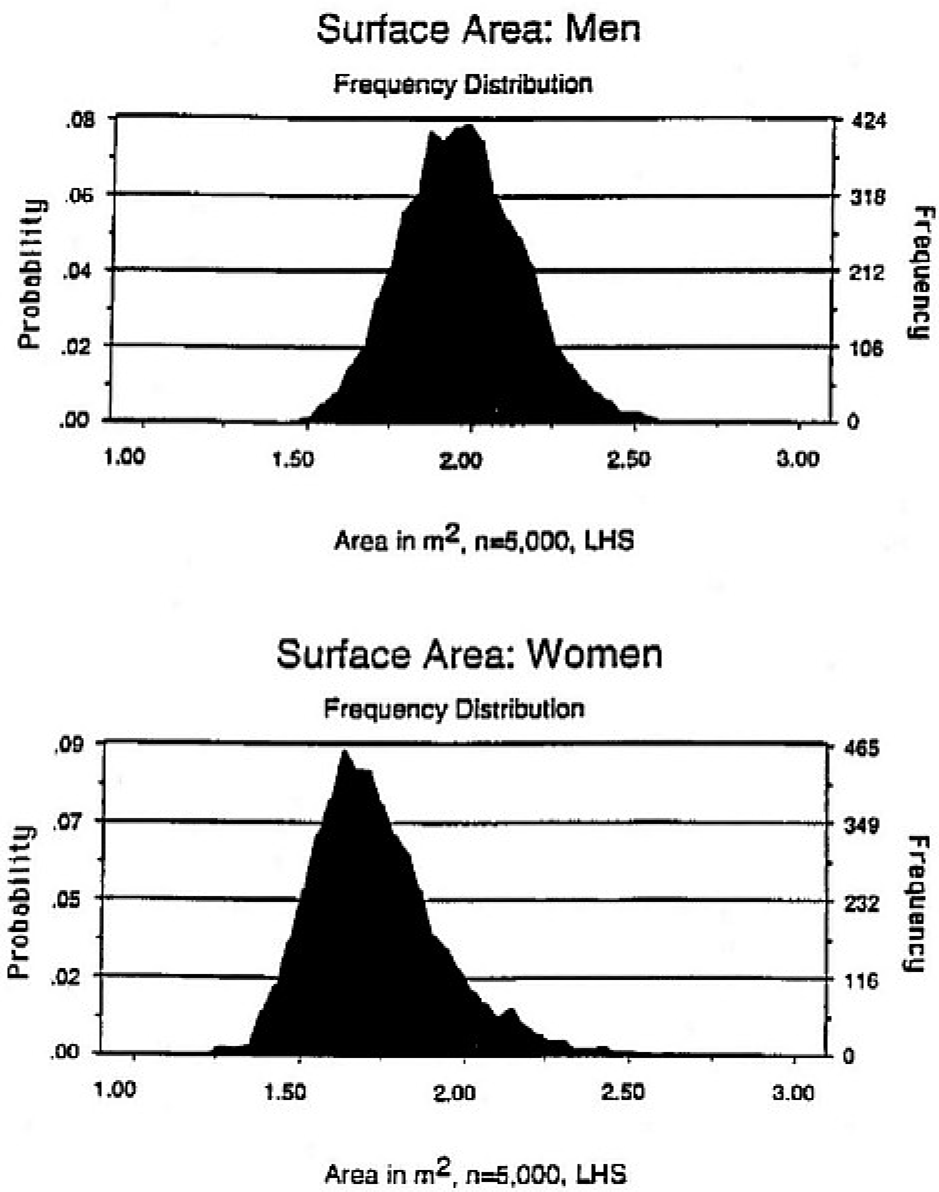

Figure 7-1. Frequency Distributions for the Surface Area of Men and Women.

Source: Murray and Burmaster (1992)

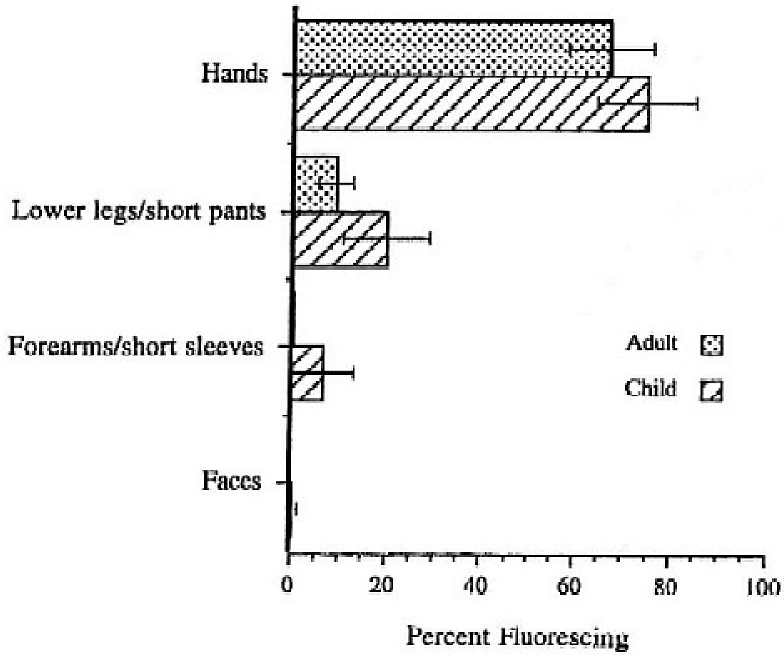

Figure 7-2. Skin Coverage as Determined by Fluorescence Versus Body Part for Adults Transplanting Plants and Children Playing in Wet Soils (bars are arithmetic means and corresponding 95% confidence intervals).
Source: Kissel et al. (1998).

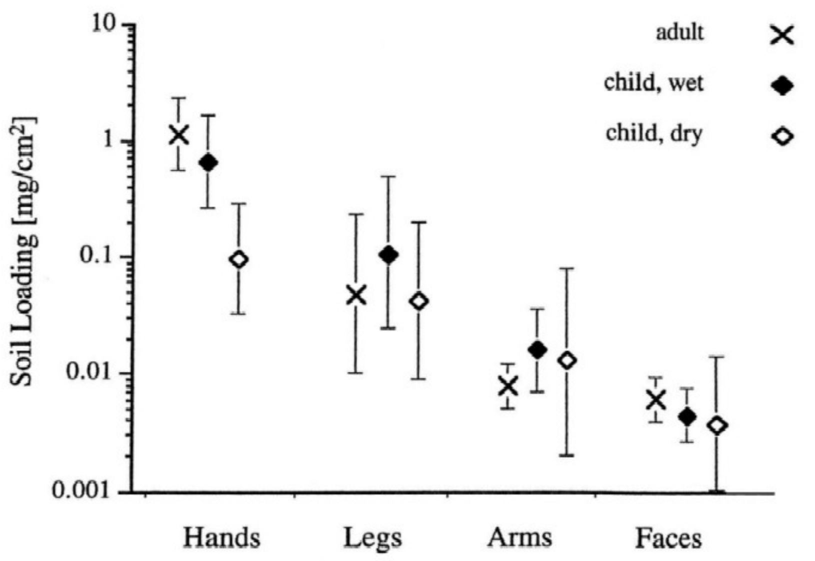

Figure 7-3. Gravimetric Loading Versus Body Part for Adults Transplanting Plants in Wet Soil and Children Playing in Wet and Dry Soils (symbols are geometric means and 95% confidence intervals).
Source: Kissel et al. (1998).

APPENDIX 7A

FORMULAS FOR TOTAL BODY SURFACE AREA

APPENDIX 7A—FORMULAS FOR TOTAL BODY SURFACE AREA

Most formulas for estimating surface area relate height to weight to surface area. The following formula was proposed by Gehan and George (1970):

$$SA = KW^{2/3} \quad \text{(Eqn. 7A-1)}$$

where:

SA = surface area in square meters,
W = weight in kg, and
K = constant.

While this 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 Du Bois and Du Bois (1989). Their model can be written:

$$SA = a_0 H^{a_1} W^{a_2} \quad \text{(Eqn. 7A-2)}$$

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 Du Bois 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 (Lentner, 1981) are based on the Du Bois and Du Bois formula.

Boyd (1935) developed new constants for the Du Bois and Du Bois 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 Du Bois and Du Bois 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 Du Bois and Du Bois formula based on height and weight.

Gehan and George (1970) proposed another set of constants for the Du Bois and Du Bois 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 surface area is:

$$SA = 0.02350\, H^{0.42246} W^{0.51456} \quad \text{(Eqn. 7A-3)}$$

or in logarithmic form:

$$\ln SA = -3.75080 + 0.42246 \ln H + 0.51456 \ln W \quad \text{(Eqn. 7A-4)}$$

where:

SA = surface area in square meters,
H = height in centimeters, and
W = weight in kg.

This prediction explains more than 99% 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) to be 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 Du Bois and Du Bois (1989) and the

Statistical Processing System (SPS) software package to obtain the standard error.

The Du Bois and Du Bois (1989) formula uses weight and height as independent variables to predict total body surface area 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% of the total variation in surface area among the observations, and it 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% 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%. Of these, 12 weighed less than 15 pounds each, one was overweight (5 feet 7 inches, 172 pounds), one was very thin (4 feet 11 inches, 78 pounds), and four were of average build. Because the same observer measured surface area for these four 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. Table 7A-1 presents the different values for the constants.

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 m^2, 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 Du Bois and Du Bois model. Their interest in making the Du Bois and Du Bois model more accurate resulted from their work in pediatrics and the fact that Du Bois and Du Bois (1989) 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 two 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 Caucasian 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 co-efficients: a_0 = 0.024265, a_1 = 0.3964, and a_2 = 0.5378. The result was the following equation for estimating surface area:

$$SA = 0.024265H^{0.3964}\,W^{0.5378} \qquad \text{(Eqn. 7A-9)}$$

expressed logarithmically as:

$$\ln SA = \ln 0.024265 + 0.3964 \ln H + 0.5378 \ln W \qquad \text{(Eqn. 7A-10)}$$

The co-efficients 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 Du Bois and Du Bois 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 Du Bois and Du Bois model that are different than those originally postulated in 1916. The Du Bois and Du Bois model can be written logarithmically as:

$$\ln SA = \ln a_0 + a_1 \ln H + a_2 \ln W \qquad \text{(Eqn. 7A-11)}$$

Table 7A-2 present the values for a_0, a_1, and a_2 obtained by the various authors discussed in this section.

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 because 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 Du Bois and Du Bois (1989). Because the Sendroy and Cecchini method is graphical, it is inherently less precise and less accurate than the formulas of other authors discussed in this section.

7A.1. REFERENCES FOR APPENDIX 7A

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Du Bois, D; Du Bois, EF. (1989). A formula to estimate the approximate surface area if height and weight be known. 1916. Nutrition 5: 303-311; discussion 312-303.

Gehan, EA; George, SL. (1970). Estimation of human body surface area from height and weight. 54: 225-235.

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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 Du Bois and Du Bois Model				
Author (year)	Number of Persons	a_0	a_1	a_2
Du Bois and Du Bois (1989)	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

8. BODY-WEIGHT STUDIES

8.1. INTRODUCTION

There are several physiological factors needed to calculate potential exposures. These include skin surface area (see Chapter 7), inhalation rate (see Chapter 6) life expectancy (see 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 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. Environmental Protection Agency (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 is 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 and are based on data derived from the National Health and Nutrition Examination Survey (NHANES) 1999−2006. 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 the body-weight recommendations.

Table 8-1 shows the mean body weight for all adults (male and female, all age groups) combined is 80 kg. Section 8.3 presents percentile data.

The mean recommended value for adults (80 kg) is different from the 70 kg commonly assumed in U.S. EPA risk assessments. Assessors are encouraged to use values that 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 that was derived assuming a body weight of 70 kg. If such an inconsistency exists, the assessor may need to adjust the dose-response relationship as described in the appendix to Chapter 1.

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, Section 8.3 provides distributions of body-weight data. These distributions may be useful if probabilistic methods are used to assess exposure. Also, if sex-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	Table 8-3 through Table 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 the secondary data analysis were 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 four data sets of NHANES data covering 1999−2006.	
Clarity and Completeness		High
Accessibility	NHANES data are available from NCHS.	
Reproducibility	The methods used were well-described; enough information was provided to allow for reproduction of results.	
Quality Assurance	NHANES follows a strict QA/QC procedures; the U.S. EPA analysis has only been reviewed internally.	
Variability and Uncertainty		High
Variability in Population	The full distributions were given in the key study.	
Uncertainty	No significant biases 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 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, non-institutionalized 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%, and an additional 4% 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:

$$\bar{x} = \frac{\sum_i w_i x_i}{\sum_i w_i} \qquad \text{(Eqn. 8-1)}$$

where:

$\bar{x}$ = sample mean,
x_i = the i^{th} observation, and
w_i = sample weight assigned to observation x_i.

Percentile values were generated by first calculating the sum of the sample 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 sample weight, equal to its own sample weight plus all sample weights listed before the observation. The 1st observation listed with a cumulative sample 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. Table 8-4 and Table 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 combining the data from various years of NHANES beginning in 1999 through 2006 may underestimate current body weights due to an observed upward trend in body weights (Ogden et al., 2004). However, these data are based on the most recent available NHANES data. 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 GENERAL POPULATION BODY-WEIGHT STUDIES

8.4.1. Najjar and Rowland (1987)—Anthropometric Reference Data and Prevalence of Overweight, United States, 1976−1980

Najjar and Rowland (1987) collected anthropometric measurement data for body weight for the U.S. population as part of the 2nd 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 six months to 74 years from the civilian, non-institutionalized 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%. 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, adjusting 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 (Najjar and Rowland, 1987). Najjar and Rowland (1987) provided descriptive statistics of the body-weight data. Table 8-6 and Table 8-7 present means and percentiles, by age category, for males and females, respectively. Although the NHANES data are nationally representative, a limitation of the study is the age of the data used.

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 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 were reported to be 0.999. The R^2 values for women's height and lognormal weight were reported as 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 one-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 bivariate normal distribution gave poor results (Brainard and Burmaster, 1992).

The advantage of this study is that it provides distributions that are suitable for use in Monte Carlo simulation. However, these distributions are now 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 NHANES II, which was based on a national probability sample of 27,801 persons 6 months to 74 years of age in the United States. (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 sex across all age groups. Table 8-8 and Table 8-9 present the statistics for the lognormal probability plots for females and males aged 9 months to 70 years, respectively. As indicated in Burmaster and Crouch (1997), Φ_2, and σ_2 are the mean and standard deviation of the logarithm of body weight for an age group. The exponential of Φ_2 provides an estimate of the median of body weight, and σ_2 is approximately equal to the coefficient of variation of the body weight. 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 9 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 sex 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 sex. Table 8-11 shows the body-weight estimates for infants 2 and 3 months of age.

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 Table 8-10 and Table 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)—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 (1963−1965) for ages 6−11 years, NHES III (1966−1970) for ages 12−17 years, NHANES I (1971−1974) for ages 1−17 years, NHANES II (1976−1980) beginning at 6 months of age, and NHANES III (1988−1994) 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 sex and age. Figure 8-1 and Figure 8-2 present weight by age percentiles for boys and girls, aged birth to 36 months, respectively. Figure 8-3 and Figure 8-4 present weight by length percentiles for boys and girls, respectively. Figure 8-5 and Figure 8-6 provide the BMI for boys and girls aged 2 to 20 years old.

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. A limitation of this analysis is that trends in the weight data cannot be assessed because data from various years were combined. Also, the analysis is based on an older data set.

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 U.S. Department of Agriculture (USDA's) 1994−1996 and the 1998 Continuing Survey of Food Intake by Individuals (CSFII). The weights recorded in the survey, and, consequently, the estimates reported, are based on self-reported data by the participants.

When viewed across sexes 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 limitations of this analysis are that body weights were self-reported and that it is based on an older data set.

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 NHES 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. Table 8-15 and Table 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. This serves to illustrate the importance of the use of timely data when analyzing body weight. Because this study is based on an analysis of NHANES data, its limitations are the same as those for that study. Another limitation is that the data are based on an older NHANES data set and may not be entirely representative of current BMI values.

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 (1971−1974), NHANES II (1976–1980), NHANES III (1988–1994), and NHANES 1999−2002. The analyses includes 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. Table 8-17 presents the sample sizes used in the analyses by age, sex, race, and survey. Table 8-18 provides mean BMI levels for ages 2 to 17. Table 8-19 shows BMI mean levels for adults 20 years and older (Ogden et al., 2004). Table 8-18 shows that in the 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). Table 8-20 shows the prevalence of overweight and obesity for children 2 to 17 years old. 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 children aged two to five years old.

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 and that it is based on older NHANES data sets.

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 United States. Low birth weight was defined as <2,500 grams (<5 pounds 8 ounces), and very low birth weight was defined as <1,500 grams (<three pounds four 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%) and very low birth weights (3.3%). Martin et al. (2007) also provided statistics on the numbers and percentages of pre-term live births in the United States. Of the 4,138,349 live births in the United States in 2005, 522,913 were defined as pre-term (i.e., less than 37 weeks gestation). A total of 43.3% of these pre-term infants had low birth weights, and 11.3% 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 is 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 sex and various age brackets (Portier et al., 2007). The estimated mean body weights are shown in Table 8-22, Table 8-23, and Table 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). 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 sexes and for single-year age groups. The study results are also based on a large sample size.

8.4.11. Kahn and Stralka (2009)—Estimated Daily Average Per Capita Water Ingestion by Child and Adult Age Categories Based on USDA's 1994−1996 and 1998 Continuing Survey of Food Intakes

As part of an analysis of water ingestion, Kahn and Stralka (2009) provided body-weight distributions for the U.S. population. The analysis was based on self-reported body weights from the 1994−1996, 1998 CSFII. The average body weight across all individuals was 65 kg. According to Kahn and Stralka (2009), 10 kg, 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 kg for the 6 to 12-month age category and 11 kg for the one-to-two-year old-category (Kahn and Stralka, 2009). Table 8-26 presents the body-weight distributions, and Table 8-27 presents the intervals around the mean and 90th and 95th percentiles.

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 and that the data are now somewhat dated.

8.5. RELEVANT STUDIES—PREGNANT WOMEN BODY-WEIGHT STUDIES

8.5.1. Carmichael et al. (1997)—The Pattern of Maternal Weight Gain in Women With Good Pregnancy Outcomes

The Institute of Medicine (IOM) publishes recommendations for total gestational weight gain. Carmichael et al. (1997) conducted a study in a cohort of 7,002 who had good pregnancy outcomes to obtain the distribution of maternal weight gain by trimester and to compare these with women who achieved the IOM recommendations. Good outcome was defined as having a vaginal delivery, 37 weeks or more of gestation, delivery of a live infant of an average size for gestational age, and from mothers with no diabetes or hypertension. The women were selected from records from the Department of Obstetrics, Gynecology and Reproductive Sciences Perinatal Database at the University of California, San Francisco. Distributions were derived for 4,218 women for whom complete data on pattern of gain for all trimesters were obtained. The mean age of the women was 27.7 years with a mean pre-pregnancy weight of 57.6 kg. Twenty-nine percent of the women were underweight, 61% were of normal weight, 5% were overweight, and 4% were obese, based on BMI calculations. Total weight gain was calculated as the difference between the self-reported pre-pregnancy weight and the last measured weight. A linear regression was applied to estimate the rate of gain in the 2nd and 3rd trimesters. Table 8-28 presents the distributions of weight gain in underweight, normal weight, overweight, and obese women during the 1st, 2nd, and 3rd trimesters. The average weight gains for the 1st, 2nd, and 3rd trimesters were 1.98 kg, 6.73 kg, and 6.37 kg, respectively. The weight gain for the 2nd and 3rd trimesters was calculated by taking the gain rate from Table 8-28 and multiplying it by 13 weeks. These data can be used to calculate the average weight of pregnant women for the 1st, 2nd, and 3rd trimesters by adding the average weight gain for the 1st trimester to the average pre-pregnancy weight of 57.6 kg and subsequently adding the average weight gain for the 2nd and 3rd trimesters to the resulting weight from the previous trimester. These calculations result in a total weight of 59.6 kg, 66.3 kg, and 72.7 kg for the 1st, 2nd, and 3rd trimesters, respectively.

The advantages of this study are that it has a large sample size, and it provides distributional data. The sample, however, may not be representative of the United States. The sample also only included pregnancies with good outcomes. The study did not provide estimates of the weight for each trimester. Instead, it provides weight gain for the 1st trimester and the rates of weight gain for the 2nd and 3rd trimesters. The total weight was estimated by the U.S. EPA based on the mean weight gain for each trimester.

8.5.2. U.S. EPA Analysis of 1999−2006 NHANES Data on Body Weight of Pregnant Women

In 2010, U.S. EPA analyzed the combined 1999−2006 NHANES data sets to examine body weight of pregnant women. Data for 1,248 pregnant women with weight measurements were extracted based from the data set based on either a positive lab pregnancy test or self-reporting of pregnancy at the examination. The NHANES data included a few very large and improbable body weights, as extreme as 186 kg from a respondent in the 1st trimester. These outliers were removed from the database (N = 26) using SAS. Table 8-29 presents the body-weight data by trimester, based on the remaining 1,222 respondents. The statistically weighted average body weight of all pregnant women was 75 kg. Due to a few large weight (>90 kg) respondents with very large sample weights (>18,000), the weighted mean body weight of 1st trimester women (76 kg) is larger than that of 2nd trimester women (73 kg).

The advantage of this study is that by combining eight years of the most recent NHANES data, an adequate sample size was achieved to estimate body weight of pregnant women by trimester. A limitation of this analysis is that high-weight respondents with large sample weight may result in uncertainties as described above.

8.6. RELEVANT FETAL WEIGHT STUDIES

8.6.1. 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 two 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, OH, from 1962 to 1969.

Table 8-30 shows percentiles for fetal weight, calculated from the data at each week of gestation. 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 sex.

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 that may affect fetal weight (i.e., maternal smoking, disease, nutrition, and addictions) were not evaluated in this study.

8.6.2. 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 five 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 1st trimester sonogram. The database was screened for possible outliers, defined as infants with birth weights that exceeded 5,000 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 5,000 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 8-31 provides the distribution of neonatal weights by gestational age from 25 weeks of gestation onward. The advantage of this study is that it provides body weights for neonates based on a relatively large sample. A limitation is the age of the data.

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Table 8-3. Mean and Percentile Body Weights (kg) 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 (kg) 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 (kg) 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 kg.
\- No data available for infants less than 2 months old.

Source: Najjar and Rowland (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 kg.
- No data available for infants less than 2 months old.

Source: Najjar and Rowland (1987).

Table 8-8. Statistics for Probability Plot Regression Analyses: Female Body Weights 6 Months to 70 Years of Age

Age Midpoint (years)	Lognormal Probability Plots Linear Curve	
	μ_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 the standard deviation, respectively, of the logarithm of body weight (kg) for an age group.

Source: Burmaster and Crouch (1997).

Table 8-9. Statistics for Probability Plot Regression Analyses: Male Body Weights 6 Months to 70 Years of Age

Age Midpoint (years)	Lognormal Probability Plots Linear Curve	
	μ_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 the standard deviation, respectively, of the logarithm of body weight (kg) for an age group.

Source: Burmaster and Crouch (1997).

Table 8-10. Body-Weight Estimates (kg) by Age and Sex, U.S. Population Derived From NHANES III (1988−1994)

Age Group	Sample Size	Population	Males and Females		Males		Females	
			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 years	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 kg) by Age, U.S. Population Derived From NHANES III (1988−1994)					
Age Group (months)	Sample Size	Population	Males and Females		
			Median	Mean	95% CI
2	243	408,837	6.3	6.3	6.1−6.4
3	190	332,823	7.0	6.9	6.7−7.1
3 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 (kg) by Sex and Age: Birth to 36 Months

Age Group (mo)	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 to <1	-	-	-	-	-	-	-	-
1 to <2	-	-	-	-	-	-	-	-
2 to <3	6.5	0.8	5.6	5.8	6.7	6.9	7.4	7.5
3 to <4	7.0	0.9	5.9	6.5	7.0	7.5	8.2	8.5
4 to <5	7.2	0.8	6.3	6.7	7.2	7.7	8.0	8.4
5 to <6	7.9	0.9	6.7	7.5	7.8	8.6	9.4	9.6
6 to <7	8.4	1.1	7.3	7.6	8.4	9.0	10.2	10.7
7 to <8	8.6	1.1	7.1	7.8	8.6	9.5	10.1	10.4
8 to <9	9.3	1.1	7.9	8.6	9.2	10.1	10.5	11.0
9 to <10	9.3	0.9	8.2	8.6	9.3	10.0	10.8	10.9
10 to <11	9.5	1.1	8.3	8.7	9.3	10.1	11.3	11.5
11 to <12	10.0	1.0	8.7	9.5	10.0	10.6	11.1	11.6
12 to <15	10.6	1.2	9.2	9.8	10.6	11.3	12.1	12.4
15 to < 8	11.4	1.9	9.9	10.5	11.3	12.0	12.8	13.5
18 to <21	12.1	1.5	10.4	11.0	11.9	12.7	13.9	15.5
21 to <24	12.4	1.3	10.9	11.6	12.4	13.1	14.4	14.7
24 to <30	13.1	1.7	11.3	12.1	12.9	14.1	15.1	15.9
30 to <36	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 to <1	-	-	-	-	-	-	-	-
1 to <2	-	-	-	-	-	-	-	-
2 to <3	5.4	0.5	4.8	5.0	5.6	5.9	6.0	-
3 to <4	6.3	0.7	5.6	5.8	6.3	6.8	7.4	7.8
4 to <5	6.7	0.9	5.8	6.1	6.6	7.4	8.0	8.3
5 to <6	7.3	0.9	6.3	6.7	7.1	7.7	8.5	8.8
6 to <7	7.7	0.8	6.6	7.1	7.6	8.1	8.9	9.0
7 to <8	8.0	1.4	6.7	7.4	7.8	8.6	9.4	9.8
8 to <9	8.3	0.9	7.3	7.8	8.3	8.9	9.4	9.8
9 to <10	8.9	0.9	7.8	8.1	8.7	9.4	10.1	10.5
10 to <11	9.0	1.1	7.8	8.4	9.0	9.5	10.4	10.9
11 to <12	9.3	1.0	7.9	8.6	9.2	10.1	10.6	10.9
12 to <15	9.8	1.1	8.5	9.1	9.8	10.4	11.3	11.6
15 to <18	10.4	1.1	9.1	9.7	10.3	11.2	11.8	12.0
18 to <21	11.1	1.4	9.6	10.2	11.0	11.9	12.8	13.5
21 to <24	11.8	1.3	10.1	10.9	11.8	12.8	13.5	13.9
24 to <30	12.5	1.5	10.8	11.5	12.4	13.3	14.5	15.1
30 to <36	13.6	1.7	11.8	12.5	13.4	14.52	15.7	16.4

\- No data available.

Source: Kuczmarski et al. (2002).

Table 8-13. Estimated Distribution of Body Weight by Fine Age Categories All Individuals, Males and Females Combined (kg)

Ages (years)	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 to 0.9	678	1,770,700	9	7	8	9	10	11	12
1 to 3	3,645	11,746,146	14	10	11	13	16	18	19
4 to 6	2,988	11,570,747	21	16	17	20	22	26	28
7 to 10	1,028	14,541,011	32	22	26	29	36	43	48
11 to 14	790	15,183,156	51	35	42	50	58	68	79
15 to 19	816	17,825,164	67	50	56	63	73	85	99
20 to 24	676	18,402,877	72	53	59	68	81	94	104
25 to 54	4,830	111,382,877	77	54	63	75	86	100	109
55 to 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 to 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 to 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 CSFII).

Table 8-14. Mean Body Weight (kg) by Age and Sex Across Multiple Surveys

Sex and Age (years)	NHES II, 1963−1965			NHES III, 1966−1970			NHANES II, 1976−1980			NHANES III, 1988−1994			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 to 29	-	-	-	-	-	-	1,261	76.3	0.5	1,638	78.4	0.6	712	83.4	0.7
30 to 39	-	-	-	-	-	-	871	79.8	0.4	1,468	82.9	0.9	704	86.0	0.9
40 to 49	-	-	-	-	-	-	695	81.7	0.5	1,220	85.1	0.8	776	89.1	0.7
50 to 59	-	-	-	-	-	-	691	80.0	0.6	851	86.0	0.5	598	88.8	0.9
60 to 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 (kg) by Age and Sex Across Multiple Surveys (continued)

Sex and Age (years)	NHES II, 1963−1965			NHES III, 1966−1970			NHANES II, 1976−1980			NHANES III, 1988−1994			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 to 29	-	-	-	-	-	-	1,290	61.7	0.5	1,663	64.4	0.6	656	71.1	0.9
30 to 39	-	-	-	-	-	-	964	66.1	0.6	1,773	70.2	0.8	699	74.1	0.9
40 to 49	-	-	-	-	-	-	765	67.6	0.6	1,355	71.6	0.8	787	76.5	1.1
50 to 59	-	-	-	-	-	-	793	68.4	0.6	996	74.3	0.8	593	76.9	1.1
60 to 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 (cm) by Age and Sex Across Multiple Surveys

Sex and Age (years)	NHES II, 1963−1965			NHES III, 1966−1970			NHANES II, 1976−1980			NHANES III, 1988−1994			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	132.5	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 to 29	-	-	-	-	-	-	1,261	177.1	0.3	1,639	176.1	0.3	724	176.7	0.3
30 to 39	-	-	-	-	-	-	871	176.3	0.3	1,468	176.6	0.3	717	176.4	0.3
40 to 49	-	-	-	-	-	-	695	175.9	0.3	1,220	176.3	0.3	784	177.2	0.3
50 to 59	-	-	-	-	-	-	691	174.7	0.3	851	175.8	0.3	601	175.8	0.3
60 to 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 (cm) by Age and Sex Across Multiple Surveys (continued)

Sex and Age (years)	NHES II, 1963−1965			NHES III, 1966−1970			NHANES II, 1976−1980			NHANES III, 1988−1994			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 to 29	-	-	-	-	-	-	1,290	163.3	0.2	1,665	162.8	0.2	663	162.8	0.3
30 to 39	-	-	-	-	-	-	964	163.1	0.2	1,776	163.4	0.3	708	163.0	0.3
40 to 49	-	-	-	-	-	-	765	162.3	0.3	1,354	162.8	0.3	794	163.4	0.2
50 to 59	-	-	-	-	-	-	793	160.5	0.3	998	161.8	0.3	601	162.3	0.3
60 to 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 (kg/m^2) by Age and Sex Across Multiple Surveys

Sex and Age (years)	NHES II, 1963−1965			NHES III, 1966−1970			NHANES I, 1971−1974			NHANES II, 1976−1980			NHANES III, 1988−1994			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 to 29	-	-	-	-	-	-	986	24.5	0.1	1,261	24.3	0.1	1,638	25.2	0.2	712	26.6	0.2
30 to 39	-	-	-	-	-	-	654	26.1	0.2	871	25.6	0.1	1,468	26.5	0.2	704	27.5	0.3
40 to 49	-	-	-	-	-	-	715	26.2	0.2	695	26.4	0.2	1,220	27.3	0.2	774	28.4	0.3
50 to 59	-	-	-	-	-	-	717	26.0	0.2	691	26.2	0.2	851	27.8	0.2	594	28.7	0.3
60 to 74	-	-	-	-	-	-	1,920	25.4	0.1	2,086	25.7	0.1	1,683	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 (kg/m^2) by Age and Sex Across Multiple Surveys (continued)

Sex and Age (years)	NHES II, 1963−1965			NHES III, 1966−1970			NHANES I, 1971−1974			NHANES II, 1976−1980			NHANES III, 1988−1994			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 to 29	-	-	-	-	-	-	2,122	23.0	0.1	1,290	23.1	0.2	1,663	24.3	0.2	654	26.8	0.3
30 to 39	-	-	-	-	-	-	1,654	24.7	0.2	964	24.9	0.2	1,773	26.3	0.3	698	27.9	0.3
40 to 49	-	-	-	-	-	-	1,232	25.7	0.2	765	25.7	0.2	1,354	27.1	0.3	783	28.6	0.4
50 to 59	-	-	-	-	-	-	780	26.2	0.2	793	26.5	0.2	996	28.4	0.3	591	29.2	0.4
60 to 74	-	-	-	-	-	-	2,131	26.5	0.2	2,349	26.5	0.1	1,673	27.4	0.2	993	29.2	0.2
75+	-	-	-	-	-	-	-	-	-	-	-	-	1,021	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 (years)	Sex	Race[a]	NHANES Examination II (1976−1980)	III (1988−1994)	1999−2002
Overall (2 to 17)			6,395 (10.6)[b]	9,610 (9.9)	6,710 (10.1)
2 to 5	Boys	White	1,082 (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	1,028 (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	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	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	Male	White	-	-	607
		Black	-	-	279
		Mexican American	-	-	399
	Female	White	-	-	569
		Black	-	-	298
		Mexican American	-	-	358
40 to 59	Male	White	-	-	676
		Black	-	-	289
		Mexican American	-	-	310
	Female	White	-	-	632
		Black	-	-	297
		Mexican American	-	-	332
60 and over[c]	Male	White	-	-	866
		Black	-	-	256
		Mexican American	-	-	318
	Female	White	-	-	862
		Black	-	-	275
		Mexican American	-	-	329

[a] Race was recorded in the 1st 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.

Sources: Freedman et al. (2006); 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 to 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 (kg/m^2) by Survey, Sex, Race/Ethnicity, and Age Group; Adults: United States

Sex, Race/Ethnicity, and Age (years)	HHANES, 1982−1984 Sample Size	HHANES, 1982−1984 Mean	HHANES, 1982−1984 Standard Error of the Mean	NHANES III, 1988−1994 Sample Size	NHANES III, 1988−1994 Mean	NHANES III, 1988−1994 Standard Error of the Mean	NHANES, 1999−2002 Sample Size	NHANES, 1999−2002 Mean	NHANES, 1999−2002 Standard Error of the Mean
Males									
Non-Hispanic White:[a]									
20 and over	-	-	-	3,152	26.8	0.1	2,116	27.9	0.2
20 to 39	-	-	-	846	25.9	0.2	607	27.1	0.2
40 to 59	-	-	-	842	27.6	0.2	673	28.7	0.3
60 and over	-	-	-	1,464	27.0	0.1	836	28.3	0.1
Non-Hispanic Black:									
20 and over[a]	-	-	-	2,091	26.6	0.1	820	27.5	0.2
20 to 39 yr[a]	-	-	-	985	26.3	0.2	279	27.1	0.3
40 to 59	-	-	-	583	27.1	0.2	289	27.7	0.4
60 and over[a]	-	-	-	523	26.4	0.3	252	28.0	0.3
Mexican American:[a]									
20 and over	-	-	-	2,229	27.3	0.1	1,018	28.0	0.2
20 to 74	2,273	26.2	0.2	2,127	27.3	0.1	959	28.1	0.2
20 to 39	1,133	25.6	0.3	1,143	26.1	0.2	399	27.1	0.3
40 to 59	856	26.9	0.1	558	28.6	0.2	309	28.9	0.3
60 to 74	284	26.3	0.2	426	27.4	0.3	251	28.6	0.3
60 and over	-	-	-	528	27.1	0.3	310	28.1	0.3
Females									
Non-Hispanic white:[a]									
20 and over	-	-	-	3,554	26.1	0.2	2,026	27.6	0.2
20 to 39	-	-	-	1,030	24.7	0.2	567	26.7	0.3
40 to 59	-	-	-	950	27.2	0.3	629	28.3	0.4
60 and over	-	-	-	1,574	26.7	0.2	830	28.2	0.2
Non-Hispanic Black:[a]									
20 and over	-	-	-	2,451	29.1	0.2	863	31.1	0.3
20 to 39	-	-	-	1,191	27.6	0.3	298	30.2	0.5
40 to 59	-	-	-	721	30.4	0.3	294	32.1	0.5
60 and over	-	-	-	539	29.4	0.4	271	31.1	0.6
Mexican American:									
20 and over	-	-	-	2,106	28.4	0.2	1,012	29.0	0.3
20 to 74[a]	3,039	27.1	0.1	2,013	28.5	0.2	960	29.1	0.3
20 to 39[a]	1,482	25.6	0.2	1,063	27.2	0.2	358	27.8	0.4
40–to 59[a]	1,159	28.2	0.2	557	29.7	0.3	332	30.4	0.5
60 to 74[a]	398	28.1	0.3	393	29.2	0.4	270	29.5	0.3
60 and over	-	-	-	486	28.7	0.4	322	28.9	0.4

[a] Statistically significant trend or difference $p < 0.05$ for all years available.
- Data not available.

Notes: BMI is calculated as weight in kilograms divided by square of height in meters. HHANES: Hispanic Health and Nutrition Examination Survey.

Source: Ogden et al. (2004).

Table 8-20. Prevalence of Overweight and Obesity[a] Among Children

		Race	Examination Year				Increase in Prevalence from 1971−1974 to 1999−2002	
			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 (yr)								
	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 ≥95th percentile or ≥30 kg/m^2; obesity is defined as a BMI ≥99th percentile or ≥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 (g)		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
4,000−4,499	289,098	167,269	22,149	64,704
4,500−4,999	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
		% 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 g (5 lb 8 oz).
[e] Very low birth weight is birth weight less than 1,500 g (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] (years)	Males (kg)			Females (kg)			Overall (kg)		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
0 to 1	9.4	1.3	179	8.8	1.3	177	9.1	1.2	356
1 to 2	11.8	1.6	370	10.8	1.4	336	11.3	1.5	706
2 to 3	13.6	1.8	375	13.0	1.5	336	13.3	1.6	711
3 to 4	15.6	1.9	418	14.9	2.1	366	15.2	1.8	784
4 to 5	17.8	2.4	404	17.0	2.3	396	17.4	2.4	800
5 to 6	19.8	2.8	397	19.6	3.2	364	19.7	2.8	761
6 to 7	23.0	3.7	133	22.1	3.9	135	22.5	3.6	268
7 to 8	25.1	3.8	148	24.7	4.6	157	24.8	3.8	305
8 to 9	28.2	5.6	147	27.8	4.8	123	28.1	5.6	270
9 to 10	31.1	5.8	145	31.8	7.3	149	31.4	5.9	294
10 to 11	36.4	7.2	157	36.1	7.7	136	36.2	7.1	293
11 to 12	40.2	9.8	155	41.8	10.1	140	41.0	9.9	295
12 to 13	44.2	9.8	145	46.4	10.1	147	45.4	10.0	292
13 to 14	49.8	11.4	173	50.9	11.2	162	50.4	11.5	335
14 to 15	57.1	10.7	186	54.7	10.7	178	55.9	10.5	364
15 to 16	61.0	10.4	184	55.1	9.0	145	58.0	9.9	329
16 to 17	67.1	11.7	178	58.1	9.6	170	62.4	10.9	348
17 to 18	66.7	11.3	173	59.6	10.4	134	63.3	10.7	307
18 to 19	71.0	12.0	164	59.0	10.2	170	64.6	10.9	334
19 to 20	71.7	11.3	148	60.1	10.1	158	65.3	10.3	306
20 to 21	71.6	12.0	114	60.5	10.7	162	65.2	10.9	276
21 to 22	74.76	12.73	150	60.39	11.14	170	66.71	11.35	320
22 to 23	76.10	12.88	135	60.51	10.11	150	67.30	11.39	285
23 to 24	75.93	11.76	148	61.21	11.48	133	68.43	10.60	281
24 to 25	75.18	11.65	129	62.71	13.44	123	68.43	10.60	252
25 to 26	76.34	11.52	118	62.64	12.46	120	68.80	10.38	238
26 to 27	79.49	14.18	127	61.74	11.77	118	70.57	12.59	245
27 to 28	76.17	12.34	112	62.83	12.18	130	68.24	11.06	242
28 to 29	79.80	14.15	104	63.79	14.34	138	69.79	12.38	242
29 to 30	77.64	11.63	124	63.33	12.92	122	69.97	10.48	246
30 to 31	78.63	13.63	103	64.90	13.71	139	70.44	12.21	242
31 to 32	78.19	14.19	108	67.71	14.45	116	72.33	13.13	224
32 to 33	79.15	12.99	102	68.94	17.51	104	73.43	12.05	206
33 to 34	80.73	12.67	86	63.43	11.77	92	71.82	11.27	178
34 to 35	81.24	14.83	83	63.03	14.43	91	70.91	12.94	174
35 to 36	79.04	12.81	91	67.30	15.62	113	72.24	11.71	204
36 to 37	80.41	14.10	79	65.41	11.27	84	72.03	12.63	163
37 to 38	79.06	12.41	83	66.81	13.08	97	71.82	11.27	180
38 to 39	83.01	15.40	65	66.56	15.72	71	74.14	13.76	136
39 to 40	79.85	13.02	71	67.21	13.85	79	73.19	11.94	150
40 to 41	84.20	13.22	76	70.56	17.70	77	76.49	12.01	153
41 to 42	81.20	15.07	73	65.25	12.91	70	73.47	13.63	143
42 to 43	79.67	11.86	74	65.81	12.14	98	71.23	10.60	172
43 to 44	81.50	14.04	68	68.45	14.89	84	73.38	12.64	152
44 to 45	82.76	13.41	65	66.96	15.19	71	73.70	11.94	136
45 to 46	80.91	13.77	62	65.18	14.78	65	72.33	12.31	127
46 to 47	82.83	15.28	68	70.45	15.91	82	75.24	13.89	150
47 to 48	82.29	11.83	55	68.02	13.67	73	73.42	10.55	128
48 to 49	81.52	12.63	77	67.39	15.71	67	74.28	11.51	144
49 to 50	80.60	13.31	77	66.83	14.54	79	73.07	12.06	156
50 to 51	81.14	14.23	79	70.81	14.67	98	75.12	13.17	177
51 to 52	81.25	11.27	69	67.20	11.99	67	73.81	10.23	136
52 to 53	82.38	15.03	73	66.07	14.58	88	72.70	13.27	161
53 to 54	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] (years)	Males (kg)			Females (kg)			Overall (kg)		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
54 to 55	76.63	13.36	61	67.62	14.64	71	71.52	12.47	132
55 to 56	81.92	15.12	62	71.93	16.17	90	75.32	13.90	152
56 to 57	77.36	11.28	69	70.82	15.40	67	73.59	10.73	136
57 to 58	79.85	13.02	64	66.87	14.41	99	71.60	11.68	163
58 to 59	79.23	12.52	73	68.73	13.60	70	73.28	11.58	143
59 to 60	80.00	12.47	72	64.43	12.88	70	71.45	11.14	142
60 to 61	79.76	12.92	183	67.28	12.83	218	72.75	11.79	401
61 to 62	78.42	11.75	169	68.12	13.83	176	72.68	10.89	345
62 to 63	77.06	12.33	188	66.09	13.69	184	71.00	11.36	372
63 to 64	77.07	11.31	162	66.41	14.03	178	70.72	10.38	340
64 to 65	77.27	13.63	185	67.45	13.77	177	72.26	12.74	362
65 to 66	77.36	13.25	158	68.48	14.68	185	71.84	12.30	343
66 to 67	75.35	13.21	138	67.36	13.95	182	70.40	12.34	320
67 to 68	73.98	12.82	143	65.98	13.47	149	69.19	11.99	292
68 to 69	74.14	14.60	124	68.87	13.63	161	71.02	13.98	285
69 to 70	74.40	13.20	129	65.59	13.39	119	69.37	12.30	248
70 to 71	75.17	13.03	128	65.04	12.47	136	69.32	12.01	264
71 to 72	74.45	12.60	115	65.62	13.53	139	69.00	11.67	254
72 to 73	73.47	12.36	100	64.89	11.58	135	68.17	11.46	235
73 to 74	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 yr represents ages from 12 to 23 mo.
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] (years)	Males (kg)			Females (kg)			Overall (kg)		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
0 to 1	8.5	1.5	902	7.8	1.6	910	8.17	1.7	1,812
1 to 2	11.6	1.5	660	10.9	1.4	647	11.2	1.5	1,307
2 to 3	13.6	1.5	644	13.2	1.8	624	13.4	1.8	1,268
3 to 4	15.8	2.3	516	15.4	2.2	587	15.6	2.2	1,103
4 to 5	17.6	2.4	549	17.9	3.2	537	17.8	3.2	1,086
5 to 6	20.1	3.0	497	20.2	3.5	554	20.2	3.5	1,051
6 to 7	23.2	5.0	283	22.6	4.7	272	22.9	4.8	555
7 to 8	26.3	5.0	269	26.3	6.2	274	26.4	6.2	543
8 to 9	30.1	6.9	266	29.8	6.7	248	30.0	6.7	514
9 to 10	34.4	7.9	281	34.3	9.0	280	34.4	9.0	561
10 to 11	37.3	8.6	297	37.9	9.5	258	37.7	9.4	555
11 to 12	42.5	10.5	281	44.2	10.5	275	43.4	10.3	556
12 to 13	49.1	11.1	203	49.1	11.6	236	49.1	11.7	439
13 to 14	54.0	12.9	187	55.7	13.2	220	54.8	13.0	407
14 to 15	63.7	17.1	188	58.3	11.8	220	60.6	12.2	408
15 to 16	66.8	14.9	187	58.3	10.1	197	61.7	10.7	384
16 to 17	68.6	14.9	194	61.5	12.8	215	65.2	13.6	409
17 to 18	72.7	13.3	196	62.4	11.9	217	67.6	12.9	413
18 to 19	71.2	14.3	176	61.5	14.2	193	66.4	15.3	369
19 to 20	73.0	12.8	168	63.6	14.5	193	68.3	15.6	361
20 to 21	72.5	13.4	149	61.7	12.9	180	66.1	13.8	329
21 to 22	72.92	12.86	161	65.01	16.03	188	69.24	17.08	349
22 to 23	76.34	14.72	160	64.07	13.61	193	69.48	14.75	353
23 to 24	77.85	14.37	172	66.99	16.24	205	72.72	17.63	377
24 to 25	78.56	15.38	187	62.79	12.62	200	70.16	14.10	387
25 to 26	80.33	17.89	171	66.19	16.05	157	74.11	17.97	328
26 to 27	75.88	12.84	143	64.89	15.19	184	69.73	16.33	327
27 to 28	81.17	14.90	176	65.10	14.43	184	73.33	16.25	360
28 to 29	81.10	18.23	154	66.97	15.26	190	73.28	16.70	344
29 to 30	81.93	16.89	156	65.89	13.65	177	73.33	15.19	333
30 to 31	83.56	16.71	163	67.76	16.85	202	75.11	18.68	365
31 to 32	79.48	13.12	155	72.48	19.32	204	77.04	20.54	359
32 to 33	81.65	15.82	159	67.53	17.22	179	74.33	18.95	338
33 to 34	84.03	16.63	153	68.49	16.03	176	75.09	17.58	329
34 to 35	82.95	15.56	162	67.55	14.27	186	76.47	16.16	348
35 to 36	81.24	16.16	143	71.45	17.47	188	76.02	18.59	331
36 to 37	87.67	21.26	163	66.02	14.29	180	77.32	16.74	343
37 to 38	83.33	17.61	123	72.04	17.69	202	76.42	18.77	325
38 to 39	82.53	14.47	136	71.58	17.43	183	76.85	18.71	319
39 to 40	82.62	12.46	122	74.57	19.41	157	79.34	20.65	279
40 to 41	85.84	15.23	152	68.70	15.80	198	75.55	17.37	350
41 to 42	86.19	18.93	148	70.11	13.80	183	78.34	15.42	331
42 to 43	85.12	16.76	161	72.72	19.46	171	79.25	21.21	332
43 to 44	86.37	17.71	139	68.94	15.35	123	77.80	17.33	262
44 to 45	90.62	20.37	120	72.61	17.15	152	79.13	18.69	272
45 to 46	83.58	13.46	108	71.78	15.76	125	78.22	17.18	233
46 to 47	80.70	13.00	102	72.07	15.53	113	76.30	16.44	215
47 to 48	85.54	17.28	116	72.09	15.98	102	79.28	17.57	218
48 to 49	82.29	14.93	93	75.80	16.09	95	79.21	16.82	188
49 to 50	82.25	16.11	85	73.41	18.26	106	77.95	19.39	191
50 to 51	81.69	13.24	77	74.05	18.03	118	77.31	18.82	195
51 to 52	85.78	15.39	84	79.48	19.60	85	83.81	20.67	169
52 to 53	87.02	13.66	93	72.00	16.86	100	79.97	18.72	193
53 to 54	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] (years)	Males(kg)			Females (kg)			Overall (kg)		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
54 to 55	86.02	16.76	86	74.63	19.97	113	79.88	21.38	199
55 to 56	83.10	14.99	82	72.56	14.06	102	76.59	14.84	184
56 to 57	87.16	15.10	96	77.69	16.74	105	83.15	17.91	201
57 to 58	86.31	15.04	89	75.65	17.87	97	82.12	19.40	186
58 to 59	83.54	15.67	81	72.26	16.47	100	76.89	17.52	181
59 to 60	87.93	16.14	74	74.00	15.33	82	80.48	16.67	156
60 to 61	83.54	14.22	130	68.73	13.60	104	75.88	15.02	234
61 to 62	81.91	15.03	119	72.26	15.42	141	76.50	16.32	260
62 to 63	81.98	15.47	116	72.97	17.54	114	77.18	18.55	230
63 to 64	84.15	14.50	118	71.32	14.48	111	76.88	15.61	229
64 to 65	84.28	15.73	116	74.34	17.40	126	78.86	18.46	242
65 to 66	85.10	14.75	127	67.47	16.08	118	76.14	18.14	245
66 to 67	81.43	15.03	102	71.82	14.58	118	76.49	15.53	220
67 to 68	84.35	15.22	117	68.98	15.22	95	76.08	16.78	212
68 to 69	80.60	11.75	98	70.72	16.56	110	76.07	17.81	208
69 to 70	84.81	18.18	113	66.57	11.74	97	74.84	13.20	210
70 to 71	80.18	14.14	92	68.36	15.72	124	72.95	16.78	216
71 to 72	79.34	14.64	126	70.74	17.89	98	75.64	19.13	224
72 to 73	78.97	13.36	119	66.70	13.89	101	72.76	15.15	220
73 to 74	82.07	17.26	109	68.24	14.14	115	74.37	15.41	224
74 to 75	79.32	15.37	84	69.08	13.67	97	73.57	14.56	181
75 to 76	77.18	10.47	75	68.58	13.50	85	72.89	14.35	160
76 to 77	79.30	14.88	64	65.68	13.88	94	70.38	14.87	158
77 to 78	80.70	13.98	64	67.33	14.16	86	72.43	15.23	150
78 to 79	75.21	11.34	50	63.67	14.31	63	67.94	15.27	113
79 to 80	78.75	11.32	45	60.21	14.41	61	67.28	16.10	106
80 to 81	76.94	15.15	108	63.55	13.10	101	68.77	14.18	209
81 to 82	73.70	13.30	96	63.17	12.70	112	66.94	13.45	208
82 to 83	73.25	12.32	81	61.96	12.01	69	67.05	12.99	150
83 to 84	72.10	15.31	63	62.78	12.23	63	65.80	12.82	126
84 to 85	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 yr represents ages from 12 to 23 mo.
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] (years)	Males (kg)			Females (kg)			Overall (kg)		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
0 to 1	9.3	1.8	116	9.3	1.5	101	9.3	1.5	217
1 to 2	11.3	1.4	144	11.5	1.9	98	11.4	1.8	242
2 to 3	13.7	2.0	130	13.3	1.9	113	13.5	2.0	243
3 to 4	16.4	2.3	105	15.2	2.1	77	15.9	2.2	182
4 to 5	18.8	2.6	95	18.1	3.2	87	18.5	3.3	182
5 to 6	20.2	3.3	65	20.7	4.9	92	20.6	4.9	157
6 to 7	22.9	4.3	94	22.0	4.5	74	22.5	4.6	168
7to 8	28.1	5.6	100	26.0	6.2	82	27.4	6.5	182
8 to 9	31.9	8.6	100	30.8	7.2	89	31.3	7.3	189
9 to 10	36.1	7.5	76	36.0	8.4	84	36.2	8.5	160
10 to 11	39.5	9.0	92	39.4	10.2	84	39.5	10.2	176
11 to 12	42.0	10.2	84	47.2	12.2	97	44.6	11.6	181
12 to 13	49.4	12.7	158	51.6	12.3	160	50.3	11.9	318
13 to 14	54.9	16.2	161	59.8	15.3	156	56.9	14.6	317
14 to 15	65.1	19.9	137	59.9	13.3	158	61.5	13.7	295
15 to 16	68.2	15.7	142	63.4	13.9	126	65.9	14.4	268
16 to 17	72.5	18.6	153	63.4	16.0	142	68.0	17.1	295
17 to 18	75.4	17.9	146	59.9	11.9	128	66.6	13.2	274
18 to 19	74.8	15.9	131	65.0	15.2	139	70.2	16.4	270
19 to 20	80.1	17.2	129	68.7	17.4	132	74.6	19.0	261
20 to 21	80.0	15.5	37	66.3	15.5	44	74.3	17.4	81
21 to 22	73.84	12.87	33	65.89	15.49	47	69.40	16.32	80
22 to 23	89.62	23.98	37	67.27	15.47	49	75.85	17.44	86
23 to 24	83.39	18.31	36	73.58	23.21	53	80.27	25.32	89
24 to 25	80.26	19.38	20	71.81	21.27	54	75.04	22.23	74
25 to 26	87.47	14.89	27	71.64	20.31	44	80.45	22.80	71
26 to 27	72.11	14.64	33	78.09	20.98	47	75.63	20.32	80
27 to 28	85.78	22.69	30	72.48	18.10	49	78.75	19.67	79
28 to 29	88.04	26.64	36	76.18	16.18	34	81.29	17.26	70
29 to 30	84.02	15.16	35	71.88	16.60	50	78.10	18.04	85
30 to 31	80.10	22.28	29	74.00	22.71	48	77.01	23.63	77
31 to 32	84.65	18.59	33	79.12	22.51	49	82.51	23.48	82
32 to 33	90.99	15.77	35	77.53	18.15	55	83.82	19.62	90
33 to 34	90.90	18.74	37	76.60	22.28	29	85.94	25.00	66
34 to 35	79.09	19.50	33	73.26	16.92	49	75.72	17.49	82
35 to 36	91.15	25.45	33	79.91	22.74	37	84.60	24.07	70
36 to 37	88.96	17.15	29	72.10	20.29	38	80.17	22.55	67
37 to 38	84.62	17.62	47	70.75	15.39	35	79.21	17.23	82
38 to 39	80.52	17.26	29	80.86	22.32	40	81.18	22.41	69
39 to 40	84.77	14.26	37	78.08	19.34	43	81.92	20.29	80
40 to 41	92.21	26.63	40	73.87	18.14	47	82.13	20.17	87
41 to 42	83.11	14.06	37	75.91	17.38	37	79.56	18.21	74
42 to 43	91.94	15.56	46	82.03	21.78	41	88.15	23.41	87
43 to 44	89.48	16.15	40	71.59	17.81	27	83.18	20.69	67
44 to 45	87.00	14.63	34	74.86	18.15	42	80.04	19.41	76
45 to 46	84.61	17.53	33	81.15	23.52	50	83.21	24.12	83
46 to 47	93.27	20.48	28	74.94	16.84	34	82.90	18.63	62
47 to 48	80.87	11.38	29	68.24	16.97	38	74.29	18.48	67
48 to 49	85.58	17.91	21	82.10	29.55	34	84.51	30.42	55
49 to 50	88.84	24.90	28	75.55	21.74	24	82.17	23.64	52
50 to 51	90.09	14.51	26	83.22	27.42	27	88.10	29.03	53
51 to 52	90.63	18.22	35	76.89	16.09	36	83.63	17.50	71
52 to 53	90.62	19.52	24	80.89	19.78	42	85.03	20.79	66
53 to 54	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] (years)	Males (kg)			Females (kg)			Overall (kg)		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
54 to 55	90.51	21.10	32	75.19	18.07	36	81.46	19.58	68
55 to 56	84.84	18.72	20	79.87	16.71	25	82.39	17.24	45
56 to 57	84.48	18.55	26	80.68	20.24	32	82.72	20.75	58
57 to 58	86.02	20.50	26	73.07	13.79	24	80.20	15.13	50
58 to 59	89.11	21.33	19	71.21	16.01	17	79.97	17.97	36
59 to 60	83.82	16.33	25	76.28	16.36	17	80.76	17.32	42
60 to 61	89.53	17.90	60	75.97	18.66	43	83.70	20.56	103
61 to 62	86.04	15.44	34	77.01	16.67	37	81.12	17.56	71
62 to 63	84.46	16.28	41	75.78	13.13	45	79.50	13.78	86
63 to 64	86.51	20.07	24	77.95	16.96	39	80.73	17.56	63
64 to 65	91.45	16.88	39	76.75	18.29	42	83.98	20.01	81
65 to 66	89.46	18.44	41	72.95	18.37	41	80.38	20.24	82
66 to 67	90.40	20.13	49	79.00	17.67	26	86.09	19.26	75
67 to 68	85.34	19.18	36	77.76	18.21	35	81.18	19.01	71
68 to 69	84.48	12.92	26	73.28	14.12	35	78.20	15.07	61
69 to 70	92.35	16.95	24	69.94	9.20	32	80.53	10.59	56
70 to 71	81.91	16.38	47	70.50	12.94	32	76.06	13.96	79
71 to 72	79.65	21.31	25	66.22	13.04	35	68.99	13.58	60
72 to 73	84.67	17.45	32	76.89	15.30	21	81.08	16.13	53
73 to 74	89.70	15.36	35	72.75	16.80	27	81.69	18.87	62
74 to 75	80.85	17.00	17	69.21	16.35	31	73.34	17.32	48
75 to 76	84.26	11.94	25	68.61	10.42	21	75.14	11.41	46
76 to 77	86.13	15.45	20	67.42	11.34	25	73.62	12.38	45
77 to 78	81.68	14.15	18	78.35	17.45	21	80.09	17.84	39
78 to 79	81.99	16.39	26	72.30	14.16	17	77.77	15.23	43
79 to 80	80.18	10.39	19	67.95	12.54	21	73.39	13.54	40
80 to 81	75.90	12.07	27	60.97	14.46	23	65.39	15.51	50
81 to 82	73.77	7.40	31	68.76	13.75	25	71.28	14.25	56
82 to 83	81.01	13.46	20	62.93	9.81	20	68.51	10.68	40
83 to 84	76.07	10.63	12	66.24	11.68	12	70.90	12.50	24
84 to 85	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 yr represents ages from 12 to 23 mo.

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 (years)	NHANES	Males (kg)			Females (kg)			Overall (kg)		
		Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
1 to 6	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	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	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+	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 1994−1996, 1998 CSFII

Weight (kg)											
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	9,049	76	45	51	54	63	74	86	99	107	126
≥65 years	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 *3rd Report on Nutrition Monitoring in the United States* (FASEB/LSRO, 1995).

Source: Kahn and Stralka (2009).

Table 8-27. Estimated Percentile Distribution of Body Weight by Fine Age Categories With Confidence Interval

Weight (kg)

Age Group	Sample Size	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	9,049	76	-	-	99	-	-	107	-	-
≥65 years	2,139	72	-	-	93	-	-	100	-	-
All ages	19,850	65	-	-	95	-	-	104	-	-

[a] Sample size does meet minimum reporting requirements as described in the 3^{rd} *Report on Nutrition Monitoring in the United States* (Vol. I) (FASEB/LSRO, 1995). 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 (2009).

Table 8-28. Distribution of 1st Trimester Weight Gain and 2nd and 3rd Trimester Rates of Gain in Women With Good Pregnancy Outcomes

Trimester	Percentile of Weight Gain					
	10th	25th	50th	75th	90th	Mean ± SD
1st Trimester, kg						
Underweight	−1.81	−0.14	1.92	3.78	5.77	1.92 ± 3.06
Normal weight	−2.21	−0.09	2.20	4.37	6.59	2.19 ± 3.47
Overweight	−2.91	−0.59	2.38	4.63	7.04	2.16 ± 3.95
Obese	−3.08	−0.86	1.17	3.89	7.22	1.65 ±3. 94
2nd Trimester, kg/wk[a]						
Underweight	0.33	0.44	0.56	0.69	0.82	0.57 ± 0.20
Normal weight	0.31	0.44	0.56	0.71	0.85	0.58 ± 0.22
Overweight	0.21	0.36	0.49	0.65	0.83	0.51 ± 0.24
Obese	0.06	0.24	0.42	0.56	0.78	0.41 ± 0.27
3rd Trimester, kg/wk[a]						
Underweight	0.26	0.36	0.47	0.60	0.71	0.48 ± 0.19
Normal weight	0.26	0.37	0.50	0.64	0.77	0.51 ± 0.21
Overweight	0.21	0.34	0.47	0.63	0.77	0.49 ± 0.22
Obese	0.19	0.31	0.43	0.64	0.80	0.47 ± 0.24

[a] To calculate the distribution of total gain (kg) in the 2nd and 3rd trimesters, multiply the values in the table by 13 wk.

SD = Standard deviation.

Source: Carmichael et al. (1997).

Table 8-29. Estimated Body Weights of Pregnant Women—NHANES (1999−2006)

Weight (kg)													
		Mean		Percentiles									
Trimester	Sample size	Estimate	SD	5th	10th	15th	25th	50th	75th	85th	90th	95th
1	204	76	3	48	50	55	60	74	91	98	106	108
2	430	73	1	50	53	57	61	72	83	93	95	98
3	402	80	1	60	63	65	69	77	88	99	104	108
Ref/Dk[a]	186	69	2	46	52	55	60	65	77	84	87	108
All	1,222	75	1	50	55	59	63	73	85	94	99	107

[a] Refers to pregnant women who either refused to tell which trimester they were in or didn't know or data were missing.
SD = Standard deviation.

Source: U.S. EPA Analysis of NHANES 1999−2006 data.

Table 8-30. Fetal Weight (g) Percentiles Throughout Pregnancy

Gestational Age (wk)	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

[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 gestational weeks.

Source: Brenner et al. (1976).

Table 8-31. 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).

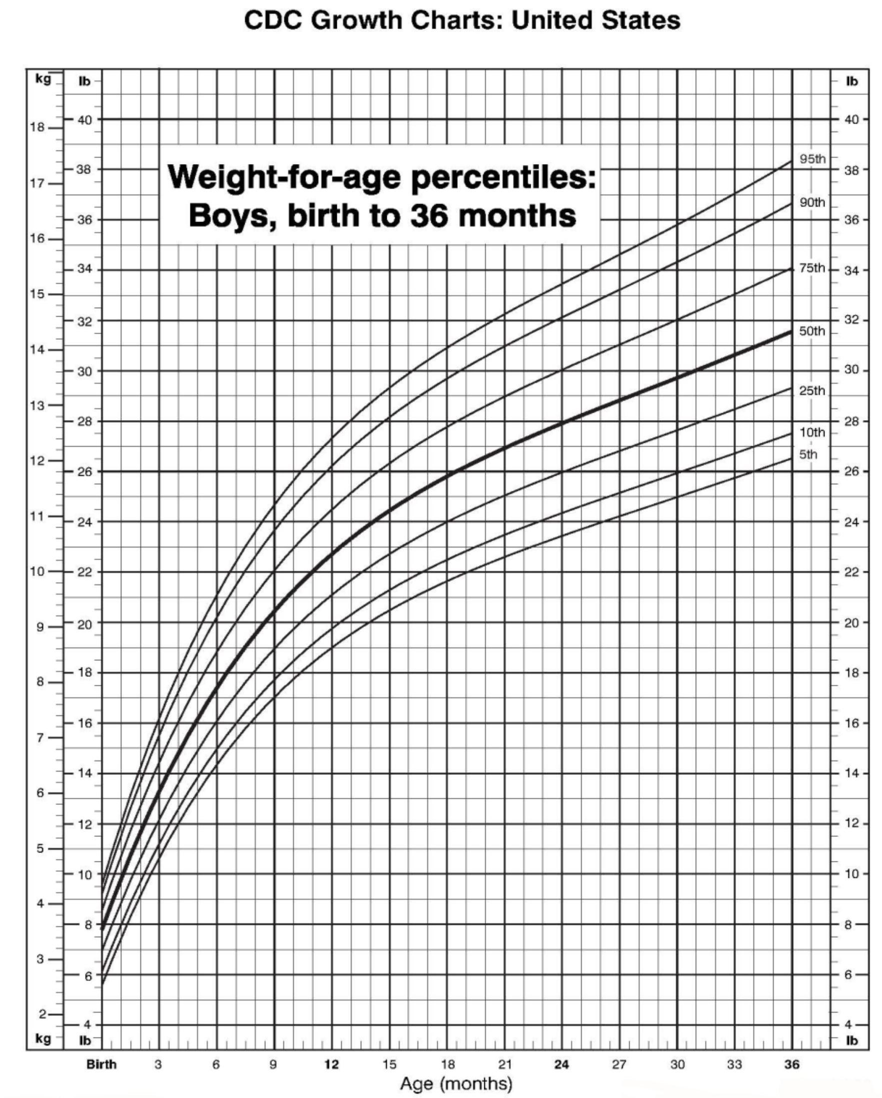

Figure 8-1. Weight by Age Percentiles for Boys Aged Birth to 36 Months.

Source: Kuczmarski et al. (2002).

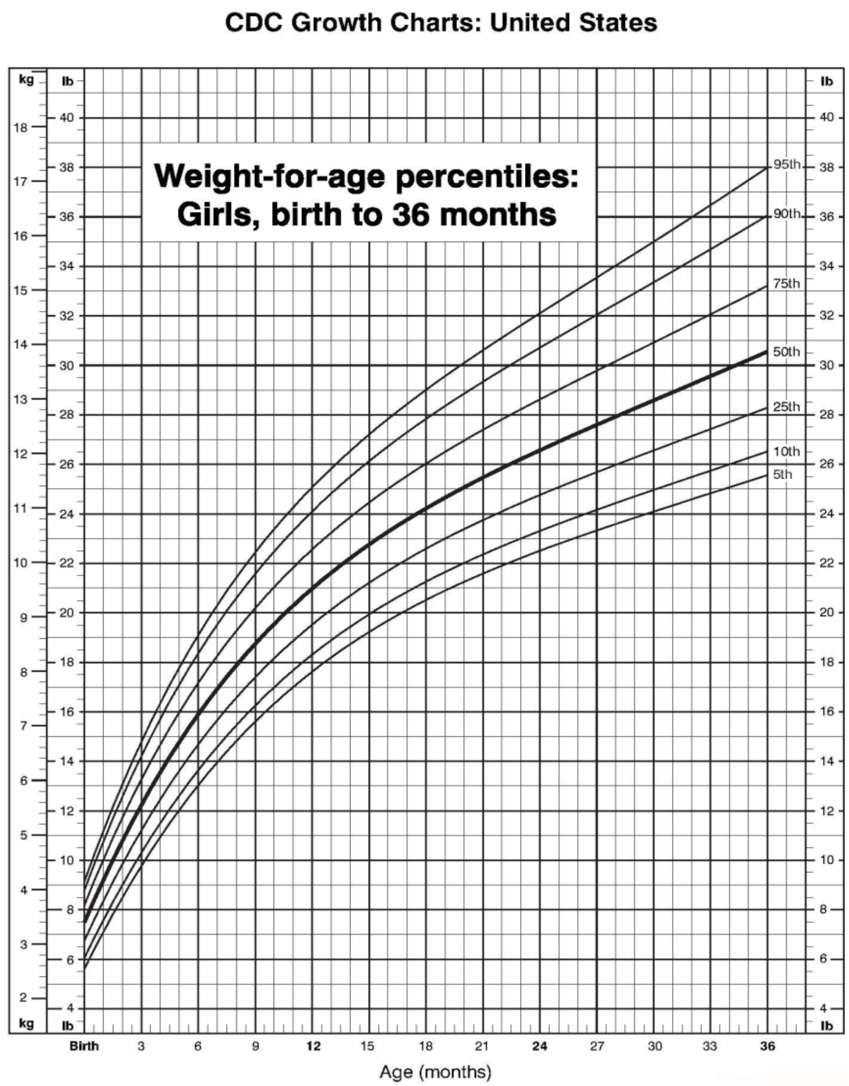

Figure 8-2. Weight by Age Percentiles for Girls Aged Birth to 36 Months.

Source: Kuczmarski et al. (2002).

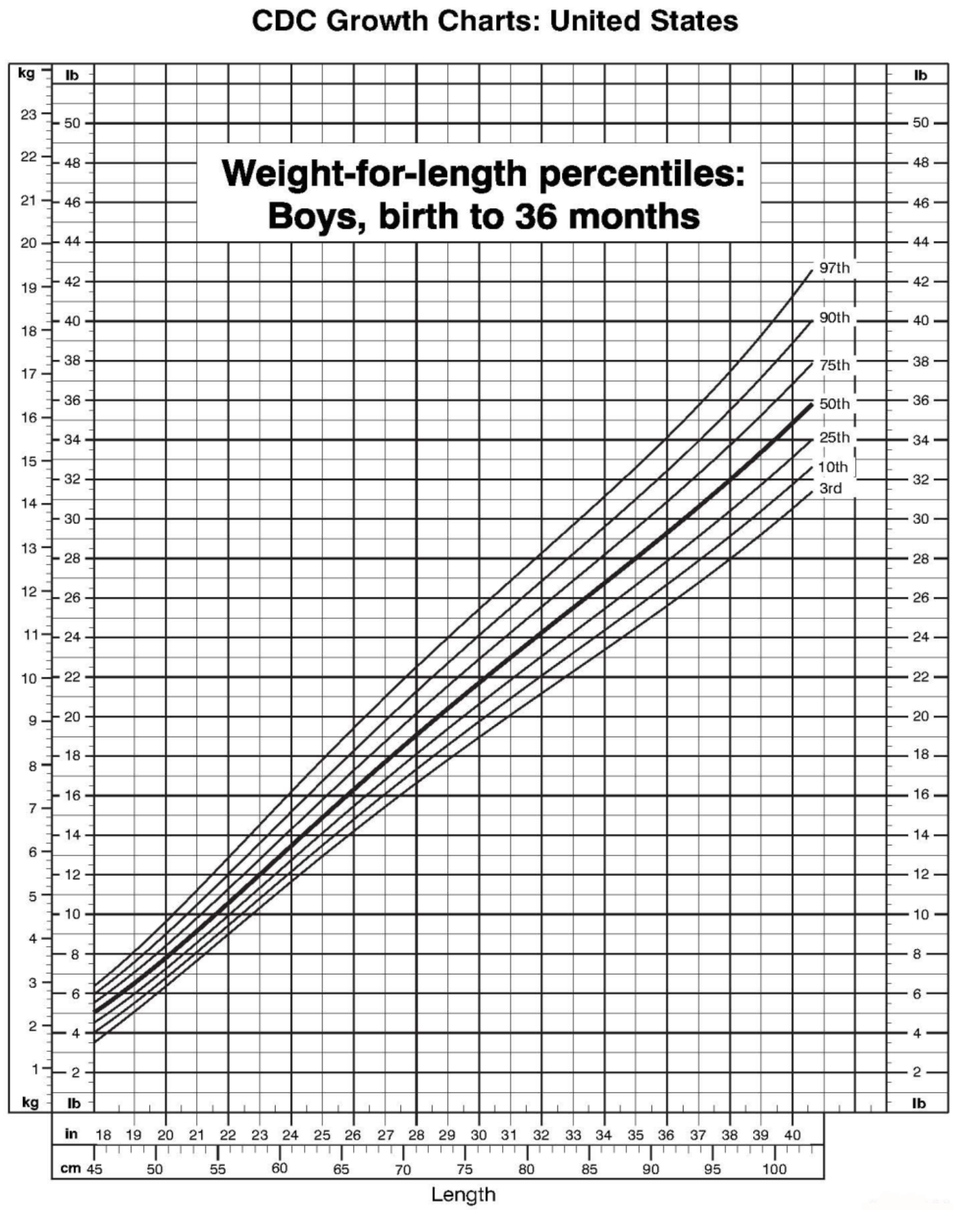

Figure 8-3. Weight by Length Percentiles for Boys Aged Birth to 36 Months.

Source: Kuczmarski et al. (2002).

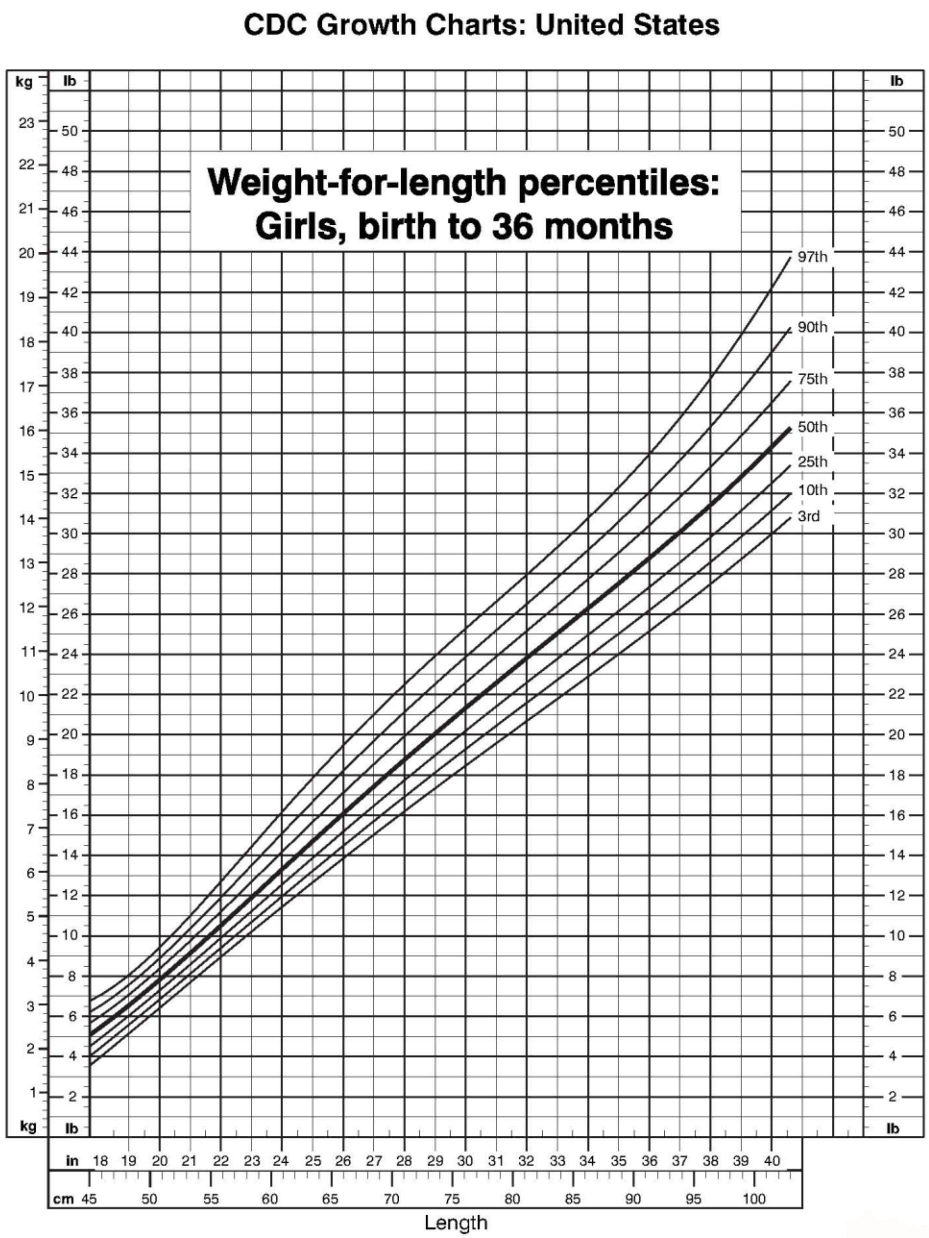

Figure 8-4. Weight by Length Percentiles for Girls Aged Birth to 36 Months.

Source: Kuczmarski et al. (2002).

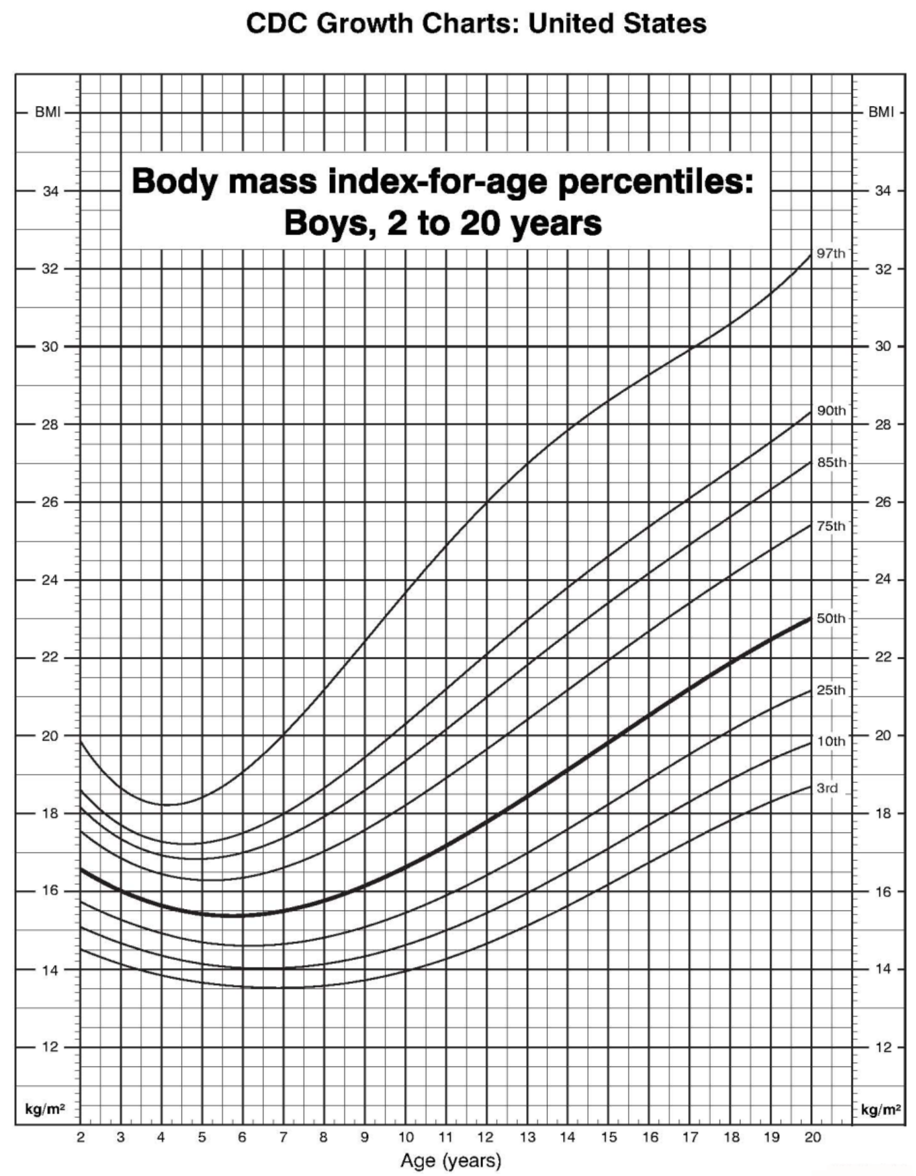

Figure 8-5. Body Mass Index-for-Age Percentiles: Boys, 2 to 20 Years.

Source: Kuczmarski et al. (2002).

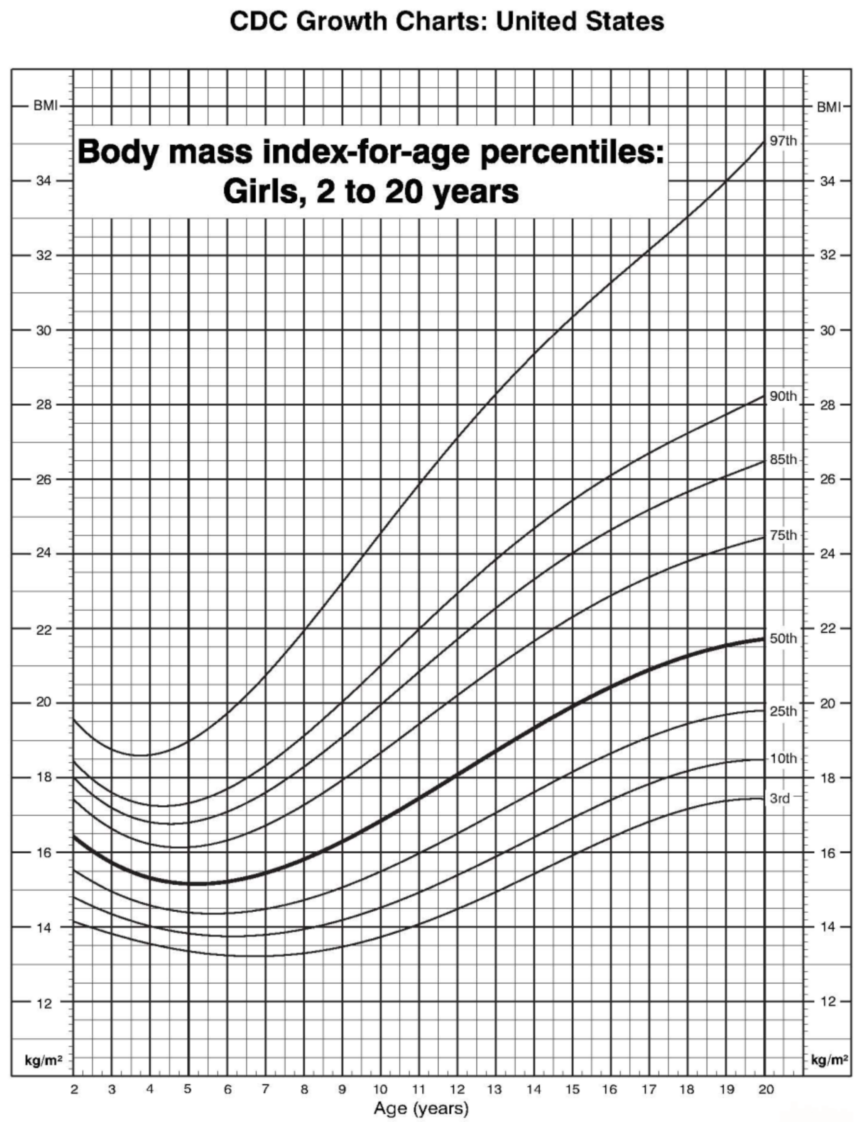

Figure 8-6. Body Mass Index-for-Age Percentiles: Girls, 2 to 20 Years.

Source: Kuczmarski et al. (2002).

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. Some of 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. Others are provided as uncooked weights based on analyses of survey data that account for weight changes that occur during cooking. 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. 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, refer 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, refer 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. Environmental Protection Agency (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. Table 9-2 provides confidence ratings for the fruit and vegetable intake recommendations.

The U.S. EPA analysis of data from the 2003−2006 National Health and Nutrition Examination Survey (NHANES) was used in selecting recommended intake rates for the general population. 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.

The NHANES 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. In general, the recommended values based on U.S. EPA's analysis of NHANES data represent the i.e., uncooked weight of the edible portion of fruits and vegetables.

Table 9-1. Recommended Values for Intake of Fruits and Vegetables, Edible Portion, Uncooked[a]						
Age Group (years)	**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	6.2	23.0[b]	10.1	25.8[b]	See Table 9-3 and Table 9-4	U.S. EPA Analysis of NHANES 2003−2006
1 to <2	7.8	21.3[b]	8.1	21.4[b]		
2 to <3	7.8	21.3[b]	8.1	21.4[b]		
3 to <6	4.6	14.9	4.7	15.1		
6 to <11	2.3	8.7	2.5	9.2		
11 to <16	0.9	3.5	1.1	3.8		
16 to <21	0.9	3.5	1.1	3.8		
21 to <50	0.9	3.7	1.1	3.8		
≥50	1.4	4.4	1.5	4.6		
Total Vegetables						
Birth to 1	5.0	16.2[b]	6.8	18.1[b]	See Table 9-3 and Table 9-4	U.S. EPA Analysis of NHANES 2003−2006
1 to <2	6.7	15.6[b]	6.7	15.6[b]		
2 to <3	6.7	15.6[b]	6.7	15.6[b]		
3 to <6	5.4	13.4	5.4	13.4		
6 to <11	3.7	10.4	3.7	10.4		
11 to <16	2.3	5.5	2.3	5.5		
16 to <21	2.3	5.5	2.3	5.5		
21 to <50	2.5	5.9	2.5	5.9		
≥50	2.6	6.1	2.6	6.1		
Individual Fruits and Vegetables—See Table 9-5 and Table 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.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

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 were adequate. The survey sampled more than 16,000 individuals. However, sample sizes 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		High
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 2003 and 2006.	
Data Collection Period	Data were collected for two non-consecutive days.	
Clarity and Completeness		High
Accessibility	The NHANES data are publicly available.	
Reproducibility	The methodology used was clearly described; enough information was included to reproduce the results.	
Quality Assurance	NHANES follows a strict QA/QC procedure. The U.S. EPA analysis has only been reviewed internally, but the methodology used has been peer reviewed in an analysis of previous data.	
Variability and Uncertainty		Medium to high for averages, low for long-term upper percentiles; low for individual fruits and vegetables
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 greater for individual fruits and vegetables.	
Evaluation and Review		Medium
Peer Review	The NCHS NHANES survey received a high level of peer review. The U.S. EPA analysis of these data has not been peer reviewed outside the Agency, but the methodology used has been peer reviewed in an analysis of previous data.	
Number and Agreement of Studies	There was one key study.	
Overall Rating		**Medium to 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

9.3.1. Key Fruits and Vegetables Intake Study

9.3.1.1. *U.S. EPA Analysis of Consumption Data From 2003−2006 National Health and Nutrition Examination Survey (NHANES)*

The key source of recent information on consumption rates of fruits and vegetables is the U.S. Centers for Disease Control and Prevention's National Center for Health Statistics' (NCHS) NHANES. Data from NHANES 2003−2006 have been used by the U.S. EPA, Office of Pesticide Programs (OPP) to generate per capita and consumer-only intake rates for both individual fruits and vegetables and total fruits and vegetables.

NHANES is designed to assess the health and nutritional status of adults and children in the United States. In 1999, the survey became a continuous program that interviews a nationally representative sample of approximately 7,000 persons each year and examines a nationally representative sample of about 5,000 persons each year, located in counties across the country, 15 of which are visited each year. Data are released on a 2-year basis, thus, for example, the 2003 data are combined with the 2004 data to produce NHANES 2003−2004.

The dietary interview component of NHANES is called *What We Eat in America* and is conducted by the U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (DHHS). DHHS' NCHS is responsible for the sample design and data collection, and USDA's Food Surveys Research Group is responsible for the dietary data collection methodology, maintenance of the databases used to code and process the data, and data review and processing. Beginning in 2003, 2 non-consecutive days of 24-hour intake data were collected. The first day is collected in-person, and the second day is collected by telephone 3 to 10 days later. These data are collected using USDA's dietary data collection instrument, the Automated Multiple Pass Method. This method provides an efficient and accurate means of collecting intakes for large-scale national surveys. It is fully computerized and uses a 5-step interview. Details can be found at USDA's Agriculture Research Service (http://www.ars.usda.gov/ba/bhnrc/fsrg).

For NHANES 2003−2004, there were 12,761 persons selected; of these, 9,643 were considered respondents to the mobile examination center (MEC) examination and data collection. However, only 9,034 of the MEC respondents provided complete dietary intakes for Day 1. Furthermore, of those providing the Day 1 data, only 8,354 provided complete dietary intakes for Day 2. For NHANES 2005−2006, there were 12,862 persons selected; of these, 9,950 were considered respondents to the MEC examination and data collection. However, only 9,349 of the MEC respondents provided complete dietary intakes for Day 1. Furthermore, of those providing the Day 1 data, only 8,429 provided complete dietary intakes for Day 2.

The 2003−2006 NHANES surveys are stratified, multistage probability samples of the civilian non-institutionalized U.S. population. The sampling frame was organized using 2000 U.S. population census estimates. NHANES oversamples low-income persons, adolescents 12 to 19 years, persons 60 years and older, African Americans, and Mexican Americans. 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. Additional information on NHANES can be obtained at http://www.cdc.gov/nchs/nhanes.htm.

In 2010, U.S. EPA, OPP used NHANES 2003−2006 data to update the Food Commodity Intake Database (FCID) that was developed in earlier analyses of data from the USDA's Continuing Survey of Food Intake among Individuals (CSFII) (U.S. EPA, 2000; USDA, 2000) (see Section 9.3.2.4), NHANES 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 558 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/).

Intake rates were generated for a variety of food items/groups based on the agricultural commodities included in the FCID. These intake rates represent intake of all forms of the product (e.g., both home produced and commercially produced) for individuals who provided data for 2 days of the survey. Note that if the person reported consuming food for only one day, their 2-day average would be half the amount reported for the one day of consumption. 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 4-year, 2-day sample weights provided in NHANES 2003−2006 to adjust the data for the sample population to reflect the national population.

Summary statistics were generated on a consumer-only and on a per capita basis. 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. Individual fruits and vegetables were selected to be consistent with Chapter 13, which was based on having at least 30 households reporting consumption for the particular fruit or vegetable. Percentiles of the intake rate distribution (i.e., 1^{st}, 5^{th}, 10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th}, 95^{th}, 99^{th}, 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. Data for females 13 to 49 years were also provided. 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 per capita intake data for total fruits and total vegetables in g/kg-day; Table 9-4 provides consumer-only intake data for total fruits and total vegetables in g/kg-day. Table 9-5 provides per capita intake data for individual fruits and vegetables in g/kg-day, and Table 9-6 provides consumer-only intake data for individual fruits and vegetables in g/kg-day. In general, these data represent intake of the edible portions of uncooked foods.

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. Also, it should be noted that the distribution of average daily intake rates generated using short-term data (e.g., 2-day) does 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.

An advantage of using the U.S. EPA's analysis of NHANES data is that it provides distributions of intake rates for various age groups of children and adults, normalized by body weight. The data set was designed to be representative of the U.S. population and includes four years of intake data combined. Another advantage is the currency of the data; the NHANES data are from 2003−2006. However, 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. Because these are 2-day averages, consumption estimates at the upper end of the intake distribution may be underestimated if these consumption values are used to assess acute (i.e., short-term) exposures, 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. *U.S. Department of Agriculture (USDA) (1996a, b, 1993, 1980)—Food and Nutrient Intakes of Individuals in One Day in the United States*

USDA calculated mean intake rates for total fruits and total vegetables using data from the 1977−1978 and 1987−1988 Nationwide Food Consumption Surveys (NFCS) (USDA, 1993, 1980) and CSFII data from 1994 and 1995 (USDA, 1996a, b). Table 9-7 presents the mean per capita total intake rates for total fruits and total vegetables from the 1977−1978 NFCS. Table 9-8 presents similar data from the 1987−1988 NFCS and the 1994 and 1995 CSFII. Note that the age classifications used in these surveys were slightly different than those used in the 1977−1978 NFCS. Table 9-7 and Table 9-8 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 consuming 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. These data are based on older surveys and may not be entirely representative of current eating patterns.

9.3.2.2. *U.S. Department of Agriculture (USDA) (1999b)—Food Consumption, Prices, and Expenditures, 1970−1997*

The USDA's Economic Research Service calculates the amount of food available for human consumption in the United States on an annual basis (USDA, 1999b). Supply and utilization balance sheets are generated based on the flow of food items from production to end uses for the years 1970 to 1997. Total available supply is estimated as the sum of production and imports (USDA, 1999b). The availability of food for human use commonly termed as "food disappearance" is determined by subtracting exported foods from the total available supply (USDA, 1999b). USDA (1999b) calculates the per capita food consumption by dividing the total food disappearance by the total U.S. population. USDA (1999b) estimated per capita consumption data for various fruit and vegetable products from 1970−1997. Table 9-9 presents retail weight per capita data. These data have been derived from the annual per capita values in units of pounds per year, presented by USDA (1999b), by converting to units of g/day.

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. 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, 1999b). These data are based on older surveys and may not be entirely representative of current consumption patterns.

9.3.2.3. *U.S. Department of Agriculture (USDA) (1999a)—Food and Nutrient Intakes by Children 1994−1996, 1998, Table Set 17*

USDA (1999a) calculated national probability estimates of food and nutrient intake by children based on four years of the CSFII (1994−1996 and 1998) for children age nine years and under, and on CSFII 1994−1996 only for children age 10 years and over. The CSFII was a series of surveys designed to measure the kinds and amounts of foods eaten by Americans. Intake data, based on 24-hour dietary recall, were collected through in-person interviews on two non-consecutive days. Section 9.3.2.4 provides additional information on these surveys.

USDA (1999a) used sample weights 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 four quarters of the year and the seven 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. Table 9-10 through Table 9-13 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 (1999a) study is that it uses the 1994−1996, 1998 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 1 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. These data are based on older surveys and may not be entirely representative of current eating patterns.

9.3.2.4. *U.S. EPA Analysis of Continuing Survey of Food Intake Among Individuals (CSFII) 1994−1996, 1998 Based on U.S. Department of Agriculture (USDA) (2000) and U.S. EPA (2000)*

U.S. EPA/OPP, in cooperation with USDA's Agricultural Research Service, used data from the 1994−1996, 1998 CSFII to develop the FCID (U.S. EPA, 2000; USDA, 2000), as described in Section 9.3.1.1. The CSFII 1994−1996 was conducted between January 1994 and January 1997 with a target population of non-institutionalized individuals in all 50 states and Washington, DC. In each of the three 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 1994−1996 and was intended to be merged with CSFII 1994−1996 to increase the sample size for children. The merged surveys are designated as CSFII 1994−1996, 1998 (USDA, 2000). Additional information on the CSFII can be obtained at http://www.ars.usda.gov/Services/docs.htm?docid=14531.

The CSFII 1994−1996, 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%. The 2-day response rate for CSFII 1998 was 82%. The CSFII 1994−1996, 1998 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 four years be combined in order to provide an adequate sample size for children.

The fruits and vegetable items/groups selected for the U.S. EPA analysis included total fruits and vegetables, and various individual fruits and vegetables. CSFII data on the foods people reported eating were converted to the quantities of agricultural commodities eaten. Intake rates for these food items/groups were calculated, and summary statistics were generated on both a per capita and a consumer-only basis using the same general methodology as in the U.S. EPA analysis of 2003−2006 NHANES data, as described in Section 9.3.1.1. 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 9-14 presents per capita intake data for total fruits and total vegetables in g/kg-day; Table 9-15 provides consumer-only intake data for total fruits and total vegetables in g/kg-day. Table 9-16 provides per capita intake data for individual fruits and vegetables, and Table 9-17 provides consumer-only intake data for individual fruits and vegetables. In general, these data represent intake of the edible portions of uncooked foods. Table 9-18 through Table 9-22 present data for exposed/protected fruits and vegetables and root vegetables. These five tables were created using only CSFII 1994−1996. These data represent as-consumed intake rates.

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 ADD equation. The cautions concerning converting these intake rates into units of g/day by multiplying by a single average body weight and the discussion of the use of short term data in the NHANES description in Section 9.3.1.1, apply to the CSFII estimates as well. A strength of U.S. EPA's analysis is that it provides distributions of intake rates for various age groups of children and adults, normalized by body weight. The analysis uses the 1994−1996, 1998 CSFII data set, which was designed to be representative of the U.S. population. Also, the data set includes four years of intake data combined and is based on a 2-day survey period. However, 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. While the CSFII data are older than the NHANES data, they provide relevant information on consumption by season, region of the United States, and urbanization, breakdowns that are not available in the publicly released NHANES data.

9.3.2.5. *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 1994−1996 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., consumer-only data).

Table 9-23 presents serving size data for selected fruits and vegetables, and Table 9-24 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.

9.3.2.6. *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; 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 sex, ethnicity, age, education, denture use, marital status, chronic disease, and weight. Food items reported in the survey were separated 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, multivariate 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. Table 9-25 presents the median servings of fruits and vegetables broken down by demographic and health characteristic. 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 sex 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 ($p = 0.01$).

An advantage of this study is that dietary information was collected on older individuals (>70 years of age). 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 sex and ethnicity difficult.

9.3.2.7. *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 population groups. The response rate for the FITS was 73% for the recruitment interview. Of the recruited households, there was a response rate of 94% for the dietary recall interviews (Devaney et al., 2004). Table 9-26 shows the characteristics of the FITS study population.

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 9-27 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% for 4 to 6 month olds to 81.6% for 19 to 24 month olds. Table 9-28 provides the top five vegetables consumed by age group. Some of the highest percentages ranged from baby food carrots (9.6%) in the 4 to 6 month old group to French fries (25.5%) in the 19 to 24 month old group. Table 9-29 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% to 4 to 6 month olds to 77.2% for 12 to 14 month olds. Table 9-30 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 are 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).

9.3.2.8. *Ponza et al. (2004)—Nutrient Food Intakes and Food Choices of Infants and Toddlers Participating in Women, Infants, and Children (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 ($N = 996$). Table 9-31 shows the total sample size described by WIC participants and non-participants.

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 9-31 presents the demographic data for WIC participants and non-participants. Table 9-32 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 (see Table 9-32). 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 9.3.2.7.

9.3.2.9. *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. Section 9.3.2.7 describes the FITS, which 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. 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. Table 9-33 and Table 9-34 present the average portion sizes for fruits and vegetables for infants and toddlers, respectively.

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. Limitations are those associated with the FITS data, as described previously in Section 9.3.2.7.

9.3.2.10. *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 of age were used for the study. The data represent a random sample of 371 Hispanic and 2,367 non-Hispanic infants and toddlers (Mennella 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; 1,228 non-Hispanic), and 12 to 24 months ($N = 124$ Hispanic; 871 non-Hispanic) of age.

Table 9-35 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 9-36 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 9.3.2.7 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 or edible portion uncooked 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 9-37 (USDA, 2007) and the following equation:

$$IR_{dw} = IR_{ww}\left[\frac{100-W}{100}\right] \qquad \text{(Eqn. 9-1)}$$

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:

$$C_{ww} = C_{dw}\left[\frac{100-W}{100}\right] \qquad \text{(Eqn. 9-2)}$$

where:

C_{ww} = wet-weight concentration,
C_{dw} = dry-weight concentration, and
W = percent water content.

Table 9-37 presents moisture data for selected fruits and vegetables taken from USDA (2007).

9.5. REFERENCES FOR CHAPTER 9

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Table 9-3. Per Capita Intake of Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Percent Consuming	Mean	SE	Percentiles 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Fruits														
Whole Population	16,783	85	1.6	0.05	0.0	0.0	0.0	0.0	0.7	2.0	4.0	6.1	14.6	65.6*
Age Group														
Birth to 1 year	865	61	6.2	0.46	0.0*	0.0*	0.0	0.0	2.2	10.2	17.6	23.0*	35.9*	56.5*
1 to 2 years	1,052	97	7.8	0.42	0.0*	0.0*	0.2	2.2	5.6	11.7	16.8	21.3*	39.3*	65.6*
3 to 5 years	978	97	4.6	0.25	0.0*	0.0	0.0	0.9	3.2	6.6	11.1	14.9	20.0*	32.1*
6 to 12 years	2,256	93	2.3	0.12	0.0*	0.0	0.0	0.1	1.3	3.2	6.4	8.7	13.8*	24.4*
13 to 19 years	3,450	80	0.9	0.04	0.0	0.0	0.0	0.0	0.2	1.3	2.6	3.5	6.1	16.7*
20 to 49 years	4,289	81	0.9	0.04	0.0	0.0	0.0	0.0	0.3	1.3	2.6	3.7	6.2	15.9*
Female 13 to 49 years	4,103	85	1.0	0.05	0.0	0.0	0.0	0.0	0.4	1.4	2.8	3.7	6.4	16.7*
50 years and older	3,893	89	1.4	0.05	0.0	0.0	0.0	0.1	0.9	2.0	3.4	4.4	6.5	17.3*
Race														
Mexican American	4,450	87	2.3	0.11	0.0	0.0	0.0	0.1	1.1	2.7	5.8	9.6	18.3	39.2*
Non-Hispanic Black	4,265	82	1.2	0.06	0.0	0.0	0.0	0.0	0.2	1.3	3.2	5.0	12.4	39.1*
Non-Hispanic White	6,757	85	1.5	0.05	0.0	0.0	0.0	0.0	0.7	1.9	3.8	5.5	14.0	65.6*
Other Hispanic	562	87	2.1	0.20	0.0*	0.0	0.0	0.0	1.0	2.8	4.9	7.1	19.5*	32.7*
Other Race—Including Multiple	749	89	2.0	0.13	0.0*	0.0	0.0	0.1	0.9	2.6	5.2	8.6	15.3*	42.1*
Vegetables														
Whole Population	16,783	100	2.9	0.04	0.0	0.4	0.7	1.3	2.3	3.7	5.7	7.5	13.2	36.1*
Age Group														
Birth to 1 year	865	73	5.0	0.28	0.0*	00*	0.0	0.0	3.3	8.7	12.9	16.2*	22.7*	36.1*
1 to 2 years	1,052	100	6.7	0.26	0.0*	1.0*	1.6	3.0	5.7	8.9	13.3	15.6*	28.7*	32.8*
3 to 5 years	978	100	5.4	0.25	0.1*	0.6	1.5	2.3	4.2	7.2	10.6	13.4	21.4*	30.3*
6 to 12 years	2,256	100	3.7	0.18	0.1*	0.5	0.9	1.5	2.8	4.8	7.6	10.4	14.8*	23.1*
13 to 19 years	3,450	100	2.3	0.05	0.0	0.3	0.5	1.1	1.8	3.0	4.3	5.5	8.9	20.0*
20 to 49 years	4,289	100	2.5	0.06	0.1	0.4	0.7	1.3	2.2	3.3	4.9	5.9	8.6	18.3*
Female 13 to 49 years	4,103	100	2.5	0.08	0.1	0.4	0.6	1.2	2.0	3.3	4.7	5.9	8.9	18.3*
50 years and older	3,893	100	2.6	0.05	0.0	0.4	0.7	1.3	2.2	3.4	4.9	6.1	9.1	22.6*
Race														
Mexican American	4,450	99	3.2	0.06	0.0	0.5	0.8	1.5	2.5	4.1	6.4	8.6	13.5	36.1*
Non-Hispanic Black	4,265	100	2.4	0.05	0.0	0.2	0.5	0.9	1.7	3.0	4.7	6.5	11.5	30.3*
Non-Hispanic White	6,757	100	2.9	0.05	0.0	0.4	0.7	1.4	2.3	3.7	5.6	7.2	12.8	29.5*
Other Hispanic	562	99	3.1	0.16	0.0*	0.2	0.7	1.2	2.2	3.8	6.3	9.4	16.3*	26.2*
Other Race—Including Multiple	749	100	3.4	0.20	0.1*	0.4	0.7	1.5	2.7	4.2	6.8	9.3	15.6*	32.8*

N = Sample size.
SE = Standard error.
Max = Maximum value.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).
Source: U.S. EPA analysis of the 2003−2006 NHANES.

Table 9-4. Consumer-Only Intake of Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Mean	SE	Percentiles 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Fruits													
Whole Population	14,362	1.9	0.05	0.0	0.0	0.0	0.2	1.0	2.3	4.4	6.7	15.2	65.6*
Age Group													
Birth to 1 year	536	10.1	0.59	0.0*	0.3*	*0.8	3.6	8.1	14.7	21.2*	25.8*	43.7*	56.5*
1 to 2 years	1,002	8.1	0.43	0.0*	0.1*	0.5	2.6	6.2	11.8	16.8	21.4*	39.3*	65.6*
3 to 5 years	924	4.7	0.24	0.0*	0.0	0.1	1.1	3.5	6.7	11.3	15.1	20.0*	32.1*
6 to 12 years	2,077	2.5	0.12	0.0*	0.0	0.0	0.2	1.6	3.4	6.6	9.2	14.5*	24.4*
13 to 19 years	2,830	1.1	0.04	0.0	0.0	0.0	0.0	0.7	1.6	2.9	3.8	6.2	16.7*
20 to 49 years	3,529	1.1	0.05	0.0	0.0	0.0	0.1	0.6	1.6	2.9	3.8	6.7	15.9*
Female 13 to 49 years	3,508	1.2	0.06	0.0	0.0	0.0	0.1	0.7	1.7	3.1	4.1	6.5	16.7*
50 years and older	3,464	1.5	0.05	0.0	0.0	0.0	0.4	1.1	2.2	3.6	4.6	6.7	17.3*
Race													
Mexican American	3,835	2.6	0.12	0.0	0.0	0.0	0.4	1.4	3.0	6.3	10.6	19.3	39.2*
Non-Hispanic Black	3,595	1.4	0.07	0.0	0.0	0.0	0.0	0.6	1.7	3.8	5.7	12.9	39.1*
Non-Hispanic White	5,795	1.8	0.05	0.0	0.0	0.0	0.2	1.0	2.2	4.1	6.1	14.5	65.6*
Other Hispanic	478	2.5	0.23	0.0*	0.0	0.0	0.3	1.5	3.0	5.0	8.6	19.5*	32.7*
Other Race—Including Multiple	659	2.3	0.16	0.0*	0.0	0.0	0.2	1.1	2.8	6.0	9.4	15.3*	42.1*
Vegetables													
Whole Population	16,531	2.9	0.04	0.0	0.4	0.7	1.3	2.3	3.7	5.7	7.5	13.2	36.1*
Age Group													
Birth to 1 year	623	6.8	0.33	0.0*	0.1*	0.4*	2.6	5.5	10.1	14.5*	18.1*	22.7*	36.1*
1 to 2 years	1,048	6.7	0.26	0.0*	1.0*	1.7	3.0	5.7	8.9	13.3	15.6*	28.7*	32.8*
3 to 5 years	977	5.4	0.25	0.1*	0.6	1.5	2.3	4.2	7.2	10.6	13.4	21.4*	30.3*
6 to 12 years	2,256	3.7	0.18	0.1*	0.5	0.9	1.5	2.8	4.8	7.6	10.4	14.8*	23.1*
13 to 19 years	3,447	2.3	0.05	0.0	0.3	0.5	1.1	1.8	3.0	4.3	5.5	8.9	20.0*
20 to 49 years	4,288	2.5	0.06	0.1	0.4	0.7	1.3	2.2	3.3	4.9	5.9	8.6	18.3*
Female 13 to 49 years	4,102	2.5	0.08	0.1	0.4	0.6	1.2	2.0	3.3	4.7	5.9	8.9	18.3*
50 years and older	3,892	2.6	0.05	0.0	0.4	0.7	1.3	2.2	3.4	4.9	6.1	9.1	22.6*
Race													
Mexican American	4,341	3.3	0.06	0.1	0.5	0.8	1.5	2.5	4.1	6.4	8.6	13.5	36.1*
Non-Hispanic Black	4,228	2.4	0.05	0.0	0.3	0.5	0.9	1.7	3.0	4.7	6.5	11.5	30.3*
Non-Hispanic White	6,683	2.9	0.05	0.1	0.4	0.7	1.4	2.3	3.7	5.6	7.2	12.8	29.5*
Other Hispanic	544	3.1	0.16	0.1*	0.3	0.7	1.3	2.2	3.8	6.4	9.4	16.3*	26.2*
Other Race—Including Multiple	735	3.4	0.21	0.2*	0.4	0.7	1.5	2.7	4.3	6.9	9.3	15.6*	32.8*

N = Sample size.
SE = Standard error.
Max = Maximum value.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).
Source: U.S. EPA analysis of the 2003−2006 NHANES.

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Apples			Asparagus			Bananas			Beans		
Whole Population	16,783	33	0.41	0.01	2	0.01	0.00	55	0.37	0.01	45	0.24	0.01
Age Group													
Birth to 1 year	865	39	2.23	0.24	1	0.00	0.00	46	1.83	0.19	30	0.54	0.06
1 to 2 years	1,052	50	1.96	0.14	2	0.03	0.01	77	2.35	0.26	49	0.69	0.06
3 to 5 years	978	42	1.21	0.10	1	0.01	0.01	73	1.00	0.09	43	0.61	0.07
6 to 12 years	2,256	39	0.74	0.06	1	0.01	0.00	68	0.42	0.04	37	0.30	0.03
13 to 19 years	3,450	27	0.27	0.02	1	0.00	0.00	50	0.15	0.01	31	0.13	0.01
20 to 49 years	4,289	28	0.21	0.02	2	0.01	0.00	48	0.20	0.01	46	0.19	0.01
Female 13 to 49 years	4,103	29	0.23	0.02	2	0.01	0.00	50	0.20	0.01	45	0.17	0.01
50 years and older	3,893	38	0.28	0.02	3	0.02	0.00	58	0.33	0.02	51	0.22	0.01
Race													
Mexican American	4,450	33	0.58	0.03	1	0.00	0.00	56	0.56	0.04	59	0.32	0.01
Non-Hispanic Black	4,265	27	0.31	0.02	0	0.00	0.00	55	0.25	0.02	43	0.25	0.01
Non-Hispanic White	6,757	35	0.40	0.02	3	0.02	0.00	54	0.36	0.02	43	0.22	0.01
Other Hispanic	562	32	0.47	0.06	1	0.00	0.00	55	0.53	0.06	58	0.25	0.03
Other Race—Including Multiple	749	32	0.47	0.04	3	0.01	0.00	58	0.43	0.04	50	0.30	0.04

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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	16,783	3	0.01	0.00	67	0.30	0.01	15	0.10	0.01	97	0.18	0.00
Age Group													
Birth to 1 year	865	5	0.00	0.00	19	0.24	0.09	6	0.07	0.02	39	0.07	0.01
1 to 2 years	1,052	1	0.00	0.00	83	1.46	0.14	16	0.30	0.06	94	0.28	0.02
3 to 5 years	978	1	0.01	0.01	84	0.97	0.11	12	0.19	0.04	96	0.28	0.02
6 to 12 years	2,256	0	0.00	0.00	80	0.46	0.04	11	0.10	0.02	98	0.21	0.02
13 to 19 years	3,450	1	0.00	0.00	64	0.19	0.01	9	0.05	0.01	98	0.15	0.01
20 to 49 years	4,289	2	0.01	0.00	62	0.17	0.01	16	0.09	0.01	98	0.19	0.01
Female 13 to 49 years	4,103	2	0.01	0.00	67	0.20	0.01	17	0.09	0.01	97	0.16	0.01
50 years and older	3,893	5	0.01	0.00	71	0.28	0.02	16	0.09	0.01	97	0.16	0.00
Race													
Mexican American	4,450	1	0.00	0.00	59	0.23	0.02	12	0.07	0.01	96	0.27	0.01
Non-Hispanic Black	4,265	1	0.00	0.00	64	0.18	0.01	12	0.07	0.01	96	0.13	0.01
Non-Hispanic White	6,757	4	0.01	0.00	69	0.33	0.02	15	0.10	0.01	97	0.17	0.00
Other Hispanic	562	3	0.00	0.00	59	0.30	0.05	16	0.13	0.04	93	0.23	0.01
Other Race—Including Multiple	749	1	0.00	0.00	66	0.38	0.06	19	0.13	0.03	97	0.25	0.02

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Cabbage			Carrots			Citrus Fruits			Corn		
Whole Population	16,783	13	0.05	0.00	47	0.14	0.00	20	0.16	0.01	96	0.43	0.01
Age Group													
Birth to 1 year	865	1	0.01	0.01	15	0.17	0.05	2	0.05	0.02	56	0.62	0.10
1 to 2 years	1,052	7	0.05	0.02	50	0.47	0.04	25	0.65	0.08	97	1.13	0.05
3 to 5 years	978	5	0.04	0.01	45	0.32	0.05	18	0.46	0.06	100	1.26	0.07
6 to 12 years	2,256	7	0.04	0.01	43	0.21	0.03	15	0.21	0.02	99	0.88	0.03
13 to 19 years	3,450	6	0.02	0.00	35	0.08	0.01	13	0.08	0.01	96	0.37	0.01
20 to 49 years	4,289	13	0.05	0.01	46	0.11	0.01	20	0.11	0.01	96	0.32	0.01
Female 13 to 49 years	4,103	12	0.05	0.01	46	0.11	0.01	21	0.11	0.01	96	0.31	0.01
50 years and older	3,893	18	0.08	0.00	54	0.12	0.01	25	0.14	0.01	96	0.27	0.01
Race													
Mexican American	4,450	10	0.03	0.00	45	0.15	0.01	27	0.37	0.03	96	0.78	0.03
Non-Hispanic Black	4,265	12	0.06	0.01	36	0.08	0.01	16	0.17	0.03	96	0.46	0.02
Non-Hispanic White	6,757	13	0.05	0.00	49	0.14	0.01	20	0.12	0.01	97	0.37	0.01
Other Hispanic	562	9	0.03	0.01	49	0.17	0.02	23	0.26	0.03	94	0.45	0.05
Other Race—Including Multiple	749	17	0.12	0.02	52	0.23	0.02	21	0.20	0.05	91	0.41	0.03

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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	16,783	40	0.09	0.00	48	0.34	0.03	95	0.80	0.02	92	0.54	0.01
Age Group													
Birth to 1 year	865	3	0.02	0.01	20	0.64	0.09	31	0.30	0.05	40	0.22	0.04
1 to 2 years	1,052	24	0.14	0.02	37	1.01	0.18	93	1.45	0.07	82	0.71	0.07
3 to 5 years	978	26	0.19	0.03	36	0.66	0.08	95	1.53	0.08	87	0.61	0.06
6 to 12 years	2,256	30	0.11	0.01	38	0.56	0.11	97	1.05	0.05	90	0.43	0.02
13 to 19 years	3,450	34	0.06	0.01	40	0.20	0.02	96	0.75	0.03	89	0.35	0.01
20 to 49 years	4,289	45	0.09	0.01	52	0.26	0.03	97	0.76	0.02	94	0.55	0.02
Female 13 to 49 years	4,103	44	0.10	0.01	51	0.30	0.04	96	0.70	0.03	93	0.58	0.03
50 years and older	3,893	43	0.08	0.01	54	0.31	0.02	95	0.66	0.03	93	0.60	0.02
Race													
Mexican American	4,450	30	0.07	0.01	42	0.27	0.02	96	1.13	0.03	90	0.40	0.02
Non-Hispanic Black	4,265	37	0.06	0.01	42	0.18	0.02	94	0.62	0.03	90	0.46	0.02
Non-Hispanic White	6,757	43	0.10	0.01	51	0.37	0.03	96	0.78	0.02	92	0.56	0.02
Other Hispanic	562	33	0.09	0.02	41	0.25	0.05	92	0.97	0.06	90	0.48	0.05
Other Race—Including Multiple	749	38	0.11	0.03	47	0.44	0.14	92	0.75	0.04	91	0.69	0.07

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Legumes			Lettuce			Onions			Peaches		
Whole Population	16,783	96	0.45	0.01	53	0.23	0.01	96	0.18	0.00	49	0.11	0.01
Age Group													
Birth to 1 year	865	58	1.58	0.15	1	0.01	0.00	38	0.07	0.01	27	0.77	0.09
1 to 2 years	1,052	97	1.65	0.24	21	0.15	0.02	94	0.27	0.02	70	0.55	0.08
3 to 5 years	978	98	1.07	0.17	29	0.23	0.03	95	0.26	0.02	68	0.31	0.05
6 to 12 years	2,256	97	0.48	0.04	37	0.17	0.01	98	0.20	0.02	67	0.13	0.02
13 to 19 years	3,450	95	0.23	0.01	53	0.20	0.01	97	0.15	0.01	45	0.05	0.01
20 to 49 years	4,289	96	0.34	0.02	62	0.26	0.01	97	0.18	0.01	43	0.04	0.01
Female 13 to 49 years	4,103	95	0.32	0.02	60	0.28	0.01	96	0.16	0.01	46	0.05	0.01
50 years and older	3,893	98	0.41	0.02	56	0.24	0.01	97	0.16	0.00	51	0.10	0.01
Race													
Mexican American	4,450	95	0.46	0.03	52	0.20	0.01	96	0.26	0.01	44	0.12	0.02
Non-Hispanic Black	4,265	96	0.39	0.02	45	0.15	0.01	95	0.13	0.01	52	0.09	0.01
Non-Hispanic White	6,757	97	0.42	0.02	55	0.25	0.01	97	0.17	0.00	50	0.11	0.01
Other Hispanic	562	96	0.63	0.17	50	0.19	0.03	93	0.22	0.01	38	0.09	0.03
Other Race—Including Multiple	749	95	0.76	0.10	51	0.22	0.03	96	0.24	0.02	46	0.09	0.02

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Pears			Peas			Pome Fruit			Pumpkins		
Whole Population	16,783	10	0.09	0.01	19	0.07	0.00	38	0.50	0.02	2	0.00	0.00
Age Group													
Birth to 1 year	865	19	0.70	0.10	36	0.66	0.07	45	2.94	0.29	0	0.00	0.00
1 to 2 years	1,052	25	0.44	0.07	27	0.29	0.04	61	2.40	0.15	0	0.01	0.01
3 to 5 years	978	25	0.32	0.06	17	0.17	0.02	54	1.53	0.11	0	0.00	0.00
6 to 12 years	2,256	17	0.13	0.02	13	0.06	0.01	48	0.87	0.06	1	0.01	0.00
13 to 19 years	3,450	8	0.03	0.00	13	0.04	0.01	31	0.30	0.02	1	0.00	0.00
20 to 49 years	4,289	6	0.04	0.01	18	0.05	0.00	31	0.25	0.02	2	0.00	0.00
Female 13 to 49 years	4,103	8	0.04	0.01	18	0.05	0.00	32	0.28	0.02	2	0.00	0.00
50 years and older	3,893	9	0.07	0.01	23	0.07	0.00	42	0.35	0.02	3	0.00	0.00
Race													
Mexican American	4,450	10	0.13	0.02	15	0.05	0.01	39	0.71	0.04	5	0.01	0.00
Non-Hispanic Black	4,265	9	0.05	0.01	20	0.08	0.01	31	0.36	0.02	0	0.00	0.00
Non-Hispanic White	6,757	10	0.08	0.01	19	0.07	0.00	39	0.48	0.02	2	0.00	0.00
Other Hispanic	562	8	0.07	0.02	19	0.07	0.02	35	0.54	0.08	4	0.01	0.01
Other Race—Including Multiple	749	11	0.16	0.05	27	0.13	0.02	36	0.63	0.06	2	0.00	0.00

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Root Tuber Vegetables			Stalk/Stem Vegetables			Stone Fruit			Strawberries		
Whole Population	16,783	99	1.15	0.02	19	0.05	0.00	52	0.16	0.01	41	0.10	0.01
Age Group													
Birth to 1 year	865	69	2.66	0.19	3	0.01	0.00	32	0.94	0.11	10	0.06	0.03
1 to 2 years	1,052	100	3.15	0.13	13	0.07	0.02	72	0.67	0.08	52	0.36	0.06
3 to 5 years	978	100	2.60	0.16	10	0.05	0.02	72	0.41	0.06	53	0.27	0.05
6 to 12 years	2,256	100	1.79	0.07	11	0.03	0.00	68	0.21	0.03	50	0.14	0.03
13 to 19 years	3,450	100	0.99	0.04	12	0.02	0.00	47	0.08	0.01	35	0.07	0.01
20 to 49 years	4,289	100	0.89	0.03	24	0.05	0.00	46	0.08	0.01	36	0.06	0.01
Female 13 to 49 years	4,103	100	0.87	0.02	21	0.04	0.00	49	0.09	0.01	39	0.07	0.01
50 years and older	3,893	100	0.91	0.03	21	0.05	0.01	55	0.17	0.02	45	0.10	0.01
Race													
Mexican American	4,450	99	1.17	0.04	12	0.02	0.00	47	0.18	0.03	34	0.07	0.01
Non-Hispanic Black	4,265	99	1.09	0.03	12	0.02	0.00	54	0.13	0.01	29	0.04	0.01
Non-Hispanic White	6,757	100	1.14	0.03	21	0.06	0.00	54	0.17	0.01	44	0.11	0.01
Other Hispanic	562	98	1.24	0.09	15	0.03	0.01	41	0.13	0.03	33	0.09	0.02
Other Race—Including Multiple	749	99	1.35	0.08	27	0.06	0.01	49	0.13	0.03	36	0.10	0.02

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Tomatoes			Tropical Fruits			White Potatoes					
Whole Population	16,783	87	0.72	0.02	66	0.46	0.02	91	0.65	0.02			
Age Group													
Birth to 1 year	865	26	0.29	0.04	48	1.97	0.20	46	0.52	0.08			
1 to 2 years	1,052	83	1.40	0.07	83	2.65	0.28	94	1.74	0.10			
3 to 5 years	978	85	1.46	0.08	81	1.19	0.09	94	1.38	0.15			
6 to 12 years	2,256	91	0.99	0.04	75	0.52	0.04	93	0.96	0.07			
13 to 19 years	3,450	89	0.69	0.03	59	0.22	0.02	92	0.61	0.03			
20 to 49 years	4,289	89	0.66	0.02	61	0.27	0.02	91	0.54	0.02			
Female 13 to 49 years	4,103	88	0.62	0.02	64	0.28	0.02	90	0.50	0.02			
50 years and older	3,893	84	0.59	0.03	68	0.40	0.02	93	0.54	0.03			
Race													
Mexican American	4,450	91	0.99	0.03	70	0.73	0.05	87	0.65	0.03			
Non-Hispanic Black	4,265	84	0.57	0.02	64	0.32	0.03	91	0.64	0.03			
Non-Hispanic White	6,757	87	0.71	0.02	65	0.42	0.02	93	0.65	0.03			
Other Hispanic	562	86	0.90	0.05	71	0.86	0.09	86	0.66	0.08			
Other Race—Including Multiple	749	82	0.66	0.03	68	0.59	0.04	87	0.69	0.06			

N = Sample size.
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: U.S. EPA analysis of the 2003−2006 NHANES.

Table 9-6. Consumer-Only Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Apples			Asparagus			Bananas			Beans			Beets		
Whole Population	5,743	1.23	0.03	204	0.63	0.05	9,644	0.68	0.02	7,635	0.53	0.01	353	0.29	0.04
Age Group															
Birth to 1 year	318	5.79	0.38	1	0.21	---	396	3.97	0.31	235	1.80	0.20	30	0.01	0.00
1 to 2 years	508	3.95	0.23	8	1.61	0.15	795	3.04	0.34	530	1.41	0.10	12	0.00	0.00
3 to 5 years	432	2.91	0.21	5	0.77	0.31	716	1.37	0.12	461	1.42	0.13	11	0.97	0.63
6 to 12 years	837	1.88	0.12	15	0.60	0.15	1,553	0.61	0.05	936	0.79	0.05	8	0.78	0.33
13 to 19 years	938	1.00	0.05	13	0.26	0.06	1,817	0.31	0.02	1,264	0.41	0.02	20	0.10	0.03
20 to 49 years	1,233	0.75	0.04	61	0.50	0.07	2,142	0.41	0.03	2,141	0.41	0.01	81	0.30	0.09
Female 13 to 49 years	1,195	0.81	0.05	41	0.42	0.07	2,215	0.39	0.03	1,845	0.39	0.01	58	0.39	0.13
50 years and older	1,477	0.75	0.03	101	0.73	0.06	2,225	0.58	0.02	2,068	0.43	0.01	191	0.28	0.05
Race															
Mexican American	1,601	1.72	0.09	18	0.44	0.08	2,490	1.00	0.05	2,482	0.54	0.02	55	0.07	0.04
Non-Hispanic Black	1,228	1.16	0.05	14	0.57	0.13	2,533	0.46	0.04	1,722	0.58	0.03	42	0.21	0.04
Non-Hispanic White	2,458	1.15	0.04	154	0.67	0.05	3,863	0.66	0.03	2,809	0.52	0.02	235	0.31	0.05
Other Hispanic	202	1.45	0.19	3	0.61	0.25	322	0.98	0.08	291	0.44	0.05	12	0.12	0.04
Other Race—Including Multiple	254	1.45	0.13	15	0.38	0.11	436	0.74	0.07	331	0.61	0.06	9	0.11	0.07

Table 9-6. Consumer-Only Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Berries and Small Fruit			Broccoli			Bulb Vegetables			Cabbage			Carrots		
Whole Population	10,981	0.45	0.02	2,047	0.65	0.03	15,773	0.19	0.00	1,833	0.43	0.02	7,231	0.30	0.01
Age Group															
Birth to 1 year	166	1.26	0.42	45	1.14	0.19	346	0.19	0.03	13	0.96	0.44	166	1.13	0.23
1 to 2 years	839	1.76	0.15	132	1.84	0.27	1,003	0.30	0.02	72	0.73	0.26	525	0.93	0.08
3 to 5 years	788	1.15	0.12	108	1.50	0.25	947	0.29	0.02	67	0.71	0.15	449	0.71	0.09
6 to 12 years	1,751	0.57	0.05	228	0.96	0.12	2,216	0.21	0.02	164	0.56	0.16	912	0.49	0.05
13 to 19 years	2,210	0.30	0.02	289	0.53	0.04	3,354	0.16	0.01	218	0.31	0.04	1,152	0.24	0.02
20 to 49 years	2,601	0.27	0.01	664	0.53	0.03	4,194	0.19	0.01	577	0.41	0.03	1,948	0.24	0.01
Female 13 to 49 years	2,705	0.31	0.02	560	0.54	0.04	3,994	0.17	0.01	461	0.41	0.05	1,755	0.24	0.01
50 years and older	2,626	0.40	0.02	581	0.56	0.02	3,713	0.17	0.00	722	0.43	0.02	2,079	0.23	0.01
Race															
Mexican American	2,563	0.38	0.02	456	0.61	0.07	4,132	0.28	0.01	390	0.32	0.04	1,912	0.33	0.02
Non-Hispanic Black	2,899	0.28	0.02	474	0.61	0.04	4,022	0.14	0.01	442	0.51	0.04	1,471	0.22	0.01
Non-Hispanic White	4,686	0.47	0.02	925	0.65	0.04	6,410	0.18	0.00	852	0.41	0.02	3,220	0.29	0.01
Other Hispanic	333	0.51	0.08	82	0.85	0.22	514	0.25	0.01	48	0.32	0.04	272	0.34	0.05
Other Race—Including Multiple	500	0.58	0.10	110	0.66	0.09	695	0.25	0.02	101	0.70	0.08	356	0.44	0.04

Table 9-6. Consumer-Only Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Citrus Fruits			Corn			Cucumbers			Cucurbits			Fruiting Vegetables		
Whole Population	3,398	0.77	0.04	15,899	0.44	0.01	5,728	0.23	0.01	7,109	0.70	0.05	15,483	0.84	0.02
Age Group															
Birth to 1 year	30	2.90	0.96	465	1.12	0.14	25	0.70	0.31	138	3.16	0.16	281	0.98	0.12
1 to 2 years	256	2.61	0.30	1,028	1.16	0.06	210	0.58	0.09	332	2.75	0.42	987	1.56	0.07
3 to 5 years	191	2.50	0.29	971	1.26	0.07	247	0.74	0.12	335	1.86	0.25	926	1.61	0.09
6 to 12 years	440	1.39	0.09	2,237	0.88	0.04	666	0.37	0.03	828	1.47	0.22	2,192	1.08	0.05
13 to 19 years	549	0.66	0.04	3,332	0.38	0.01	1,191	0.18	0.01	1,347	0.50	0.06	3,304	0.78	0.03
20 to 49 years	896	0.55	0.05	4,134	0.33	0.01	1,827	0.20	0.01	2,138	0.50	0.06	4,155	0.78	0.02
Female 13 to 49 years	860	0.53	0.04	3,967	0.32	0.01	1,596	0.24	0.01	1,874	0.59	0.08	3,945	0.73	0.03
50 years and older	1,036	0.57	0.04	3,732	0.28	0.01	1,562	0.19	0.01	1,991	0.57	0.03	3,638	0.69	0.03
Race															
Mexican American	1,148	1.40	0.06	4,185	0.81	0.03	1,218	0.25	0.02	1,733	0.65	0.05	4,079	1.18	0.03
Non-Hispanic Black	669	1.04	0.14	4,058	0.48	0.02	1,471	0.17	0.01	1,647	0.44	0.04	3,943	0.66	0.03
Non-Hispanic White	1,323	0.59	0.04	6,454	0.39	0.01	2,627	0.23	0.01	3,211	0.73	0.06	6,293	0.82	0.02
Other Hispanic	127	1.10	0.14	516	0.48	0.05	166	0.26	0.05	212	0.60	0.10	498	1.05	0.06
Other Race—Including Multiple	131	0.96	0.24	686	0.45	0.03	246	0.29	0.06	306	0.94	0.29	670	0.81	0.04

Table 9-6. Consumer-Only Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Leafy Vegetables			Legumes			Lettuce			Onions			Peaches		
Whole Population	14,824	0.59	0.01	15,808	0.46	0.01	7,946	0.44	0.01	15,695	0.18	0.00	8,542	0.22	0.01
Age Group															
Birth to 1 year	351	0.55	0.09	459	2.74	0.21	17	0.34	0.16	342	0.19	0.02	215	2.80	0.31
1 to 2 years	896	0.86	0.08	1,011	1.70	0.25	216	0.70	0.09	998	0.28	0.02	700	0.79	0.10
3 to 5 years	861	0.70	0.06	957	1.09	0.17	297	0.78	0.11	941	0.28	0.02	676	0.45	0.07
6 to 12 years	2,035	0.48	0.02	2,198	0.49	0.04	931	0.45	0.02	2,209	0.20	0.02	1,517	0.20	0.03
13 to 19 years	3,106	0.39	0.01	3,256	0.24	0.01	1,882	0.38	0.02	3,333	0.15	0.01	1,675	0.11	0.02
20 to 49 years	4,008	0.59	0.02	4,135	0.35	0.02	2,576	0.43	0.02	4,177	0.19	0.01	1,845	0.10	0.01
Female 13 to 49 years	3,789	0.62	0.03	3,915	0.34	0.02	2,379	0.47	0.02	3,969	0.16	0.01	1,996	0.11	0.01
50 years and older	3,567	0.65	0.02	3,792	0.42	0.02	2,027	0.43	0.01	3,695	0.16	0.00	1,914	0.21	0.02
Race															
Mexican American	3,847	0.44	0.02	4,089	0.49	0.03	2,120	0.38	0.02	4,115	0.27	0.01	1,951	0.28	0.04
Non-Hispanic Black	3,786	0.51	0.03	4,044	0.41	0.02	1,803	0.34	0.02	4,004	0.14	0.01	2,432	0.18	0.02
Non-Hispanic White	6,046	0.61	0.02	6,454	0.44	0.02	3,438	0.46	0.01	6,369	0.17	0.00	3,530	0.22	0.01
Other Hispanic	475	0.53	0.06	517	0.66	0.18	248	0.39	0.05	514	0.24	0.01	250	0.25	0.08
Other Race—Including Multiple	670	0.76	0.07	704	0.79	0.10	337	0.43	0.04	693	0.25	0.02	379	0.19	0.04

Table 9-6. Consumer-Only Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Pears			Peas			Pome Fruit			Pumpkins			Root Tuber Vegetables		
Whole Population	1,965	0.89	0.04	3,133	0.39	0.02	6,699	1.31	0.03	285	0.22	0.02	16,478	1.16	0.02
Age Group															
Birth to 1 year	144	3.77	0.38	236	1.83	0.11	371	6.50	0.42	3	0.73	0.39	583	3.88	0.24
1 to 2 years	243	1.79	0.21	257	1.05	0.11	621	3.92	0.23	4	2.13	0.41	1,050	3.15	0.13
3 to 5 years	221	1.31	0.20	180	0.97	0.13	537	2.82	0.18	8	0.80	0.21	978	2.60	0.16
6 to 12 years	403	0.77	0.12	309	0.51	0.06	1,071	1.82	0.10	35	0.55	0.16	2,256	1.79	0.07
13 to 19 years	272	0.35	0.04	416	0.34	0.04	1,085	0.98	0.05	40	0.19	0.06	3,447	0.99	0.04
20 to 49 years	278	0.63	0.05	780	0.26	0.02	1,362	0.81	0.04	95	0.20	0.04	4,278	0.90	0.03
Female 13 to 49 years	323	0.56	0.07	675	0.27	0.02	1,352	0.87	0.05	87	0.22	0.04	4,097	0.87	0.02
50 years and older	404	0.72	0.06	955	0.29	0.01	1,652	0.84	0.04	100	0.17	0.02	3,886	0.92	0.03
Race															
Mexican American	518	1.25	0.14	644	0.37	0.04	1,851	1.81	0.09	160	0.28	0.06	4,316	1.18	0.04
Non-Hispanic Black	489	0.61	0.07	812	0.42	0.04	1,512	1.15	0.05	10	0.71	0.33	4,218	1.10	0.03
Non-Hispanic White	807	0.84	0.05	1,364	0.38	0.02	2,821	1.23	0.03	91	0.17	0.02	6,667	1.15	0.03
Other Hispanic	54	0.90	0.12	116	0.39	0.08	223	1.55	0.21	11	0.28	0.12	544	1.26	0.09
Other Race—Including Multiple	97	1.51	0.32	197	0.49	0.07	292	1.78	0.16	13	0.23	0.14	733	1.36	0.08

Table 9-6. Consumer-Only Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Stalk/Stem Vegetables			Stone Fruit			Strawberries			Tomatoes			Tropical Fruits		
Whole Population	2,409	0.24	0.01	8,966	0.30	0.02	6,168	0.24	0.02	14,240	0.83	0.02	11,299	0.70	0.02
Age Group															
Birth to 1 year	15	0.26	0.07	235	2.98	0.33	88	0.60	0.28	246	1.11	0.12	423	4.12	0.30
1 to 2 years	101	0.58	0.10	721	0.92	0.10	480	0.70	0.12	895	1.68	0.09	862	3.19	0.33
3 to 5 years	81	0.50	0.10	691	0.56	0.08	460	0.51	0.09	840	1.72	0.09	800	1.47	0.11
6 to 12 years	212	0.24	0.04	1,545	0.31	0.04	1,019	0.28	0.06	2,071	1.09	0.05	1,733	0.69	0.05
13 to 19 years	387	0.15	0.01	1,719	0.16	0.02	1,076	0.20	0.03	3,093	0.77	0.03	2,151	0.37	0.03
20 to 49 years	941	0.22	0.01	1,961	0.17	0.02	1,466	0.17	0.02	3,894	0.74	0.02	2,692	0.44	0.02
Female 13 to 49 years	719	0.20	0.01	2,101	0.18	0.02	1,492	0.19	0.03	3,679	0.71	0.02	2,720	0.44	0.03
50 years and older	672	0.26	0.03	2,094	0.30	0.03	1,579	0.23	0.03	3,201	0.70	0.03	2,638	0.58	0.02
Race															
Mexican American	411	0.18	0.02	2,043	0.38	0.05	1,438	0.22	0.02	3,897	1.09	0.03	3,031	1.03	0.07
Non-Hispanic Black	409	0.15	0.01	2,497	0.24	0.02	1,276	0.15	0.02	3,547	0.68	0.02	2,865	0.51	0.05
Non-Hispanic White	1,336	0.26	0.02	3,753	0.31	0.02	2,979	0.25	0.03	5,714	0.82	0.02	4,498	0.64	0.02
Other Hispanic	71	0.17	0.03	270	0.31	0.08	198	0.29	0.06	470	1.05	0.06	399	1.21	0.12
Other Race—Including Multiple	182	0.22	0.02	403	0.27	0.04	277	0.27	0.05	612	0.81	0.04	506	0.86	0.06

Table 9-6. Consumer-Only Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	White Potatoes														
Whole Population	14,944	0.72	0.02												
Age Group															
Birth to 1 year	389	1.14	0.15												
1 to 2 years	982	1.86	0.10												
3 to 5 years	915	1.46	0.15												
6 to 12 years	2,111	1.03	0.07												
13 to 19 years	3,163	0.67	0.03												
20 to 49 years	3,861	0.59	0.02												
Female 13 to 49 years	3,691	0.56	0.02												
50 years and older	3,523	0.58	0.03												
Race															
Mexican American	3,773	0.75	0.03												
Non-Hispanic Black	3,881	0.70	0.03												
Non-Hispanic White	6,180	0.71	0.03												
Other Hispanic	466	0.77	0.08												
Other Race—Including Multiple	644	0.79	0.06												

N = Sample size.
SE = Standard error.
Source: U.S. EPA analysis of the 2003−2006 NHANES.

Table 9-7. 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 Consuming 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 consuming fruit in a day.

Source: USDA (1980).

Table 9-8. Mean Total Fruit and Total Vegetable Intake (as-consumed) in a Day by Sex and Age (1987−1988, 1994, and 1995)[a]									
Age (years)	Per Capita Intake (g/day)			Percent of Population Consuming in 1 Day			Consumer-Only Intake (g/day)[b]		
	1987−1988	1994	1995	1987−1988	1994	1995	1987−1988	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 (1987−1988) 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 consuming fruits in a day.

Source: USDA (1996a, b).

Table 9-9. Per Capita Consumption of Fresh Fruits and Vegetables in 1997[a]

Fresh Fruits		Fresh Vegetables	
Food Item	Per Capita Consumption (g/day)[b]	Food Item	Per Capita Consumption (g/day)[b]
Citrus		Artichokes	0.6
Oranges (includes Temple oranges)	16.9	Asparagus	0.7
Tangerines and Tangelos	3.0	Bell Peppers	8.3
Lemons	3.4	Broccoli	6.0
Limes	1.4	Brussel Sprouts	0.4
Grapefruit	7.6	Cabbage	11.8
Total Fresh Citrus	32.2	Carrots	15.1
		Cauliflower	1.9
Non-citrus		Celery	7.0
Apples	22.0	Sweet Corn	9.2
Apricots	0.1	Cucumber	7.2
Avocados	1.6	Eggplant	0.5
Bananas	34.5	Escarole/Endive	0.2
Cherries	0.6	Garlic	2.1
Cranberries	0.1	Head Lettuce	28.1
Grapes	9.1	Romaine Lettuce	7.0
Kiwi Fruit	0.5	Onions	20.9
Mangoes	1.7	Radishes	0.5
Peaches and Nectarines	6.7	Snap Beans	1.6
Pears	4.1	Spinach	0.6
Pineapple	2.9	Tomatoes	20.0
Papayas	0.6	Total Fresh Vegetables	149.8
Plums and Prunes	1.9		
Strawberries	4.9		
Melons	34.5		
Total Fresh Non-citrus	125.6		
Total Fresh Fruits	157.8		

[a] Based on retail-weight equivalent. Includes imports; excludes exports and foods grown in home gardens. Data for 1997 were used.

[b] Original data were presented in lbs/year; data were converted to g/day by multiplying by a factor of 454 g/lb and dividing by 365 day/year.

Source: USDA (1999b).

Table 9-10. Mean Quantities of Vegetables Consumed Daily by Sex and Age, for Children, per Capita (g/day, as-consumed)[a]

Age Group (years)	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	1,126	57	9	1	2	19	1[b]	[b,c]	6	5	16
1	1,016	79	26	11	5	9	7	1	8	9	16
2	1,102	87	32	17	4	5	11	2	7	10	17
1 to 2	2,118	83	29	14	5	7	9	1	7	9	17
3	1,831	91	34	17	5	5	13	2	5	11	16
4	1,859	97	37	19	6	5	11	3	5	12	18
5	884	103	44	22	4	6	12	3	6	12	17
3 to 5	4,574	97	38	20	5	5	12	3	5	11	17
≤5	7,818	88	31	16	4	7	10	2	6	10	17
Males											
6 to 9	787	110	47	26	4	5	16	5	5	11	16
6 to 11	1,031	115	50	27	5	5	16	5	5	11	18
12 to 19	737	176	85	44	6	6	28	12	3[b]	10	25
Females											
6 to 9	704	110	42	22	5	4	14	6	5	13	21
6 to 11	969	116	46	25	5	4	15	7	5	12	22
12 to 19	732	145	61	31	9	4	18	12	4	8	28
Males and Females											
≤9	9,309	97	37	19	4	6	12	3	6	11	18
≤19	11,287	125	53	27	6	6	17	7	5	10	22

[a] Based on data from 1994−1996, 1998 CSFII.
[b] Estimate is not statistically reliable due to small samples size reporting intake.
[c] 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 9-11. Percentage of Individuals Consuming Vegetables, by Sex and Age, for Children (%)[a]

Age Group (years)	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	1,126	47.2	12.3	4.3	2.3	20.5	1.8	0.2[b]	7.8	8.5	14.8
1	1,016	73.3	40.4	25.2	6.4	13.3	18.0	3.9	13.7	17.6	19.4
2	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	2,118	75.9	43.6	29.9	7.0	11.8	24.6	5.7	12.6	16.2	20.9
3	1,831	80.5	46.7	34.7	7.0	10.7	34.1	8.3	10.1	14.6	24.7
4	1,859	80.7	47.3	34.8	7.2	12.0	33.0	10.0	9.0	16.4	26.5
5	884	83.0	50.7	38.3	4.6	13.3	36.5	13.4	10.4	16.1	28.8
3 to 5	4,574	81.4	48.2	35.9	6.3	12.0	34.5	10.6	9.9	15.7	26.7
≤5	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	787	78.8	47.9	38.0	6.3	12.5	38.2	13.1	7.8	15.0	29.7
6 to 11	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	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	704	80.5	48.2	36.3	5.9	11.9	33.8	15.8	8.4	15.9	26.6
6 to 11	969	81.7	50.8	38.9	5.4	11.4	33.5	17.1	7.8	15.1	29.2
12 to 19	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	9,309	77.1	44.6	32.9	6.1	12.7	30.7	10.3	9.6	15.2	25.2
≤19	11,287	78.3	46.8	35.3	5.6	11.2	34.6	16.6	7.0	11.9	29.4

[a] Based on data from 1994−1996, 1998 CSFII.

[b] 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 (1999a).

Table 9-12. Mean Quantities of Fruits Consumed Daily by Sex and Age, for Children, per Capita (g/day, as-consumed)[a]

Age Group (years)	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	1,126	131	4	4	-[b,c]	126	14	10	1[b]	39	61
1	1,016	267	47	42	2	216	22	23	8	29	134
2	1,102	276	65	56	2	207	27	20	10	20	130
1 to 2	2,118	271	56	49	2	212	24	22	9	24	132
3	1,831	256	61	51	1	191	27	18	13	24	110
4	1,859	243	62	52	1	177	31	17	14	22	92
5	884	218	55	44	-[b,c]	160	31	14	13	24	78
3 to 5	4,574	239	59	49	1	176	30	16	13	23	93
≤5	7,818	237	52	44	1	182	26	17	10	26	103
Males											
6 to 9	787	194	58	51	-[b,c]	133	32	11	21	20	50
6 to 11	1,031	183	67	60	-[b,c]	113	28	11	16	19	40
12 to 19	737	174	102	94	1[b]	70	13	8	11[b]	10	29
Females											
6 to 9	704	180	63	54	1[b]	113	23	10	10	25	46
6 to 11	969	169	64	54	-[b,c]	103	21	8	8	23	42
12 to 19	732	157	72	67	-[b,c]	83	13	5	15	14	35
Males and Females											
≤9	9,309	217	55	47	1	159	27	15	12	24	81
≤19	11,287	191	70	62	1	118	21	11	12	19	56

[a] Based on data from 1994−1996, 1998 CSFII.
[b] Estimate is not statistically reliable due to small samples size reporting intake.
[c] 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 (1999a).

Table 9-13. Percentage of Individuals Consuming, Fruits by Sex and Age, for Children (%)[a]

Age Group (years)	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	1,126	59.7	3.6	2.7	0.4[b]	59.0	15.7	13.3	1.8	29.9	33.0
1	1,016	81.0	23.6	19.0	5.9	73.0	23.4	25.1	6.9	26.5	43.2
2	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	2,118	78.8	27.2	21.3	5.6	68.8	23.7	22.6	7.7	22.9	40.0
3	1,831	74.5	27.9	21.4	4.1	64.2	22.4	17.5	7.8	20.1	33.3
4	1,859	72.6	28.0	21.8	3.0	62.1	23.7	15.7	7.6	20.0	30.8
5	884	67.6	26.9	19.5	1.3[b]	56.9	21.9	12.6	7.4	19.0	24.5
3 to 5	4,574	71.6	27.6	20.9	2.8	61.0	22.7	15.3	7.6	19.7	29.5
≤5	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	787	59.0	24.8	20.5	0.8[b]	49.1	20.3	8.7	7.3	16.8	15.5
6 to 11	1,031	56.5	25.2	21.6	1.1[b]	44.2	18.2	8.0	6.6	15.4	12.7
12 to 19	737	44.5	24.7	21.7	1.0[b]	27.1	8.2	6.0	4.1	7.1	8.2
Females											
6 to 9	704	64.9	27.9	22.3	1.5[b]	50.4	17.3	8.8	7.4	20.4	17.3
6 to 11	969	62.1	27.7	21.5	1.1[b]	47.2	16.2	7.3	7.4	19.0	14.9
12 to 19	732	45.6	22.4	18.1	1.1[b]	30.2	8.2	4.4	6.0	11.3	9.7
Males and Females											
≤9	9,309	68.3	25.2	19.8	2.5	58.0	20.9	14.0	7.1	20.6	26.7
≤19	11,287	57.8	24.8	20.1	1.8	44.4	15.2	9.7	6.2	15.5	17.9

[a] Based on data from 1994−1996, 1998 CSFII.
[b] 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 9-14. Per Capita Intake of Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

Population Group	*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
Non-metropolitan	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 9-14. Per Capita Intake of Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	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: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 9-15. Consumer-Only Intake of Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

Population Group	*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
Non-metropolitan	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 9-15. Consumer-Only Intake of Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	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: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

Population Group	*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
Non-metropolitan	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 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	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 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	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 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	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 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	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 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	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 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994–1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	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 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	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 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	4,845	94.2	1.02	0.06

N = Sample size.
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: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 9-17. Consumer-Only Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

Population Group	*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
Non-metropolitan	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 9-17. Consumer-Only Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	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 9-17. Consumer-Only Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	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 9-17. Consumer-Only Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	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 9-17. Consumer-Only Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	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 9-17. Consumer-Only Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	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 9-17. Consumer-Only Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*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
Non-metropolitan	3,889	0.86	0.03	2,697	0.64	0.05	4,436	1.08	0.06

N = Sample size.
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: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 9-18. Per Capita Intake of Exposed Fruits Based on 1994−1996 CSFII (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
Non-	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: U.S. EPA analysis of the 1994−1996 CSFII.

Table 9-19. Per Capita Intake of Protected Fruits Based on 1994−1996 CSFII (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
Non-metropolitan	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: U.S. EPA analysis of the 1994−1996 CSFII.

Table 9-20. 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
Non-metropolitan	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: U.S. EPA analysis of the 1994−1996 CSFII.

Table 9-21. Per Capita Intake of Protected Vegetables Based on 1994−1996 CSFII (g/kg-day, as-consumed)													
Population	Percent			Percentile									
Group	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
Non-metropolitan	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: U.S. EPA analysis of the 1994−1996 CSFII.

Table 9-22. Per Capita Intake of Root Vegetables Based on 1994−1996 CSFII (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
Non-metropolitan	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: U.S. EPA analysis of the 1994−1996 CSFII.

Table 9-23. Quantity (as-consumed) of Fruits and Vegetables Consumed per Eating Occasion and the Percentage of Individuals Consuming These Foods in Two Days

Food category	Percent Consuming[a]	Quantity Consumed per Eating Occasion (gram)		Consumer-Only Quantity Consumed per Eating Occasion at Specified Percentiles (gram)[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 potatoes	8.9	135	3	36	47	70	105	192	284	308
Baked potatoes	12.4	120	2	48	61	92	106	143	184	217
Boiled potatoes	5.3	157	5	34	52	91	123	197	308	368
Mashed potatoes	15.0	188	3	46	61	105	156	207	397	413
Dried beans and peas	8.0	133	3	22	33	64	101	173	259	345
Baked beans	4.7	171	6	24	47	84	126	235	314	385
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

[a] = Percent consuming at least once in two days.
SE = Standard error of the mean.
Source: Smiciklas-Wright et al. (2002) (based on 1994−1996 CSFII data).

Table 9-24. Quantity (as-consumed) of Fruits and Vegetables Consumed per Eating Occasion and Percentage of Individuals Consuming These Foods in Two Days, by Food

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

Table 9-24. Quantity (as-consumed) of Fruits and Vegetables Consumed Per Eating Occasion and Percentage of Individuals Consuming These Foods in Two Days, by Food (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 a small sample size and a large SE.
PC = Percent consuming at least once in two days.
SE = Standard error of the mean.
N = Sample size.

Source: Smiciklas-Wright et al. (2002) (based on 1994−1996 CSFII data).

Table 9-25. Consumption of Major Food Groups: Median Servings (and ranges) by Demographic and Health Characteristics, for Older Adults

Subject Characteristic		*N*	Fruits and Vegetables (servings per day)
Sex			
	Female	80	5.7 (1.5−8.1)
	Male	50	4.5 (0.8−8.8)
Ethnicity[a]			
	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 years	42	4.5 (1.6−8.1)
	75 to 79 years	36	5.6 (0.8−8.0)
	80 to 84 years	36	5.6 (1.5−8.8)
	≥ 85 years	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			
	8th grade or less	37	5.0 (1.5−8.1)
	9th to 12th 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[b]			
	130 pounds	18	6.0 (1.8−8.0)
	131 to 150 pounds	32	5.5 (1.5−8.0)
	151 to 170 pounds	27	5.7 (1.7−8.1)
	171 to 190 pounds	22	5.6 (1.8−8.8)
	191 pounds	29	4.5 (0.8−8.0)

[a] $p < 0.05$.
[b] Two missing values.
N = Number of individuals.

Source: Vitolins et al. (2002).

Table 9-26. Characteristics of the Feeding Infants and Toddlers Study (FITS) Sample Population

	Sample Size	Percentage of Sample
Sex		
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 data	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 9-27. 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 9-28. 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 9-29. 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 9-30. 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 9-31. Characteristics of Women, Infants, and Children (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
Sex						
Male	55	54	55	51	57	52
Female	45	46	45	49	43	48
Child's Ethnicity		[b]		[b]		[b]
Hispanic or Latino	20	11	24	8	22	10
Non-Hispanic or Latino	80	89	76	92	78	89
Child's Race		[b]		[b]		[b]
White	63	84	63	86	67	84
Black	15	4	17	5	13	5
Other	22	11	20	9	20	11
Child In Daycare				[b]		[c]
Yes	39	38	34	46	43	53
No	61	62	66	54	57	47
Age of Mother		[b]		[b]		[b]
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	9	23	11	21	11	26
Missing	2	2	1	1	0	1
Mother's Education		[b]		[b]		[b]
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		[b]		[b]		[b]
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				[b]		[c]
Yes	46	51	45	60	55	61
No	53	48	54	40	45	38
Missing	1	1	1	0	0	1
Urbanicity		[b]		[b]		[b]
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] χ^2 tests 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 the χ^2 tests are listed next to the variable under the column labeled non-participants for each of the three age groups.

[b] $p < 0.01$ non-participants significantly different from WIC participants on the variable.

[c] $p < 0.05$ 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 9-32. Food Choices for Infants and Toddlers by Women, Infants, and Children (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[a]	33.8	33.8	73.1	72.3
Raw Vegetables	1.4	0.1[b]	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[a]	20.7	18.2	43.1	38.3
Fruits						
Any Fruit	47.8	39.2[a]	64.7	81.0[b]	58.5	74.6[b]
Baby Food Fruits	43.8	36.9	48.4	57.4[a]	3.8	6.5
Non-Baby Food Fruit	8.1	4.0	22.9	35.9[b]	56.4	70.9[b]
Fresh Fruit	5.4	3.8	14.3	24.3[b]	43.6	57.0[b]
Canned Fruit	3.4	0.5[b]	10.3	17.3[b]	22.3	25.3
Sample Size (unweighted)	265	597	351	808	205	791

a = $p < 0.05$ non-participants significantly different from WIC participants.
b = $p < 0.01$ non-participants significantly different from WIC participants.
WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Ponza et al. (2004).

Table 9-33. 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 ± SE	
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.
SE = Standard error.

Source: Fox et al. (2006).

Table 9-34. 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 ± SE	
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.
SE = Standard error of the mean.

Source: Fox et al. (2006).

Table 9-35. 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[b]	58.1	5.6[c]	6.3
Non-Baby Food Fruit	9.1[c]	1.3[c]	35.8	27.4	64.2	68.0
Canned Fruit	2.3[c]	-	8.8	13.7	12.1[d]	26.2
Fresh Fruit	9.1[b,c]	-	30.0[d]	17.7	59.3	53.1
Vegetables						
Any Vegetable or 100% Vegetable Juice[e]	30.0	27.3	66.2	70.3	76.0	80.5
Type of Preparation						
Baby Food Vegetables	25.7	25.4	34.4[b]	47.6	4.1[c]	4.9
Cooked Vegetables	4.2[c]	2.4[c]	33.2	29.4	71.4	72.9
Raw Vegetables	2.3[c]	-	8.3[c]	2.6	25.0	13.1
Types of Vegetables[e]						
Dark Green Vegetables[f]	-	-	3.3[c]	3.1	11.4[c]	7.5
Deep Yellow Vegetables[g]	21.0	18.2	32.2	25.9	20.0	15.4
Starchy Vegetable:						
White Potatoes	1.4[c]	2.3[c]	20.7	17.4	43.5	39.0
French Fries/Fried Potatoes	-	-	5.7[c]	5.3	23.4	20.3
Baked/Mashed	-	-	14.4[c]	10.7	19.8	17.7
Other Starchy Vegetables[h]	5.0[c]	4.0	6.7[d]	15.1	16.6	22.2
Other Non-Starchy Vegetables[i]	8.1[c]	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] = Significantly different from non-Hispanic at the $p < 0.05$.
[c] = Statistic is potentially unreliable because of a high coefficient of variation.
[d] = Significantly different from non-Hispanic at the $p < 0.01$.
[e] Total includes commercial baby food, cooked vegetables, raw vegetables, and 100% vegetable juices.
[f] Reported dark green vegetables include broccoli, spinach, romaine lettuce, and other greens such as kale.
[g] Reported yellow vegetables include carrots, pumpkin, sweet potatoes, and winter squash.
[h] 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.
[i] Reported non-starchy vegetables include asparagus, cauliflower, cabbage, onions, green beans, mixed vegetables, peppers, and tomatoes.

\- = Less than 1% of the group consumed this food on a given day.
N = Sample size.

Source: Mennella et al. (2006).

Table 9-36. Top Five Fruits and Vegetables Consumed by Hispanic and Non-Hispanic Infants and Toddlers per Age Group[a]

Age (month)	*N*	Ethnicity: Hispanic	Ethnicity: Non-Hispanic
		Top Fruits By Age Group	
4 to 5	84 Hispanic	Bananas (16.3%)	Apples (12.5%)
	538 non-Hispanic	Apples (14.7%)	Bananas (10.0%)
		Peaches (10.9%)	Pears (5.9%)
		Melons (3.5%)	Peaches (5.8%)
		Pears (2.5%)	Prunes (1.6%)
6 to 11	136 Hispanic	Bananas (35.9%)	Apples (32.9%)
	1,228 non-Hispanic	Apples (29.7%)	Bananas (31.5%)
		Pears (15.2%)	Pears (17.5%)
		Peaches (11.7%)	Peaches (13.9%)
		Melons (4.7%)	Apricots (3.7%)
12 to 24	124 Hispanic	Bananas (41.5%)	Bananas (30.9%)
	871 non-Hispanic	Apples (25.7%)	Apples (22.0%)
		Berries (8.5%)	Grapes (12.3%)
		Melons (7.6%)	Peaches (9.6%)
		Pears (7.3%)	Berries (8.7%)
		Top Vegetables By Age Group	
4 to 5	84 Hispanic	Carrots (9.9%)	Sweet Potatoes (7.5%)
	538 non-Hispanic	Sweet Potatoes (6.8%)	Carrots (6.6%)
		Green Beans (5.8%)	Green Beans (5.9%)
		Peas (5.0%)	Squash (5.4%)
		Squash (4.3%)	Peas (3.8%)
6 to 11	136 Hispanic	Potatoes (20.7%)	Carrots (17.5%)
	1,228 non-Hispanic	Carrots (19.0%)	Potatoes (16.4%)
		Mixed Vegetables (11.1%)	Green Beans (15.9%)
		Green Beans (11.0%)	Squash (11.8%)
		Sweet Potatoes (8.7%)	Sweet Potatoes (11.4%)
12 to 24	124 Hispanic	Potatoes (43.5%)	Potatoes (39.0%)
	871 non-Hispanic	Tomatoes (23.1%)	Green Beans (19.6%)
		Carrots (18.6%)	Peas (12.8%)
		Onions (11.8%)	Carrots (12.3%)
		Corn (10.2%)	Tomatoes (11.9%)

[a] Percentage consuming at least one in a day is in parentheses.
N = Sample size.

Source: Mennella et al. (2006).

Table 9-37. 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*	-	*with skin
	86.67**	-	**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 9-37. 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 and 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—blackeyed 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 and liquid

Table 9-37. 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	-	
Towel gourd	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.

* Number without added sugar.

Source: USDA (2007).

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. Finfish and shellfish are exposed to these pollutants and may become sources of contaminated food if the contaminants bioconcentrate in fish tissue or bioaccumulate through the food chain. Some chemicals (e.g., polychlorinated biphenyls and dioxins) are stored in fatty tissues, while others (e.g., mercury and arsenic) are typically found in the non-lipid components.

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. Because 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. Subsistence fishermen are those individuals who consume fresh caught fish as a major source of food. Their intake rates are generally higher than those of the general population. It should be noted that, depending on the study, the data presented in this chapter for Native American populations may or may not reflect subsistence fishing. Harper and Harris (2008), and Donatuto and Harper (2008) describe some difficulties associated with evaluating fish intake rates among Native American subsistence populations. For example, Donatuto and Harper (2008) suggest that contemporary Native American subsistence intake rates may be lower (i.e., suppressed) compared to heritage rates. Also, the intake rates among certain subsets of the Native American populations may be higher than the rate for the average Native American (Donatuto and Harper, 2008; Harper and Harris, 2008).

This chapter focuses on intake rates of fish. Note that in this section the term fish refers to both finfish and shellfish, unless otherwise noted. 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 general population studies in this chapter use the term consumer-only intake when referring to the quantity of fish and shellfish consumed by individuals during the survey period. These data are generated by averaging intake across only the individuals in the survey who consumed fish and shellfish. Per capita intake rates are generated by averaging consumer-only intakes over the entire survey 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 fish at some time but did not consume it 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 population of fish consumers. Similarly, the discussions regarding recreationally caught fish consumption use the terms “all respondents” and “consuming anglers.” “All respondents” represents both survey individuals/anglers who ate recreationally caught fish during the survey period and those that did not but may eat recreationally caught fish during other periods. “Consuming anglers” refers only to the individuals who ate fish during the survey period.

The determination to use consumer-only or per capita estimates of fish consumption in exposure assessments depends on the purpose of the assessment and on the source of the data. Both approaches can be a source of valuable insights on analyses of exposure and risk related to consumption of fish. This is because in the overall population, fish is not a frequently consumed item, and quantities may be relatively small, while in some populations, fish is consumed frequently and in large quantities. Nationwide surveys of food intake such as the Continuing Survey of Food Intake by Individuals (CSFII) or the National Health and Nutrition Examination Survey (NHANES) provide objective measures of food consumption that by design include overall, population-based estimates of fish consumption. The data from the CSFII or NHANES can be analyzed in terms of overall per capita consumption or consumers only. Although the CSFII and NHANES data are collected over short time periods, the large scale nature and design of such studies offer substantial advantages. In exposure analysis and risk assessment applications where fish intake is a concern, usually consumer-only data are of greater interest because of the relative infrequency of fish consumption. Both approaches are a source of valuable insights and help to provide context for the results from specialized surveys that typically focus on fish consumption. Specialized surveys are done for a variety of reasons using different methodologies that typically focus on relatively small, high-fish consuming groups. It may be important to know how results based on small, high consuming groups compare to overall estimates of consumption based on per capita data and consumer-only data. The data presented in this chapter come from a variety of sources and were collected using various methodologies. Some data come from creel surveys where fishermen are usually asked, among other things, how much they have caught and the number of family members with which they will share their catch. These data will not represent usual behavior because one cannot assume that the angler will have the same luck over time. In all likelihood, there will be variation in the amounts caught and consumed by anglers that should be considered. Other data come from mail surveys or personal or phone interviews where participants are asked to recall how much fish each family member eats over a certain period of time. In some cases, data are recorded by survey participants in a food diary. Some surveys may ask about frequency of consumption, but not the amount. Frequency of consumption data can be combined with information on amount consumed per eating occasion to estimate consumption. The recall period determines if the survey characterizes long-term (i.e., usual intake) or short-term consumption. Exposure assessors are generally interested in estimates of long-term behaviors, but longer recall periods are associated with generally higher reporting error that should be considered. If the data come from a survey where long-term or usual intake is characterized (i.e., how often does someone eat fish in a year?), then consumer-only estimates may capture day-to-day variability in consumption. On the other hand, if the survey instrument used to collect the data characterizes short-term consumption (e.g., how much was eaten in a week, how much was consumed on a particular day), then a per capita estimate may account for the fact that individuals who are not consumers during the survey period may consume fish at some point over a longer time period. Using consumer-only data from short-term surveys may tend to overestimate consumption over the long term, especially at the high end, because it would not include days where respondents do not consume fish. Overestimates of consumption could, however, be considered conservative with regard to intake of contaminants and, thus, provide the basis for measures protective of human health.

The U.S. Environmental Protection Agency (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.

Refer 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 1 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, 1/30 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 database and the survey weights should be inversely proportional to the expected number of times that an individual's interviews are included in the database.

In the published analyses of most creel studies, there is no mention of sampling weights; by default, all weights are set to one, implying equal probability of sampling. However, because 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; the authors used data from two creel studies (Puffer et al., 1982; 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. (1982) 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% 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% of the income is received by, for example, the top 10% of the population, which consists of individuals making more than $100,000." 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% of total income is received by individuals with incomes below this level and 10% 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 (see Section 10.3), marine recreational angler populations (see Section 10.4), freshwater recreational populations (see Section 10.5), and Native American populations (see 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 and adults. Information on other population studies (see Section 10.7), serving size (see Section 10.8), and other factors to consider (see 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 (finfish, shellfish, and total fish and shellfish combined);
- Recreational Marine Intake;
- Recreational Freshwater Intake; and
- Native American 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 analysis of data from the Centers for Disease Control and Prevention (CDC) NHANES 2003–2006.

Table 10-1 presents a summary of the recommended values for per capita and consumer-only intake of finfish, shellfish, and total finfish and shellfish combined. Table 10-2 provides confidence ratings for the fish intake recommendations for the general population. The U.S. EPA analysis of 2003–2006 NHANES data 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.

Note that the fish intake values presented in Table 10-1 are reported as uncooked fish weights. 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 (i.e., concentration times weight), 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 because the concentration in the cooked fish is likely to be higher, if the mass of the contaminant remains constant after cooking. Reported weights are also more likely to reflect uncooked weight, and interpretation of advisories are likely to be in terms of uncooked weights. Although it is generally more conservative and appropriate to use uncooked fish intake rates, one should also be sure to use like measures. That is to say, avoid using raw fish concentrations and cooked weights to estimate the dose. For more information on cooking losses and conversions necessary to account for such losses, refer to Chapter 13 of this handbook.

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. The key study on fish ingestion provides intake data based on uncooked fish weights. However, relevant data on both "as-prepared" (i.e., as-consumed) and uncooked general population fish intake are also presented in this handbook. The assessor should choose the intake data that best matches the concentration data that are being used.

The NHANES 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 analysis of NHANES survey data used to develop the recommended intake rates in this handbook did not consider the source of the fish consumed. This type of information may be relevant for some assessments.

Recommended values should be selected that are relevant to the assessment, choosing the appropriate age groups and type of fish (i.e., finfish, shellfish, or total finfish, and shellfish). 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 estimates that target a particular region or geographical area, if relevant data are available. In addition, seasonal, sex, and fish species variations should be considered when appropriate, if data are available. Also, relevant data on general population fish intake in this chapter may be used if appropriate to the scenarios being assessed. For example, older data from the U.S. EPA's analysis of data from the 1994–1996 and 1998 CSFII provide intake rates for freshwater/estuarine fish and shellfish, marine fish and shellfish, and total fish and shellfish that are not available from the more recent NHANES analysis.

10.2.2. Recommendations—Recreational Marine Anglers

Table 10-3 presents the recommended values for recreational marine anglers. These values are based on the surveys of the National Marine Fisheries Service (NMFS, 1993). The values from NMFS (1993) are assumed to represent intake of marine fish among adult recreational fishers. Values represent both individuals who ate recreational fish during the survey period and those that did not, but may eat recreationally caught fish during other periods. Age-specific values were not available from this source. However, recommendations for children were estimated based on the ratios of marine fish intake for general population children to that of adults using data from U.S. EPA's analysis of CSFII data from 1994–1996 and 1998 (U.S. EPA, 2002) (see Section 10.3.2.6), multiplied by the adult recreational marine fish intake rates for the Atlantic, Gulf, and Pacific regions, using data from NMFS (1993) (see Section 10.4.1.1). The ratios of each age group to adults >18 years were calculated separately for the means and 95th percentiles. 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 data from the relevant studies provided in this chapter if appropriate to the scenarios being assessed. Table 10-4 presents the confidence ratings for recommended recreational marine fish intake rates.

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 (see Figure 10-1). For example, factors associated with water body, climate, fishing regulations, availability of alternate fishable water bodies, and water body productivity may affect recreational fish intake rates. However, data from several relevant recreational freshwater studies are provided in this chapter. Table 10-5 summarizes data from these studies. Assessors may use these data, if appropriate to the scenarios and locations being assessed. Although recommendations are not provided, some general observations can be made. Most of the studies in Table 10-5 represent state-wide surveys of recreational anglers. These include Alabama, Connecticut, Indiana, Maine, Michigan, Minnesota, North Dakota, and Wisconsin. Consumption data from these states would include freshwater fish from rivers, lakes, and ponds. The average range of consumption for all respondents from these states varies from 5 g/day to 51 g/day. Another two studies represent consumption of fish from specific rivers. These included Savannah River in Georgia and The Clinch River in Tennessee. The consumption rates for all respondents from these two rivers ranged from 20 g/day to 70 g/day. One of the studies in Table 10-5 represents the consumption of fish from three lakes in Washington, and another represents consumption of fish from Lake Ontario. The average consumption rate for all responding adults was 10 g/day for the three Washington lakes. It can also be noted that a large percentage of recreational anglers consumed fish and shellfish during the survey period. Thus, values for all respondents and consuming anglers are fairly similar. For Lake Ontario, the average consumption rate for adults was 5 g/day.

10.2.4. Recommendations—Native American Populations

Recommended values are also not provided for Native American 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 Per Capita and Consumer-Only Values for Fish Intake (g/kg-day), Uncooked Fish Weight, by Age

	Per Capita				Consumers Only			
Age	*N*	% Consuming	Mean	95th percentile	*N*	Mean	95th percentile	Source
Finfish[a]								
All	16,783	23	0.16	1.1	3,204	0.73	2.2	U.S. EPA Analysis of NHANES 2003–2006 data
Birth to 1 year	865	2.6	0.03	0.0[b]	22	1.3	2.9[b]	
1 to <2 years	1,052	14	0.22	1.2[b]	143	1.6	4.9[b]	
2 to <3 years	1,052	14	0.22	1.2[b]	143	1.6	4.9[b]	
3 to <6 years	978	15	0.19	1.4	156	1.3	3.6[b]	
6 to <11 years	2,256	15	0.16	1.1	333	1.1	2.9[b]	
11 to <16 years	3,450	15	0.10	0.7	501	0.66	1.7	
16 to <21 years	3,450	15	0.10	0.7	501	0.66	1.7	
21 to <50 years	4,289	23	0.15	1.0	961	0.65	2.1	
Females 13 to 49 years	4,103	22	0.14	0.9	793	0.62	1.8	
50+ years	3,893	29	0.20	1.2	1,088	0.68	2.0	
Shellfish[a]								
All	16,783	11	0.06	0.4	1,563	0.57	1.9	U.S. EPA Analysis of NHANES 2003–2006 data
Birth to 1 year	865	0.66	0.00	0.0[b]	11	0.42	2.3[b]	
1 to <2 years	1,052	4.4	0.04	0.0[b]	53	0.94	3.5[b]	
2 to <3 years	1,052	4.4	0.04	0.0[b]	53	0.94	3.5[b]	
3 to <6 years	978	4.6	0.05	0.0	56	1.0	2.9[b]	
6 to <11 years	2,256	7.0	0.05	0.2	158	0.72	2.0[b]	
11 to <16 years	3,450	5.1	0.03	0.0	245	0.61	1.9	
16 to <21 years	3,450	5.1	0.03	0.0	245	0.61	1.9	
21 to <50 years	4,289	13	0.08	0.5	605	0.63	2.2	
Females 13 to 49 years	4,103	11	0.06	0.3	474	0.53	1.8	
50+ years	3,893	13	0.05	0.4	435	0.41	1.2	
Total Finfish and Shellfish[a]								
All	16,783	29	0.22	1.3	4,206	0.78	2.4	U.S. EPA Analysis of NHANES 2003–2006 data
Birth to 1 year	865	3.1	0.04	0.0[b]	30	1.2	2.9[b]	
1 to <2 years	1,052	17	0.26	1.6[b]	183	1.5	5.9[b]	
2 to <3 years	1,052	17	0.26	1.6[b]	183	1.5	5.9[b]	
3 to <6 years	978	18	0.24	1.6	196	1.3	3.6[b]	
6 to <11 years	2,256	22	0.21	1.4	461	0.99	2.7[b]	
11 to <16 years	3,450	18	0.13	1.0	685	0.69	1.8	
16 to <21 years	3,450	18	0.13	1.0	685	0.69	1.8	
21 to <50 years	4,289	31	0.23	1.3	1,332	0.76	2.5	
Females 13 to 49 years	4,103	28	0.19	1.2	1,109	0.68	1.9	
50+ years	3,893	36	0.25	1.4	1,319	0.71	2.1	

[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.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Table 10-2. Confidence in Recommendations for General Population Fish Intake		
General Assessment Factors	Rationale	Rating
Soundness		High
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		High
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	Data were derived from 2003–2006 NHANES.	
Data Collection Period	Data were collected for 2 non-consecutive days.	
Clarity and Completeness		High
Accessibility	The primary data are accessible through CDC.	
Reproducibility	The methodology was clearly presented; enough information was available to allow for reproduction of the results.	
Quality Assurance	Quality assurance of NHANES data was good; quality control of secondary analysis was good.	
Variability and Uncertainty		Medium to high for averages; low for long-term upper percentiles
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.	
Evaluation and Review		Medium
Peer Review	The National Center for Health Statistics (NCHS) NHANES survey received a high level of peer review. The U.S. EPA analysis of these data has not been peer reviewed outside the Agency, but the methodology used has been peer reviewed in analysis of previous data.	
Number and Agreement of Studies	The number of studies is one.	
Overall Rating		**Medium to High** (mean) **Medium** (long-term upper percentiles)

Table 10-3. Recommended Values for Recreational Marine Fish Intake		
Age Group	Intake Rate[a]	
	Mean g/day[b]	95th Percentile g/day[b]
Atlantic		
3 to <6 years	2.5	8.8
6 to <11 years	2.5	8.6
11 to <16 years	3.4	13
16 to <18 years	2.8	6.6
>18 years	5.6	18
Gulf		
3 to <6 years	3.2	13
6 to <11 years	3.3	12
11 to <16 years	4.4	18
16 to <18 years	3.5	9.5
>18 years	7.2	26
Pacific		
3 to <6 years	0.9	3.3
6 to <11 years	0.9	3.2
11 to <16 years	1.2	4.8
16 to <18 years	1.0	2.5
>18 years	2.0	6.8

[a] Represents intake for the recreational fishing population only. Data from U.S. EPA analysis of NMFS (1993) assumed to represent adults >18 years. Values represent both survey anglers 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 were estimated based on the ratios of marine fish intake for general population children to that of adults using data from U.S. EPA's analysis of CSFII data (see Table 10-31), multiplied by the adult recreational marine fish intake rates for the Atlantic, Gulf, and Pacific regions, using data from NMFS (1993) (see Table 10-50).The ratios of each age group to adults >18 years were calculated separately for the means and 95th percentiles.

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		Low to 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 United States.	
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 95th 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 to the amount eaten by adults.	
Evaluation and Review		Medium
Peer Review	Data from NMFS (1993) were reviewed by NMFS and U.S. EPA. U.S. EPA's analysis was not peer reviewed outside of EPA.	
Number and Agreement of Studies	The number of studies is one.	
Overall Rating		**Low to Medium** (adults) **Low** (children)

Table 10-5. Summary of Relevant Studies on Freshwater Recreational Fish Intake				
Location	Population Group	Mean g/day	95th Percentile g/day	Source
Alabama	All Respondents (Adults)	44[a]	-	ADEM (1994)
	Consuming Anglers	53[b]	-	
Connecticut	All Respondents	51[c]	-	Balcom et al. (1999)
	Consuming Anglers	53[c,d]	-	
Georgia (Savannah River)	All Respondents (Adult Whites)	38[e]	-	Burger et al. (1999)
	All Respondents (Adult Blacks)	70[e]	-	
Indiana	All Respondents	16	61	Williams et al. (1999)
	Consuming Anglers	20	61	
Maine	All Respondents	5.0	21	ChemRisk (1992); Ebert et al. (1993)
	Consuming Anglers	6.4	26	
Michigan	Consuming Anglers			West et al. (1993; 1989)
	1 to 5 years	5.6	-	
	6 to 10 years	7.9	-	
	11 to 20 years	7.3	-	
	21 to 80 years	16[f]	-	
	All ages	14	39	
Minnesota	All Respondents			Benson et al. (2001)
	0 to 14 years	1.2 (50th percentile)	14	
	>14 years (male)	4.5 (50th percentile)	40	
	15 to 44 (female)	2.1 (50th percentile)	25	
	>44 (female)	3.6 (50th percentile)	37	
	Consuming Anglers	14	37	
New York (Lake Ontario)	All Respondents (Adults)	4.9[f]	18	Connelly et al. (1996)
	Consuming Anglers	5.8[g]	-	
North Dakota	All Respondents			Benson et al. (2001)
	0 to 14 years	1.7 (50th percentile)	22	
	>14 years (male)	2.3 (50th percentile)	25	
	15 to 44 (female)	4.3 (50th percentile)	30	
	>44 (female)	4.2 (50th percentile)	33	
	Consuming Anglers	12	43	
Tennessee (Clinch River)	All Respondents	20[e,h]	-	Rouse Campbell et al. (2002)
	Consuming Anglers	38[e,h]	-	
Washington	All Respondents (Adults)	10	42	Mayfield et al. (2007)
	Children of Respondents	7	29	
	Consuming Anglers (Adults)	15[i]	-	
Wisconsin	All Respondents (Adults)	11	37	Fiore et al. (1989)
	Consuming Anglers	12	37	
Summary (mean ranges)	Statewide Surveys[j]	5–51 g/day		
	Rivers[k]	20–70 g/day		
	Lakes[l]	5–10 g/day		

Table 10-5. Summary of Relevant Studies on Freshwater Recreational Fish Intake (continued)

a	Based on the average of two methods.
b	Value represents anglers who consumed recreationally caught fish during the survey period, calculated by dividing all respondents by the percent consuming of 83%.
c	Values included consumption of both freshwater and saltwater fish.
d	Value calculated by dividing all respondents by the percent consuming of 97%.
e	Calculated as amount eaten per year divided by 365 days per year.
f	Based on average of multiple adult age groups.
g	Value calculated by dividing all respondents by the percent consuming of 84%.
h	Values included consumption of both self-caught and store-bought fish.
i	Value calculated by dividing all respondents by the percent consuming of 66%.
j	Represents the range from the following states: Alabama, Connecticut, Indiana, Maine, Michigan, Minnesota, North Dakota, and Wisconsin.
k	Represents the range from the following rivers: Savannah River in GA and The Clinch River in TN.
l	Represents the range from three lakes in Washington and Lake Ontario.
-	Estimate not available.
Note	All respondents represent both survey anglers who ate recreational fish during the survey period and those that did not, but may eat recreationally caught fish during other periods.

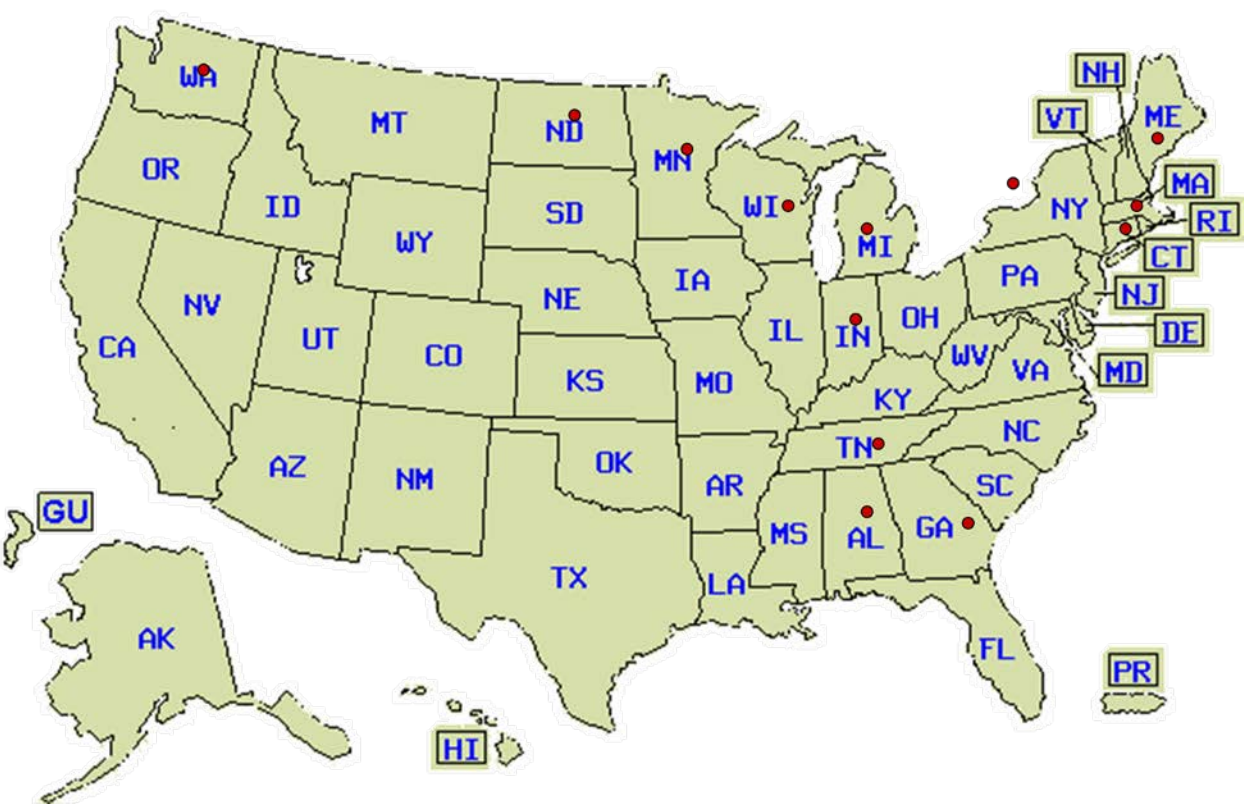

Figure 10-1. Locations of Freshwater Fish Consumption Surveys in the United States.

Table 10-6. Summary of Relevant Studies on Native American Fish Intake				
Location/Tribe	Population Group	Mean [a]	95th Percentile[a]	Source
94 Alaska Communities	All Respondents			Wolfe and Walker (1987)
	Lowest of 94	16 g/day	-	
	Median of 94	81 g/day	-	
	Highest of 94	770 g/day	-	
Chippewa Indians (Wisconsin)	All Respondents			Peterson et al. (1994)
	Adults	39 g/day[b]	-	
4 Columbia River Tribes (Oregon)	All Respondents			CRITFC (1994)
	Adults	59 g/day	170 g/day	
	Children ≤5 years	11 g/day (50th percentile)	98 g/day	
	Consumers			
	Adults	63 g/day[c]	183[c]	
Florida	All Respondents	0.8 g/kg-day	4.5 g/kg-day	Westat (2006)
	Consumers[d]	1.5 g/kg-day	5.7 g/kg-day	
Minnesota	All Respondents	2.8 g/kg-day	-	Westat (2006)
	Consumers[d]	2.8 g/kg-day	-	
Mohawk Tribe (New York and Canada)	All Respondents			Fitzgerald et al. (1995)
	Women	13 g/day[e]	-	
	Consuming Women	16 g/day[e]	-	
Mohawk Tribe (New York and Canada)	All Respondents[f]			Forti et al. (1995)
	Adults	25 g/day	131 g/day	
	Children 2 years[f]	10 g/day	54 g/day	
	Consumers			
	Adults[f]	29 g/day	135 g/day	
	Children 2 years[f]	13 g/day	58 g/day	
North Dakota	All Respondents	0.4 g/kg-day	0.9[g]	Westat (2006)
	Consumers[b]	0.4 g/kg-day	0.8[g]	
Tulalip Tribe (Washington)	All Respondents			Toy et al. (1996)
	Adult	0.9 g/kg-day	2.9 g/kg-day	
	Children birth ≤5 years	0.2 g/kg-day	0.7 g/kg-day[g]	
Squaxin Island Tribe (Washington)	All Respondents			
	Adults	0.9 g/kg-day	3.0 g/kg-day	
	Children	0.8 g/kg-day	2.1 g/kg-day[g]	
Tulalip Tribe (Washington)	Consumers			Polissar et al. (2006)
	Adults	1.0 g/kg-day	2.6 g/kg-day	
	Children birth ≤5 years	0.4 g/kg-day	0.8 g/kg-day[g]	
Squaxin Island Tribe (Washington)	Consumers			
	Adults	1.0 g/kg-day	3.4 g/kg-day	
	Children birth ≤5 years	2.9 g/kg-day	7.7 g/kg-day	
Suquamish Tribe (Washington)	All Respondents			Duncan (2000)
	Adults	2.7 g/kg-day	10 g/kg-day	
	Children <6 years	1.5 g/kg-day	7.3 g/kg-day	
	Consumers			
	Adults	2.7 g/kg-day	10 g/kg-day	
	Children <6 years	1.5 g/kg-day	7.3 g/kg-day	

Table 10-6. Summary of Relevant Studies on Native American Fish Intake (continued)	
[a]	Results are reported in g/day or g/kg-day, depending on which was provided in the source material.
[b]	All respondents consumed fish caught in Northern Wisconsin lakes.
[c]	Value calculated by dividing all respondents by the percent consuming of 93%.
[d]	Based on uncooked fish weight.
[e]	Value represents consumption by Mohawk women >1 year before pregnancy. Value estimated by multiplying number of fish meals/year by the 90th percentile meal size of 209 g/meal for general population females 20–39 years old from Smiciklas-Wright et al. (2002).
[f]	Based on 90th percentile general population meal size, based on Pao et al. (1982).
[g]	Value represents the 90th percentile.
-	Estimate not available.

10.3. GENERAL POPULATION STUDIES

10.3.1. Key General Population Study

10.3.1.1. *U.S. EPA Analysis of Consumption Data From 2003–2006 NHANES*

The key source of recent information on consumption rates of fish and shellfish is the U.S. CDC's NCHS' NHANES. Data from NHANES 2003–2006 have been used by the U.S. EPA, Office of Pesticide Programs (OPP) to generate per capita and consumer-only intake rates for finfish, shellfish, and total fish and shellfish combined.

NHANES is designed to assess the health and nutritional status of adults and children in the United States. In 1999, the survey became a continuous program that interviews a nationally representative sample of approximately 7,000 persons each year and examines a nationally representative sample of about 5,000 persons each year, located in counties across the country, 15 of which are visited each year. Data are released on a 2-year basis, thus, for example, the 2003 data are combined with the 2004 data to produce NHANES 2003–2004.

The dietary interview component of NHANES is called *What We Eat in America* and is conducted by the U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (DHHS). DHHS' NCHS is responsible for the sample design and data collection, and USDA's Food Surveys Research Group is responsible for the dietary data collection methodology, maintenance of the databases used to code and process the data, and data review and processing. Beginning in 2003, 2 non-consecutive days of 24-hour intake data were collected. The first day is collected in-person, and the second day is collected by telephone 3 to 10 days later. These data are collected using USDA's dietary data collection instrument, the Automated Multiple Pass Method. This method provides an efficient and accurate means of collecting intakes for large-scale national surveys. It is fully computerized and uses a five-step interview. Details can be found at USDA's Agriculture Research Service (http://www.ars.usda.gov/ba/bhnrc/fsrg).

For NHANES 2003–2004, there were 12,761 persons selected; of these, 9,643 were considered respondents to the mobile examination center (MEC) for examination and data collection. However, only 9,034 of the MEC respondents provided complete dietary intakes for Day 1. Furthermore, of those providing the Day 1 data, only 8,354 provided complete dietary intakes for Day 2. For NHANES 2005–2006, there were 12,862 persons selected; of these, 9,950 were considered respondents to the MEC examination and data collection. However, only 9,349 of the MEC respondents provided complete dietary intakes for Day 1. Furthermore, of those providing the Day 1 data, only 8,429 provided complete dietary intakes for Day 2.

The 2003–2006 NHANES surveys are stratified, multistage probability samples of the civilian non-institutionalized U.S. population. The sampling frame was organized using 2000 U.S. population census estimates. NHANES oversamples low-income persons, adolescents 12–19 years, persons 60 years and older, African Americans, and Mexican Americans. Several sets of sampling weights are available for use with the intake data. By using appropriate weights, data for all 4 years of the surveys can be combined. Additional information on NHANES can be obtained at http://www.cdc.gov/nchs/nhanes.htm.

In 2010, U.S. EPA's OPP used NHANES 2003–2006 data to update the Food Commodity Intake Database (FCID) that was developed in earlier analyses of data from the U.S. Department of Agriculture's (USDA's) CSFII (U.S. EPA, 2002; USDA, 2000). NHANES 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, clam chowder may contain the commodities clams, vegetables, and spices. FCID contains approximately 553 unique commodity names and eight-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/).

Intake rates were generated for finfish, shellfish, and finfish and shellfish combined. These intake rates represent intake of all forms of the food (e.g., both self-caught and commercially caught) for individuals who provided data for 2 days of the survey. 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. Note that if the person reported consuming fish on only one day of the survey, their 2-day average would be half the amount reported for the one day of consumption. 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 4-year, 2-day sample weights provided in NHANES 2003–2006 to adjust the data for the sample population to reflect the national population.

Summary statistics were generated on a consumer-only and on a per capita basis. Summary statistics, including number of observations, percentage of the population consuming fish, mean intake rate, and standard error of the mean intake rate were calculated for finfish, shellfish, and finfish and shellfish combined, for both the entire population and consumers only (see Table 10-7 to Table 10-12). 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).

The results are presented in units of g/kg-day (same as the CSFII data). 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 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. Also, it should be noted that the distribution of average daily intake rates generated using short-term data (e.g., 2-day) does 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. 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.

The advantages of using the U.S. EPA's analysis of NHANES data are that it provides distributions of intake rates for various age groups of children and adults, normalized by body weight. The data set was designed to be representative of the U.S. population, and includes 4 years of intake data combined. Another advantage is the currency of the data. The NHANES data are from 2003–2006. However, short-term consumption data may not accurately reflect long-term eating patterns and may under-represent infrequent consumers of a given fish species. This is particularly true for the tails (extremes) of the distribution of food intake. Because these are 2-day averages, consumption estimates at the upper end of the intake distribution may be underestimated if these consumption values are used to assess acute (i.e., short-term) exposures. 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.

10.3.2. Relevant General Population Studies

10.3.2.1. *SRI (1980)—Seafood Consumption Study*

SRI (1980) utilized data that were originally collected in a study funded by the Tuna Research Foundation (TRF) to estimate fish intake rates. The TRF study of fish consumption was performed by the National Purchase Diary 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 Food and Drug Administration, USDA and TRF, conducted an intensive effort to identify and correct errors in the database. SRI (1980) summarized the TRF survey methodology and used the corrected tape to generate fish intake distributions for various population groups.

The TRF survey sample included 9,590 families, of which 7,662 (25,162 individuals) completed the questionnaire, a response rate of 80%. The survey was weighted to represent the U.S. population.

The population of fish consumers represented 94% of the U.S. population. For this population of "fish consumers," SRI (1980) calculated means and percentiles of fish consumption by demographic variables (age, sex, race, census region, and community type) and overall (see Table 10-13). 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.

Table 10-14 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 10-15 presents mean total fish consumption by fish species.

The TRF 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. Ruffle et al. (1994) used the percentiles data of Rupp et al. (1980) to estimate the best-fitting lognormal parameters for each distribution. Table 10-16 presents the optimal lognormal parameters, the mean (μ) and standard deviation (σ). These parameters can be used to determine percentiles of the corresponding distribution of average daily fish consumption rates through the relation $(p) = \exp[\mu + z(p)\sigma]$ where DCR(p) is the p^{th} percentile of the distribution of average daily fish consumption rates and $z(p)$ is the z-score associated with the p^{th} percentile (e.g., $z(50) = 0$). The mean average daily fish consumption rate is given by exp $[\mu + 0.5\sigma^2]$.

The advantages of the TRF data survey are that it was a large, nationally representative survey with a high response rate (80%) and was conducted over an entire year. In addition, consumption was recorded in a daily diary over a 1-month period; this format should be more reliable than one based on 1-month recall. The upper percentiles presented are derived from 1 month of data and are likely to overestimate the corresponding upper percentiles of the long-term (i.e., 1 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 (1 month) is considerably longer than those of many other consumption studies, including the USDA National Food Consumption Surveys, CSFII, and NHANES, which report consumption over a 2-day to 1-week period. Another obvious limitation of this database is that it is now over 30 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% (e.g., adding $0.22 = \ln(1.25)$ increases the distribution by 25%). Although the TRF survey distinguished between recreationally and commercially caught fish, SRI (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 1977–1978 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 three consecutive days of dietary data. For the first day's data, participants supplied dietary recall information to an in-home interviewer. Second and 3rd day dietary intakes were recorded by participants. A total of 15,000 households were included in the 1977–1978 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 database 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 (1993)—Food and Nutrient Intakes by Individuals in the United States, 1 Day, 1987–1988: Nationwide Food Consumption Survey 1987–1988*

The USDA 1987–1988 (NFCS) also consisted of a household and individual component. 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 "1-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 United States, and demographic and socioeconomic groups were represented. Sampling weights were used to match the population distribution of

13 demographic characteristics related to food intake (USDA, 1992).

Total fish intake was estimated based on consumption of fish products identified in the NFCS database 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 1987–1988 survey; the household response rate was 38%. One-day data were obtained for 10,172 (81%) of the 12,522 individuals in participating households; 8,468 (68%) individuals completed 3-day diet records.

USDA (1992) used the 1-day data to derive per capita fish intake rate and intake rates for consumers of total fish. Table 10-17 shows these rates, calculated by sex and age group. Intake rates for consumers only were calculated by dividing the per capita intake rates by the fractions of the population consuming fish in 1 day.

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, 1992). In addition, the data from this survey have been superseded by more recent surveys.

10.3.2.4. *U.S. EPA (1996)—Descriptive Statistics From a Detailed Analysis of the National Human Activity Pattern Survey (NHAPS) Responses*

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 (U.S. EPA, 1996). 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 (U.S. EPA, 1996). The participant responses were weighted according to selected demographics such as age, sex, and race to ensure that results were representative of the U.S. population. Of those 4,700 respondents, 2,980 (59.6%) ate seafood (including shellfish, eels, or squid) in the last month (see Table 10-18). The number of servings per month was categorized in ranges of 1–2, 3–5, 6–10, 11–19, and 20+ servings per month (see Table 10-19). The highest percentage (35%) of the respondent population had an intake of 3–5 servings per month. Most (92%) of the respondents purchased the seafood they ate (see Table 10-20).

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 114 g/serving based on the 1994–1996 CSFII survey (see Section 10.8). The CSFII serving size 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 340 to 570 g/month or 11.3 to 19.0 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 U.S. EPA (1996). It is not known if they included processed or canned seafood and seafood mixtures 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 U.S. EPA CSFII analysis.

10.3.2.5. *Stern et al. (1996)—Estimation of Fish Consumption and Methylmercury Intake in the New Jersey Population*

Stern et al. (1996) reported on a 7-day fish consumption recall survey that was conducted in 1993 as part of the New Jersey Household Fish Consumption Study. Households were contacted by telephone using the random-digit dialing technique, and the survey completion rate was 72% of households contacted. Respondents included 1 adult (i.e., $\geq$18 years) resident per household, for a total of

1,000 residents. The sample was "stratified to provide equal numbers of men and women and proportional representation by county" (Stern et al., 1996). Survey respondents provided data on consumption of all seafood consumed within the previous 7 days, including the number of fish meals, fish type, amount eaten at each meal, frequency of consumption, and whether the consumption patterns during the recall period were typical of their intake throughout the year.

Stern et al. (1996) reported that "of the 1,000 respondents, 933 reported that they normally consume fish at least a few times per year and 686 reported that they consumed fish during the recall period" (Stern et al., 1996). Table 10-21 presents the distribution of the number of meals for the 7-day recall period. The average portion size was 168 grams. Approximately "4–5% of all fish meals consisted of fish obtained non-commercially, and only about 13% of these consisted of freshwater fish" (Stern et al., 1996). Tuna was consumed most frequently, followed by shrimp and flounder/fluke (see Table 10-22).

Table 10-23 provides the average daily consumption rates (g/day) for all fish for all adults and for women of childbearing age (i.e., 18–40 years). The mean fish intake rate for all adult consumers was 50 g/day, and the 90th percentile was 107 g/day. For women of childbearing age, the mean fish intake rate was 41 g/day, and the 90th percentile was 88 g/day. Table 10-24 provides information on the frequency of fish consumption.

The advantages of this study are that it is based on a 7-day recall period and that data were collected for the frequency of eating fish. However, the data are based on fish consumers in New Jersey and may not be representative of the general population of the United States.

10.3.2.6. *U.S. EPA (2002)—Estimated Per Capita Fish Consumption in the United States*

U.S. EPA's Office of Water used data from the 1994–1996 CSFII and its 1998 Children's Supplement (referred to collectively as CSFII 1994–1996, 1998) to generate fish intake estimates (U.S. EPA, 2002). Participants in the CSFII 1994–1996, 1998 provided 2 non-consecutive days of dietary data. The Day 2 interview occurred 3 to 10 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 seven 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 2 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 1 of the 2 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 that had 2-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 non-response.

U.S. EPA (2002) reported means, medians, and estimates of the 90th, 95th, and 99th percentiles of fish intake. The 90% 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 10-25 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. Table 10-26 provides a list of the fish species categorized within each habitat. Table 10-26 also shows per capita consumption estimates by species. Table 10-27 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. Table 10-28 shows per capita consumption estimates by species on an uncooked equivalent basis.

Table 10-29 through Table 10-36 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 sex. 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). Table 10-29 through Table 10-32 present fish intake data (g/day and mg/kg-day; as prepared and uncooked) on a per capita basis, and Table 10-33 through Table 10-36 provide data for consumers only.

The advantages of this study are its large size 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 NFCSs, which reported per capita fish intake rates [e.g., Pao et al. (1982); USDA (1993)], excluded certain fish-containing foods (e.g., fish mixtures, frozen plate meals) in their calculations.

10.3.2.7. *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, sex, 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% for the general population and 10% 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 on 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 7 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% of respondents reported eating fish or shellfish).

Table 10-37 through Table 10-46 present key findings of the Westat (2006) consumption study. The tables show the fish and shellfish consumption rates for various groups 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 body weight 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).

An advantage of this study is that it focused on individuals within the general population that may consume more fish and shellfish and, thus, may be at higher risk from exposure to contaminants in fish than other members of the population. Also, it provides distributions of fish consumption for different age cohorts, ethnic groups, socioeconomic status, types of fish (i.e., freshwater, marine, estuarine), and sources of fish (i.e., store-bought versus self-caught). However, the data were collected in four states and may not be representative of the U.S. population as a whole.

10.3.2.8. *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) summarized the analysis conducted by Westat (2006) described in Section 10.3.2.7. Moya et al. (2008) utilized the data to generate intake rates for 3 age groups of children (i.e., 1 to <6 years, 6 to <11 years, and 11 to <16 years) and 3 age groups of adults (16 to <30 years, 30 to <50 years, and >50 years), which are also listed by sex. These data represented the general population and angler 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 10-47 presents the intake rates for the general population who consumed fish and shellfish in g/kg-day, as-consumed. Table 10-47 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.

This analysis is based on the data from Westat (2006). Therefore, the advantages and limitations are the same as those of the Westat (2006) study. Also, while data were provided for individuals who ate self-caught fish, it is not possible from this analysis to determine the proportion of self-caught fish represented by marine or freshwater habitats.

10.3.2.9. *Mahaffey et al. (2009)—Adult Women's Blood Mercury Concentrations Vary Regionally in the United States: Association With Patterns of Fish Consumption (NHANES 1999–2004)*

Mahaffey et al. (2009) used NHANES 1999–2004 data to evaluate relationships between fish intake and blood mercury levels. Mercury intake via fish ingestion was evaluated for four coastal populations (i.e., Atlantic, Pacific, Gulf of Mexico, and Great Lakes), and four non-coastal populations defined by U.S. census regions (i.e., Northeast, South, Midwest, and West) (Mahaffey et al., 2009). Serving size data, based on 24-hour dietary recall, were used with 30-day food frequency data to estimate mercury intake from consumption of fish over a 30-day period. The frequency data used in the study indicated that people living on the Atlantic coast consumed fish most frequently (averaging 6 meals/month), followed closely by those of the Gulf and Pacific coasts. People living in non-coastal areas or on the coasts of the Great Lakes consumed fish least often (averaging ≤4 meals/month). Figure 10-2 illustrates these regional differences.

The advantage of this study is that it is based on relatively recent NHANES data (i.e., 1999–2004), it uses data from the 30-day food frequency questionnaire, and it provides regional data that are not available elsewhere. However, because the study focused on mercury exposure, it did not provide non-chemical specific fish intake data (in g/day or g/kg-day) that can be used to support risk assessments for other chemicals (i.e., only frequency data were provided). It does, however, provide useful information on the relative differences in frequency of fish intake for regional populations.

10.4. MARINE RECREATIONAL STUDIES

10.4.1. Key Marine Recreational Study

10.4.1.1. *National Marine Fisheries Service (1993, 1986a, b, c)*

The 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 2 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% 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 that 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 type 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:

$$Y = [(wt\ of\ A\ catch) \times I_A + (wt\ of\ B1\ catch) \times I_B] \times [Fishing\ frequency] \qquad \text{(Eqn. 10-1)}$$

where I_A (I_B) are indicator variables equal to one 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 because 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; West et al., 1989; Puffer et al., 1982). Thus, the average daily intake rate (ADI) for each angler was calculated as

$$ADI = Y \times (0.5)/[2.5 \times 365] \qquad \text{(Eqn. 10-2)}$$

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 Table 10-48 and Table 10-49 are based on the results of the 1993 survey. Sample sizes were 200,000 for the telephone survey and 120,000 for the field surveys. All coastal states in the continental United States were included in the survey except Texas and Washington.

Table 10-48 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 eight million; an additional 750,000 non-coastal residents participated in marine finfishing in their home state.

Table 10-49 presents the estimated total weight of the type A and B1 catch by region and time of year. For each region, the greatest catches were during the 6-month period from May through October. This period accounted for about 90% of the North and Mid-Atlantic catch, about 80% of the Northern California and Oregon catch, about 70% of the Southern Atlantic and Southern California catch, and 62% 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 10-50 presents the mean and 95th percentile of average daily intake (ADI) of recreationally caught marine finfish among anglers by region. The mean ADI values among all anglers were 5.6, 7.2, and 2.0 g/day for the Atlantic, Gulf, and Pacific regions, respectively. Table 10-51 gives the distribution of catch, by species, for the Atlantic, Gulf, and Pacific regions.

The NMFS surveys provide a large, geographically representative sample of marine angler activity in the United States. The major limitation of this database 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 assumed to be 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 marine fish. These data are approximately 2 decades old and may not be entirely representative of current intake rates. Also, data were not available for children.

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, WA. The objectives of this survey included determining (1) the 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 because 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 four sub-areas of Commencement Bay on five mornings and five evenings; in the fall, the areas were sampled on four 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 one).

There were 304 interviews in the summer and 204 in the fall. About 60% of anglers were White, 20% Black, and 19% Asian, and the rest were Hispanic or Native American. Table 10-52 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.

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. (1982) study (see Section 10.4.2.2). In the re-analysis, Price et al. (1994) calculated a median intake rate of 1.0 g/day and a 90^{th} percentile rate of 13 g/day. The distribution of fishing frequency generated by Pierce et al. (1981) is shown in Table 10-52. Note that when equal weights were used, Price et al. (1994) found a median rate of 19 g/day (Table 10-53).

The same limitations apply to interpreting the results presented here to those presented in the discussion of Puffer et al. (1982) (see Section 10.4.2.2). As with the Puffer et al. (1982) data described in the following section, these values (1.0 g/day and 19 g/day) are both probably underestimates because 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 50^{th} 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. (1982)—Intake Rates of Potentially Hazardous Marine Fish Caught in the Metropolitan Los Angeles Area*

Puffer et al. (1982) 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. (1982) estimated daily consumption rates (g/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. Table 10-54 shows the ethnic and age distribution of respondents; 88% 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. (1982) 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. (1982) also evaluated fish preparation methods; Appendix 10B presents these data. Table 10-55 presents the cumulative distribution of recreational fish (finfish and shellfish) consumption by survey respondents; 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., 1982). Table 10-56 presents a description of catch patterns for primary fish species kept.

As mentioned in the introduction to this chapter, intake distributions derived from analyses of creel surveys that 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% of the target population has intake above this level; instead, 50% of recreational fish consumption is by individuals consuming at or above 37 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. (1982) 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. (1982), generated an approximate revised intake distribution. This distribution was dramatically lower than that obtained by Puffer et al. (1982); the median was estimated at 2.9 g/day [compared with 37 from Puffer et al. (1982)] and the 90th percentile at 35 g/day [compared to 225 g/day from Puffer et al. (1982)].

There are several limitations to the interpretation of the percentiles presented by both Puffer et al. (1982) 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 dependent 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) because 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. (1982) 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. (1982) [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., 1982). 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% were younger than 20 years, 49% were 21–40 years old, 24% were 41–60 years old, and 2% 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 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 (see Table 10-57). All of the crabbers (100%) and 96% 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% and crabbers—100%), and all fisherman and crabbers ate their catch. Seventy-two percent of the fisherman and crabbers from the lagoons lived within 3 km, 18% lived 17–30 km away, and 1 group came from 66 km away. Because 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 et 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% male, 50% were 21 to 40 years old, most fished with pole or cast, and most fished for 1.5 hours. In Humacao, 96% 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% of the group caught only tilapia, but respondents stated that in June they caught mostly robalo and tarpon. Generally, the fisherman stated that they ate 2.1 fish (maximum of 11 fish) from 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, each weighing 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. *Moya and Phillips (2001)—Analysis of Consumption of Home-Produced Foods*

The 1987–1988 NFCS was also utilized to estimate consumption of home-produced (i.e., self-caught) 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. Some of the data on fish consumption from households who consumed self-caught fish are also provided in Moya and Phillips (2001). A total of 2.1% of the total survey population reported self-caught 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 mean 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.

The NFCS household component contains the question “Does anyone in your household fish?” For the population answering yes to this question (21% of households), the NFCS data show that 9% consumed home-produced fish in the week of the survey; the mean intake rate for fish consumers from fishing households was 2.2 g/kg-day (all ages combined, see Table 13-20) for the fishing population. Note that 92% of individuals reporting home-produced 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 mean per capita intake rate among all those living in 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 an average national per capita self-caught fish consumption rate of 11.8 g/day among the population of individuals who fish. However, this intake rate represents intake of both freshwater and saltwater fish combined. According to the data in Chapter 13 (see Table 13-68), home-produced fish consumption accounted for 32.5% of total fish consumption among households who fish.

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.

The advantage of this study is that it provides a national perspective on the consumption of self-caught fish. A limitation of this study is that these values include both freshwater and saltwater fish. The proportion of freshwater to saltwater is unknown and will vary depending on geographical location. Intake data cannot be presented for various age groups due to sample size limitations. The unweighted number of households, who responded positively to the survey question “do you fish”? was also low (i.e., 220 households).

10.4.2.6. *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: (1) a field survey of fishermen as they returned from their fishing trips, and (2) 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, sex, 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. Follow-up phone interviews typically occurred 2 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 g/day. Males were found to have consumed more fish than women, and Caucasians consumed more fish per day than the other races surveyed (see Table 10-58). 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 oz/day) than for un-skinned fish (0.517 oz/day). Although most respondents fried their catch (0.553 oz/day), baking and broiling were also common (0.484 and 0.541 oz/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.

10.4.2.7. *Santa Monica Bay Restoration Project (SMBRP) (1995)—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, CA. The study was conducted between September 1991 and August 1992. Surveys were conducted at 11 piers and jetties, three private boat launches and hoists, 11 beach and intertidal sites, and five 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 1 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%), 21 to 40 years old (54%), White (43%), and had an annual household income of $25,000 to $50,000 (39%).

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 (see Table 10-59). 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% of all anglers were aware of health warnings about consumption of fish from Santa Monica Bay. Of these anglers, 50% had altered their seafood consumption habits as a result of the warnings (46% stopped consuming some species, 25% ate less of all species, 19% stopped consuming all fish, and 10% 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 under-represented in this study.

It should also be noted that this study was not adjusted for avidity bias, but the California Office of Environmental Health Hazard Assessment has adjusted the distribution of fish consumption for avidity bias and other factors in the Air Toxics Hot Spots Program Risk Assessment Guidelines Part IV: Exposure Assessment and Stochastic Analysis Technical Support (see http://www.oehha.ca.gov/air/hot_spots/finalStoc.html).

10.4.2.8. *Florida State Department of Health and Rehabilitative Services (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 (Florida State Department of Health and Rehabilitative Services, 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%) were either subsistence fishermen, Everglade residents, or both. Subsistence fishermen were defined in the survey as "people who rely on fish and the wildlife of the Everglades as a source of dietary protein for themselves and their families." 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) (Florida State Department of Health and Rehabilitative Services, 1995). Respondents were administered a three-page questionnaire from which demographic information, fishing and eating habits, and other variables were obtained (Florida State Department of Health and Rehabilitative Services, 1995).

Table 10-60 shows the ranges, means, and standard deviations of selected characteristics by various groups of the survey population. Sixty-two percent of the respondents were male with a slight preponderance of Black individuals (43% White, 46% Black non-Hispanic, and 11% Hispanic). Most of the respondents reported earning an annual income of $15,000 or less per family before taxes (Florida State Department of Health and Rehabilitative Services, 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 were 1.8 and 1.5 per week with standard deviations of 2.5 and 1.4, respectively. Table 10-60 also indicates that 71% of the respondents reported knowing about the mercury health advisories. Of those who were aware, 26% reported that they had lowered their consumption of fish caught in the Everglades, while the rest (74%) reported no change in consumption patterns (Florida State Department of Health and Rehabilitative Services, 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 populations expected to have higher consumption rates.

10.4.2.9. *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 1996/1997 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% 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% from Calhoun, 30% from Victoria, and 20% 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%. 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 10-61 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, (see Table 10-62). On average, members of each cohort consumed slightly more than 3 meals per month of finfish, although small children and youths consumed slightly less than 3 meals per month of finfish and less than 1 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% 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%, blue crabs for 35%, and shrimp for 29% of the total.

The study authors noted that because 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% 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.

10.4.2.10. *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, NJ. This research also tested the null hypotheses that there are no sex differences in fishing behavior and consumption patterns and no sex 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% 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 seven times per month and crabbed three times per month (see Table 10-63). 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 grams of fish per month (48.3 g/day). Most of the subjects (80%) ate the fish they caught.

The study found that there were significant differences in fishing behavior and consumption as a function of sex. 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 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 sex differences with regard to the average number of fish caught or in fish size. Nearly 90% of the subjects believed the fish and crabs from Barnegat Bay were safe to eat, although approximately 40% 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 sex 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.

10.4.2.11. *Chiang (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 (see Table 10-64). "Fish consumers" were considered to be people who ate fish at least once a month, and this group made up 86.9% 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%) followed by frying (78.4%), and baking (63.6%).

Of all survey respondents, 48.5% 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% reported recalling its contents, and 60.3% 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-ounce 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.

10.4.2.12. *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 . The catching and consumption of 13 finned fish species and 3 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 4 weeks. Anglers were not asked about the consumption habits of other members of their families.

About 15% 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% consumed about 1 fish meal per month or less; 10% ate about 2 fish meals per month; and 10% 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 4 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 (see Table 10-65). The overall mean consumption rate was 23 g/day.

More than 50% of the finfish caught by anglers were striped bass, and about 25% were halibut. Approximately 15% of the anglers caught each of the following fish: jacksmelt, sturgeon, and white croaker. All other species were caught by less than 10% 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 education levels, 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 4 weeks indicated, in general, that they were likely to have eaten 1 fish meal from another source in the same time period.

More than 60% of the anglers interviewed reported having knowledge of the health advisories. Of that 60%, 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. Data are also specific to the San Francisco Bay area and may not be representative of anglers in other locations.

10.4.2.13. *Burger (2002a)—Consumption Patterns and Why People Eat Fish*

Burger (2002a) evaluated fishing behavior and consumption patterns among 267 anglers who were interviewed at locations around Newark Bay and the New York-New Jersey Harbor estuary in 1999. Among the 267 study respondents, 13% were Asian, 21% were Hispanic, 23% were Black, and 43% were White. Survey participants provided demographic information as well as information on their fish and crab consumption, knowledge of fishing advisories, and reasons for angling. Individual monthly fish consumption was estimated by multiplying the reported number of fish meals eaten per month by an average portion size, based on comparisons to a three-dimensional model of an 8-ounce fish fillet. Individual monthly crab consumption was estimated by multiplying the reported number of crabs eaten per month by the edible portion of crab, which was assumed to weigh 70 grams. Yearly fish and crab consumption was estimated by multiplying the monthly consumption rates by the number of months in a year over which the survey respondents reported eating self-caught fish or crabs. Intake rates were provided separately for those who fished only (44%), for those who crabbed only (44%), and for respondents who reported both fishing and crabbing (12%) (Burger, 2002a). Burger (2002a) also reported that more than 30% of the respondents reported that they did not eat the fish or crabs that they caught. Table 10-66 provides the average daily intake rates of fish and crab. U.S. EPA calculated these average daily intake rates by dividing the yearly intake rates provided by Burger (2002a) by 365 days/year.

Burger (2002a) also evaluated potential differences in consumption based on age, income, and race/ethnicity. Consumption was found to be negatively correlated with mean income and positively correlated with age for fish, but not crabs. An evaluation of differences based on ethnicity indicated that Whites were the least likely to eat their catch than other groups; 49% of Whites, 40% of Hispanics, 24% of Asians, and 22% of Blacks reported that they did not eat the fish or crabs that they caught. Among all ethnicities most people indicated that they fished (63%) or crabbed (68%) for recreational purposes, and very few (4%) reported that they angled to obtain food.

The advantages of this study are that it provides information for both fish and crab intake, and that it provides data on intake over a longer period of time than many of the other studies summarized in this chapter. However, the data are for individuals living in the Newark Bay area and may not be representative of the U.S. population as a whole. Also, there may be uncertainties in long-term intake estimates that are based on recall.

10.4.2.14. *Mayfield et al. (2007)—Survey of Fish Consumption Patterns of King County (Washington) Recreational Anglers*

Mayfield et al. (2007) conducted a series of fish consumption surveys among recreational anglers at marine and freshwater sites in King County, WA. The marine surveys were conducted between 1997 and 2002 at public parks and boat launches throughout Elliot Bay and the Duwamish River, and at North King County marine locations. The numbers of individuals interviewed at these three locations were 807, 152, and 228, respectively. The majority of participants were male, 15 years and older, and were either Caucasian or Asian and Pacific Islander. Data were collected on fishing location preferences, fishing frequency, consumption amounts, species preferences, cooking methods, and whether family members would also consume the catch. Respondent demographic data were also collected. Consumption rates were estimated using information on fishing frequency, weight of the catch, a cleaning factor, and the number of individuals consuming the catch. Mean recreational marine fish and shellfish consumption rates were 53 g/day and 25 g/day, respectively (see Table 10-67). Mayfield et al. (2007) also reported differences in intake according to ethnicity. Mean marine fish intake rates were 73, 60, 50, 43, and 35 g/day for Native American, Caucasian, Asian and Pacific Islander, African American, and Hispanic/Latino respondents, respectively.

The advantages of this study are that it provides additional perspective on recreational marine fish intake. However, the data are limited to a specific area of the United States and may not be representative of anglers in other locations.

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 socio-demographic 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 polychlorinated biphenyls (PCBs) and Dichlorodiphenyldichloroethylene

(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 1 year.

A total of 801 surveys were returned (50% response rate). Of these, 601 (75%) 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 mean and 95th percentile intake rate of sport-caught fish for all respondents were 11.2 g/day and 37.3 g/day, respectively. Among consumers, who comprised 91% 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; the 95th percentile of 63.4 g/day of total fish intake represents 102 fish meals per year.

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 the same meal size (227 g/meal) used by Fiore et al. (1989). This meal size is higher than the mean meal size of 114 g/meal, but similar to the 90th percentile meal size for general population adults (age 20–39 years) reported in a study by Smiciklas-Wright et al. (2002). However, because data for the general population may underestimate meal size for anglers, use of an upper percentile general population value may reflect higher intake among anglers. This is supported by data from other studies in the literature that have shown that the average meal size for sport fishing populations is higher than those of the general population. For example, Balcom et al. (1999) reported an average meal size for sport-caught fish for the angler population of 7.3 ounces (i.e., 207 grams), while the average meal size for the general population was 5 ounces (142 grams). Other studies reported similar meal sizes for sport-caught fish. West et al. (1989) stated that the meal size most often reported in their survey was 8 ounces (i.e., 227 grams), and Connelly et al. (1996) estimated an average meal size of 216 grams. Another study reported an average meal size of 376 grams (Burger et al., 1999). Therefore, the meal size used by Fiore et al. (1989) was deemed reasonable to represent a mean value for the population of sport anglers. Table 10-68 presents distributions of fish consumption using a meal size of 227 grams.

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 1-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%).

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 7 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 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%.

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., 1 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-ounces, respectively, for portions that were less, about the same, and more than the 8-ounce 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 ounces and for serving sizes at least 10% greater than 8 ounces were determined. In both cases, a serving size of 12 ounces was consistent with the Pao et al. (1982) distribution. The weights used in the U.S. EPA analysis then were 5, 8, and 12 ounces for fish meals described as less, about the same, and more than the 8-ounces picture, respectively. The mean serving size from Pao et al. (1982) was about 5 ounces, well below the value of 8 ounces most commonly reported by respondents in the West et al. (1989) survey.

Table 10-69 displays the mean number of total and recreational fish meals for each household member based on the 7-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 g/day and g/kg body weight-day bases. 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% of survey respondents (i.e., licensed anglers) and about 84% 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 7-day short-term recall period.

The results of these comparisons are displayed in Table 10-70; it shows that, on average, there is general agreement between estimates made using 1-year recall and estimates based on 7-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, pertains 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 ounces 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. Table 10-71 displays the fish intake distribution estimated by U.S. EPA.

The distribution shown in Table 10-71 is based on respondents who consumed recreational caught fish. As mentioned above, these represent 75% of all respondents and 84% 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 (95^{th} percentile among consumers) corresponds to the 95.8^{th} 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 were 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%, was relatively low. In addition, the usual fish intake distribution generated here employed a constant fish meal size, 8 ounces. 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 re-analyzed 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 (Ebert et al., 1993; ChemRisk, 1992). Because 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 to 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 households. 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. Because 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%; 1,369 (85%) of the 1,612 respondents were included in the "all angler" population, and 1,053 (65%) were included in the "consuming angler" population. Table 10-72 presents freshwater fish intake distributions. The mean and 95th percentile were 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 10-72 also presents intake distributions for fish caught from rivers and streams. Among "river anglers," the mean and 95th percentile were 1.9 g/day and 6.2 g/day, respectively, while among "consuming river anglers," the mean and the 95th percentile were 3.7 g/day and 12.0 g/day, respectively. Table 10-73 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 groups were not calculated (ChemRisk, 1992).

Table 10-74 presents the consumption, by species, of freshwater fish caught. The largest species consumption was salmon from ice fishing (~292,000 grams); white perch (380,000 grams) for lakes and ponds; and Brook trout (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 p^{th} 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% of recreational fish consumption was by individuals with intake rates above 3.1 g/day, and 50% was by individuals with intakes above 20 g/day. Those above 3.1 g/day make up about 30% of the "all angler" population, and those above 20 g/day make up about 5% of this population; thus, the top 5% of the angler population consumed 50% 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% was 18 or under.

A total of 55% 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% 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% (i.e., 100–80%) of the consuming population in the survey; this number then is $0.2 \times (0.55 \times 4{,}872) = 536$. Dividing this number by the sampling fraction of 0.007 (0.7%), 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% of the state's population.

ChemRisk (1992) reported that the fish consumption estimates were based upon the following assumptions: a 40% 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). 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% of all anglers consumed no freshwater fish, and 55% of the river anglers ate no freshwater fish. An advantage of this study is that 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% (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 meals/year. The maximum number of meals consumed was 757 meals/year. About 25% of anglers reported that they did not consume sport-caught fish.

Connelly et al. (1992) found that 80% 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% of anglers exceeded the advisory recommendations in some way; 15% ate listed species above the limit, and 5% ate more than one sport-caught meal per week.

Connelly et al. (1992) found that respondents eating more than 1 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% of anglers were aware of the health advisory. Over 50% 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.

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 a mean intake rate (g/day) by assuming a meal size of 227 g/meal (i.e., 8 ounces). This value corresponds to the adult general population 90th percentile meal size derived from Smiciklas-Wright et al. (2002). The resulting mean intake rate among the angler population would be 6.8 g/day. However, about 25% of this population reported no sport-caught fish consumption. Therefore, the mean consumption rate among consuming anglers would be 27.4 g/day (i.e., 6.8 g/day divided by 0.25).

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, 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. Table 10-75 presents socio-demographic characteristics of the respondents. 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% 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% of those surveyed indicated that they eat their catch. Of those anglers who eat their catch, 48% reported being aware of advisories. Approximately 24% 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% of Hispanic Americans were likely to eat their catch, while 77% of African Americans and 47% of Caucasian Americans intended to eat their catch. Of those who eat their catch, 87% were likely to share their meal with others (including women of childbearing age, and children under the age of 15).

For subsistence anglers, more low-income than upper-income anglers eat their catch (Hudson River Sloop Clearwater, 1993). Approximately 10% 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, 1993).

The average frequency of fish consumption reported was just under 1 (0.9) meal over the previous week, and 3 meals over the previous month. Approximately 35% of all anglers who eat their catch exceeded the amounts recommended by the New York State health advisories. Less than half (48%) of all the anglers interviewed were aware of the State health advisories or fishing bans. Only 42% 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% 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 1991–1992 survey 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 7 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 ten, 5- or 8-ounce portions 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%; 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 6 months.

Of these 2,681 respondents, 2,475 (93%) 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 10-76 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 80^{th} 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. However, because this survey only measured fish consumption over a short (1 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 95^{th} percentile calculated by U.S. EPA (1995) was 77.9; this is about double the 95^{th} percentile estimated using yearlong 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 (ADEM) (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 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 2 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% 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-ounce Serving Method and the Harvest Method. The 4-ounce Serving Method estimated consumption based on a typical 4-ounce 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-ounce Serving Method, while only 563 anglers were utilized in the calculations of mean estimates of daily consumption, based on the Harvest Method.

Table 10-77 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-ounce Serving Method, calculated from study sites, and an annual average of 45.8 g/day using the 4-ounce 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-ounce 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-ounce 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-ounce 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% less fish than poverty-level White anglers, while upper-income Black anglers ate about 80% 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 (see Table 10-77). It was also found the lowest fish consumption rate occurred in the spring.

The advantages of this study are that it compares estimates of intake using two different methods and provides some perspective on seasonal differences in intake. Data are not provided for children, and the number of observations for some race/ethnic groups is very small.

10.5.8. Connelly et al. (1996)—Sportfish Consumption Patterns of Lake Ontario Anglers and the Relationship to Health Advisories, 1992

The objectives of the Connelly 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-ounce fish steaks and fillets on dinner plates. An 8-ounce size was assumed unless participants noted their meal size was smaller than 8 ounces, in which case, a 4-ounce size was assumed, or they noted it was larger than 8 ounces, in which case, a 12-ounce 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%) 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%, 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%, 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 (standard error = 2.3) fish meals per person from all sources in 1992; of these meals, 28% were sport caught (Connelly et al., 1996). Less than 1% ate no fish for the year, and 16% 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 10-78 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 10-79, 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%—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%) were aware of the Lake Ontario health advisory. This advisory counseled to eat none of nine fish species from Lake Ontario and to eat no more than one meal per month of another four 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% 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% of respondents, and 72% of respondents reporting Lake Ontario fish consumption, ate at least one species of fish over the advisory limit. Interestingly, 90% of those violating the advisory reported that they believed they were eating within advisory limits.

10.5.9. Balcom et al. (1999)—Quantification of Seafood Consumption Rates for Connecticut

Balcom et al. (1999) conducted a seafood consumption study in Connecticut, 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 10-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 population groups 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 population groups.

The survey showed that over 33% of the respondents ate 1–2 meals of fish or seafood per week, including 39% of the general population, 35% of the sport fishing population, 38% of the commercial and minority populations, and 39% of the limited income population. A total of 36% of the Southeast Asian population consumed 2–3 meals per week with 2.1% consuming 5 or more meals per week, while 43% of non-Southeast Asians consumed 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 (see Table 10-80). The consumption of sport fish among consuming anglers can be estimated by dividing the consumption for all respondents by the percentage of consuming anglers reported by Balcom et al. (1999) of 97% to yield 52.7 g/day. 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 association among household members in terms of the tendency to eat fish and seafood, but there was no dependence between households. 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. In addition, the proportion of intake that can be attributed to freshwater fish is not known.

10.5.10. 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% were White, 28% were African American, and 2% 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 (see Table 10-81). 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, ate 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 because 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.

10.5.11. Williams et al. (1999)—Consumption of Indiana Sport-Caught Fish: Mail Survey of Resident License Holders

In 1997, sport-caught fish consumption among licensed Indiana anglers was assessed using a mail survey (Williams et al., 1999). Anglers were asked about their consumption patterns during a 3-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 1 and 2 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 (see Table 10-82).

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%). 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.

10.5.12. 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 sex differences in consumption patterns of self-caught fish and wild game in a meat and fish diet. A total of 457 people were randomly selected and interviewed while attending the Palmetto Sportsmen's Classic in Columbia, SC in March 1998. The mean age of the respondents was 40 years and ranged from 15 to 74. 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, sex, age, location of residence, occupation, and income. The section on consumption of wild game and fish included specific questions about the number of meals eaten and the source (i.e., self-caught fish, store-bought fish, and restaurant fish).

The results of this study indicated that there were no sex differences in the percentage of people who ate commercial protein sources, but there were significant sex differences for the consumption of most wild-caught game and fish. A higher proportion of men (81.5%) ate wild-caught species than women (73.2%). There were also sex differences in mean monthly meals and mean serving sizes for wild-caught fish. Men ate more meals of wild-caught fish than woman, and men also ate larger portions than women. The mean number of wild-caught fish meals eaten per month was 2.24 for men and 1.52 for women. The mean serving size was 373 grams for men and 232 for 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 provides information on sex differences with regard to consumption of wild-caught fish. Information on the number of monthly meals and meal size is provided. However, the study did not distinguish between marine and freshwater fish. In addition, all subjects interviewed were White.

10.5.13. 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% of those surveyed, with African American anglers accounting for the majority of this group (25.1% of all respondents). Respondents reporting household incomes below $25,000 comprised 30.9% of the respondents. Anglers were asked to report their Indiana sport-caught fish consumption frequency for a 3-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 (see Table 10-83). Of the anglers surveyed, 75.4% of White active consumers reported being aware of the fish consumption advisory, while 70.0% 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 advantages of this study are that it was designed to determine the consumption rates of Indiana anglers, particularly those in minority and low-income groups, during a portion of the year. However, information was not collected for the period of September through January, so calculation of year-round consumption was not possible.

10.5.14. 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. 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% of the surveys, and new mothers and Native Americans each received 12.5% 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 median total fish and sport fish consumption rates for the general population (2,312 respondents) of 12.3 and 2.8 g/day, respectively (see Table 10-84). The total number of Minnesota Bois Forte Tribe respondents was 232, and median total fish and sport fish consumption rates in g/day were 9.3 and 2.8, respectively. For Minnesota residents with fishing licenses (2,020 respondents), median total fish and sport fish consumption rates in g/day were 13.2 and 3.9, respectively. For Minnesota respondents without fishing licenses, median total fish and sport fish consumption rates in g/day were 7.5 and 0, respectively. Table 10-84 also shows median intake rates for purchased fish, upper percentile intake rates for total fish, sport fish and purchased fish for various age groups.

The North Dakota survey showed median total fish and sport fish consumption rates for the general population (1,406 respondents) of 12.6 and 3.0 g/day, respectively (see Table 10-84). The total number of North Dakota Spirit Lake Nation and Three Affiliated Tribes respondents was 105, and the median total fish and sport fish consumption rates in g/day were 1.4 and 0, respectively. For North Dakota residents with fishing licenses (1,101 respondents), median total fish and sport fish consumption rates in g/day were 14.0 and 4.5, respectively. For North Dakota respondents without fishing licenses, median total fish and sport fish consumption rates in g/day were

7.2 and 0, respectively. Table 10-84 also shows median intake rates for purchased fish, upper percentile intake rates for total fish, sport fish and purchased fish for various age groups.

Westat (2006) analyzed the raw data from Benson et al. (2001) to derive fish consumption rates for various age, sex, and ethnic groups, and according to the source of fish consumed (i.e., bought or caught) and habitat (i.e., freshwater, estuarine, or marine). Westat (2006) calculated consumption rates of freshwater fish for consuming anglers. For Minnesota and North Dakota, these values are identical to the consumption rates estimated by Westat (2006) for consuming anglers of all self-caught fish (i.e., freshwater and saltwater). From this observation, it can be concluded that all the consumption of self-caught fish comes from freshwater. The mean and 95th percentile consumption rate for consuming anglers of freshwater fish reported by Westat (2006) are 14 g/day and 37 g/day, respectively, for Minnesota and 12 g/day and 43 g/day, respectively, for North Dakota.

The authors noted that 80% of respondents in Minnesota and 72% 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% 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% of households in Minnesota and 40.0% 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.

10.5.15. Moya and Phillips (2001)—Analysis of Consumption of Home-Produced Foods

As discussed in Section 10.4.2.5, some data on fish consumption from households who fish are provided in Chapter 13 and in Moya and Phillips (2001). This information is based on an analysis of data from the household component of the USDA's 1987–1988 NFCS. This analysis shows a mean consumer-only fish consumption of 2.2 g/kg-day (all ages combined, see Table 13-20) for the fishing population. This value can be converted to a per capita value by multiplying by the number of consumers and dividing by the total number of positive responses to the survey question "do you fish?" Assuming an average body weight of 59 kg for the survey population results in an average national per capita self-caught fish consumption rate of 12 g/day among the population of individuals who fish. However, this mean intake rate represents intake of both freshwater and saltwater fish combined. Converting this number into the edible portion by multiplying by 0.5 as described in Section 10.4.2.5, the mean national per capita self-caught fish consumption rate is about 6 g/day.

The advantage of this study is that it provides a national perspective on the consumption of self-caught fish. A limitation of this study is that these values include both freshwater and saltwater fish. The proportion of freshwater to saltwater is unknown and will vary depending on geographical location. Intake data cannot be presented for various age groups due to sample size limitations. The unweighted number of households, who responded positively to the survey question "do you fish?" was also low (i.e., 220 households).

10.5.16. Rouse Campbell et al. (2002)—Fishing Along the Clinch River Arm of Watts Bar Reservoir Adjacent to the Oak Ridge Reservation, Tennessee: Behavior, Knowledge, and Risk Perception

Rouse 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 in East Tennessee. 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% 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% did not eat fish. Of the 65% who ate fish, only 38% ate fish from the study area. This 38% (77 people) was considered useful to the study and, thus, were the main focus of the data analysis. These anglers averaged 2 meals of fish per month, with an average consumption rate of 37 grams per day or 13.7 kilograms per year (see Table 10-85). They caught almost 90% 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.

10.5.17. Burger (2002b)—Daily Consumption of Wild Fish and Game: Exposure of High-End Recreationists

Burger (2002b) determined consumption patterns for a range of wild-caught fish and game in South Carolina. The population selected for dietary surveys were attendees at the Palmetto Sportsman's Classic in Columbia, South Carolina. Individual dietary surveys were conducted at the show in March, 1998, on 458 participants who were randomly selected from an attending population of approximately 60,000 people. Of the survey participants, 15% were Black, 85% were White, and 33% were women. The age composition was similar for black and white respondents; however, Black participants had significantly lower mean incomes than White participants.

The dietary survey took about 20 minutes to complete and was divided into three parts: a section on demographics; one on the number of meals consumed of different types of fish and meat for each of the past 12 months, and a section collecting information on serving size and cooking methods. The types of fish and meat inquired about included wild-caught fish, store-bought fish, restaurant fish, deer, wild-caught quail, restaurant quail, dove, duck, rabbit, squirrel, raccoon, wild turkey, beef, chicken, pork, and any wild game not listed in the questionnaire. Respondents were asked to provide information regarding serving/portion size and what percent of their meals they consumed as meat as opposed to stews. The average number of meals eaten as meat and stew were separately determined for each of the 12 months, then multiplied by the average serving size. Yearly consumption rates were then determined by summing across months for each type of fish or meat. Means and percentiles were computed using SAS.

Mean daily consumption of wild-caught fish ranged from 32.6 g/kg-day for respondents less than 32 years of age to 171.0 g/kg-day for Black respondents (see Table 10-86). The disparity in mean consumption was the greatest for ethnicity and income level, with black and low income respondents eating more than twice as much wild-caught fish as Whites or higher income respondents. Male fish consumption (mean of 55.2 g/kg-day) was higher than that of females (mean of 39.1 g/kg-day), while by age, fish consumption was highest among the 33−45 year olds (mean intake of 71.3 g/kg-day). The author suggested that although the high consumption of wild-caught fish for this age group may reflect a more active lifestyle, it may also reflect exposure of women of child-bearing age. As shown in Table 10-86, the differences between mean consumption rates and 99th percentile values were very large. For some population groups at the higher end of the distribution, fish consumption was ten times greater than that of the mean.

This study provides useful comparisons on wild-caught fish intake among populations with differing ethnicity, sex, age, and income level. Data on fish consumption at the higher end of the distribution were also provided. A limitation of the study includes the fact that the study was based on dietary recall which is less reliable over time and may have recall bias. In addition, although the methodology indicated that information was collected and/or calculated for serving/portion size, the percent of meals consumed as meat versus stews, and yearly consumption rates, no data were provided for these parameters in the study.

10.5.18. Mayfield et al. (2007)—Survey of Fish Consumption Patterns of King County (Washington) Recreational Anglers

Mayfield et al. (2007) conducted a series of fish consumption surveys among recreational anglers at marine and freshwater sites in King County, WA. The freshwater surveys were conducted between 2002 and 2003 at "freshwater locations around Lake Sammamish, Lake Washington, and Lake Union" (Mayfield et al., 2007). A total of 212 individuals were interviewed at these locations. The majority of participants were male, 18 years and older, and were either Caucasian or Asian and Pacific Islander. Data were collected on fishing location preferences, fishing frequency, consumption amounts, species preferences, cooking methods, and whether family members would also consume the catch. Respondent demographic data were also collected. Consumption rates were estimated using information on fish meal frequency and meal size. The mean recreational freshwater fish consumption rates were 10 g/day for all respondents and 7 g/day for the children of survey respondents (see Table 10-87). Mayfield et al. (2007) also reported differences in intake according to ethnicity. Mean freshwater fish intake rates were 40, 38, 20, 19, and 2 g/day for Native American, African

American, Asian and Pacific Islander, Caucasian, and Hispanic/Latino respondents, respectively.

The advantage of this study is that it provides additional perspective on recreational freshwater fish intake. However, the data are limited to a specific area of the United States and may not be representative of anglers in other locations.

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 data set 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. Note average consumption by household member can be misleading because households include both children and adults whose intake rates may be very different. Dressed weight varied by species and community but, in general, was 70% to 75% 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 data set 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%) 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% or more of the population, but for about 40% of the communities, they comprised less than 50% 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 because it 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 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/year 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. 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%, yielding a sample size of 513 tribal members, 18 years old and above. Of these, 58% were female, and 59% 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). Nearly equal sample sizes were collected from 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%, 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 g/day (CRITFC, 1994). Table 10-88 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%) of respondents indicated that they were not fish consumers. Table 10-89 shows that mean intake was slightly higher in males than females (63 g/day versus 56 g/day) and was higher in the over 60 years age group (74.4 g/day) than in the 18–39 years (57.6 g/day) or 40–59 years (55.8 g/day) age groups. Intake also tended to be higher among those living on the reservation. The mean intake for nursing mothers—59.1 g/day—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. Appendix 10B presents the weighted percentage of adults consuming specific fish parts.

A total of 49% 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% reported that they obtained fish from either self-harvesting, family, or friends; at tribal ceremonies; or from tribal distributions. Of all fish consumed, 41% came from self- or family harvesting, 11% from the harvest of friends, 35% from tribal ceremonies or distribution, 9% from stores, and 4% 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 5 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% for salmon, followed by 46.5% (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/day, while the mean intake rate for December and January was 30.7 g/day. Salmon was the species eaten by the highest number of respondents (92%) followed by trout (70%), lamprey (54%), and smelt (52%). Table 10-90 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 10-91 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 because 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 because 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 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 population.

10.6.3. 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 2 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 2 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% were reachable), and their demographic and fish consumption patterns were obtained. Peterson et al. (1994) reported that the non-respondents' socioeconomic information and fish consumption were similar to the respondents.

A total of 175 of the original random sample (38%) 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% of the respondents reporting April and May (spearfishing season) as the highest fish consumption months (Peterson et al., 1994). Table 10-92 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 sex, 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% of respondents reported eating 1 or less fish meals per week, and only 2% reported daily fish consumption. A total of 72% of respondents reported Walleye consumption in the previous 2 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 a meal size of 227 g/meal, the rate reported here of 1.2 fish meals per week translates into a mean fish intake rate of 39 g/day in this population. This meal size is similar to an adult general population 90th percentile meal size derived from Smiciklas-Wright et al. (2002) (see Section 10.8.2).

The advantages of this study are that it targeted a specific Native American population and provides some perspective on peak consumption and species of fish consumed. However, the data are more than 2 decades old and may not be entirely representative of current intake patterns.

10.6.4. Fitzgerald et al. (1995)—Fish PCB Concentrations and Consumption Patterns Among Mohawk Women at Akwesasne

Akwesasne is a Native American community of 10,000 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 living on the Akwesasne Reservation and 154 nursing Caucasian controls living in Warren and Schoharie counties, which are primary rural like the Akwesasne. 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%; 154 out of 287 control nursing Caucasian women responded, a response rate of 54%. Statistical analysis focused upon socio-demographic, physical, reproductive, lifestyle, and dietary and consumption differences between the Mohawk and control women.

Potential participants were identified prior to, or shortly after, delivery. The interviews were conducted at home within 1 month postpartum and were structured to collect information for socio-demographics, 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 1 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 10-93 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 10-93 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 10-94 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%) Mohawk mothers and 72 (47%) 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 1 year before pregnancy) to 9.2 (less than 1 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 10-95 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) (see Table 10-95). 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 1 year before and more than 1 year before). Fitzgerald et al. (1995) noted that dietary recall for a period more than 1 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 1 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 noted 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 value of weight per fish meal would have to be assumed. Smiciklas-Wright et al. (2002) reported 209 grams as the 90th percentile weight of fish consumed per eating occasion for general population females 20–39 years old. Using this value, the rate reported of 27.6 fish meals per year for consumers only (over 1 year before pregnancy) translates into a mean fish intake rate of 15.8 g/day.

A limitation of this study is that information on meal size was not available. It is not known whether the 90th percentile meal size from the general population is representative of the population of Mohawk women.

10.6.5. Forti et al. (1995)—Health Risk Assessment for the Akwesasne Mohawk Population From Exposure to Chemical Contaminants in Fish and Wildlife

Forti et al. (1995) estimated the potential exposure of residents of the Mohawk Nation at Akwesasne to PCBs through the ingestion of locally caught fish and wildlife, and human milk. The study was part of a remedial investigation/feasibility study (RI/FS) for a National Priorities List site near Massena, NY and the St. Lawrence River. Forti et al. (1995) used data collected in 1979–1980 on the source (store bought or locally caught), species, and frequency of fish consumption among 1,092 adult Mohawk Native Americans. The information on frequency of fish consumption was combined with an assumed meal size of 227 grams to estimate intake among the adult population. This meal size represents the 90th percentile meal size for fish consumers in the U.S. population as reported by Pao et al. (1982). Children were assumed to eat fish at the same frequency as adults but were assumed to have a meal size of 93 grams.

Table 10-96 presents the mean and 95th percentile fish intake estimates for the Mohawk population, as reported by Forti et al. (1995). Mean intake of local fish was estimated to be 25 g/day for all adult fish consumers and 29 g/day for adult consumers only; 95th percentile rates for these groups were 131 and 135 g/day, respectively. Mean intake of local fish was estimated to be 10 g/day among all Mohawk children and 13 g/day among children consumers only; 95th percentile estimates for these groups were 54 and 58 g/day, respectively.

The advantage of this study is that it provides additional perspective on intake among Native

American populations, especially those in the St. Lawrence River area. However, the fish intake survey data used in this analysis were collected more than 3 decades ago and may not represent current intake patterns for this population. Also, the Forti et al. (1995) report provides limited details about the survey methodology and data used to estimate intake. It should also be noted that fish intake rates were estimated using a 90th percentile meal size. It is not known whether the 90th percentile meal size from the general population is representative of this population of Native Americans.

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 14 tribes in the region. Commercial fishing is a major source of income for members of both tribes; some members of 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 years, and their dependents, aged 5 years and under, in terms of their consumption rate of anadromous, pelagic, bottom fish, and shellfish in grams per kilogram of 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 1-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, aged 18 years old and older, and 69 children between birth and 5 years old, were surveyed on consumption of 52 species. The response rate was 77% for the Squaxin Island tribe and 76% 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% from the mean, with an additional 25% 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 5 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 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 (see Table 10-97). As shown in Table 10-98, consumption per body weight varied by sex (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 (see Table 10-99). Among adults, consumption generally followed a curvilinear pattern, with greater median consumption in the age range of 35 to 64 years old, and lower consumption in the age range of 18 to 34 years old and 65 years old and over (see Table 10-100). No consistent pattern of consumption by income was found for either tribe (see Table 10-101).

The mean and median consumption rates for children 5 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 (see Table 10-102). 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.

The advantage of this study is that the data can be used to improve how exposure assessments are conducted for populations that include high consumers of fish and shellfish and to identify cultural characteristics that may place tribal members at disproportionate risk to chemical contamination. 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 population groups. 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 weighted 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.

Adults, 16 years and older, were selected randomly from a Tribal enrollment roster. The study had a participation rate of 64.8%, 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 6 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 6 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 (see Table 10-103). Table 10-104, Table 10-105, and Table 10-106 provide consumption rates for adults by species, sex, and age, respectively. For children under 6 years of age, the mean consumption rate of all finfish and shellfish was 1.48 g/kg-day (see Table 10-107 and Table 10-108). The Suquamish Tribe's seafood consumption rates for adults and children under 6 years of age were higher than 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. Westat (2006)—Fish Consumption in Connecticut, Florida, Minnesota, and North Dakota

As discussed in Section 10.3.2.7, Westat (2006) analyzed the raw data from three fish consumption studies to derive fish consumption rates for various age, sex, 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. Consumption rates for individuals of Native American heritage were available for the states of Florida, Minnesota, and North Dakota. Fish intake distributions for these populations are presented in Table 10-41 for all respondents and Table 10-42 for consuming individuals. The mean and 95th percentile for all Native American respondents were 0.8 g/kg-day and 4.5 g/kg-day for Florida, respectively. The mean fish intake rate for all Native American respondents for Minnesota was 2.8 g/kg-day. The mean and 90th percentile fish intake rate for all Native American respondents for North Dakota were 0.4 g/kg-day and 0.9 g/kg-day, respectively. The mean and 95th percentile intake rate for Native American consumers only for Florida were 1.5 g/kg-day and 5.7 g/kg-day, respectively. The mean fish intake rate for Native American consumers only for Minnesota was 2.8 g/kg-day. The mean and 90th percentile fish intake rate for Native American consumers only for North Dakota were 0.4 g/kg-day and 0.8 g/kg-day, respectively (Westat, 2006).

A limitation of this study is that sample sizes for these populations were small. Intake rates represent consumption of fish from all sources. Also, the study did not specifically target Native Americans, and it is not known whether the Native Americans included in the survey lived on reservations.

10.6.9. 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, sex, 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 sexes. Consumption per body weight varied by sex (males consumed more) and age (those 35 to 64 years old 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 (see Table 10-109). Table 10-110 presents consumption rates for adults by species and sex. Table 10-111 and Table 10-112 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 (see Table 10-113). Table 10-114 presents consumption rates for children by species and sex.

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 and 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 by 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, WA. APIs represent one of the most diverse and rapidly growing immigrant populations in the United States. In 1997, APIs (166,000) accounted for 10% of King County's population, an increase from 8% in 1990. Between 1990 and 1997, the total population of King Country increased by 9%, while the population of APIs increased by 43% (U.S. EPA, 1999).

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%) were first generation (i.e., born outside the United States). There were slightly more women (53%) than men (47%), and 35% 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 10-115, the mean overall consumption rate for all seafood combined was 1.9 g/kg body weight-day (g/kg-day), with a median consumption rate of 1.4 g/kg-day. The predominant seafood consumed was shellfish (46% of all seafood). The API community consumed more shellfish (average consumption rate of 0.87 g/kg-day) than all finfish combined (an average consumption rate of 0.82 g/kg-day). Within the category of finfish, pelagic fish were consumed most by the API members, mean consumption rate 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 10-116 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%) for higher finfish consumers, and Vietnamese (50%) were in the higher shellfish consumer category.

Table 10-117 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 10-118 presents consumption rates by sex. 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% of the respondents consumed shrimp, crab, and squid. Table 10-119 presents these data. For all survey participants, the head, bones, eggs, and other organs were consumed 20% of the time. Fillet without skin was consumed 45% of the time, and fillet with skin, 55% of the time. Consumption patterns of shellfish parts varied depending on the type of shellfish.

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 baked, boiled, broiled, roasted, or poached method, averaging 65% and 78%, respectively.

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 from 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. Caution should be used to avoid extrapolation of data to other ethnic groups that have potentially significant cultural differences. 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.

10.7.2 Shilling et al. (2010)—Contaminated Fish Consumption in California's Central Valley Delta

Shilling et al. (2010) conducted a survey of 373 anglers and 137 community members between September 2005 and June 2008, in a region of the Sacramento-San Joaquin River Delta where subsistence fishing rates are high. This area was also chosen as an area where mercury concentrations in fish tissues were likely to be high. Anglers were selected for interviews as they were encountered in order to reduce bias, however, approximately 5% of the anglers approached did not speak English and were unable to be interviewed. Community members were chosen for interviews based on knowledge that an extended family member fished in this area. The interviews were conducted primarily in the early morning and late afternoon, and all days of the week were represented. Subjects were told at the beginning of the interview that the study was about fishing activity along the river, but not that it was related to fish contamination. Anglers and community members were grouped according to ethnicity, and fish consumption rates were calculated based on each individual's 30-day recall of how much and how often types of fish were eaten. Mean, median and 95th percentile fish consumption rates were calculated for study participants according to ethnicity, age, and sex. In addition, fish intake was determined for households containing women of child-bearing age, children, and for respondents whose awareness of warnings about fish contamination in the area ranged from no awareness to high awareness.

Regardless of ethnicity, the fish species that were primarily targeted by anglers in this study were striped bass, salmon, shad, and catfish, similar to those identified in creel survey data for this region from the California Department of Fish and Game. Consumption rates for locally caught and commercially obtained fish are shown in Table 10-120. Mean intake of locally caught fish among all ethnic groups ranged from 6.5 g/day for Native American anglers to 57.6 g/day for Southeast Asian/Lao anglers. For all anglers, the mean and median consumption rates of locally caught fish were 27.4 and 19.7 g/day, respectively. These values increased to 40.6 g/day (mean) and 26.1 g/day (median) when commercially obtained fish were included. The 95th percentile intake rates for all anglers were 126.6 g/day for local fish consumption and 147.3 g/day for total fish consumption. Fish consumption rates were not significantly different among age groups, but were higher for anglers from households with either children or women of child-bearing age.

No significant trend (p = 0.78) was observed across the 3-year study period for the consumption of locally caught fish. Peak consumption rates occurred during the fall, when striped bass and salmon return to the area to spawn and fishing activity is the highest. Fish consumption rates were significantly different for anglers and community members, with the exception of Southeast Asians. No significant difference was observed between the day of the week when surveying was conducted and ethnic group or fish consumption rates, or between anglers with higher or lower awareness of warnings about fish contamination in the area.

The advantages of this study are that the sample size was fairly large and that a number of ethnic groups were included. Limitations of the study include the fact that information on fish consumption was based on 30-day recall data and that the study was limited to one geographic area and may not be representative of the U.S. general population.

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 1977–1978 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. Table 10-121 displays the distributions, by age and sex, for the quantity of fish consumed per eating occasion (Pao et al., 1982). For the general population, the average quantity of fish consumed per fish meal was 117 grams, with a 95th percentile of 284 grams. 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 superseded by the analysis of the 1994–1996 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 1994–1996 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., consumer-only data).

Table 10-122 and Table 10-123 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 average meal size for finfish (other than tuna) for adults 20 years and older was 114 g/meal (see Table 10-122). It should be noted that this value represents fish eaten in any form (e.g., as an ingredient in a meal) and not just fish eaten as a meal (e.g., fish fillet).

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 because 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. Refer 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 10-124 provides summary results from these studies on fish preparation methods; Appendix 10B presents further details on preparation methods, as well as results from some studies on parts of fish consumed.

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 are 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., milligram of 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 10-125 and the following equation:

$$IR_{dw} = IR_{ww}\left[\frac{100-W}{100}\right] \quad \text{(Eqn. 10-4)}$$

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:

$$C_{ww} = C_{dw}\left[\frac{100-W}{100}\right] \quad \text{(Eqn. 10-5)}$$

where:

C_{ww} = wet-weight concentration,
C_{dw} = dry-weight concentration, and
W = percent water content.

The moisture content data presented in Table 10-125 are 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

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.

The total fat content (percent) measured and/or calculated in various fish forms (i.e., raw, cooked, smoked, etc.) for selected fish species is presented in Table 10-125, based on data from USDA (2007). The total percent fat content is based on the sum of saturated, monounsaturated, and polyunsaturated fat.

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 10-125 and the following equation:

$$IR_{lw} = IR_{ww}\left[\frac{L}{100}\right] \quad \text{(Eqn. 10-6)}$$

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:

$$C_{ww} = C_{lw}\left[\frac{L}{100}\right] \quad \text{(Eqn. 10-7)}$$

where:

C_{ww} = wet-weight concentration,
C_{lw} = lipid-weight concentration, 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 10-125 are for selected fish taken from USDA (2007).

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Table 10-7. Per Capita Intake of Finfish (g/kg-day), Edible Portion, Uncooked Fish Weight

							Percentiles										
Population Group	N	% Consuming	Mean	SE	Lower 95% CL	Upper 95%CL	Min	1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	16,783	23	0.16	0.01	0.14	0.18	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.1	2.3	13.4[b]
Age Group (years)																	
0 to 1	865	2.6	0.03	0.01	0.01	0.06	0.0[b]	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0[b]	1.5[b]	3.7[b]
1 to 2	1,052	14	0.22	0.05	0.12	0.32	0.0[b]	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.5	1.2[b]	4.3[b]	13.4[b]
3 to 5	978	15	0.19	0.03	0.13	0.25	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.7	1.4	2.7[b]	7.0[b]
6 to 12	2,256	15	0.16	0.04	0.08	0.24	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.5	1.1	2.6[b]	6.7[b]
13 to 19	3,450	15	0.10	0.01	0.08	0.11	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.7	1.7	6.9[b]
20 to 49	4,289	23	0.15	0.01	0.13	0.17	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	2.2	8.5[b]
Females 13 to 49	4,103	22	0.14	0.01	0.11	0.16	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.9	1.8	8.5[b]
50+	3,893	29	0.20	0.02	0.16	0.23	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.1	0.7	1.2	2.4	6.1[b]
Race																	
Mexican American	4,450	16	0.15	0.02	0.11	0.18	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.1	2.6	8.5[b]
Non-Hispanic Black	4,265	24	0.18	0.02	0.15	0.22	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.1	2.4	8.8[b]
Non-Hispanic White	6,757	22	0.15	0.01	0.13	0.17	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	2.0	13.4[b]
Other Hispanic	562	22	0.18	0.03	0.11	0.24	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.5	1.0	2.7[b]	7.3[b]
Other [a]	749	33	0.31	0.05	0.20	0.42	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.2	1.1	2.0	4.0[b]	6.5[b]

[a] Other: Other Race - including Multiple Races.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

N = Sample size.
SE = Standard error.
CL = Confidence limit.
Min = Minimum value.
Max = Maximum value.
Source: U.S. EPA analysis of NHANES 2003–2006.

Table 10-8. Consumer-Only Intake of Finfish (g/kg-day), Edible Portion, Uncooked Fish Weight

Population Group	N	Mean	SE	Lower 95%CL	Upper 95% CL	Min	Percentiles 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	3,204	0.73	0.03	0.67	0.78	0.0[b]	0.0	0.0	0.0	0.2	0.5	1.0	1.6	2.2	4.0	13.4[b]
Age Group (years)																
0 to 1	22	1.31	0.31	0.68	1.94	0.1[b]	0.1[b]	0.2[b]	0.2[b]	0.4[b]	0.8[b]	2.0[b]	2.8[b]	2.9[b]	3.7[b]	3.7[b]
1 to 2	143	1.61	0.27	1.06	2.16	0.0[b]	0.0[b]	0.1[b]	0.2[b]	0.5[b]	0.8[b]	1.7[b]	3.6[b]	4.9[b]	13.4[b]	13.4[b]
3 to 5	156	1.28	0.13	1.01	1.55	0.0[b]	0.0[b]	0.0[b]	0.2[b]	0.5	1.0	1.7	2.7[b]	3.6[b]	5.6[b]	7.0[b]
6 to 12	333	1.05	0.12	0.81	1.29	0.0[b]	0.0[b]	0.0[b]	0.1[b]	0.3	0.7	1.4	2.1[b]	2.9[b]	6.5[b]	6.7[b]
13 to 19	501	0.66	0.03	0.59	0.73	0.0[b]	0.0[b]	0.0	0.0	0.2	0.5	0.9	1.4	1.7	2.6[b]	6.9[b]
20 to 49	961	0.65	0.02	0.60	0.70	0.0[b]	0.0[b]	0.0	0.0	0.2	0.4	0.9	1.5	2.1	3.9[b]	8.5[b]
Females 13 to 49	793	0.62	0.04	0.54	0.69	0.0[b]	0.0	0.0	0.0	0.1	0.4	0.9	1.4	1.8	2.9	8.5[b]
50+	1,088	0.68	0.04	0.61	0.76	0.0[b]	0.0[b]	0.0	0.0	0.2	0.5	0.9	1.5	2.0	3.2[b]	6.1[b]
Race						0.0[b]										
Mexican American	584	0.93	0.04	0.84	1.03	0.0[b]	0.0[b]	0.0	0.0	0.3	0.7	1.3	1.9	2.8	4.7[b]	8.5[b]
Non-Hispanic Black	906	0.77	0.05	0.66	0.88	0.0[b]	0.0	0.0	0.1	0.2	0.5	1.0	1.7	2.1	4.9	8.8[b]
Non-Hispanic White	1,405	0.67	0.03	0.62	0.72	0.0[b]	0.0[b]	0.0	0.0	0.2	0.5	0.9	1.5	1.9	3.2[b]	13.4[b]
Other Hispanic	101	0.82	0.10	0.61	1.03	0.0[b]	0.0[b]	0.0[b]	0.1[b]	0.3	0.5	1.0	2.0[b]	2.7[b]	4.9[b]	7.3[b]
Other [a]	208	0.96	0.14	0.68	1.23	0.0[b]	0.0[b]	0.0[b]	0.0	0.2	0.5	1.3	2.2	3.6[b]	5.3[b]	6.5[b]

a Other: Other Race - including Multiple Races.
b Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

N = Sample size.
SE = Standard error.
CL = Confidence limit.
Min = Minimum value.
Max = Maximum value.

Source: U.S. EPA analysis of NHANES 2003–2006.

Table 10-9. Per Capita Intake of Shellfish (g/kg-day), Edible Portion, Uncooked Fish Weight

Population Group	N	% Consuming	Mean	SE	Lower 95% CL	Upper 95% CL	Percentiles Min	1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	16,783	11	0.06	0.01	0.05	0.07	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.4	6.6[b]
Age Group (years)																	
0 to 1	865	0.66	0.00	0.00	0.00	0.01	0.0[b]	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0[b]	0.0[b]	2.3[b]
1 to 2	1,052	4.4	0.04	0.01	0.02	0.06	0.0[b]	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0[b]	1.0[b]	6.6[b]
3 to 5	978	4.6	0.05	0.01	0.02	0.08	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4[b]	4.0[b]
6 to 12	2,256	7.0	0.05	0.01	0.02	0.08	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.4[b]	4.9[b]
13 to 19	3,450	5.1	0.03	0.01	0.02	0.04	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	4.5[b]
20 to 49	4,289	13	0.08	0.01	0.06	0.10	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	1.9	5.4[b]
Females 13 to 49	4,103	11	0.06	0.01	0.04	0.07	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.3	5.3[b]
50+	3,893	13	0.05	0.01	0.04	0.07	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	1.0	5.2[b]
Race																	
Mexican American	4,450	9.5	0.08	0.01	0.05	0.11	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.8	6.6[b]
Non-Hispanic Black	4,265	12	0.06	0.01	0.04	0.07	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	1.1	4.9[b]
Non-Hispanic White	6,757	10	0.05	0.01	0.04	0.07	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.2	5.4[b]
Other Hispanic	562	15	0.09	0.02	0.05	0.14	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.4	0.7	2.1[b]	2.6[b]
Other[a]	749	20	0.13	0.02	0.10	0.17	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.4	0.9	2.6[b]	4.5[b]

[a] Other: Other Race - including Multiple Races.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

N = Sample size.
SE = Standard error.
CL = Confidence limit.
Min = Minimum value.
Max =Maximum value.
Source: U.S. EPA analysis of NHANES 2003–2006.

Table 10-10. Consumer-Only Intake of Shellfish (g/kg-day), Edible Portion, Uncooked Fish Weight																
				Lower	Upper		Percentiles									
Population Group	N	Mean	SE	95%CL	95% CL	Min	1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	1,563	0.57	0.03	0.50	0.63	0.0[b]	0.0[b]	0.0	0.0	0.1	0.3	0.7	1.3	1.9	3.0[b]	6.6[b]
Age Group (years)																
0 to 1	11	0.42	0.21	0.00	0.85	0.0[b]	0.0[b]	0.0[b]	0.0[b]	0.0[b]	0.2[b]	0.2[b]	1.3[b]	2.3[b]	2.3[b]	2.3[b]
1 to 2	53	0.94	0.18	0.56	1.31	0.0[b]	0.0[b]	0.0[b]	0.1[b]	0.2[b]	0.6[b]	1.0[b]	1.6[b]	3.5[b]	6.6[b]	6.6[b]
3 to 5	56	1.00	0.18	0.63	1.36	0.0[b]	0.0[b]	0.0[b]	0.1[b]	0.4[b]	0.7[b]	1.4[b]	2.9[b]	2.9[b]	4.0[b]	4.0[b]
6 to 12	158	0.72	0.12	0.47	0.97	0.0[b]	0.0[b]	0.1[b]	0.1[b]	0.2	0.5	1.1	1.7[b]	2.0[b]	4.5[b]	4.9[b]
13 to 19	245	0.61	0.06	0.49	0.74	0.0[b]	0.0[b]	0.0	0.0	0.1	0.4	0.9	1.5	1.9	2.7[b]	4.5[b]
20 to 49	605	0.63	0.06	0.52	0.75	0.0[b]	0.0[b]	0.0	0.0	0.1	0.4	0.8	1.8	2.2	4.3[b]	5.4[b]
Females 13 to 49	474	0.53	0.06	0.40	0.66	0.0[b]	0.0[b]	0.0	0.0	0.1	0.3	0.6	1.2	1.8	4.5[b]	5.3[b]
50+	435	0.41	0.02	0.36	0.46	0.0[b]	0.0[b]	0.0	0.0	0.1	0.3	0.5	0.9	1.2	1.8[b]	5.2[b]
Race																
Mexican American	331	0.83	0.10	0.62	1.04	0.0[b]	0.0[b]	0.0	0.1	0.2	0.5	1.1	1.9	2.8	4.3[b]	6.6[b]
Non-Hispanic Black	449	0.48	0.03	0.41	0.54	0.0[b]	0.0[b]	0.0	0.0	0.1	0.3	0.6	1.1	1.7	2.5[b]	4.9[b]
Non-Hispanic White	617	0.53	0.05	0.44	0.63	0.0[b]	0.0[b]	0.0	0.0	0.1	0.3	0.6	1.2	1.9	3.0[b]	5.4[b]
Other Hispanic	49	0.64	0.07	0.49	0.79	0.0[b]	0.0[b]	0.0[b]	0.1[b]	0.3[b]	0.4	0.9[b]	1.3[b]	2.1[b]	2.6[b]	2.6[b]
Other [a]	117	0.67	0.06	0.55	0.80	0.0[b]	0.0[b]	0.1[b]	0.1[b]	0.2	0.4	0.9	1.4[b]	2.6[b]	2.6[b]	4.5[b]

[a] Other: Other Race - including Multiple Races.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

N = Sample size.
SE = Standard error.
CL = Confidence limit.
Min = Minimum value.
Max = Maximum value.

Source: U.S. EPA analysis of NHANES 2003–2006.

Table 10-11. Per Capita Intake of Total Finfish and Shellfish Combined (g/kg-day), Edible Portion, Uncooked Fish Weight

Population Group	N	% Consuming	Mean	SE	Lower 95%CL	Upper 95% CL	Percentiles										
							Min	1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	16,783	29	0.22	0.014	0.20	0.25	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.1	0.8	1.3	2.7	13.4[b]
Age Group (years)																	
0 to 1	865	3.1	0.04	0.01	0.02	0.06	0.0[b]	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0[b]	1.5[b]	5.1[b]
1 to 2	1,052	17	0.26	0.06	0.15	0.38	0.0[b]	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.7	1.6[b]	4.7[b]	13.4[b]
3 to 5	978	18	0.24	0.03	0.17	0.31	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.9	1.6	3.4[b]	7.0[b]
6 to 12	2,256	22	0.21	0.05	0.12	0.31	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.8	1.4	2.7[b]	6.7[b]
13 to 19	3,450	18	0.13	0.01	0.10	0.15	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	1.7	6.9[b]
20 to 49	4,289	31	0.23	0.02	0.20	0.27	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.1	0.8	1.3	2.7	8.6[b]
Females 13 to 49	4,103	28	0.19	0.02	0.16	0.22	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.2	2.4	8.6[b]
50+	3,893	36	0.25	0.02	0.21	0.29	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.3	0.9	1.4	2.6	6.1[b]
Race																	
Mexican American	4,450	22	0.23	0.03	0.17	0.28	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.4	3.5	8.6[b]
Non-Hispanic Black	4,265	32	0.24	0.02	0.20	0.28	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.2	0.8	1.3	2.7	8.9[b]
Non-Hispanic White	6,757	28	0.20	0.01	0.17	0.23	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.1	0.7	1.2	2.4	13.4[b]
Other Hispanic	562	32	0.27	0.05	0.17	0.37	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.2	0.9	1.7	3.1[b]	7.3[b]
Other [a]	749	43	0.45	0.06	0.32	0.58	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.4	1.5	2.5	4.1[b]	6.5[b]

[a] Other: Other Race - including Multiple Races.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

N = Sample size.
SE = Standard error.
CL = Confidence limit.
Min = Minimum value.
Max = Maximum value.

Source: U.S. EPA analysis of NHANES 2003–2006.

Table 10-12. Consumer-Only Intake of Total Finfish and Shellfish Combined (g/kg-day), Edible Portion, Uncooked Fish Weight

Population Group	N	Mean	SE	Lower 95%CL	Upper 95% CL	Min	Percentiles 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	4,206	0.78	0.03	0.73	0.83	0.0[b]	0.0	0.0	0.1	0.2	0.5	1.1	1.8	2.4	4.2	13.4[b]
Age Group (years)						0.0[b]										
0 to 1	30	1.18	0.29	0.59	1.76	0.0[b]	0.0[b]	0.0[b]	0.1[b]	0.2[b]	0.7[b]	1.6[b]	2.8[b]	2.9[b]	5.1[b]	5.1[b]
1 to 2	183	1.54	0.25	1.04	2.04	0.0[b]	0.0[b]	0.1[b]	0.2[b]	0.4[b]	0.8	1.7[b]	3.5[b]	5.9[b]	13.4[b]	13.4[b]
3 to 5	196	1.31	0.14	1.04	1.59	0.0[b]	0.0[b]	0.1[b]	0.2[b]	0.5	1.0	1.7	2.9[b]	3.6[b]	6.2[b]	7.0[b]
6 to 12	461	0.99	0.08	0.82	1.15	0.0[b]	0.0[b]	0.1[b]	0.1	0.3	0.7	1.4	2.0	2.7[b]	5.2[b]	6.7[b]
13 to 19	685	0.69	0.03	0.63	0.76	0.0[b]	0.0	0.0	0.0	0.2	0.5	1.0	1.5	1.8	3.0	6.9[b]
20 to 49	1,332	0.76	0.04	0.68	0.83	0.0[b]	0.0[b]	0.0	0.0	0.2	0.5	1.0	1.8	2.5	4.2[b]	8.6[b]
Females 13 to 49	1,109	0.68	0.04	0.60	0.76	0.0[b]	0.0	0.0	0.0	0.2	0.4	0.9	1.5	1.9	4.0	8.6[b]
50+	1,319	0.71	0.03	0.64	0.77	0.0[b]	0.0[b]	0.0	0.1	0.2	0.5	1.0	1.6	2.1	3.3[b]	6.1[b]
Race						0.0[b]										
Mexican American	831	1.01	0.06	0.88	1.14	0.0[b]	0.0[b]	0.0	0.1	0.3	0.8	1.3	2.1	3.2	5.6[b]	8.6[b]
Non-Hispanic Black	1,212	0.76	0.04	0.67	0.85	0.0[b]	0.0	0.0	0.1	0.2	0.5	1.0	1.8	2.2	4.9	8.9[b]
Non-Hispanic White	1,753	0.73	0.03	0.67	0.78	0.0[b]	0.0[b]	0.0	0.0	0.2	0.5	1.0	1.6	2.1	3.4[b]	13.4[b]
Other Hispanic	136	0.86	0.11	0.63	1.09	0.0[b]	0.0[b]	0.0[b]	0.1[b]	0.3	0.5	1.2	2.0[b]	2.6[b]	5.2[b]	7.3[b]
Other [a]	274	1.03	0.13	0.77	1.29	0.0[b]	0.0[b]	0.0[b]	0.1	0.2	0.6	1.4	2.5	2.9[b]	6.1[b]	6.5[b]

[a] Other: Other Race - including Multiple Races.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

N = Sample size.
SE = Standard error.
CL = Confidence limit.
Min = Minimum value.
Max = Maximum value.

Source: U.S. EPA analysis of NHANES 2003–2006.

Table 10-13. Total Fish Consumption, Consumers Only, by Demographic Variables[a]		
	Intake (g/person-day)	
Demographic Category	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 10-13. Total Fish Consumption, Consumers Only, by Demographic Variables[a] (continued)		
	Intake (g/person-day)	
Demographic Category	Mean	95th Percentile
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% of the U.S. population.

SMSA = Standard metropolitan statistical area.

Source: SRI (1980).

Table 10-14. Percent Distribution of Total Fish Consumption for Females and Males by Age[a]

Age (years)	Consumption Category (g/day)										
	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: SRI (1980).

Table 10-15. 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% of the U.S. population.
[b] Designated as freshwater or estuarine species.

Source: SRI (1980).

Table 10-16. Best Fits of Lognormal Distributions Using the Non-Linear Optimization Method			
	Adults	Teenagers	Children
Shellfish			
μ	1.370	–0.183	0.854
σ	0.858	1.092	0.730
Finfish (freshwater)			
μ	0.334	0.578	–0.559
σ	1.183	0.822	1.141
Finfish (saltwater)	2.311	1.691	0.881
μ	0.72	0.830	0.970
σ			

The following equations may be used with the appropriate μ and σ values to obtain an average Daily Consumption Rate (DCR), in grams, and percentiles of the DCR distribution.

$DCR50 = \exp(\mu)$

$DCR90 = \exp[\mu + z(0.90) \times \sigma]$

$DCR99 = \exp[\mu + z(0.99) \times \sigma]$

$DCR_{avg} = \exp[\mu + 0.5 \times \sigma^2]$

Source: Ruffle et al. (1994).

Table 10-17. 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 1987–1988 data for 1 day.

[b] Intake for users only was calculated by dividing the per capita consumption rate by the fraction of the population consuming fish in 1 day.

Source: USDA (1992).

Table 10-18. 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	4,663	1,811	38.8	2,780	59.6	72	1.5
Sex							
*	2	1	50.0	1	50.0	*	*
Male	2,163	821	38.0	1,311	60.6	31	1.4
Female	2,498	989	39.6	1,468	58.8	41	1.6
Age (years)							
*	84	25	29.8	42	50.0	17	20.2
1 to 4	263	160	60.8	102	38.8	1	0.4
5 to 11	348	177	50.9	166	47.7	5	1.4
12 to 17	326	179	54.9	137	42.0	10	3.1
18 to 64	2,972	997	33.5	1,946	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	3,774	1,475	39.1	2,249	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	4,243	1,625	31.2	1,366	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	2,017	630	31.2	1,366	67.7	21	1.0
Part Time	379	134	35.4	236	62.3	9	2.4
Not Employed	1,309	529	40.4	766	58.5	14	1.1
Education							
*	1,021	550	53.9	434	42.5	37	3.6
<High School	399	196	49.1	198	49.6	45	1.3
High School Graduate	1,253	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

Table 10-18. 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*	%
Census Region							
Northeast	1,048	370	35.3	655	62.5	23	2.2
Midwest	1,036	449	43.3	575	55.5	12	1.2
South	1,601	590	36.9	989	61.8	22	1.4
West	978	402	41.1	561	57.4	15	1.5
Day of Week							
Weekday	3,156	1,254	39.7	1,848	58.6	54	1.7
Weekend	1,507	557	37.0	932	61.8	18	1.2
Season							
Winter	1,264	462	36.6	780	61.7	22	1.7
Spring	1,181	469	39.7	691	58.5	21	1.8
Summer	1,275	506	39.7	745	58.4	24	1.9
Fall	943	374	39.7	564	59.8	5	0.5
Asthma							
No	4,287	1,674	39.0	2,563	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	4,500	1,750	38.9	2,698	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	4,424	1,726	9.0	2,648	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: U.S. EPA (1996).

Table 10-19. Number of Respondents Reporting Consumption of a Specified Number of Servings of Seafood in 1 Month

Population Group	Total *N*	Number of Servings in a Month					
		1–2	3–5	6–10	11–19	20+	DK
Overall	2,780	918	990	519	191	98	64
Sex							
*	1,311	405	458	261	101	57	29
Male	1,468	512	532	258	90	41	35
Female	1	1	*	*	*	*	*
Age (years)							
*	42	13	16	5	4	1	3
1 to 4	102	55	29	12	2	*	4
5 to 11	166	72	57	21	6	4	6
12 to 17	137	68	54	9	2	1	3
18 to 64	1,946	603	679	408	145	79	32
>64	387	107	155	64	32	13	16
Race							
*	2,249	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							
*	2,566	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	1,366	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

Table 10-19. 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
Day of Week							
Weekday	1,848	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	2,563	846	917	475	180	88	57
Yes	207	69	71	42	11	9	5
DK	10	3	2	2	*	1	2
Angina							
No	2,698	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	2,648	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: U.S. EPA (1996).

Table 10-20. 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	2,780	3	2,584	154	39
Sex					
*	1,311	1	1,206	85	19
Male	1,468	2	1,377	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	1,946	3	1,810	106	27
>64	387	*	359	22	6
Race					
*	2,249	1	2,092	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					
*	2,566	2	2,387	140	37
No	182	*	169	13	*
Yes	15	*	12	1	2
DK	17	1	16	*	*
Employment					
*	399	*	368	25	6
Full Time	1,366	2	1,285	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

Table 10-20. 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
Day of Week					
Weekday	1,848	2	1,724	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	2,563	2	2,384	142	35
Yes	207	1	190	12	4
DK	10	*	10	*	*
Angina					37
No	2,698	3	2,507	151	2
Yes	68	*	63	3	*
DK	14	*	14	*	
Bronchitis/Emphysema					
No	2,648	3	2,457	149	39
Yes	121	*	116	5	*
DK	11	*	11	*	*

* = Missing data.
DK = Don't know.
N = Sample size.
Refused = Respondent refused to answer.

Source: U.S. EPA (1996).

Table 10-21. Distribution of Fish Meals Reported by NJ Consumers During the Recall Period

Meals	*N*	% of Total	Cumulative %
1	288	41.9	41.9
2	204	29.7	71.7
3	118	17.2	88.9
4	34	5.0	93.9
5	16	2.3	96.2
6	13	1.9	98.1
7	7	1.0	99.1
≥7	6	0.9	100.0
Total	686	99.9	--

N = Number of respondents.

Source: Stern et al. (1996).

Table 10-22. Selected Species Among All Reported Meals by NJ Consumers During the Recall Period

Species	% of total reported meals (*N* = 1,447)
Tuna[a]	19.2
Shrimp	13.5
Founder/fluke	11.9
Shellfish/clams, etc.[b]	8.2
Finfish (unidentified)	7.5
Salmon	5.3
Swordfish	1.5
Shark	0.3
Total	67.4

[a] Includes fresh and canned tuna, as fillets, sandwiches, and salads.
[b] Includes soups and stews.
N = Number of meals.

Source: Stern et al. (1996).

Table 10-23. Cumulative Probability Distribution of Average Daily Fish Consumption (g/day)

Percentile	All Adult Fish Consumers (≥18 years)	Fish Consuming Women (18 to 40 years)
Arithmetic mean	50.2	41.0
Geometric mean	36.6	30.8
Percentiles		
5th	9.1	7.0
10th	12.2	10.3
25th	24.3	20.3
40th	28.4	24.3
50th	32.4	28.0
60th	42.6	33.4
75th	62.1	48.6
90th	107.4	88.1
95th	137.7	106.8
99th	210.6	142.3

Source: Stern et al. (1996).

Table 10-24. Distribution of the Usual Frequency of Fish Consumption[a]

Usual Frequency	All Fish Consumers *N* = 933	% of Total	Consumers During Recall Period *N* = 686	% of Total
>2 times/week	63	6.8	59	8.6
1 to 2 times/week	365	39.1	335	48.8
2 times/month	173	18.5	136	19.8
1 time/month	206	22.0	121	17.6
Few times/year	126	13.5	35	5.1

[a] Based on survey respondents and household members.
N = Sample size.

Source: Stern et al. (1996).

Table 10-25. 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	Estimate (90% Interval) Shellfish
Fresh/Estuarine	Mean	2.6 (2.3–2.8)	2.0 (1.8–2.3)
	50th percentile	0.0 (0.0–0.0)	0.0 (0.0–0.0)
	90th percentile	0.0 (0.0–0.0)	0.0 (0.0–0.2)
	95th percentile	6.7 (5.3–9.3)	9.6 (7.9–10.6)
	99th percentile	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 percentile	0.0 (0.0–0.0)	0.0 (0.0–0.0)
	90th percentile	26.3 (24.3–27.4)	0.0 (0.0–0.0)
	95th percentile	46.1 (43.1–47.5)	0.0 (0.0–0.0)
	99th percentile	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 percentile	0.0 (0.0–0.0)	0.0 (0.0–0.0)
	90th percentile	34.8 (31.4–36.6)	0.0 (0.0–0.0)
	95th percentile	59.8 (57.5–61.6)	22.6 (17.2–26.3)
	99th percentile	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 10-26. Daily Average Per Capita Estimates of Fish Consumption: U.S. Population—Mean Consumption by Species Within Habitat, as Prepared

Habitat	Species	Estimated Mean g/Person/Day	Habitat	Species	Estimated Mean g/Person/Day	Habitat	Species	Estimated Mean g/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, mixed 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 (Estuarine)	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 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 10-27. Per Capita Distribution of Fish Intake (g/day) by Habitat and Fish Type for the U.S. Population, Uncooked Fish Weight

Habitat	Statistic	Estimate (90% Interval)	
		Finfish	Shellfish
Fresh/Estuarine	Mean	3.6 (3.2–4.0)	2.7 (2.4–3.1)
	50th percentile	0.0 (0.0–0.0)	0.0 (0.0–0.0)
	90th percentile	0.0 (0.00–0.7)	0.0 (0.0–0.0)
	95th percentile	14.1 (10.0–16.8)	12.8 (10.5–13.8)
	99th percentile	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 percentile	0.0 (0.0–0.0)	0.0 (0.0–0.0)
	90th percentile	37.5 (35.7–37.6)	0.0 (0.0–0.0)
	95th percentile	62.9 (61.3–65.5)	0.0 (0.0–0.0)
	99th percentile	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 percentile	0.0 (0.0–0.0)	0.0 (0.0–0.0)
	90th percentile	48.7 (45.3–50.4)	0.0 (0.0–0.0)
	95th percentile	81.8 (79.5–85.0)	23.2 (18.3–28.3)
	99th percentile	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 10-28. Daily Average Per Capita Estimates of Fish Consumption U.S. Population—Mean Consumption by Species Within Habitat, Uncooked Fish Weight

Habitat	Species	Estimated Mean g/Person/Day	Habitat	Species	Estimated Mean g/Person/Day	Habitat	Species	Estimated Mean g/Person/Day
Estuarine	Shrimp	2.20926	Marine (Cont.)	Lobster	0.21290	All	Perch (Freshwater)	0.18148
	Flounder	0.58273		Scallop (Marine)	0.18951	Species	Squid	0.15438
	Catfish (Estuarine)	0.48928		Squid	0.15438	(Cont.)	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, mixed 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 (Estuarine)	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 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 Survey. 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 10-29. Per Capita Distributions of Fish (finfish and shellfish) Intake (g/day), as Prepared[a]

Age (years)	N	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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 10-29. Per Capita Distributions of Fish (finfish and shellfish) Intake (g/day), as Prepared[a] (continued)					
Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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 (BI); percentile intervals 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" (FASEB/LSRO, 1995).

Source: U.S. EPA (2002).

Table 10-30. Per Capita Distribution of Fish (finfish and shellfish) Intake (mg/kg-day), as Prepared[a]					
Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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 (2,383–3,073)
15 to 44	2,369	118 (104–132)	444 (368–547)	880 (760–954)	1,643 (1,454–1,819)
45 and older	2,764	149 (133–166)	568 (504–673)	889 (831–990)	1,859 (1,725–2,011)
All ages	10,127	136 (125–147)	494 (445–543)	908 (868–954)	1,965 (1,817–2,247)
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 10-30. Per Capita Distribution of Fish (finfish and shellfish) Intake (mg/kg-day), as Prepared[a] (continued)

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
			All Fish		
Females					
14 and under	4,879	203 (178–227)	693 (929–1,408)	1,344 (1,224–1,489)	3,297 (2,823–3,680)
15 to 44	2,275	181 (158–204)	641 (641–879)	1,040 (910–1,226)	2,292 (2,096–2,494)
45 and older	2,569	238 (212–263)	812 (797–956)	1,265 (1,165–1,353)	2,696 (2,247–2,974)
All ages	9,723	205 (188–221)	731 (797–912)	1,211 (1,128–1,256)	2,651 (2,358–2,823)
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* (FASEB/LSRO, 1995).

Source: U.S. EPA (2002).

Table 10-31. Per Capita Distribution of Fish (finfish and shellfish) Intake (g/day), Uncooked Fish Weight[a]

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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 (0.0–0.2)	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 (0.0–0.0)	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 (121.0–167.0)
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 10-31. Per Capita Distribution of Fish (finfish and shellfish) Intake (g/day), Uncooked Fish Weight[a] (continued)

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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* (FASEB/LSRO, 1995).

Source: U.S. EPA (2002).

Table 10-32. Per Capita Distribution of Fish (finfish and shellfish) Intake (mg/kg-day), Uncooked Fish Weight[a]

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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 (1,310–1,549)	3,684* (2,458–4,353)
11 to 15	975	153 (117–189)	481 (361–609)	1,251 (808–1,390)	2,381* (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 (3,318–4,065)
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 10-32. Per Capita Distribution of Fish (finfish and shellfish) Intake (mg/kg-day), Uncooked Fish Weight[a] (continued)

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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* (FASEB/LSRO, 1995).

Source: U.S. EPA (2002).

Table 10-33. Consumer-Only Distribution of Fish (finfish and shellfish) Intake (g/day), as Prepared[a]					
Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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 10-33. Consumer-Only Distribution of Fish (finfish and shellfish) Intake (g/day), as Prepared[a] (continued)					
Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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* (FASEB/LSRO, 1995).

Source: U.S. EPA (2002).

Table 10-34. Consumer-Only Distributions of Fish (finfish and shellfish) Intake (mg/kg-day), as Prepared[a]

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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 (3,068–3,830)	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 (1,320–1,743)	4,307 (3,472–4,624)	5,257 (4,926–5,746)	10,644* (9,083–12,735)
6 to 10	132	1,296 (1,004–1,588)	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 (3,927–4,962)	5,767 (5,041–6,519)	8,185 (6,907–8,842)
15 to 44	403	1,147 (1,061–1,234)	2,404 (2,014–2,660)	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 10-34. Consumer-Only Distributions of Fish (finfish and shellfish) Intake (mg/kg-day), as Prepared[a] (continued)

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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 (5,073–6,987)
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* (FASEB/LSRO, 1995).

Source: U.S. EPA (2002).

Table 10-35. Consumer-Only Distributions of Fish (finfish and shellfish) Intake (g/day), Uncooked Fish Weight[a]					
Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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)

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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 (246–300)	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)

Table 10-35. Consumer-Only Distributions of Fish (finfish and shellfish) Intake (g/day), Uncooked Fish Weight[a] (continued)

[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* (FASEB/LSRO, 1995).

Source: U.S. EPA (2002).

Table 10-36. Consumer-Only Distributions of Fish (finfish and shellfish) Intake (mg/kg-day), Uncooked Fish Weight[a]

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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 10-36. Consumer-Only Distributions of Fish (finfish and shellfish) Intake (mg/kg-day), Uncooked Fish Weight[a] (continued)					
Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (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* (FASEB/LSRO, 1995).

Source: U.S. EPA (2002).

Table 10-37. Fish Consumption per kg Body Weight, All Respondents, by Selected Demographic Characteristics (g/kg-day, as-consumed)

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
Sex								
	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 (years)-Sex Category								
	Child 1 to 5	26	0.32	51.7	0.00	0.05	0.95	1.47
	Child 6 to 10	26	0.51	86.7	0.00	0.35	1.13	1.29
	Child 11 to 15	21	0.27	85.6	0.00	0.19	0.52	0.89
	Female 16 to 29	17	0.67	79.9	0.00	0.31	1.06	4.02
	Female 30 to 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 to 29	14	0.16	70.5	0.00	0.14	0.41	0.53
	Male 30 to 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 to 11 years	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 to 20,000	40	0.39	86.4	0.00	0.26	0.96	1.45
	20,000 to 50,000	150	0.47	87.4	0.00	0.28	1.04	1.43
	>50,000	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		15,367	0.47	50.5	0.00	0.06	1.27	1.91
Sexes								
	Male	7,911	0.44	49.2	0.00	0.00	1.22	1.84
	Female	7,426	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 10-37. Fish Consumption per kg Body Weight, All Respondents, by Selected Demographic Characteristics (g/kg-day, as-consumed) (continued)								
					Percentiles			
State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	10th	50th	90th	95th
Florida (continued)								
Age (years)-Sex Category								
	Child 1 to 5	1,102	0.89	37.8	0.00	0.00	2.75	3.97
	Child 6 to 10	938	0.44	39.4	0.00	0.00	1.37	2.03
	Child 11 to 15	864	0.37	42.9	0.00	0.00	1.02	1.44
	Female 16 to 29	1,537	0.44	49.1	0.00	0.00	1.10	1.75
	Female 30 to 49	2,264	0.53	56.6	0.00	0.20	1.38	1.98
	Female 50+	2,080	0.41	56.5	0.00	0.20	1.14	1.62
	Male 16 to 29	1,638	0.44	46.1	0.00	0.00	1.11	1.72
	Male 30 to 49	2,540	0.43	53.0	0.00	0.11	1.17	1.77
	Male 50+	2,206	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	11,607	0.46	51.6	0.00	0.09	1.24	1.84
	Black, Non-Hispanic	1,603	0.54	48.3	0.00	0.00	1.49	2.24
	Hispanic	1,556	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 to 11 years	1,481	0.40	41.5	0.00	0.00	1.16	1.69
	High School	4,992	0.46	48.5	0.00	0.00	1.26	1.96
	Some College	4,791	0.49	52.3	0.00	0.11	1.30	1.98
	College Grad	4,012	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 to 20,000	3,314	0.47	45.9	0.00	0.00	1.21	2.11
	20,000 to 50,000	6,678	0.48	50.4	0.00	0.06	1.28	1.92
	>50,000	3,136	0.51	57.5	0.00	0.21	1.38	1.99
	Unknown	2,239	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
Sexes								
	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 (years)-Sex Category								
	Child 1 to 5	47	0.57	97.4	0.05	0.45	1.09	1.74
	Child 6 to 10	46	0.33	88.4	0.00	0.21	0.82	1.34
	Child 11 to 15	68	0.22	92.8	0.02	0.19	0.54	0.59
	Female 16 to 29	47	0.67	96.0	0.02	0.15	0.61	4.48
	Female 30 to 49	132	0.24	95.0	0.02	0.22	0.50	0.58

Table 10-37. Fish Consumption per kg Body Weight, All Respondents, by Selected Demographic Characteristics (g/kg-day, as-consumed) (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Minnesota (continued)								
Age (years)-Sex Category								
	Female 50+	162	0.34	94.9	0.03	0.21	0.90	1.35
	Male 16 to 29	55	0.10	92.3	0.01	0.07	0.26	0.33
	Male 30 to 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
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 to 11 years	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 to 20,000	87	0.40	91.0	0.03	0.20	1.20	1.61
	20,000 to 50,000	326	0.34	91.3	0.01	0.17	0.62	0.90
	>50,000	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
Sexes								
	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 (years)-Sex Category								
	Child 1 to 5	30	0.67	94.4	0.04	0.22	1.56	3.83
	Child 6 to 10	44	0.51	92.0	0.07	0.29	1.14	1.49
	Child 11 to 15	55	0.40	97.1	0.06	0.21	1.01	1.24
	Female 16 to 29	42	0.18	89.9	0.00	0.11	0.39	0.63
	Female 30 to 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 to 29	36	0.22	100.0	0.04	0.13	0.45	0.56
	Male 30 to 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	*	*

Table 10-37. Fish Consumption per kg Body Weight, All Respondents, by Selected Demographic Characteristics (g/kg-day, as-consumed) (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
North Dakota (continued)								
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
Respondent Education								
	0 to 11 years	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 to 20,000	51	0.52	93.7	0.02	0.17	1.79	2.55
	20,000 to 50,000	235	0.27	94.2	0.02	0.14	0.70	1.13
	>50,000	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

* Percentiles cannot be estimated due to small sample size.

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are 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 10-38. Fish Consumption per kg Body Weight, Consumers Only, by Selected Demographic Characteristics (g/kg-day, as-consumed)

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
Sex								
	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 (years)-Sex Category								
	Child 1 to 5	14	0.61	100	0.16	0.55	1.42	1.56
	Child 6 to 10	22	0.59	100	0.14	0.47	1.15	1.30
	Child 11 to 15	18	0.32	100	0.07	0.19	0.52	0.84
	Female 16 to 29	14	0.84	100	0.11	0.35	1.12	3.10
	Female 30 to 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 to 29	10	0.23	100	0.08	0.21	0.47	0.56
	Male 30 to 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 to 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 to 20,000	35	0.45	100	0.08	0.32	1.13	1.47
	20,000 to 50,000	133	0.54	100	0.07	0.33	1.12	1.45
	>50,000	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		7,757	0.93	100	0.19	0.58	1.89	2.73
Sexes								
	Male	3,880	0.90	100	0.18	0.55	1.85	2.65
	Female	3,861	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 10-38. Fish Consumption per kg Body Weight, Consumers Only, by Selected Demographic Characteristics (g/kg-day, as-consumed) (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Florida (continued)								
Age (years)-Sex Category								
	Child 1 to 5	420	2.34	100	0.50	1.74	4.67	6.80
	Child 6 to 10	375	1.10	100	0.28	0.81	2.23	2.97
	Child 11 to 15	365	0.85	100	0.20	0.63	1.62	2.16
	Female 16 to 29	753	0.89	100	0.16	0.55	1.77	2.42
	Female 30 to 49	1,287	0.94	100	0.18	0.63	1.86	2.68
	Female 50+	1,171	0.73	100	0.19	0.52	1.52	2.05
	Male 16 to 29	754	0.96	100	0.16	0.52	1.77	2.65
	Male 30 to 49	1,334	0.81	100	0.17	0.53	1.69	2.44
	Male 50+	1,192	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	5,957	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 to 11 years	613	0.96	100	0.22	0.60	1.86	2.81
	High School	2,405	0.96	100	0.18	0.58	1.98	2.83
	Some College	2,511	0.93	100	0.18	0.58	1.91	2.70
	College Grad	2,190	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 to 20,000	1,534	1.03	100	0.19	0.61	2.22	2.99
	20,000 to 50,000	3,370	0.95	100	0.19	0.60	1.91	2.78
	>50,000	1,806	0.89	100	0.17	0.56	1.87	2.73
	Unknown	1,047	0.74	100	0.17	0.51	1.61	2.09
Minnesota								
All Sexes		793	0.33	100	0.04	0.2	0.65	1.08
	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 (years)-Sex Category								
	Child 1 to 5	46	0.58	100	0.07	0.46	1.1	1.75
	Child 6 to 10	42	0.38	100	0.05	0.25	1.01	1.36
	Child 11 to 15	63	0.24	100	0.03	0.21	0.55	0.59

Table 10-38. Fish Consumption per kg Body Weight, Consumers Only, by Selected Demographic Characteristics (g/kg-day, as-consumed) (continued)								
					Percentiles			
State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	10th	50th	90th	95th
Minnesota (continued)								
Age (years)-Sex Category								
	Female 16 to 29	44	0.69	100	0.02	0.16	0.66	2.95
	Female 30 to 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 to 29	52	0.11	100	0.02	0.08	0.27	0.33
	Male 30 to 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	*	*	*	*
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 to 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 to 20,000	77	0.44	100	0.09	0.20	1.30	1.63
	20,000 to 50,000	301	0.37	100	0.05	0.18	0.65	0.96
	>50,000	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 Sexes		546	0.34	100	0.05	0.19	0.74	1.21
	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 (years)-Sex Category								
	Child 1 to 5	28	0.70	100	0.05	0.23	1.58	3.82
	Child 6 to 10	41	0.56	100	0.11	0.30	1.17	1.51
	Child 11 to 15	53	0.41	100	0.06	0.22	1.04	1.26
	Female 16 to 29	38	0.20	100	0.04	0.15	0.41	0.67
	Female 30 to 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 to 29	36	0.22	100	0.04	0.13	0.45	0.56

Table 10-38. Fish Consumption per kg Body Weight, Consumers Only, by Selected Demographic Characteristics (g/kg-day, as-consumed) (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
North Dakota (continued)								
Age (years)-Sex Category								
	Male 30 to 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 to 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
Household Income ($)								
	0 to 20,000	48	0.55	100	0.07	0.19	1.80	2.62
	20,000 to 50,000	221	0.29	100	0.04	0.15	0.73	1.17
	>50,000	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

* Percentiles cannot be estimated due to small sample size.

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are 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 10-39. Fish Consumption per kg Body Weight, All Respondents by State, Acquisition Method, (g/kg-day, as-consumed)

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 ($) Group								
	Bought; 0 to 20,000	40	0.38	86.4	0.00	0.26	0.96	1.45
	Bought; 20,000 to 50,000	150	0.46	86.6	0.00	0.27	0.93	1.42
	Bought; >50,000	214	0.38	84.1	0.00	0.24	0.99	1.27
	Bought; Unknown	16	0.32	73.4	0.00	0.30	0.75	1.00
	Caught; 0 to 20,000	40	0.01	11.0	0.00	0.00	0.00	0.05
	Caught; 20,000 to 50,000	150	0.01	18.1	0.00	0.00	0.02	0.06
	Caught; >50,000	214	0.01	16.8	0.00	0.00	0.01	0.02
	Caught; Unknown	16	0.00	6.2	0.00	0.00	0.00	0.01
Habitat								
	Freshwater	420	0.01	36.4	0.00	0.00	0.03	0.07
	Estuarine	420	0.10	76.0	0.00	0.04	0.23	0.43
	Marine	420	0.29	84.8	0.00	0.17	0.67	0.97
Fish/Shellfish Type								
	Shellfish	420	0.13	74.6	0.00	0.06	0.30	0.55
	Finfish	420	0.27	82.7	0.00	0.14	0.69	0.95
Florida								
All		15,367	0.47	50.5	0.00	0.06	1.27	1.91
Acquisition Method								
	Bought	15,367	0.41	47.5	0.00	0.00	1.12	1.70
	Caught	15,367	0.06	7.4	0.00	0.00	0.00	0.34
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	3,314	0.41	42.5	0.00	0.00	1.10	1.84
	Bought; 20,000 to 50,000	6,678	0.41	47.4	0.00	0.00	1.11	1.68
	Bought; >50,000	3,136	0.45	54.2	0.00	0.14	1.27	1.79
	Bought; Unknown	2,239	0.32	45.3	0.00	0.00	0.99	1.45
	Caught; 0 to 20,000	3,314	0.06	6.7	0.00	0.00	0.00	0.32
	Caught; 20,000 to 50,000	6,678	0.07	7.8	0.00	0.00	0.00	0.38
	Caught; >50,000	3,136	0.06	8.4	0.00	0.00	0.00	0.42
	Caught; Unknown	2,239	0.03	5.5	0.00	0.00	0.00	0.16
Habitat								
	Freshwater	15,367	0.04	9.1	0.00	0.00	0.00	0.26
	Estuarine	15,367	0.10	26.5	0.00	0.00	0.32	0.54
	Marine	15,367	0.33	40.3	0.00	0.00	0.90	1.43
Fish/Shellfish Type								
	Shellfish	15,367	0.07	21.1	0.00	0.00	0.22	0.43
	Finfish	15,367	0.39	41.9	0.00	0.00	1.10	1.67

Table 10-39. Fish Consumption per kg Body Weight, All Respondents by State, Acquisition Method, (g/kg-day, as-consumed) (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 ($) Group								
	Bought; 0 to 20,000	87	0.26	90.7	0.02	0.12	0.61	1.06
	Bought; 20,000 to 50,000	326	0.18	84.4	0.00	0.10	0.45	0.58
	Bought; >50,000	327	0.20	93.9	0.02	0.10	0.55	0.86
	Bought; Unknown	97	0.21	91.3	0.01	0.18	0.54	0.65
	Caught; 0 to 20,000	87	0.14	70.4	0.00	0.03	0.28	1.00
	Caught; 20,000 to 50,000	326	0.15	66.0	0.00	0.04	0.25	0.36
	Caught; >50,000	327	0.09	55.5	0.00	0.02	0.24	0.39
	Caught; Unknown	97	0.04	56.7	0.00	0.02	0.12	0.14
Habitat								
	Freshwater	837	0.11	60.6	0.00	0.03	0.22	0.37
	Estuarine	837	0.02	67.5	0.00	0.01	0.05	0.09
	Marine	837	0.18	89.9	0.00	0.09	0.46	0.68
Fish/Shellfish Type								
	Shellfish	837	0.04	67.5	0.00	0.01	0.10	0.18
	Finfish	837	0.27	94.0	0.01	0.15	0.57	0.83
North Dakota								
All		575	0.32	95.2	0.03	0.18	0.71	1.18
Acquisition Method								
	Bought	575	0.23	89.9	0.00	0.10	0.52	0.93
	Caught	575	0.09	68.3	0.00	0.04	0.24	0.40
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	51	0.41	88.0	0.00	0.12	1.34	2.03
	Bought; 20,000 to 50,000	235	0.21	90.6	0.01	0.09	0.48	1.01
	Bought; >50,000	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 to 20,000	51	0.10	53.9	0.00	0.01	0.23	0.45
	Caught; 20,000 to 50,000	235	0.07	59.4	0.00	0.02	0.18	0.30
	Caught; >50,000	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 10-39. Fish Consumption per kg Body Weight, All Respondents by State, Acquisition Method,g/kg-day, as-consumed) (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

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are 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 10-40. Fish Consumption per kg Body Weight, Consumers Only, by State, Acquisition Method (g/kg-day, as-consumed)

State	Category	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
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 ($) Group								
	Bought; 0 to 20,000	35	0.44	100	0.08	0.30	1.13	1.47
	Bought; 20,000 to 50,000	132	0.53	100	0.07	0.32	1.03	1.46
	Bought; >50,000	182	0.45	100	0.06	0.30	1.04	1.29
	Bought; Unknown	12	0.44	100	0.10	0.41	0.84	1.03
	Caught; 0 to 20,000	4	0.05	100	*	0.01	*	*
	Caught; 20,000 to 50,000	30	0.08	100	0.00	0.02	0.23	0.46
	Caught; >50,000	36	0.03	100	0.00	0.02	0.08	0.11
	Caught; Unknown	1	0.01	100	*	*	*	*
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	1	0.01	100	*	*	*	*
	Eats Caught and Bought	70	0.49	100	0.10	0.34	1.10	1.33
	Eats Bought Only	291	0.48	100	0.06	0.32	1.06	1.39
Habitat								
	Freshwater	157	0.04	100	0.00	0.02	0.07	0.15
	Estuarine	327	0.14	100	0.01	0.06	0.30	0.51
	Marine	361	0.34	100	0.04	0.23	0.78	1.09
Eats Freshwater/Estuarine Caught Fish								
	Sometimes	50	0.46	100	0.09	0.29	1.10	1.25
	Never	312	0.49	100	0.07	0.32	1.06	1.41
Fish/Shellfish Type								
	Shellfish	320	0.18	100	0.02	0.09	0.37	0.68
	Finfish	353	0.32	100	0.02	0.20	0.77	1.08
Florida								
All		7,757	0.93	100	0.19	0.58	1.89	2.73
Acquisition Method								
	Bought	7,246	0.86	100	0.17	0.54	1.77	2.55
	Caught	1,212	0.83	100	0.15	0.52	1.74	2.36
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	1,418	0.97	100	0.19	0.58	2.10	2.78
	Bought; 20,000 to 50,000	3,141	0.87	100	0.18	0.56	1.74	2.50
	Bought; >50,000	1,695	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 to 20,000	246	0.89	100	0.19	0.60	1.94	2.77
	Caught; 20,000 to 50,000	563	0.90	100	0.15	0.53	1.79	2.38
	Caught; >50,000	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 10-40. Fish Consumption per kg Body Weight, Consumers Only, by State, Acquisition Method,(g/kg-day, as-consumed) (continued)								
State / Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
				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 and Bought	701	1.81	100	0.50	1.15	3.35	5.09
Eats Bought Only	6,545	0.85	100	0.18	0.54	1.75	2.49
Habitat							
Freshwater	1,426	0.47	100	0.07	0.30	1.09	1.51
Estuarine	4,124	0.37	100	0.07	0.23	0.80	1.14
Marine	6,124	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	7,064	0.88	100	0.18	0.56	1.81	2.60
Fish/Shellfish Type							
Shellfish	3,260	0.35	100	0.07	0.21	0.74	1.02
Finfish	6,428	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 to 20,000	76	0.29	100	0.04	0.13	0.64	1.08
Bought; 20,000 to 50,000	284	0.22	100	0.03	0.13	0.47	0.74
Bought; >50,000	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 to 20,000	56	0.19	100	0.02	0.05	0.49	1.09
Caught; 20,000 to 50,000	232	0.23	100	0.02	0.08	0.30	0.46
Caught; >50,000	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 and 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 10-40. Fish Consumption per kg Body Weight, Consumers Only, by State, Acquisition Method,(g/kg-day, as-consumed) (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 to 20,000	45	0.47	100	0.05	0.14	1.54	2.22
	Bought; 20,000 to 50,000	213	0.23	100	0.03	0.11	0.52	1.03
	Bought; >50,000	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 to 20,000	27	0.19	100	0.01	0.08	0.42	0.64
	Caught; 20,000 to 50,000	142	0.11	100	0.02	0.05	0.25	0.40
	Caught; >50,000	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 and 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

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are 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 10-41. Fish Consumption per kg Body Weight, 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
Sex								
	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 (years)-Sex Category								
	Child 1 to 5	26	0.43	51.7	0.00	0.07	1.25	1.95
	Child 6 to 10	26	0.71	86.7	0.00	0.48	1.55	1.74
	Child 11 to 15	21	0.37	85.6	0.00	0.25	0.71	1.20
	Female 16 to 29	17	0.88	79.9	0.00	0.43	1.41	5.25
	Female 30 to 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 to 29	14	0.23	70.5	0.00	0.21	0.55	0.74
	Male 30 to 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 to 11 years	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 to 20,000	40	0.52	86.4	0.00	0.34	1.28	1.86
	20,000 to 50,000	150	0.64	87.4	0.00	0.39	1.40	1.93
	>50,000	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		15,367	0.59	50.5	0.00	0.08	1.59	2.39
Sexes								
	Male	7,911	0.55	49.2	0.00	0.00	1.51	2.32
	Female	7,426	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 10-41. Fish Consumption per kg Body Weight, 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 (years)-Sex Category								
	Child 1 to 5	1,102	1.10	37.8	0.00	0.00	3.41	4.85
	Child 6 to 10	938	0.54	39.4	0.00	0.00	1.69	2.55
	Child 11 to 15	864	0.46	42.9	0.00	0.00	1.27	1.92
	Female 16 to 29	1,537	0.55	49.1	0.00	0.00	1.42	2.20
	Female 30 to 49	2,264	0.67	56.6	0.00	0.27	1.73	2.56
	Female 50+	2,080	0.52	56.5	0.00	0.27	1.44	2.04
	Male 16 to 29	1,638	0.55	46.1	0.00	0.00	1.41	2.20
	Male 30 to 49	2,540	0.54	53.0	0.00	0.16	1.49	2.21
	Male 50+	2,206	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	11,607	0.57	51.6	0.00	0.12	1.56	2.33
	Black, Non-Hispanic	1,603	0.67	48.3	0.00	0.00	1.87	2.77
	Hispanic	1,556	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 to 11 years	1,481	0.50	41.5	0.00	0.00	1.45	2.16
	High School	4,992	0.58	48.5	0.00	0.00	1.59	2.45
	Some College	4,791	0.61	52.3	0.00	0.15	1.59	2.47
	College Grad	4,012	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 to 20,000	3,314	0.59	45.9	0.00	0.00	1.55	2.61
	20,000 to 50,000	6,678	0.61	50.4	0.00	0.08	1.61	2.42
	>50,000	3,136	0.65	57.5	0.00	0.27	1.77	2.53
	Unknown	2,239	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
Sexes								
	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 10-41. Fish Consumption per kg Body Weight, 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 (years)-Sex Category								
	Child 1 to 5	47	0.76	97.4	0.06	0.60	1.46	2.32
	Child 6 to 10	46	0.44	88.4	0.00	0.28	1.09	1.79
	Child 11 to 15	68	0.29	92.8	0.02	0.25	0.72	0.78
	Female 16 to 29	47	0.89	96.0	0.03	0.20	0.81	5.97
	Female 30 to 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 to 29	55	0.13	92.3	0.01	0.09	0.35	0.44
	Male 30 to 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 to 11 years	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 to 20,000	87	0.53	91.0	0.04	0.27	1.60	2.14
	20,000 to 50,000	326	0.45	91.3	0.02	0.23	0.83	1.20
	>50,000	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
Sexes								
	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 10-41. Fish Consumption per kg Body Weight, 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 (years)-Sex Category								
	Child 1 to 5	30	0.89	94.4	0.05	0.30	2.08	5.10
	Child 6 to 10	44	0.68	92.0	0.09	0.39	1.52	1.99
	Child 11 to 15	55	0.53	97.1	0.07	0.28	1.35	1.65
	Female 16 to 29	42	0.24	89.9	0.00	0.15	0.52	0.84
	Female 30 to 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 to 29	36	0.29	100.0	0.05	0.17	0.61	0.75
	Male 30 to 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 to 11 years	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 to 20,000	51	0.69	93.7	0.03	0.23	2.39	3.40
	20,000 to 50,000	235	0.36	94.2	0.03	0.18	0.93	1.51
	>50,000	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

* Percentiles cannot be estimated due to small sample size.

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are 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 10-42. Fish Consumption per kg Body Weight, 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
Sex								
	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 (years)-Sex Category								
	Child 1 to 5	14	0.83	100	0.21	0.74	1.88	2.07
	Child 6 to 10	22	0.81	100	0.21	0.74	1.57	1.76
	Child 11 to 15	18	0.43	100	0.12	0.30	0.72	1.14
	Female 16 to 29	14	1.10	100	0.15	0.47	1.50	4.07
	Female 30 to 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 to 29	10	0.32	100	0.11	0.30	0.63	0.78
	Male 30 to 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 to 11 years	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 to 20,000	35	0.60	100	0.10	0.43	1.53	1.90
	20,000 to 50,000	133	0.73	100	0.12	0.46	1.55	1.98
	>50,000	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		7,757	1.16	100	0.24	0.73	2.39	3.37
Sexes								
	Male	3,880	1.12	100	0.23	0.69	2.33	3.32
	Female	3,861	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 10-42. Fish Consumption per kg Body Weight, 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 (years)-Sex Category								
	Child 1 to 5	420	2.92	100	0.63	2.16	5.73	8.37
	Child 6 to 10	375	1.37	100	0.38	1.01	2.72	3.45
	Child 11 to 15	365	1.06	100	0.28	0.79	2.02	2.78
	Female 16 to 29	753	1.12	100	0.23	0.71	2.22	3.10
	Female 30 to 49	1,287	1.18	100	0.24	0.78	2.39	3.31
	Female 50+	1,171	0.91	100	0.24	0.66	1.92	2.53
	Male 16 to 29	754	1.19	100	0.22	0.66	2.26	3.30
	Male 30 to 49	1,334	1.02	100	0.22	0.67	2.18	3.05
	Male 50+	1,192	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	5,957	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 to 11 years	613	1.20	100	0.27	0.74	2.38	3.53
	High School	2,405	1.20	100	0.23	0.73	2.49	3.58
	Some College	2,511	1.16	100	0.24	0.72	2.39	3.39
	College Grad	2,190	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 to 20,000	1,534	1.28	100	0.25	0.77	2.77	3.66
	20,000 to 50,000	3,370	1.20	100	0.25	0.75	2.41	3.45
	>50,000	1,806	1.13	100	0.22	0.71	2.39	3.37
	Unknown	1,047	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
Sexes								
	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 10-42. Fish Consumption per kg Body Weight, 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 (years)-Sex Category								
	Child 1 to 5	46	0.78	100	0.09	0.62	1.47	2.33
	Child 6 to 10	42	0.50	100	0.06	0.33	1.35	1.81
	Child 11 to 15	63	0.32	100	0.04	0.28	0.73	0.78
	Female 16 to 29	44	0.92	100	0.03	0.21	0.88	3.93
	Female 30 to 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 to 29	52	0.14	100	0.02	0.11	0.36	0.44
	Male 30 to 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 to 11 years	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 to 20,000	77	0.59	100	0.12	0.27	1.73	2.17
	20,000 to 50,000	301	0.49	100	0.07	0.24	0.86	1.28
	>50,000	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
Sexes								
	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 10-42. Fish Consumption per kg Body Weight, 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 (years)-Sex Category								
	Child 1 to 5	28	0.94	100	0.07	0.31	2.11	5.09
	Child 6 to 10	41	0.74	100	0.14	0.40	1.56	2.02
	Child 11 to 15	53	0.54	100	0.08	0.29	1.39	1.68
	Female 16 to 29	38	0.27	100	0.05	0.19	0.54	0.89
	Female 30 to 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 to 29	36	0.29	100	0.05	0.17	0.60	0.75
	Male 30 to 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 to 11 years	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 to 20,000	48	0.74	100	0.09	0.25	2.40	3.49
	20,000 to 50,000	221	0.39	100	0.05	0.20	0.97	1.55
	>50,000	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

* Percentiles cannot be estimated due to small sample size.

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are 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 10-43. Fish Consumption per kg Body Weight, All Respondents, by State, Acquisition Method, Uncooked (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 ($) Group								
	Bought; 0 to 20,000	40	0.51	86.4	0.00	0.34	1.28	1.86
	Bought; 20,000 to 50,000	150	0.62	86.6	0.00	0.37	1.22	1.93
	Bought; >50,000	214	0.52	84.1	0.00	0.33	1.34	1.64
	Bought; Unknown	16	0.45	73.4	0.00	0.42	1.02	1.36
	Caught; 0 to 20,000	40	0.01	11.0	0.00	0.00	0.00	0.06
	Caught; 20,000 to 50,000	150	0.02	18.1	0.00	0.00	0.03	0.08
	Caught; >50,000	214	0.01	16.8	0.00	0.00	0.01	0.03
	Caught; Unknown	16	0.00	6.2	0.00	0.00	0.00	0.01
Habitat								
	Freshwater	420	0.02	36.4	0.00	0.00	0.05	0.09
	Estuarine	420	0.15	76.0	0.00	0.06	0.36	0.59
	Marine	420	0.40	84.8	0.00	0.23	0.90	1.29
Fish/Shellfish Type								
	Shellfish	420	0.19	74.6	0.00	0.09	0.43	0.76
	Finfish	420	0.36	82.7	0.00	0.19	0.94	1.28
Florida								
All		15,367	0.59	50.5	0.00	0.08	1.59	2.39
Acquisition Method								
	Bought	15,367	0.51	47.5	0.00	0.00	1.41	2.16
	Caught	15,367	0.08	7.40	0.00	0.00	0.00	0.45
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	3,314	0.51	42.5	0.00	0.00	1.34	2.32
	Bought; 20,000 to 50,000	6,678	0.52	47.4	0.00	0.00	1.40	2.12
	Bought; >50,000	3,136	0.57	54.2	0.00	0.19	1.58	2.27
	Bought; Unknown	2,239	0.40	45.3	0.00	0.00	1.21	1.82
	Caught; 0 to 20,000	3,314	0.08	6.7	0.00	0.00	0.00	0.42
	Caught; 20,000 to 50,000	6,678	0.09	7.8	0.00	0.00	0.00	0.48
	Caught; >50,000	3,136	0.08	8.4	0.00	0.00	0.00	0.53
	Caught; Unknown	2,239	0.04	5.5	0.00	0.00	0.00	0.21
Habitat								
	Freshwater	15,367	0.05	9.1	0.00	0.00	0.00	0.33
	Estuarine	15,367	0.13	26.5	0.00	0.00	0.43	0.73
	Marine	15,367	0.40	40.3	0.00	0.00	1.11	1.76
Fish/Shellfish Type								
	Shellfish	15,367	0.11	21.1	0.00	0.00	0.32	0.61
	Finfish	15,367	0.48	41.9	0.00	0.00	1.35	2.08

Table 10-43. Fish Consumption per kg Body Weight, All Respondents, by State, Acquisition MethodUncooked (g/kg-day) (continued)								
					Percentiles			
State	Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	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 ($) Group								
	Bought; 0 to 20,000	87	0.35	90.7	0.02	0.15	0.82	1.42
	Bought; 20,000 to 50,000	326	0.25	84.4	0.00	0.13	0.60	0.77
	Bought; >50,000	327	0.27	93.9	0.02	0.14	0.74	1.15
	Bought; Unknown	97	0.28	91.3	0.02	0.23	0.72	0.86
	Caught; 0 to 20,000	87	0.18	70.4	0.00	0.04	0.38	1.33
	Caught; 20,000 to 50,000	326	0.20	66.0	0.00	0.06	0.33	0.48
	Caught; >50,000	327	0.12	55.5	0.00	0.03	0.31	0.53
	Caught; Unknown	97	0.05	56.7	0.00	0.02	0.16	0.19
Habitat								
	Freshwater	837	0.15	60.6	0.00	0.03	0.30	0.49
	Estuarine	837	0.03	67.5	0.00	0.01	0.06	0.12
	Marine	837	0.24	89.9	0.00	0.12	0.61	0.91
Fish/Shellfish Type								
	Shellfish	837	0.06	67.5	0.00	0.02	0.13	0.24
	Finfish	837	0.36	94.0	0.02	0.19	0.76	1.11
North Dakota								
All		575	0.43	95.2	0.05	0.24	0.95	1.58
Acquisition Method								
	Bought	575	0.30	89.9	0.00	0.13	0.69	1.24
	Caught	575	0.13	68.3	0.00	0.05	0.31	0.53
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	51	0.55	88.0	0.00	0.15	1.79	2.71
	Bought; 20,000 to 50,000	235	0.28	90.6	0.01	0.13	0.65	1.35
	Bought; >50,000	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 to 20,000	51	0.14	53.9	0.00	0.01	0.31	0.61
	Caught; 20,000 to 50,000	235	0.09	59.4	0.00	0.03	0.23	0.40
	Caught; >50,000	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 10-43. Fish Consumption per kg Body Weight, 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

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are 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 10-44. Fish Consumption per kg Body Weight, Consumers Only, by State, Acquisition Method, Uncooked (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 ($) Group								
	Bought; 0 to 20,000	35	0.59	100	0.10	0.41	1.53	1.90
	Bought; 20,000 to 50,000	132	0.71	100	0.11	0.45	1.40	1.98
	Bought; >50,000	182	0.62	100	0.08	0.41	1.45	1.75
	Bought; Unknown	12	0.61	100	0.13	0.57	1.14	1.41
	Caught; 0 to 20,000	4	0.07	100	*	0.02	*	*
	Caught; 20,000 to 50,000	30	0.11	100	0.01	0.03	0.30	0.62
	Caught; >50,000	36	0.04	100	0.00	0.02	0.11	3.15
	Caught; Unknown	1	0.01	100	*	*	*	*
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	1	0.03	100	*	*	*	*
	Eats Caught and Bought	70	0.67	100	0.13	0.46	1.54	1.71
	Eats Bought Only	291	0.66	100	0.09	0.43	1.50	1.82
Habitat								
	Freshwater	157	0.05	100	0.00	0.03	0.10	0.21
	Estuarine	327	0.19	100	0.01	0.09	0.40	0.69
	Marine	361	0.47	100	0.06	0.31	1.03	1.45
Eats Freshwater/Estuarine Caught Fish								
	Sometimes	50	0.64	100	0.12	0.39	1.53	1.68
	Never	312	0.66	100	0.10	0.44	1.50	1.83
Fish/Shellfish Type								
	Shellfish	320	0.26	100	0.03	0.14	0.56	0.91
	Finfish	353	0.43	100	0.03	0.26	1.03	1.45
Florida								
All		7,757	1.16	100	0.24	0.73	2.39	3.37
Acquisition Method								
	Bought	7,246	1.07	100	0.23	0.68	2.22	3.18
	Caught	1,212	1.05	100	0.20	0.64	2.18	3.03
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	1,418	1.20	100	0.24	0.72	2.54	3.44
	Bought; 20,000 to 50,000	3,141	1.09	100	0.24	0.70	2.18	3.21
	Bought; >50,000	1,695	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 to 20,000	246	1.14	100	0.26	0.76	2.40	3.72
	Caught; 20,000 to 50,000	563	1.14	100	0.20	0.67	2.31	3.13
	Caught; >50,000	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 10-44. Fish Consumption per kg Body Weight, Consumers Only, by State, Acquisition Method, Uncooked (g/kg-day) (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 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 and Bought	701	2.28	100	0.65	1.48	4.38	6.37
	Eats Bought Only	6,545	1.06	100	0.23	0.68	2.20	3.08
Habitat								
	Freshwater	1,426	0.59	100	0.09	0.37	1.36	1.89
	Estuarine	4,124	0.50	100	0.10	0.31	1.05	1.46
	Marine	6,124	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	7,064	1.11	100	0.24	0.71	2.27	3.24
Fish/Shellfish Type								
	Shellfish	3,260	0.50	100	0.10	0.30	1.07	1.42
	Finfish	6,428	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 to 20,000	76	0.39	100	0.05	0.18	0.85	1.44
	Bought; 20,000 to 50,000	284	0.29	100	0.04	0.17	0.63	0.99
	Bought; >50,000	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 to 20,000	56	0.26	100	0.02	0.07	0.65	1.45
	Caught; 20,000 to 50,000	232	0.31	100	0.03	0.10	0.41	0.61
	Caught; >50,000	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 and 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 10-44. Fish Consumption per kg Body Weight, Consumers Only, by State, Acquisition Method, Uncooked (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 to 20,000	45	0.63	100	0.06	0.19	2.06	2.97
	Bought; 20,000 to 50,000	213	0.30	100	0.04	0.15	0.69	1.37
	Bought; >50,000	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 to 20,000	27	0.25	100	0.02	0.10	0.56	0.86
	Caught; 20,000 to 50,000	142	0.15	100	0.02	0.07	0.33	0.54
	Caught; >50,000	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 and 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

* Percentiles cannot be estimated due to small sample size.

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are 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 10-45. Fish Consumption per kg Body Weight, All Respondents, by State, Subpopulation, and Sex (g/kg-day, as-consumed)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Connecticut								
Population for Sample Selection								
	Anglers	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 Fishermen	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 Sex Group								
	Angler; Males	197	0.68	97.5	0.08	0.41	1.68	2.16
	Angler; Females	53	0.49	98.1	0.10	0.30	1.06	1.45
	Aquaculture Students; Males	10	0.21	90.0	0.00	0.09	0.75	0.85
	Aquaculture Students; Females	15	0.24	66.7	0.00	0.03	0.62	0.91
	Asians; Males	188	1.06	99.5	0.27	0.88	1.99	2.44
	Asians; Females	208	1.24	99.0	0.36	0.92	2.85	3.33
	Commercial Fishermen; Males	94	0.67	92.6	0.05	0.46	1.54	1.62
	Commercial Fishermen; Females	79	0.63	100	0.06	0.42	1.40	1.93
	EFNEP Participants; Males	25	1.05	88.0	0.00	0.33	2.83	3.80
	EFNEP Participants; Females	42	0.96	85.7	0.00	0.26	2.02	3.95
	General; Males	201	0.39	86.2	0.00	0.24	1.05	1.34
	General; Females	219	0.43	84.0	0.00	0.28	0.95	1.30
	WIC Participants; Males	312	0.94	79.2	0.00	0.45	2.30	3.52
	WIC Participants; Females	387	0.69	79.1	0.00	0.40	1.64	2.43
Florida								
Population for Sample Selection								
	General	15,367	0.47	50.5	0.00	0.06	1.27	1.91
Population for Sample Selection and Sex Group								
	General; Males	7,911	0.44	49.2	0.00	0.00	1.22	1.84
	General; Females	7,426	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 Indians	216	0.21	88.9	0.00	0.13	0.52	0.64
	Anglers	1,152	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 10-45. Fish Consumption per kg Body Weight, All Respondents, by State, Subpopulation, and Sex (g/kg-day, as-consumed) (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Minnesota (continued)								
Population for Sample Selection and Sex Group								
	American Indians; Males	108	0.19	89.8	0.00	0.14	0.46	0.55
	American Indians; Females	108	0.23	88.0	0.00	0.12	0.57	0.93
	Anglers; Males	606	0.30	96.9	0.04	0.18	0.63	0.93
	Anglers; Females	546	0.31	95.6	0.04	0.17	0.70	1.04
	General; Males	419	0.26	95.3	0.02	0.16	0.58	1.06
	General; Females	418	0.36	93.4	0.02	0.21	0.65	1.10
	New Mothers; Males	205	0.27	86.3	0.00	0.15	0.67	0.93
	New Mothers; Females	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 Sex Group								
	American Indians; Males	50	0.35	58.0	0.00	0.04	0.76	1.39
	American Indians; Females	56	0.36	62.5	0.00	0.05	1.34	2.32
	Anglers; Males	467	0.32	95.3	0.04	0.19	0.77	1.14
	Anglers; Females	387	0.33	93.8	0.03	0.19	0.77	1.18
	General; Males	276	0.32	96.2	0.04	0.19	0.68	1.20
	General; Females	299	0.32	94.2	0.03	0.17	0.73	1.16

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are 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.
EFNEP = Expanded Food and Nutrition Education Program.
WIC = USDA's Women, Infants, and Children Program.

Source: Westat (2006).

Table 10-46. Fish Consumption per kg, Consumers Only, by State, Subpopulation, and Sex (g/kg-day, as-consumed)

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 Sex 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 10-46. Fish Consumption per kg, Consumers Only, by State, Subpopulation, and Sex (g/kg-day, as-consumed) (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Florida								
Population for Sample Selection								
	General	7,757	0.93	100	0.19	0.58	1.89	2.73
Population for Sample Selection and Sex Group								
	General; Male	3,880	0.90	100	0.18	0.55	1.85	2.65
	General; Female	3,861	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	7,064	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	1,109	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 Sex 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 10-46. Fish Consumption per kg, Consumers Only, by State, Subpopulation, and Sex (g/kg-day, as-consumed) (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 Sex 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

* Percentiles cannot be estimated due to small sample size.

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are 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 10-47. Fish Consumption Among General Population 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	1,287	0.94	0.87–1.00	0.18	0.33	0.63	1.0	1.9	2.7	20
Males	1,334	0.81	0.74–0.88	0.17	0.28	0.53	0.95	1.7	2.4	23
>50 years										
Females	1,171	0.73	0.69–0.77	0.19	0.31	0.52	0.94	1.5	2.1	7.4
Males	1,192	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	6,545	0.85	0.81–0.89	0.18	0.30	0.54	0.98	1.8	2.5	24

Table 10-47. 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.
\- Not reported.

Source: Moya et al. (2008).

Table 10-48. 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 10-49. 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 10-50. 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
Southern California	2.0	5.5
Northern 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, and FL (Atlantic Coast); Gulf—AL, MS, LA, and FL (Gulf Coast).

Source: NMFS (1993).

Table 10-51. 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) = <1,000 kg.

Source: NMFS (1993).

Table 10-52. 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., Areas #1, #2, #3, and #4)

[b] Fall—September through November, includes 4 survey days and 4 survey areas (i.e., Areas #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., Areas #1, #2, #3, #4, and #5)

Source: Pierce et al. (1981).

Table 10-53. Selected Percentile Consumption Estimates (g/day) for the Survey and Total Angler Populations Based on the Re-Analysis of the Puffer et al. (1982) and Pierce et al. (1981) Data

	50th Percentile	90th Percentile
Survey Population		
Puffer et al. (1982)	37	225
Pierce et al. (1981)	19	155
Average	28	190
Total Angler Population		
Puffer et al. (1982)	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 10-54. 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. (1982).

Table 10-55. 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. (1982).

Table 10-56. Catch Information for Primary Fish Species Kept by Sport Fishermen (N = 1,059)

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	1,752	4
Shellfish[a]	421	3

[a] Crab, mussels, lobster, abalone.

Source: Modified from Puffer et al. (1982).

Table 10-57. 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/hour	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/hour	11.3 ± 2.5
Fish eaten/week	6.8 ± 0.7
Range in no. eaten/week	3–30

Source: Burger and Gochfeld (1991).

Table 10-58. Fish Consumption of Delaware Recreational Fishermen and Their Households

	N	Mean Consumption (g/day)	SE (%)
All respondents	867	17.5	5.3
Sex			
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

N = Sample size.
SE = Standard error.

Source: KCA Research Division (1994).

Table 10-59. Seafood Consumption Rates of All Fish by Ethnic and Income Groups of Santa Monica Bay

		Consumption (g/day)			
Category	*N*	Mean	95% CI	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 to $10,000	27	40.5	29.1	21.4	48.2
$10,000 to $25,000	90	40.4	9.3	21.4	80.4
$25,000 to $50,000	149	46.9	10.5	21.4	113.0
>$50,000	130	58.9	20.6	21.4	128.6

N = Sample size.
CI = Confidence interval.

Source: Santa Monica Bay Restoration Project (1995).

Table 10-60. Means and Standard Deviations of Selected Characteristics by Population Groups in Everglades, Florida

Variables (N[a] = 330)	Mean ± SD[b]	Range
Age (years)	38.6 ± 18.8	2 to 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.
\- Not reported.

Source: Florida State Department of Health and Rehabilitative Services (1995).

Table 10-61. 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% of the individuals consumed shellfish, resulting in a 90th percentile of zero.

Source: Alcoa (1998).

Table 10-62. 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 10-63. 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 (ounces)	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 10-64. 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 10-65. Consumption Rates (g/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
Sex							
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 to $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 4 weeks prior to the date they were interviewed. Recent consumers are a subset of the overall consumer group.

N = Sample size.

SD = Standard deviation.

HS/GED= High school/general education development.

Source: SFEI (2000).

Table 10-66. Mean ± SD Consumption Rates for Individuals Who Fish or Crab in the Newark Bay Area				
	People that crab	People that fish	People that both crab and fish	
			Crab values	Fish values
Sample size	110	111	33	33
Number of times per month consuming	3.39 ± 0.42	4.06 ± 0.76	2.96 ± 0.45	3.56 ± 0.66
Serving size				
Number of crabs	6.15 ± 0.85	-	7.27 ± 0.91	-
Fish or crabs (grams) (crabs assumed to weigh 70 grams each)	439 ± 61.2	331 ± 42.1	509 ± 63.8	428 ± 57.6
Monthly consumption (g/month)	1,980 ± 561	1,410 ± 266	1,620 ± 330	1,630 ± 358
Number of months per year fishing and/or crabbing	3.31 ± 0.13	4.92 ± 0.33	3.5 ± 0.37	7.24 ± 0.74
Yearly consumption (g/year)	5,760 ± 1,360	8,120 ± 2,040	6,230 ± 1,790	13,600 ± 3,480
Average daily consumption (g/day)[a]	15.8 ± 3.7	22.2 ± 5.6	17.1 ± 4.9	37.3 ± 9.5

[a] Estimated by U.S. EPA by dividing yearly consumption rate by 365 days/year.
SD = Standard deviation.
Note: Sample size is slightly different from that reported in the text of Burger (2002a).

Source: Burger (2002a).

Table 10-67. Consumption Rates (g/day) for Marine Recreational Anglers in King County, WA							
Location	Sample Size	Mean	SD	SE	Percentiles		
					50th	90th	95th
Marine Fish Consumption							
Duwamish River[a]	50	8	13	2	2	23	42
Elliott Bay	377	63	91	5	31	145	221
North King County	67	32	40	5	17	85	102
All Locations	494	53	83	4	21	121	181
Shellfish Consumption							
Duwamish River[a]	16	20	33	8	4	77	123
Elliott Bay	49	28	33	5	14	74	119
North King County	31	22	33	6	12	62	132
All Locations	96	25	33	3	11	60	119

[a] The Duwamish River is tidally influenced by Elliott Bay, and anglers caught marine species; therefore, data for these locations were considered to represent marine locations.
SD = Standard deviation.
SE = Standard error.

Source: Mayfield et al. (2007).

Table 10-68. Percentile and Mean Intake Rates for Wisconsin Sport Anglers (all respondents)

Percentile	Annual Number of Sport-Caught Meals	Intake Rate of Sport-Caught Meals (g/day)
25th	4	2.6
50th	10	6.2
75th	25	15.5
90th	50	31.3
95th	60	37.2
98th	100	62.1
100th	365	227
Mean	18	11.2

Source: Raw data on sport-caught meals from Fiore et al. (1989). U.S. EPA calculated distributions of intake rates using a value of 227 grams per fish meal.

Table 10-69. 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 g/day	Recreational Fish g/day	Total Fish g/kg-day	Recreational Fish g/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
11 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
41 to 60	0.923	0.42	547	29.3	14.2	0.387	0.186
61 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 10-70. Comparison of 7-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 to 4 times a week	1.96	2
Once a week	1.19	1.2
2 to 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 10-71. 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 g/day	Recreational Fish Intake g/day	All Fish Intake g/kg-day	Recreational Fish Intake g/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 10-72. 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 (g/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 non-consumers).
[f] Values in brackets [ ] are percentiles at the mean consumption rates.

Source: ChemRisk (1992); Ebert et al. (1993).

Table 10-73. 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 seasons.
[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 10-74. 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 ($\times 10^3$) Consumed	Quantity Consumed (#)	Grams ($\times 10^3$) Consumed	Quantity Consumed (#)	Grams ($\times 10^3$) 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 10-75. Socio-Demographic 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 to 29	26%
	30 to 44	35%
	45 to 59	23%
	>60	12%
Annual Household Income	<$10,000	16%
	$10,000 to 29,999	41%
	$30,000 to 49,999	29%
	$50,000 to 69,999	10%
	$70,000 to 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 10-76. Mean Sport-Fish Consumption by Demographic Variables, Michigan Sport Anglers Fish Consumption Study, 1991–1992

	N	Mean (g/day)	95% CI
Income[a]			
<$15,000	290	21.0	16.3–25.8
$15,000 to $24,999	369	20.6	15.5–25.7
$25,000 to $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 to 100,000)	464	12.9	10.7–15.0
Town (2,000 to 20,000)	475	19.4	15.5–23.3
Small Town (100 to 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 to 29	266	18.9	13.9–23.9
30 to 39	583	16.6	13.5–19.7
40 to 49	556	16.5	13.4–19.6
50 to 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] $p < 0.01$, F test.
[b] $p < 0.05$, F test.
N = Sample size.
CI = Confidence interval.

Source: West et al. (1993).

Table 10-77. Mean Per Capita Freshwater Fish Intake of Alabama Anglers						
	Mean Consumption (g/day)					
	Harvest Method[a]			4-Ounce Serving Method[b]		
	N	Site meals	All meals	*N*	Site Meals	All Meals
All respondents	563	32.6	43.1	1,303	30.3	45.8
All respondents; all meals; 4-ounce serving method	-	-	-	-	-	44.8
Age (years)						16
20 to 30	-	-	-	-	-	39
31 to 50	-	-	-	-	-	76
51 and over	-	-	-	-	-	
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
Seasons						
Fall	130	29.7	43.4	303	32.0	49.4
Winter	56	26.2	34.2	177	30.8	43.9
Spring	185	21.5	29.3	414	20.5	33.6[c]
Summer	192	46.7	57.0	417	36.4	53.0[c]

[a] The Harvest Method used the actual harvest of fish and dressing method reported to calculate consumption rates.
[b] The 4-ounce Serving Method estimated consumption based on a typical 4-ounce serving size.
[c] Statistical difference at $p < 0.05$.
N = Number of respondents.

Source: Alabama Department of Environmental Management (ADEM) (1994).

Table 10-78. 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 10-79. Mean Annual Fish Consumption (g/day) for Lake Ontario Anglers, 1992, by Socio-Demographic 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 to 100,000)	19.8	5.8
City (>100,000)	13.1	2.2
Income		
<$20,000	20.5	4.9
$21,000 to 34,000	17.5	4.7
$35,000 to 50,000	16.5	4.8
>$50,000	20.7	6.1
Age (years)		
<30	13.0	4.1
30 to 39	16.6	4.3
40 to 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 10-80. Seafood Consumption Rates of Nine Connecticut Population Groups (cooked, edible meat, g/day)

	N	Mean	SD	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 aged 15 to 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.
SD = Standard deviation.
Source: Balcom et al. (1999).

Table 10-81. Fishing Patterns and Consumption Rates of People Fishing Along the Savannah River (Mean ± SE)

	N	Age (years)	Years Fished	Years Fished Savannah River	Distance Traveled (km)	How Often Eat Fish/Month	Serving Size (grams)	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.
SE = Standard error.

Source: Burger et al. (1999).

Table 10-82. Fish Consumption Rates for Indiana Anglers—Mail Survey (g/day)

			Percentile			
	N	Mean	50th	80th	90th	95th
Active Consumers	1,045	19.8	9.5	28.4	37.8	60.5
Potential and Active Consumers	1,261	16.4	7.6	23.6	37.8	60.5

N = Sample size.

Source: Williams et al. (1999).

Table 10-83. Fish Consumption Rates for Indiana Anglers—On-Site Survey (g/day)

			Percentile			
	N	Mean	50th	80th	90th	95th
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 to $34,999	62	18.8	7.6	23.6	60.5	90.7
$35,000 to $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						
<$25,000	180	10.2	3.8	9.5	23.6	37.8
$25,000 to $34,999	117	7.4	0	7.6	15.1	37.8
$35,000 to $49,999	91	6.8	0	5.7	22.7	23.6
>$50,000	126	13.6	0	7.6	37.8	113.4

N = Sample size.

Source: Williams et al. (2000).

Table 10-84. Consumption of Sport-Caught and Purchased Fish by Minnesota and North Dakota Residents (g/day)

		Percentile				
	N	50th	75th	90th	95th	99th
Minnesota						
Sport-caught fish only						
Age in years (sex)						
0 to 14	582	1.2	4.2	9.0	13.7	26.7
14 and over (males)	996	4.5	10.6	23.7	39.8	113.9
15 to 44 (females)	505	2.1	5.8	14.0	24.9	75.9
44 and over (females)	460	3.6	8.2	20.8	37.2	101.3
General population	2,312	2.8	7.9	17.3	28.9	78.0
Bois Forte Tribe	232	2.8	6.6	12.0	19.6	120.6
With fishing license	2,020	3.9	9.2	18.9	30.4	94.5
Without fishing license	490	0.0	2.0	4.5	7.0	51.1
Purchased Fish Only						
Age in years (sex)						
0 to 14	582	3.6	9.3	18.0	31.3	61.2
14 and over (males)	996	7.4	15.4	30.3	47.5	91.6
15 to 44 (females)	505	6.1	14.0	29.2	50.3	103.7
44 and over (females)	460	7.1	14.6	25.3	42.5	89.4
General population	2,312	6.6	14.4	27.7	43.2	91.3
Bois Forte Tribe	232	3.4	9.0	14.4	24.1	71.9
With fishing license	2,020	6.4	14.0	25.9	39.7	88.7
Without fishing license	490	5.6	12.7	29.6	55.4	98.7
Total						
Age in years (sex)						
0 to 14	582	6.9	14.0	25.6	38.1	78.2
14 and over (males)	996	15.1	27.2	50.3	72.3	155.6
15 to 44 (females)	505	10.1	19.1	39.5	69.2	147.7
44 and over (females)	460	13.8	22.8	45.2	64.1	139.3
General population	2,312	12.3	22.6	42.8	64.5	128.7
Bois Forte Tribe	232	9.3	14.5	26.0	38.4	123.0
With fishing license	2,020	13.2	23.1	42.3	64.5	133.5
Without fishing license	490	7.5	15.2	30.4	58.7	110.0
North Dakota						
Sport-Caught Fish Only						
Age in years (sex)						
0 to 14	343	1.7	6.0	13.3	21.6	44.3
14 and over (males)	579	2.3	6.8	15.1	24.6	79.8
15 to 44 (females)	311	4.3	10.7	23.8	30.1	89.8
44 and over (females)	278	4.2	11.5	21.8	32.5	87.5
General population	1,406	3.0	9.2	16.4	27.4	80.9
Spirit Lake Nation Tribes	105	0.0	2.9	20.3	36.3	97.6
With fishing license	1,101	4.5	11.2	21.2	30.8	87.2
Without fishing license	391	0.0	1.5	4.8	7.9	23.1

Table 10-84. Consumption of Sport-Caught and Purchased Fish by Minnesota and North Dakota Residents (g/day) (continued)

			Percentile			
	N	50th	75th	90th	95th	99th
Purchased Fish Only						
Age in years (sex)						
0 to 14	343	4.7	14.3	23.1	32.9	90.7
14 and over (males)	579	7.4	15.4	30.3	47.5	91.6
15 to 44 (females)	311	7.1	16.1	33.5	50.6	90.9
44 and over (females)	278	6.1	15.4	30.3	47.0	90.7
General population	1,406	6.4	15.4	29.1	47.8	95.6
Spirit Lake Nation Tribes	105	1.2	16.5	30.0	40.7	143.5
With fishing license	1,101	6.8	15.9	29.5	47.0	95.6
Without fishing license	391	5.7	15.1	30.2	52.8	112.2
Total						
Age in years (sex)						
0 to 14	343	9.2	20.4	35.7	57.1	97.4
14 and over (males)	579	7.4	15.4	30.3	47.5	91.6
15 to 44 (females)	311	14.1	27.3	49.8	80.5	137.5
44 and over (females)	278	13.5	25.4	49.3	78.8	144.5
General population	1,406	12.6	24.1	46.7	71.4	126.3
Spirit Lake Nation Tribes	105	1.4	21.2	50.7	80.8	179.8
With fishing license	1,101	14.0	25.3	49.2	76.2	131.4
Without fishing license	391	7.2	15.9	33.5	54.1	116.1

N = Sample size.

Source: Benson et al. (2001).

Table 10-85. 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 (grams)	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 to $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 to $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

N = Sample size.

Source: Rouse Campbell et al. (2002).

Table 10-86. Daily Consumption of Wild-Caught Fish, Consumers Only (g/kg-day, as-consumed)

Population	*N*	Consumers (%)	g/person/day						
			Mean	Range	Median	75th	90th	95th	99th
Ethnicity									
Black	39	79	171.0	1.88–590.0	137.0	240.0	446.0	557.0	590.0
White	415	78	38.8	0.35–902.0	15.3	37.6	93.0	129.0	286.0
All	458	78	50.2	0.35–902.0	17.6	47.8	123.0	216.0	538.0
Sex									
Female	149	72	39.1	0.35–412.0	11.6	32.8	123.0	172.0	373.0
Male	308	80	55.2	0.63–902.0	21.3	56.4	127.0	235.0	557.0
All	458	73	50.2	0.35–902.0	17.6	47.8	123.0	216.0	538.0
Age (years)									
<32	145	77	32.6	0.63–412.0	14.2	37.6	66.5	123.0	216.0
33 to 45	159	77	71.3	7.52–902.0	18.8	67.6	177.0	354.0	590.0
>45	150	78	44.0	0.35–538.0	20.0	44.4	100.0	164.0	286.0
Income									
$0 to <20K	98	82	104.0	31.9–590.0	31.9	151.0	285.0	429.0	590.0
$20 to 30K	95	82	32.7	0.35–460.0	15.0	37.2	93.0	120.0	460.0
>$30K	172	76	40.9	0.47–902.0	19.4	45.8	87.9	127.0	216.0

N = Sample size.

Source: Burger (2002b).

Table 10-87. Consumption Rates (g/day) for Freshwater Recreational Anglers in King County, WA							
Location	Sample Size	Mean	SD	SE	Percentiles		
					50th	90th	95th
Freshwater Fish Consumption							
King County Lakes (all respondents)	128	10	24	2	0	23	42
King County Lakes (children of respondents)	81	7	20	2	0	17	29

SD = Standard deviation.
SE = Standard error.

Source: Mayfield et al. (2007).

Table 10-88. Number of Grams per Day of Fish Consumed by All Adult Respondents (consumers and non-consumers combined)—Throughout the Year

Number of g/day	Cumulative Percent	Number of g/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; *N* = sample size.
Weighted Mean = 58.7 g/day.
Weighted SE = 3.64; SE = standard error.
90th Percentile 97.2 g/day < (90th) < 130 g/day.
95th Percentile = 170 g/day.
99th Percentile = 389 g/day.

Source: CRITFC (1994).

Table 10-89. Fish Intake Throughout the Year by Sex, Age, and Location by All Adult Respondents			
	N	Weighted Mean (g/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 and 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 10-90. Fish Consumption Rates Among Native American Children (age 5 years and under)[a]	
g/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 g/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 10-91. Number of Fish Meals 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 10-92. Socio-Demographic Factors and Recent Fish Consumption

	Peak Consumption[a]		Recent Consumption[b]			
	Average Meals/Week[c]	≥3 meals/week[d] (%)	Walleye	N. Pike	Muskellunge	Bass
All participants (*N* = 323)	1.7	20	4.2	0.3	0.3	0.5
Sex						
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 (years)						
<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 10-93. 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 Year Before Pregnancy[a]				>1 Year Before Pregnancy[b]			
	Mohawk		Control		Mohawk		Control		Mohawk		Control	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
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.
N = Number of respondents.

Source: Fitzgerald et al. (1995).

Table 10-94. 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 Year Before Pregnancy	>1 Year Before Pregnancy	During Pregnancy	≤1 Year Before Pregnancy	>1 Year 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. Controls.
b $p < 0.05$ for Mohawk vs. Controls.
( ) = 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 10-95. 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 (years)						
<20	7.7	0.8	13.5	13.9	27.4	10.4
20 to 24	1.3	5.9	5.7	14.5	20.4	15.9
25 to 29	3.9	9.9	15.5	6.2	25.1	5.4
30 to 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 (Years)						
<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 to 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.
Note: $F(r1, r2)$ = F statistic with r1 and r2 degrees of freedom.

Source: Fitzgerald et al. (1995).

Table 10-96. Fish Consumption Rates for Mohawk Native Americans (g/day)

Population Group	Sample Size	Fish Intake Rate		% Consuming
		Mean	95th Percentile	
Adults—all[a]				
All fish	1,092	28	132	90%
Local fish	1,092	25	131	90%
Adults—consumers only[a]				
All fish	983	31	142	90%
Local fish	972	29	135	90%
Children—all[b]				
Local fish	--	10	54	--
Children—consumers only[b]				
Local fish	--	13	58	--

[a] Value based on assumption that 1 fish meal = 227 grams (1/2 pound) [based on data from Pao et al. (1982)].
[b] Value for 2-year old child, based on assumption that children consume fish at the same frequency as adults but have a smaller meal size (93 grams).

Source: Forti et al. (1995).

Table 10-97. 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[a]	0.000	0.008	0.111	0.186	0.007	0.033	(0.020, 0.046)
Shellfish[a]	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[b]	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[a]	0.000	0.026	0.176	0.345	0.010	0.063	(0.048, 0.078)
Shellfish[a]	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[b]	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)

[a] $p < 0.01$ comparing two tribes (Wilcoxon-Mann-Whitney test).
[b] $p < 0.05$
N = Sample size.
SE = Standard error.
CI = Confidence interval.

Source: Toy et al. (1996).

Table 10-98. Median and Mean Consumption Rates by Sex (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	0.775[b]	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] $p < 0.05$ for difference in consumption rate by sex within a tribe (Wilcoxon-Mann-Whitney test).
N = Sample size.
CI = Confidence interval.

Source: Toy et al. (1996).

Table 10-99. Median Consumption Rate for Total Fish by Sex and Tribe (g/day)

	Tulalip Tribe	Squaxin Island Tribe
Male	53	66
Female	34	25

Source: Toy et al. (1996).

Table 10-100. Percentiles of Adult Consumption Rates by Age (g/kg-day)

	Tulalip Tribes				Squaxin Island Tribe		
Ages (years)	5%	50%	90%	95%	50%	90%	95%
Shellfish							
18 to 34	0.00	0.181	1.163	1.676	0.073	0.690	1.141
35 to 49	0.00	0.161	1.827	1.836	0.073	0.547	1.094
50 to 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 to 34	0.013	0.156	1.129	1.956	0.289	1.618	2.963
35 to 49	0.002	0.533	2.188	2.388	0.383	2.052	2.495
50 to 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 to 34	0.044	0.571	2.034	2.615	0.500	2.385	3.147
35 to 49	0.006	0.968	3.666	4.204	0.483	2.577	3.053
50 to 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 10-101. 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 to $15,000	0.071	0.121
$15,001 to $20,000	0.144	0.072
$20,001 to $25,000	0.202	0.000
$25,001 to $35,000	0.416	0.030
$35,001+	0.175	0.090
Total finfish		
≤ $10,000	0.235	0.272
$10,001 to $15,000	0.095	0.254
$15,001 to $20,000	0.490	0.915
$20,001 to $25,000	0.421	0.196
$25,001 to $35,000	0.236	0.387
$35,001+	0.286	0.785
Total fish		
≤$10,000	0.521	0.476
$10,001 to $15,000	0.266	0.432
$15,001 to $20,000	0.640	0.961
$20,001 to $25,000	0.921	0.233
$25,001 to $35,000	0.930	0.426
$35,001+	0.607	1.085

Source: Toy et al. (1996).

Table 10-102. Mean, 50th, and 90th Percentiles of Consumption Rates for Children Age Birth to 5 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 10-103. 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	95th	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 limit.
UCL = Upper confidence limit.
GM = Geometric mean.
MSE = 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 10-104. 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 10-104. Adult Consumption Rate (g/kg-day) for Consumers Only (continued)

		Consumers Only					
Group	Species	*N*	Mean	SE	Median	75th Percentile	90th Percentile
Group E (cont'd)	Red Rock Crab	19	0.037	0.010	0.012	0.057	0.117
	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
	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.
--- Not reported.

Table 10-105. Adult Consumption Rate (g/kg-day) by Sex

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 = 0.02)														
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.
MSE = Multiplicative standard error.
Note: 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 10-106. Adult Consumption Rate (g/kg-day) by Age

Species/Age 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 to 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 to 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 to 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 to 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 to 42 Years	58	0.122	0.026	0.071	0.173	0.000	0.055	0.134	0.301	0.578	54	93	0.061	1.186
43 to 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 to 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 to 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 to 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 to 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 to 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 to 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 to 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 to 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 to 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 to 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 to 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 to 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 10-106. Adult Consumption Rate (g/kg-day) by Age (continued)

Species/Age Group	All Adult Respondents (Including Non-Consumers)										Consumers Only			
	N	Mean	SE	95% LCL	95% UCL	Percentiles 5th	50th	75th	90th	95th	*N*	%	GM	MSE
All Seafood (p = 0.09)														
16 to 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 to 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.
MSE = Multiplicative standard error.
Note: 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 10-107. 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 0.035.

Source: Duncan (2000).

Table 10-108. 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	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 10-109. Percentiles and Mean of Consumption Rates for Adult Consumers Only (g/kg-day)

Species	N	Mean	SD	95% CI	Percentiles						
					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 10-110. Percentiles and Mean of Consumption Rates by Sex for Adult Consumers Only (g/kg-day)

Species	Sex	*N*	Mean	SD	95% CI	Percentiles						
						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 10-110. Percentiles and Mean of Consumption Rates by Sex for Adult Consumers Only (g/kg-day) (continued)

						Percentiles						
Species	Sex	*N*	Mean	SD	95% CI	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.
\- = No data.

Source: Polissar et al. (2006).

Table 10-111. Percentiles and Mean of Consumption Rates by Age for Adult Consumers Only—Squaxin Island Tribe (g/kg-day)

Species	Age Group (years)	*N*	Mean	SD	95% CI	Percentiles 5th	10th	25th	50th	75th	90th	95th
Anadromous fish	18 to 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 to 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 to 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 to 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 to 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 to 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 to 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 to 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 to 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 to 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 to 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 to 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 to 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 to 49	10	0.014	0.008	(0.009–0.019)	-	0.005	0.007	0.015	0.020	0.022	-
	50 to 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 10-111. Percentiles and Mean of Consumption Rates by Age for Adult Consumers Only—Squaxin Island Tribe (g/kg-day) (continued)

Species	Age Group (years)	*N*	Mean	SD	95% CI	Percentiles 5th	10th	25th	50th	75th	90th	95th
All finfish	18 to 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 to 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 to 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 to 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 to 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 to 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.
\- = No data.

Source: Polissar et al. (2006).

Table 10-112. Percentiles and Mean of Consumption Rates by Age for Adult Consumers Only—Tulalip Tribe (g/kg-day)

Species	Age Group (years)	*N*	Mean	SD	95% CI	Percentiles 5th	10th	25th	50th	75th	90th	95th
Anadromous fish	18 to 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 to 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 to 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 to 34	12	0.092	0.099	(0.051–0.173)	-	0.016	0.021	0.054	0.124	0.218	-
	35 to 49	15	0.077	0.118	(0.039–0.206)	-	0.013	0.015	0.021	0.087	0.189	-
	50 to 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 to 34	14	0.075	0.138	(0.033–0.205)	-	0.007	0.010	0.020	0.078	0.142	-
	35 to 49	16	0.066	0.069	(0.041–0.112)	-	0.007	0.023	0.053	0.077	0.152	-
	50 to 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 to 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 to 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 to 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 to 34	15	0.097	0.146	(0.043–0.197)	-	0.010	0.017	0.033	0.102	0.319	-
	35 to 49	13	0.057	0.085	(0.022–0.123)	-	0.004	0.006	0.014	0.049	0.187	-
	50 to 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 to 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 to 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 to 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 to 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 to 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 to 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	-	-

\- = No data.

Source: Polissar et al. (2006).

Table 10-113. 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.
\- = No data.

Source: Polissar et al. (2006).

Table 10-114. Percentiles and Mean of Consumption Rates by Sex for Child Consumers Only (g/kg-day)

					Percentiles						
Species	Sex	*N*	Mean	SD	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.
\- = No data.

Source: Polissar et al. (2006).

Table 10-115. Consumption Rates of API Community Members

Category	*N*	Median (g/kg-day)	Mean (g/kg-day)	Percentage of Consumption[a]	SE	95% LCI (g/kg-day)	95% UCI (g/kg-day)	90th Percentile (g/kg-day)
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	0.043	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.
UCI = 95% upper confidence interval.
Note: Confidence intervals were computed based on the Student's t-distribution. Rates were weighted across ethnic groups.

Source: U.S. EPA (1999).

Table 10-116. Demographic Characteristics of "Higher" and "Lower" Seafood Consumers

		All Finfish		Shellfish	
	N	Lower Consumers (%)	Higher Consumers[a] (%)	Lower Consumers (%)	Higher Consumers[b] (%)
Female	107	76	24	71	29
Male	95	81	19	79	21
18 to 29 years	78	85	15	73	27
30 to 54 years	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 percentile = 1.144 g/kg-day.
[b] Higher Consumer: >75 percentile = 1.072g/kg-day.
N = Sample size.

Source: U.S. EPA (1999).

Table 10-117. Seafood Consumption Rates by Ethnicity for Asian and Pacific Islander Community (g/kg-day)[a]											
Category	Ethnicity	*N*	Mean	SE	10 Percentile	Median	90 Percentile	% 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

Table 10-117. Seafood Consumption Rates by Ethnicity for Asian and Pacific Islander Community (g/kg-day)[a] (continued)											
Category	Ethnicity	*N*	Mean	SE	10 Percentile	Median	90 Percentile	% With Non-Zero Consumption	Consumers (%)	95% LCI	95% UCI
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 10-117. Seafood Consumption Rates by Ethnicity for Asian and Pacific Islander Community (g/kg-day)[a] (continued)

Category	Ethnicity	*N*	Mean	SE	10 Percentile	Median	90 Percentile	% With Non-Zero Consumption	Consumers (%)	95% LCI	95% UCI
Miscellaneous Fish	Cambodian	20	0.113	0.026	0.000	0.087	0.345	18	90	0.058	0.168
($p < 0.001$)	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	Cambodian	20	0.390	0.098	0.061	0.223	1.379	20	100	0.185	0.594
($p < 0.001$)	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

Table 10-117. Seafood Consumption Rates by Ethnicity for Asian and Pacific Islander Community (g/kg-day)[a] (continued)

Category	Ethnicity	*N*	Mean	SE	10 Percentile	Median	90 Percentile	% With Non-Zero Consumption	Consumers (%)	95% LCI	95% UCI
All Fish	Cambodian	20	1.421	0.274	0.245	1.043	3.757	20	100	0.850	1
($p < 0.001$)	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
All Seafood	Cambodian	20	1.423	0.274	0.245	1.043	3.759	20	100	0.851	1.995
($p < 0.001$)	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/day. Weighted by population percentage.
N = Sample size.
SE = Standard error.
LCI = Lower confidence interval.
UCI = Upper confidence interval.
Note: *p*-values are based on Kruskal-Wallis test.

Source: U.S. EPA (1999).

Table 10-118. Consumption Rates by Sex for All Asian and Pacific Islander Community

	Female				Male			
Category	*N*	Mean (g/kg-day)	SE	Median (g/kg-day)	*N*	Mean (g/kg-day)	SE	Median (g/kg-day)
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.
Note: *p*-values are based on Mann-Whitney test.

Source: U.S. EPA (1999).

Table 10-119. 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
Mackerel	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 10-119. 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 10-120. Mean, Median and 95th Percentile Fish Intake Rates for Different Groups (g/day)							
Sample Group	**Sample Size**	**Local Fish Intake[a]**			**Total Fish Intake[b]**		
		Mean	**Median**	**95th**	**Mean**	**Median**	**95th**
Ethnicity							
African American	32	31.2	21.3	242.3	48.3	21.3	252.0
Southeast Asian	152	32.3	17.0	129.4	42.8	24.1	180.2
Hmong	67	17.8	14.9	89.6	22.3	19.1	89.6
Lao	30	57.6	21.3	310.4	65.2	24.1	317.5
Vietnamese	33	27.1	21.7	152.4	55.4	36.1	249.3
Asian/Pacific Islander	38	23.8	15.6	148.3	46.1	35.0	156.4
Hispanic	45	25.8	19.1	155.9	36.3	14.2	169.5
Native American	6	6.5	ND[c]	ND	69.9	108.4	ND
White	57	23.6	21.3	138.9	34.7	28.4	139.2
Russian	17	23.7	17.7	ND	36.1	35.5	ND
All Anglers	373	27.4	19.7	126.6	40.6	26.1	147.3
Southeast Asian[d]	286	40.8	17.0	128.5	50.3	25.5	144.5
Hmong[d]	130	21.3	14.9	102.1	26.5	17.0	119.7
Lao[d]	54	47.2	17.0	265.8	54.4	28.4	267.0
Age							
18 to 34	143	32.0	24.6	138.9	44.9	25.5	151.5
35 to 49	130	22.7	14.2	120.5	36.8	24.0	143.9
>49	87	30.6	17.0	207.0	44.3	24.1	217.2
Sex							
Female	35	38.2	22.5	226.8	53.9	24.6	263.1
Male	336	26.4	19.5	129.3	39.3	26.1	146.6
Household Contains							
Women 18 to 49 years	217	33.0	21.2	142.2	46.6	25.5	158.1
Children	174	35.1	22.2	142.8	49.2	27.1	171.9
Awareness[e]							
0	172	24.7	18.2	121.6	35.5	23.0	143.5
1	44	42.8	28.0	361.1	52.9	28.5	361.1
2	115	28.4	21.3	139.6	45.8	28.0	151.7
3	35	12.2	13.8	62.4	28.1	20.8	95.6
4	7	57.1	36.1	ND	65.0	39.0	ND

[a] Locally caught fish.
[b] Locally caught and commercially obtained fish.
[c] Not determined because of insufficient data.
[d] All data shown are for angler surveying, except for these groups which are rates from combined angler and community surveys.
[e] Respondent responses when asked about their awareness of warnings about fish contamination ranged from 0 = no awareness to 4 = high awareness.

Source: Shilling et al. (2010).

Table 10-121. 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 to 2 Male-Female	52	38	8	28	43	58	112	125	168
3 to 5 Male-Female	70	51	12	36	57	85	113	170	240
6 to 8 Male-Female	81	58	19	40	72	112	160	170	288
9 to 14 Male	101	78	28	56	84	113	170	255	425
9 to 14 Female	86	62	19	45	79	112	168	206	288
15 to 18 Male	117	115	20	57	85	142	200	252	454
15 to 18 Female	111	102	24	56	85	130	225	270	568
19 to 34 Male	149	125	28	64	113	196	284	362	643
19 to 34 Female	104	74	20	57	85	135	184	227	394
35 to 64 Male	147	116	28	80	113	180	258	360	577
35 to 64 Female	119	98	20	57	85	152	227	280	480
65 to 74 Male	145	109	35	75	113	180	270	392	480
65 to 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 10-122. 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 10-123. 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).

Table 10-124. Percentage of Individuals Using Various Cooking Methods at Specified Frequencies

Study	Use Frequency	Bake	Pan Fry	Deep Fry	Broil or Grill	Poach	Boil	Smoke	Raw	Other
Connelly et al. (1992)	Always	24[a]	51	13		24[a]				
	Ever	75[a]	88	59		75[a]				
Connelly et al. (1996)	Always	13	4	4						
	Ever	84	72	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. (1982)	As Primary Method	16.3	52.5	12					0.25	19[h]

[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 10-125. 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
Caviar, 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 10-125. 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
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

Table 10-125. Mean Percent Moisture and Total Fat Content for Selected Species (continued)

Species	Moisture Content (%)	Total Fat Content (%)	Comments
	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
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

Table 10-125. Mean Percent Moisture and Total Fat Content for Selected Species (continued)

Species	Moisture Content (%)	Total Fat Content (%)	Comments
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	Cooked, 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
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).

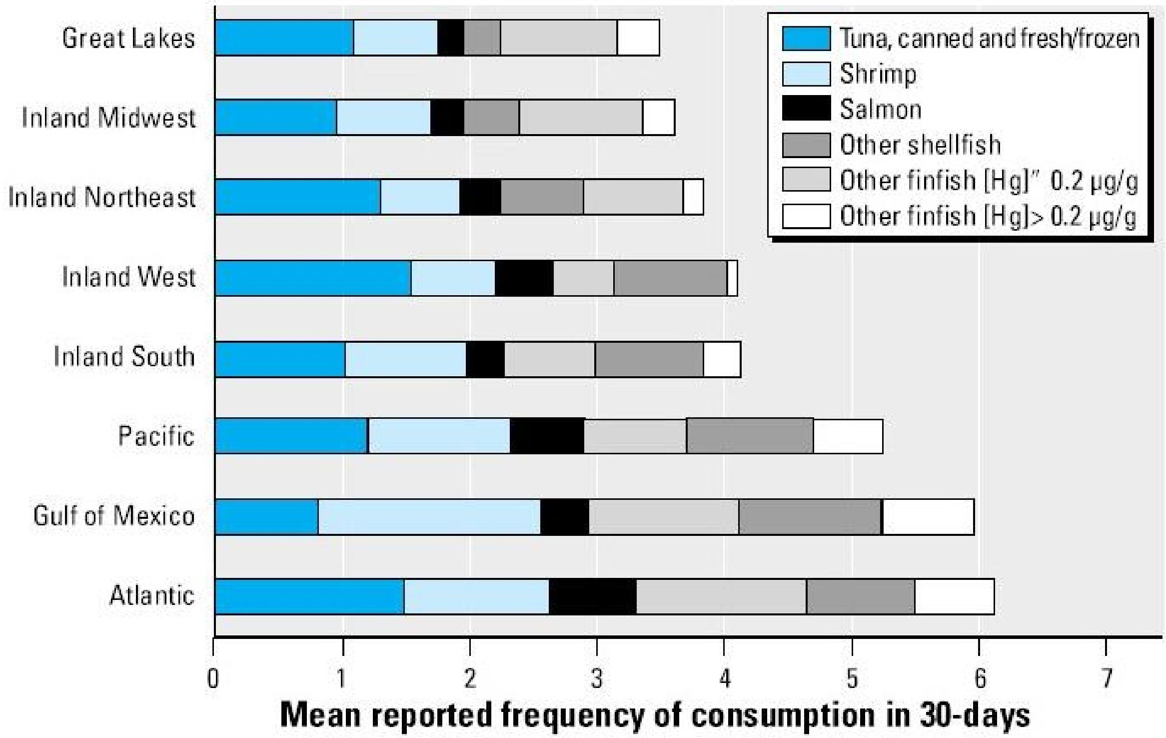

Figure 10-2. Species and Frequency of Meals Consumed by Geographic Residence.

Source: Mahaffey et al. (2009).

APPENDIX 10A:

RESOURCE UTILIZATION DISTRIBUTION

10A.1. 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% of individuals consume below it; on the other hand, the 50th percentile of the resource utilization distribution is that level such that 50% 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 i^{th} 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 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 *p*th 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	0	0	0.5	0.2	--
Total (*N*)	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.

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	0.0	0.0	0.3	0.4	0.0	0.2
Total (*N*)	246	448	417	502	287	1,946
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	0.0	0.0	0.0	0.4	0.0	0.1
Total (*N*)	174	287	246	294	163	1,187

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*)	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

N = Total number of respondents.

Source: West et al. (1993).

Table 10B-4. Percent of Fish Meals Prepared Using Various Cooking Methods by Education

Ethnicity	Through Some H.S.	H.S. Degree	College Degree	Post-Graduate Education
Total Fish				
Cooking Method				
Pan Fried	44.7	41.8	28.8	22.9
Deep Fried	23.6	23.6	23.8	19.4
Boiled	2.2	2.8	5.1	5.8
Grilled/Broiled	8.9	10.9	23.8	34.1
Baked	8.1	12.1	11.6	12.8
Combination	10.0	5.1	3.0	3.8
Other (Smoked, etc.)	2.1	3.4	4.0	1.3
Don't Know	0.5	0.3	0	0
Total (*N*)	236	775	704	211
Sport Fish				
Pan Fried	56.1	52.4	41.8	36.3
Deep Fried	13.6	15.8	18.6	12.9
Boiled	2.8	2.4	3.0	0
Grilled/Broiled	6.3	9.4	21.7	28.3
Baked	7.4	10.6	6.1	14.9
Combination	10.1	6.3	3.9	6.5
Other (Smoked, etc.)	2.8	3.3	4.6	1.0
Total (*N*)	0.8	0	0	0
	146	524	421	91

N = Total number of respondents.

Source: West et al. (1993).

Table 10B-5. Percent of Fish Meals Prepared Using Various Cooking Methods by Income

Ethnicity	0–$24,999	$25,000–$39,999	$40,000–or more
Total Fish			
Cooking Method			
Pan Fried	44.8	39.1	26.5
Deep Fried	21.7	22.2	23.4
Boiled	2.1	3.5	5.6
Grilled/Broiled	11.3	15.8	25.0
Baked	9.1	12.3	13.3
Combination	8.7	2.9	2.5
Other (Smoked, etc.)	2.4	4.0	3.5
Don't Know	0	0.2	0.3
Total (*N*)	544	518	714
Sport Fish			
Pan Fried	51.5	51.4	42.0
Deep Fried	15.8	15.8	17.2
Boiled	1.8	2.1	3.7
Grilled/Broiled	12.0	12.2	19.4
Baked	7.2	10.0	10.0
Combination	9.1	3.8	3.5
Other (Smoked, etc.)	2.7	4.6	3.8
Total (*N*)	0	0	0.3
	387	344	369

N = Total number of respondents.

Source: West et al. (1993).

Table 10B-6. Percent of Fish Meals Where Fat was Trimmed or Skin was Removed, by Demographic Variables

	Total Fish		Sport Fish	
Population	Trimmed Fat (%)	Skin Off (%)	Trimmed Fat (%)	Skin Off (%)
		Total Fish		
Residence Size				
Large City/Suburb	51.7	31.6	56.7	28.9
Small City	56.9	34.1	59.3	36.2
Town	50.3	33.4	51.7	33.7
Small Town	52.6	45.2	55.8	51.3
Rural Non-Farm	42.4	32.4	46.2	34.6
Farm	37.3	38.1	39.4	42.1
Age (years)				
17–30	50.6	36.5	53.9	39.3
31–40	49.7	29.7	51.6	29.9
41–50	53.0	32.2	58.8	37.0
51–65	48.1	35.6	48.8	37.2
Over 65	41.6	43.1	43.0	42.9
Ethnicity				
Black	25.8	37.1	16.0	40.1
Native American	50.0	41.4	56.3	36.7
Hispanic	59.5	7.1	50.0	23.0
White	49.3	34.0	51.8	35.6
Other	77.1	61.6	75.7	65.5
Education				
Some High School	50.8	43.9	49.7	47.1
High School Degree	47.2	37.1	49.5	37.6
College Degree	51.9	31.9	55.9	33.8
Post-Graduate	47.6	26.6	53.4	38.7
Income				
<$25,000	50.5	43.8	50.6	47.3
$25,000–$39,999	47.8	34.0	54.9	34.6
$40,000 or more	50.2	28.6	51.7	27.7
Overall	49.0	34.7	52.1	36.5

Source: Modified from West et al. (1993).

Table 10B-7. Method of Cooking of Most Common Species Kept by Sportfishermen

Species	Percent of Anglers Catching Species	Use as Primary Cooking Method (%)				
		Deep Fried	Pan Fry	Bake and Charcoal Broil	Raw	Other[b]
White Croaker	34	19	64	12	0	5
Pacific Mackerel	25	10	41	28	0	21
Pacific Bonito	18	5	33	43	2	17
Queenfish	17	15	70	6	1	8
Jacksmelt	13	17	57	19	0	7
Walleye Perch	10	12	69	6	0	13
Shiner Perch	7	11	72	8	0	11
Opaleye	6	16	56	14	0	14
Black Perch	5	18	53	14	0	15
Kelp Bass	5	12	55	21	0	12
California Halibut	4	13	60	24	0	3
Shellfish[a]	3	0	0	0	0	100

[a] Crab, mussels, lobster, abalone.
[b] Boil, soup, steam, stew.
N = 1,059.

Source: Modified from Puffer et al. (1982).

Table 10B-8. Adult Consumption of Fish Parts

Species	Number Consuming	Weighted Percent Consuming Specific Parts					
		Fillet	Skin	Head	Eggs	Bones	Organs
Salmon	473	95.1	55.8	42.7	42.8	12.1	3.7
Lamprey	249	86.4	89.3	18.1	4.6	5.2	3.2
Trout	365	89.4	68.5	13.7	8.7	7.1	2.3
Smelt	209	78.8	88.9	37.4	46.4	28.4	27.9
Whitefish	125	93.8	53.8	15.4	20.6	6.0	0.0
Sturgeon	121	94.6	18.2	6.2	11.9	2.6	0.3
Walleye	46	100	20.7	6.2	9.8	2.4	0.9
Squawfish	15	89.7	34.1	8.1	11.1	5.9	0.0
Sucker	42	89.3	50.0	19.4	30.4	9.8	2.1
Shad	16	93.5	15.7	0.0	0.0	3.3	0.0

Source: CRITFC (1994).

10B.1. REFERENCES FOR APPENDIX 10B

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