

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. Chapter 9 of the *Exposure Factors Handbook* provides information on and recommendations for fruit and vegetable ingestion rates. This information is highlighted here.

9.2 Recommended Exposure Factors

Table 9-1 presents a summary of the recommended values for per capita and consumer-only intake of total fruits and total vegetables. These values are based on the U.S. EPA analysis of NHANES 2003-2006 data. NHANES collected 24-hour dietary intake data via interviews conducted on 2 non-consecutive days. U.S. EPA converted intake data on the foods people reported eating to the quantities of agricultural commodities eaten (e.g., an apple pie may contain the commodities apples, flour, fat, sugar, and spices), and estimated intake rates for fruits and vegetables. 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). 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. Overall confidence in the averages is medium-high, low for some individual fruits and vegetables with small sample size, and low in the long-term upper percentiles.



Table 9-1. Recommended Values for Intake of Fruits and Vegetables, Edible Portion, Uncooked^{a, b}

Age Group	Per Capita		Consumers Only	
	Mean	95 th Percentile	Mean	95 th Percentile
	g/kg-day	g/kg-day	g/kg-day	g/kg-day
Total Fruits				
Birth to 1 year	6.2	23.0 ^c	10.1	25.8 ^c
1 to <2 years	7.8	21.3 ^c	8.1	21.4 ^c
2 to < 3 years	7.8	21.3 ^c	8.1	21.4 ^c
3 to <6 years	4.6	14.9	4.7	15.1
6 to <11 years	2.3	8.7	2.5	9.2
11 to <16 years	0.9	3.5	1.1	3.8
16 to <21 years	0.9	3.5	1.1	3.8
21 to <50 years	0.9	3.7	1.1	3.8
≥50 years	1.4	4.4	1.5	4.6
Total Vegetables				
Birth to 1 year	5.0	16.2 ^c	6.8	18.1 ^c
1 to <2 years	6.7	15.6 ^c	6.7	15.6 ^c
2 to < 3 years	6.7	15.6 ^c	6.7	15.6 ^c
3 to <6 years	5.4	13.4	5.4	13.4
6 to <11 years	3.7	10.4	3.7	10.4
11 to <16 years	2.3	5.5	2.3	5.5
16 to <21 years	2.3	5.5	2.3	5.5
21 to <50 years	2.5	5.9	2.5	5.9
≥50 years	2.6	6.1	2.6	6.1
Individual Fruits and Vegetables—See Tables 9-5 and 9-6 in the <i>Exposure Factors Handbook</i>				
^a Analysis was conducted using slightly different childhood age groups than those recommended in <i>Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants</i> (U.S. EPA, 2005). Data were placed in the standardized age categories closest to those used in the analysis.				
^b For multiple percentiles, see Tables 9-3 and 9-4 in the <i>Exposure Factors Handbook</i> .				
^c Estimates are less statistically reliable based on guidance published in the <i>Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations</i> (NCHS, 1993).				
Source: U.S. EPA analysis of NHANES 2003-2006 data.				

For more information about the key studies used to derive the recommended values for intake of fruits and vegetables, refer to **Chapter 9 of the *Exposure Factors Handbook*** at <http://www.epa.gov/ncea/efh/pdfs/efh-chapter09.pdf>. Detailed information on the intake studies is provided in Section 9.3. Section 9.4 presents information on the conversion between intake rates for wet weight and dry weight (i.e., the weight of the food consumed after the moisture content has been removed). For more information on consumption of individual fruits and vegetables, refer to Chapter 9 of the *Exposure Factors Handbook*.

For more information on potential contaminant loss to cooking and conversions necessary to account for such losses, refer to Chapter 13 of the *Exposure Factors Handbook*.