

## 4. Non-Dietary Ingestion Factors

### 4.1 Introduction

Adults and children have the potential for exposure to toxic substances through non-dietary ingestion when these substances are transferred from treated surfaces to the hands or objects that are mouthed. Mouthing behavior includes all activities in which objects, including fingers, are touched by the mouth or put into the mouth except for eating and drinking, and includes licking, sucking, chewing, and biting (Groot et al., 1998). Adults mouth objects such as cigarettes, pens and pencils, or their hands. Young children mouth objects, surfaces, or their fingers as they explore their environment. Data on mouthing frequency (e.g., contacts per hour or contacts per minute) and/or duration of mouthing events (how long each contact lasts, expressed in units of seconds or minutes) are required in order to estimate the magnitude of exposure to toxic substances through this behavior. Chapter 4 of the *Exposure Factors Handbook* provides information on mouthing behaviors and their frequency and duration in children and adults. Highlights of these data are provided here.

### 4.2 Recommended Exposure Factors

**Hand-to-Mouth and Object-to-Mouth Frequencies:** Mouthing frequencies are expressed in units of contacts per hour, between either any part of the hand (including fingers and thumbs) and the mouth, or between an object or surface and the mouth. The recommended hand-to-mouth frequencies are based on data from Xue et al. (2007). The recommendations for frequency of object-to-mouth contact are based on data from Xue et al. (2009). Xue et al. (2007, 2009) report a secondary analysis of data from several studies summarized in Chapter 4 of the *Exposure Factors Handbook*, as well as data from unpublished studies. Table 4.1 presents the recommended values for mouthing frequency. The overall confidence rating for hand-to-mouth and object-to-mouth contact frequency is low.

**Hand-to-Mouth and Object-to-Mouth Duration:** Recommendations for duration of object-to-mouth contacts are based on data from Juberg et al. (2001), Greene (2002), and Beamer et al. (2008). Recommendations for

hand-to-mouth duration are not provided because the algorithm to estimate exposures from this pathway is not time dependent. Table 4-1 presents the recommended values for mouthing duration. The overall confidence rating for hand-to-mouth and object-to-mouth duration is low.



**For more information** about the key studies used to derive the recommended mouthing frequency and duration values, refer to **Chapter 4 of the *Exposure Factors Handbook*** at <http://www.epa.gov/ncea/efh/pdfs/efh-chapter04.pdf>. Detailed information about studies on mouthing frequency in children is included in Section 4.3, and studies regarding mouthing duration are provided in Section 4.4. Information on mouthing prevalence (i.e., the number or percentage of children performing specific mouthing behaviors at a certain age) is provided in Section 4.5.

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

Age Group	Hand-to-Mouth <sup>a</sup>			
	Indoor Frequency (contacts/hour)		Outdoor Frequency (contacts/hour)	
	Mean	95 <sup>th</sup> Percentile	Mean	95 <sup>th</sup> Percentile
Birth to <3 months	-	-	-	-
3 to <6 months	28	65	-	-
6 to <12 months	19	52	15	47
1 to <2 years	20	63	14	42
2 to <3 years	13	37	5	20
3 to <6 years	15	54	9	36
6 to <11 years	7	21	3	12
11 to <16 years	-	-	-	-
16 to <21 years	-	-	-	-
Age Group	Object-to-Mouth <sup>b</sup>			
	Indoor Frequency (contacts/hour)		Outdoor Frequency (contacts/hour)	
	Mean	95 <sup>th</sup> Percentile	Mean	95 <sup>th</sup> Percentile
Birth to <3 months	-	-	-	-
3 to <6 months	11	32	-	-
6 to <12 months	20	38	-	-
1 to <2 years	14	34	8.8	21
2 to <3 years	9.9	24	8.1	40
3 to <6 years	10	39	8.3	30
6 to <11 years	1.1	3.2	1.9	9.1
11 to <16 years	-	-	-	-
16 to <21 years	-	-	-	-
Age Group	Mean Duration (minutes/hour) <sup>c</sup>		95 <sup>th</sup> Percentile Duration (minutes/hour) <sup>c</sup>	
Birth to <3 months	-		-	
3 to <6 months	11 <sup>d</sup>		26 <sup>e</sup>	
6 to <12 months	9 <sup>f</sup>		19 <sup>g</sup>	
1 to <2 years	7 <sup>h</sup>		22 <sup>h</sup>	
2 to <3 years	10 <sup>i</sup>		11 <sup>j</sup>	
3 to <6 years	-		-	
6 to <11 years	-		-	
11 to <16 years	-		-	
16 to <21 years	-		-	

<sup>a</sup> Source: Xue et al., 2007.

<sup>b</sup> Source: Xue et al., 2009.

<sup>c</sup> Source: Juberg et al., 2001; Greene, 2002; and Beamer et al., 2008.

<sup>d</sup> Mean calculated from Juberg et al., 2001 (0 to 18 months) and Greene, 2002 (3 to 12 months).

<sup>e</sup> Calculated 95<sup>th</sup> percentile from Greene, 2002 (3 to 12 months).

<sup>f</sup> Mean calculated from Juberg et al., 2001 (0 to 18 months); Greene, 2002 (3 to 12 months); and Beamer et al., 2008 (6 to 13 months).

<sup>g</sup> Calculated 95<sup>th</sup> percentile from Greene, 2002 (3 to 12 months) and Beamer et al., 2008 (6 to 13 months).

<sup>h</sup> Mean and 95<sup>th</sup> percentile from Greene, 2002 (12 to 24 months).

<sup>i</sup> Mean calculated from Juberg et al., 2001 (19 to 36 months); Greene, 2002 (24 to 36 months); and Beamer et al., 2008 (20 to 26 months).

<sup>j</sup> Calculated 95<sup>th</sup> percentile from Greene, 2002 (24 to 36 months) and Beamer et al., 2008 (20 to 26 months).

- No data.