	Study/Reference	Summary	Study Methodology	Sample Size	Age (years)	Ingestion Medium	Central Tendency p50 (mean)	p95 (mg/day)	Study Duration	Long term extrapolation	Primary or Secondary data	Notes	EFH
Key Studies of Primary Analysis	Calabrese et al. (1989)	Amherst Study: mass balance approach. Sample dust and soil was collected in the child's play areas and analyzed for the presence of the tracers used.	Tracers: Al, Ba, Mn, Si, Vn, Y, Zi, Ti	64	1 to 4	soil dust soil + dust	-261 to +96 -340 to +127 -340 to +456	106 to 1,903 160 to 2,916 159 to 3,174	Two weeks (two 3-4 day time periods)	No	Primary	One child may have had pica behavior. Authors were unable to distinguish the contribution of soil and dust since tracer concentration was similar for the two mediums. Negative values come from very high levels of barium and manganese (and possibly other tracers) in food.	Yes
	Calabrese et al. (1997)	Anaconda Study: Superfund site in Montana. Soil ingestion was estimated using a mass balance approach.	Tracers: Al, Ce, La, Nd, Si, Ti, Y, Zr	64	1 to 4	soil dust	20.1 26.8	282.4 613.6	one week (seven consecutive days)	No	Primary	A control study in adults was also conducted to test the stability and reliability of the tracers. Al, Si, Y were found to be most stable/reliable.	Yes
	Van Wijnen et el (1990)	Netherland Study: included 4 groups of children: 1. that live in the inner city (with little soil contact), 2. living in homes with a garden, 3. from campgrounds, and 4. admitted to a hospital (control group)	Tracers: Al, Ti, and Acid-insoluble residue (AIR)	292	0.1 to <1 1 to 5	Soil Soil	NR (0 to 30a) NR (0 to 200a)	NR NR	Two weeks (two 3-4 day time periods)	No	Primary	LTM method was used (limiting tracer method). Values presented represents the ingestion rate *after* correcting the ingestion rate by subtracting the ingestion rate of the control group of children in the hospital.	Yes
	Davis et al. (1990)	Washington State (three cities): Soil and dust ingestion was evaluated by analyzing soil, dust, feces, urine, and duplicate food, dietary supplement, medication and mouthwash samples for the tracer elements. Children were randomly selected.	Tracer: Aluminum Tracer: Silicon	104	2 to 7	soil/dust soil/dust	NR (60) NR (160)	NR NR	one week	No	Primary	Values were adjusted to represent a weighted average of the tracer concentration in yard soil and house dust based on proportion of time spent indoors and outdoors (assuming ingestion of soil was the same as ingestion of dust).	Yes
	Davis and Mirick (2006)	Children and adults from same family: Soil ingestion was estimated using a mass balance approach.	Tracers: Al, Si	12 38 12 38	3 to 8 **adults** 3 to 8 **adults**	soil soil soil soil	30 0 to 20 45 200 to 260	NR NR NR NR	11 consecutive days	No	Primary	Titanium was shown to be reliable and stable in children, but not in adults (Calabrese and Stanek 1995)	Yes
	Vermeer and Frate (1979)	Surveyed about geophagy (regular consumption of clay over weeks); N= 229 in 50 households; 56 women, 33 men, 140 children or adolescents.	Questionaire/ Survey	115 56	1 to 13 Female Adults	Soil Soil	NR NR	NR NR	NA	No	Data not empirically collected	No geophagia was reported among men or adolescents. Also, only 2 children over the age of 4 practiced geophagia.	Yes

	Study/Reference	Summary	Study Methodology	Sample Size	Age (years)	Ingestion Medium	Central Tendency p50 (mean)	p95 (mg/day)	Study Duration	Long term extrapolation	Primary or Secondary data	Notes	EFH
Key Studies of Secondary Analysis	Wong (1988); Calabrese and Stanek (1993)	Wong (1988) is a dissertation investigating the exposure to parasites. Calabrese and stanek reviewed because of its information on soil ingestion, particularly soil pica.	Tracer: Silicon	15	0.3 to 7.5	soil	NR	NR	4 months; 1 fecal sample collected per month	No	Both	5 of the 24 younger children displayed soil pica (> 1 g soil per day) on at least one occasion. Study did not use mass balance, but instead used hospitalized children as controls. Children were in government institutions waiting for foster home placement.	Yes
				28	1.8 to 14	soil	NR	NR					
	Stanek and Calabrese (2000)	Anaconda reanalysis. After correcting for tracer error, ingestion rate data was re-analyzed. Original study by Calabrese et al. 1997	Tracers: Al, Si, Ti	64	1 to 4	soil	24	91		Yes	Primary		Yes
			Tracers: Al, Si, Ti			soil	17	106					
	Calabrese et al. (1989)	Amherst Study: reanalysis	Tracer: Al, Si, Y only	64	1 to 4	Soil	9 to 40	106 to 653	Two weeks (two - 3 to 4 day time periods)	No	Secondary	Authors performed adult control study to determine reliability of tracers and found that of the eight used, only Al, Si, and Y were stable and reliable.	No
						Dust	15 to 49	169 to 692					
						Soil + Dust	11 to 49	159 to 653					
	Calabrese and Stanek (1995)	After correcting for tracer error, ingestion rate data was re-analyzed. Original study by Van Wijnen et al. 1990	Day care/campground-revisited	292	0.1 to 5	soil	111	NR		No	Secondary		Yes
						soil	160	NR					
	Calabrese and Stanek (1995)	After correcting for tracer error, ingestion rate data was re-analyzed. Original study by Binder et al. 1986.	Tracer: Al	59	1 to 3	soil	121	NR		No	Secondary	The four best tracers were used (i.e., most stable with lowest F/S ratio)	No
			Tracer: Si			soil	136	NR					
			Tracer: Ti			soil	618	NR					
	Calabrese and Stanek (1995)	After correcting for tracer error, ingestion rate data was re-analyzed. Original study by Davis et al., 1990	Tracer: Al	104	2 to 7	soil	25	NR	one week	No	Secondary	The four best tracers were used (i.e., most stable with lowest F/S ratio)	Yes
			Tracer: Si			soil	59	NR					
			Tracer: Ti			soil	81	NR					
	Calabrese and Stanek (1995)	After correcting for tracer error, ingestion rate data was re-analyzed. Original study by Calabrese 1989 (Amherst Study)	Tracer: Al	64	1 to 4	soil	29	NR	Two weeks (two - 3 to 4 day time periods)	No	Secondary	The four best tracers were used (i.e., most stable with lowest F/S ratio)	Yes
			Tracer: Si			soil	40	NR					
			Tracer: Ti			soil	55	NR					
	Calabrese and Stanek (1995)	After correcting for tracer error, ingestion rate data was re-analyzed. Original study by Calabrese 1989	Tracers: Al, Si, Ti, Y, and Zr	6	Adults	soil	87	142	Three weeks	No	Secondary	The four best tracers were used (i.e., most stable with lowest F/S ratio)	Yes
	Hogan et al. (1998)	Biokinetic model comparison methodology to review the measured blood lead levels of children living near lead smelting communities.		478	0.3 to 1	soil	30	NR		No	Secondary	The study populations were in general random samples of children 6 months to 7 years of age. **The values derived for infants (i.e., <1 year) and children are EFH recommended values for soil and/or dust central tendency ingestion rates.**	
						dust	30						
					1 to 6	soil	50	NR					
			Biokinetic Model			dust	60	NR					Yes
	Ozkaynak et al. (2011)	Ozkaynak et al. developed soil and dust ingestion rates for children using US EPA SHEDS model.	Activity Pattern		3 to <6	soil/dust	37.75	224		Yes?	Secondary	60% of ingestion was from soil, 30% from dust on hands, and 10% from dust on objects.	Yes
	Wilson et al. (2013	Revisits the activity pattern method but simplifies it to overall activities and does not distinguish between individual activities.	Activity Pattern		0.2 to adult	soil	1.2 to 23	4.8 to 75		No	Secondary		No

Notes:
IR= ingestion rate
mg= milligrams
NR= Not reported
p50= the 50th percentile
p95= the 95th percentile
Mean= arithemetic mean unless otherwise denoted
a = geometric mean
** Value is presented as Best Tracer Methodology (BTM)
Best Tracer Methodology (BTM) uses food/soil (F/S) tracer concentration ratios in order to correct for errors caused by misalignment of tracer input and outputs, ingestion of non-food sources, and non-soil sources.
F/S ratio is the tracer concentration present in duplicate Food/Tracer concentration in Soil where children (or adults) spend their time

Table 5. Calculated arithmetic mean soil ingestion rates

Age (year)	Arithmetic ± SD (p95)
1 to 5	20 ± 26 (64)
5 to 11	23 ± 32 (75)
11 to 18	1.5 ± 2.6 (5.3)