Supplementary Materials

Table S1. Definition of soil and dust ingestion (SDI) in different studies.

Reference	SDI Definition	Age group	Deficiency
Li et al. (2021) [1]	ingest dust through mouthing hands (hand-to-mouth transfer) and objects (object-to-mouth transfer)	≤ 80 years	neglect SDI through the diet
Davis et al.(1990、2006) [2,3]	through recreation, gardening, eating locally grown food, and direct dust ingest	Young children	neglect SDI through mouth-to-object and hand-to-hand contact
Moya et al. (2014) [4]	unintentional SDI through contact of objects (including fingers) with the mouth, and intentional ingestion of soil (i.e., soil xenophagy)	Children	neglect SDI through the diet
Hubbard et al. (2022) [5]	SDI through increased exposure to soil or dust as a result of hobbies, occupations, or behaviors (e.g., cleaning)	≥21 years	neglect of SDI through contact with objects, contaminated food and from hands
This review	(1) adsorbed on object surfaces via direct mouth-object contact; (2) adhering to human hands (including geophagic and incidental behaviors) via mouth-hand contact; and (3) contained on the surfaces of food, fruits, etc., via dietary	all ages	-

Table S2. Summary of soil and dust ingestion rate (SDIR) from prior studies using the tracer element methodology.

Reference	SDIR (mg/d)		Tracers	Age group	N	Location
	Mean	median				
Binder et al. (1986) [6]	181	121	Al	1-3 years	59	USA
	184	136	Si			
Clausing et al. (1987) [7]	56	-	Al, Ti	2-4 years	18	Netherlands
Calabrese et al. (1989) [8]	154	30.0	Al	1-4 years	64	USA
	29.0	-19.0	Ba			
	483	49.0	Si			
	170	30.0	Ti			
	456	123	V			
	65.0	11.0	Y			
	23.0	11.0	Zr			
Davis et al. (1990) [2]	38.9	25.3	Al	2-7 years	104	USA
	82.4	59.4	Si			
	246	81.3	Ti			
J. H. Van Wijnen et al. (1990) [9]	0-90.0	-	Al, Ti	1-5 years	162	Netherlands
Stanek et al. (1995) [10]	29.0	13.0	Al	1-4 years	64	USA
	65.0	52.0	Ba			
	121	121	Mn			
	32.0	12.0	Si			
	31.0	15.0	Ti			
	47.0	24.0	V			
	15.0	6.00	Y			
	15.0	11.0	Zr			
	45.0	13.0	Overall			
EJ. Calabrese et al. (1997) [11]	2.70	-3.30	Al	1-4 years	10	USA

	117	44.9	Ce			
	8.60	84.5	La			
	42.3	32.1	Y			
	23.3	7.9	Al, Si, Ti, Y, Zr			
Bothe (2004) [12]	22	-	Al, Si, Sc, Ti, Ga, Y, Zr, Nb, La, Ce, Nd	<1	22	Germany
	100	-		1-2		
	35	-		2-7		
	57	-		7-12		
Davis et al. (2006) [3]	36.7	33.3	Al	3-7 years	12	USA
	38.1	26.4	Si			
	92.1	0.00	Al	Adults (mother)	19	
	23.2	5.20	Si			
	68.4	23.2	Al	Adults (father)	19	
	26.1	0.20	Si			
Stanek III et al. (2012) [13]	26.0	33.0	Al, Si	1-7 years	216	USA
	4.00	9.00		1-2 years	39	
	21.0	22.0		2-3 years	55	
	32.0	57.0		3-4 years	47	
	41.0	36.0		4-<8 years	75	
Doyle et al. (2012a) [14]	75.0	50.0	Al, Ce, La, Si	>20 years	7	Canada
	36.9	31.0	Al			
	49.4	40.0	Si			
	72.2	51	Ce			
Irvine et al. (2014) [15]	32.0	18.0	Al, Ce, La, Si	adults	9	Canada
	33.0	32.0	Al			
	11.0	10.0	Ce			
	12.0	11.0	La			
	75.0	61.0	Si			
	368	394	Ba			

Chien et al. (2015) [16]	9.60	0.00	Si	<3 years	66	China
Wang et al. (2015) [17]	1.79[b]	-	Ce, V, Y	3-<7 years	60	China
	2.12[b]	-		7-<13 years	30	
	0.49[b]	-		13-<17 years	30	
Lin et al. (2017) [18]	73.5	51.7	Al, Ce, Sc, V, Y	2.5-11.9 years	177	China
	47.7	27.8	Al			
	63.1	36.5	Ba			
	53.5	34.8	Ce			
	231	147	Mn			
	77.7	54.8	Sc			
	81.9	36.7	Ti			
	106.4	92.1	V			
	79.8	59.1	Y			
Ma et al. (2018) [19]	9.53[b]	8.72[b]	Ce	3-7 years	30	China
	7.06[b]	7.05[b]	V			
	6.61[b]	6.26[b]	Y			
	7.93[b]	7.96[b]	Ce	7-12 years	30	
	5.83[b]	5.74[b]	V			
	6.08[b]	5.64[b]	Y			
Wang et al. (2018a) [20]	60.8	41.4	Al, Ce, Sc, V, Y	2.5-<6 years	210	China
	91.6	72.7	Al, Ce, Sc, V, Y	6-<12years		
Wang et al. (2018b) [21]	45.2	44.8	Al, Ce, Sc, V, Y	12-16.5 years	30	China
	37.6	25.9	Al			
	53.7	23.1	Ba			
	53.1	40.4	Ce			
	56.9	53.2	Sc			
	62.7	50.9	Ti			
	66.0	74.8	V			
	45.8	40.5	Y			

Smolders et al. (2019) [22]	460[a]	360	Nb, Ti, V	2-3 years	10	Congo
	325	415		4-15 years	85	
	180	225		>15 years	64	
Yang et al. (2022) [23]	148	45.9	Al, Ce, Sc, Ti, Y	2-16 years	61	China
	113	124	Al			
	193	-210	Ba			
	18.8	27.1	Ce			
	57.5	23.9	Sc			
	228	176	Ti			
	166	-263	V			
	53.0	39.2	Y			
Gong et al. (2022) [24]	44.8	-	Ce, Sc, V, Y	2-17 years	240	China

[a] geometric mean; [b] hand-to-mouth SDIR.

Table S3. Summary of SDIR from prior studies using the biokinetic model comparison methodology.

Reference	Average all models (mg/d)	50/25/10/15-aveSDIR (mg/d)	Age group	Location
Von Lindern et al. (2016) [25]	84.0	86.0	0.5-<1 years	Idaho, UAS
	93.0	94.0	1-<2 years	
	67.0	67.0	2-<3 years	
	62.0	63.0	3-<4 years	
	65.0	67.0	4-<5 years	
	51.0	52.0	5-<6 years	
	53.0	55.0	6-<7 years	
	50.0	51.0	7-<8years	
	59.0	63.0	8-<9 years	
	57.0	59.0	9-<10 years	

Table S4. Summary of SDIR from prior studies using the activity pattern methodology.

Reference	SDIR (mg/d)	Age group	Location	Note
Day et al. (1975) [26]	100	not given	UK	-
Duggan et al. (1977) [27]	20	not given	UK	-
Özkaynak et al. (2011) [28]	68.0	3-<6 years	USA	-
Wilson et al. (2013) [29]	36.0	0-6 months	Canada	-
	61.0	7 months-4 years		
	55.0	5-11 years		
	3.70	12-19 years		
	4.20	20-59 years		
	3.80	>60 years		
Kwong et al. (2019) [30]	162	3-5 months	Bangladesh	-
	224	0.5-<1 years		
	234	1-<2 years		
	168	2-<3 years		
	178	3-<4 years		
Wang et al. (2021) [31]	90.7	2-3 years	Taiwan, China	sand (direct contact)
	29.8			clay (direct contact)
Özkaynak et al. (2022) [32]	35.0	0-<0.5 years	USA	-
	44.0	0.5-<1 years		
	48.0	1-<2 years		
	52.0	2-<3 years		
	59.0	3-<6 years		
	56.0	6-<11 years		
	44.0	11-<16 years		
	23.0	16-<21 years		
Hubbard et al. (2022) [33]	7.00	≥21 years	USA	low soil and dust
	33.0			moderate soil
	123			high soil
	25.0			high dust

Table S5. Summary of SDIR from prior studies using the dust/soil loading-activity pattern-based parametric formula methodology.

Reference	SDIR (mg/d)	Age group	Location
Li et al. (2023) [34]	245	1-12 years	China
	33.1	18-22 years	
	19.7	>45 years	

Table S6. Impact of different research methods on SDIR.

Method	Main types of deviations	Impacts on SDIR	Reference
TEM	tracer source error, transit time error, tracer element selection	underestimated (incomplete tracking of excretion, tracer absorbed in the gastrointestinal tract) or overestimated (non-dietary intake not accounted for)	Binder et al. (1986) [6] 、Lin et al. (2017) [18]
BMBC	inadequate consideration of model exposure duration and source of biomarkers	failure to consider all relevant sources may lead to overestimation of SDIR by underestimating biomarker concentrations	Wilson et al. (2013) [29], Von Lindern et al. (2016) [25]
APM	inadequate and missing information	inconclusive	Özkaynak et al. (2022) [32]
LPFM	insufficient data and differences in the choice of calculation parameters	inconclusive	Li et al. (2023) [34]

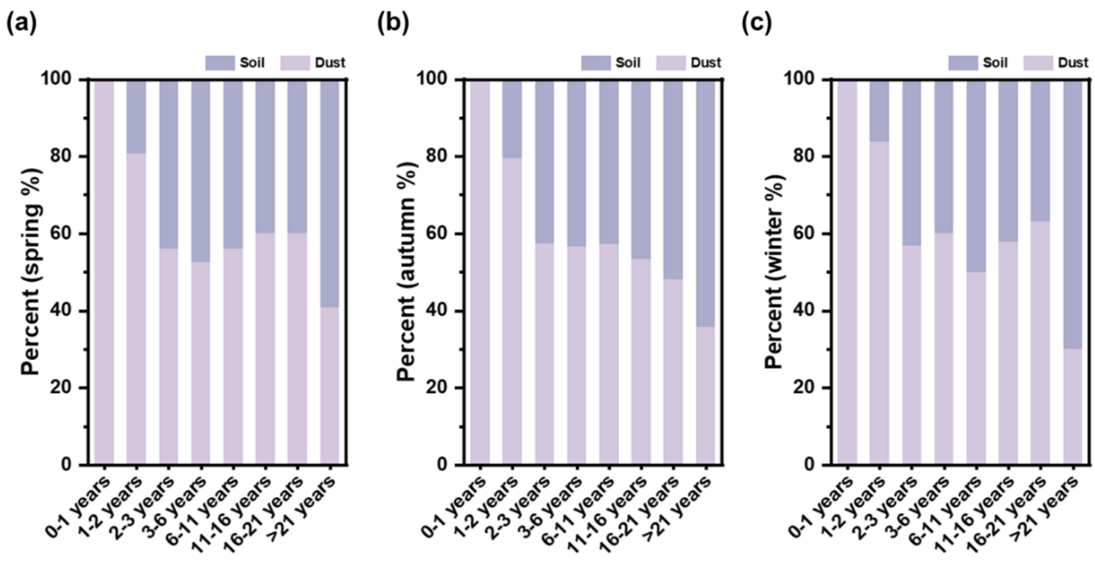

Figure S1. (a) Percentage of respective SDIR in different age groups during spring months, (b) Percentage of respective SDIR in different age groups during autumn months, and (c) Percentage of respective SDIR in different age groups during winter months. Reproduced with permission. Copyright 2022, Elsevier B.V. Publishing [33] and 2022, Nature Publishing [32].

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