

Supplementary Materials: Pollution Indexing and Health Risk Assessment of Heavy-Metals-Laden Indoor and Outdoor Dust in Elementary School Environments in Riyadh, Saudi Arabia

Modhi O. Alotaibi ¹, Lamia A. Albedair ², Nahaa Alotaibi ¹, Mudawi M. Elobeid ³, Hamed A. Al-Swadi ^{4,5}, Zafer Alasmary ⁴ and Munir Ahmad ^{4,*}

Table S1. The concentrations of the heavy metals in the outdoor dust samples of elementary schools in Riyadh city.

Site	Concentration of heavy metals in outdoor dust (mg kg^{-1})								
	Fe	Ti	Mn	Cd	Co	Cu	Ni	Pb	Zn
S1	4950	3690	536	0.075	3.08	40.7	13.8	2.91	56.3
S2	5960	4440	554	0.051	3.26	39.6	13.9	3.62	43.4
S3	5680	3590	471	0.031	1.67	34.0	7.42	2.37	34.6
S4	5720	3240	415	0.041	2.57	38.9	11.2	2.99	31.7
S5	6340	3790	457	0.053	2.94	43.8	17.8	7.60	45.5
S6	5830	3700	456	0.087	4.15	32.8	18.0	4.44	49.7
S7	4760	2950	398	0.100	2.50	31.8	11.1	3.37	47.4
S8	6550	3860	479	0.095	2.89	32.8	12.3	13.8	51.1
S9	5690	3140	438	0.065	3.77	40.1	16.0	3.83	66.8
S10	5290	3720	412	0.053	2.92	35.4	12.3	3.90	56.9
S11	16,000	5400	401	0.091	4.62	29.9	19.8	0.25	45.3
S12	7380	3980	509	0.054	2.96	48.2	12.3	4.26	56.9
S13	9140	4710	300	0.063	3.51	49.3	16.0	10.3	66.7
S14	5870	2590	318	0.049	1.90	37.2	8.63	2.84	67.0
S15	7010	3690	472	0.052	2.71	46.6	12.2	3.12	168
S16	6970	3760	475	0.053	2.72	47.0	11.8	4.07	64.0
S17	4470	3270	405	0.063	3.24	50.9	14.1	3.67	66.5
S18	6060	3600	438	0.097	3.90	80.5	17.0	4.90	106
Max	16,000	5400	554	0.100	4.62	80.5	19.8	13.8	168
Min	4470	2590	300	0.031	1.67	29.9	7.42	0.250	31.7
Average	6648	3729	441	0.065	3.07	42.2	13.6	4.57	62.4
SD	2499	627	63.5	0.020	0.72	11.2	3.20	3.03	30.2
CV	37.6	16.8	14.4	30.9	23.3	26.6	23.4	66.4	48.3

Table S2. The concentrations of the heavy metals in the indoor dust samples of schools in Riyadh city.

Site	Concentration of heavy metals in indoor dust (mg kg^{-1})								
	Fe	Ti	Mn	Cd	Co	Cu	Ni	Pb	Zn
S1	5400	3430	538	0.079	4.80	46.6	21.4	4.44	54.7
S2	6270	3810	586	0.194	4.82	52.4	20.7	7.29	110
S3	6550	3610	521	0.074	3.29	68.8	15.2	4.35	124
S4	4540	3100	372	0.057	3.22	52.7	14.8	7.75	63.6
S5	6860	4150	487	0.037	2.90	56.3	13.1	13.5	95.8
S6	5750	2900	420	0.054	3.40	33.5	14.3	4.15	64.1
S7	4620	3220	434	0.045	2.60	41.7	11.4	3.31	93.4
S8	5570	2710	356	0.066	3.93	37.1	16.5	4.52	66.4
S9	4030	2290	322	0.049	2.45	33.2	10.7	3.07	49.4
S10	6300	3500	440	0.078	3.28	45.9	15.2	5.04	90.3
S11	13,300	3420	409	0.097	3.30	81.1	15.5	2.91	92.8
S12	6690	3620	460	0.077	2.85	63.9	12.3	3.73	73.8
S13	8200	1870	413	0.076	3.82	71.8	17.0	4.03	91.6
S14	10,300	3590	405	0.088	3.15	78.6	14.1	4.09	214
S15	5040	3110	432	0.070	3.36	55.9	15.7	3.43	81.7
S16	5620	3140	400	0.129	3.29	49.3	14.3	4.70	81.6
S17	6270	3040	364	0.068	3.31	103	13.2	4.52	143
S18	6040	3610	448	0.103	4.26	93.3	18.9	4.95	104
Max	13,00	4150	586	0.194	4.82	103	21.4	13.5	214
Min	4030	1870	322	0.037	2.45	33.2	10.7	2.91	49.4
Average	6519	3229	434	0.080	3.45	59.2	15.2	4.99	94.1
SD	2149	532	64.8	0.035	0.64	19.6	2.80	2.40	37.2
CV	33.0	16.5	14.9	43.7	18.6	33.0	18.4	48.2	39.5

Table S3. The indoor and outdoor ratio (I/O) in dust samples of schools in Riyadh city.

Site	Indoor and Outdoor ration (I/O) of dust								
	Fe	Ti	Mn	Cd	Co	Cu	Ni	Pb	Zn
S1	1.1	0.9	1.0	1.1	1.6	1.1	1.5	1.5	1.0
S2	1.1	0.9	1.1	3.8	1.5	1.3	1.5	2.0	2.5
S3	1.2	1.0	1.1	2.4	2.0	2.0	2.0	1.8	3.6
S4	0.8	1.0	0.9	1.4	1.3	1.4	1.3	2.6	2.0
S5	1.1	1.1	1.1	0.7	1.0	1.3	0.7	1.8	2.1
S6	1.0	0.8	0.9	0.6	0.8	1.0	0.8	0.9	1.3
S7	1.0	1.1	1.1	0.5	1.0	1.3	1.0	1.0	2.0
S8	0.9	0.7	0.7	0.7	1.4	1.1	1.3	0.3	1.3
S9	0.7	0.7	0.7	0.7	0.6	0.8	0.7	0.8	0.7
S10	1.2	0.9	1.1	1.5	1.1	1.3	1.2	1.3	1.6
S11	0.8	0.6	1.0	1.1	0.7	2.7	0.8	11.6	2.0
S12	0.9	0.9	0.9	1.4	1.0	1.3	1.0	0.9	1.3
S13	0.9	0.4	1.4	1.2	1.1	1.5	1.1	0.4	1.4
S14	1.8	1.4	1.3	1.8	1.7	2.1	1.6	1.4	3.2
S15	0.7	0.8	0.9	1.3	1.2	1.2	1.3	1.1	0.5
S16	0.8	0.8	0.8	2.4	1.2	1.0	1.2	1.2	1.3
S17	1.4	0.9	0.9	1.1	1.0	2.0	0.9	1.2	2.2
S18	1.0	1.0	1.0	1.1	1.1	1.2	1.1	1.0	1.0
Max	1.8	1.4	1.4	3.8	2.0	2.7	2.0	11.6	3.6
Min	0.7	0.4	0.7	0.5	0.6	0.8	0.7	0.3	0.5
Average	1.0	0.9	1.0	1.4	1.2	1.4	1.2	1.8	1.7
SD	0.2	0.2	0.2	0.8	0.3	0.5	0.3	2.4	0.8

Table S4. The calculated data of the PI and IPI for heavy metals of dust samples in outdoor and indoor areas.

Site	Pollution index PI																			
	Outdoor dust					IPI	Indoor dust					IPI								
	Fe	Ti	Mn	Cd	Co	Cu	Ni	Pb	Zn	Fe	Ti	Mn	Cd	Co	Cu	Ni	Pb	Zn		
S1	0.1	0.6	0.6	0.4	0.1	0.6	0.1	0.2	0.7	0.4	0.1	0.6	0.6	0.4	0.1	0.7	0.2	0.3	0.7	0.4
S2	0.1	0.7	0.6	0.3	0.1	0.6	0.1	0.2	0.5	0.4	0.1	0.6	0.7	1.0	0.1	0.7	0.2	0.5	1.4	0.6
S3	0.1	0.6	0.5	0.2	0.0	0.5	0.1	0.1	0.4	0.3	0.1	0.6	0.6	0.4	0.1	1.0	0.2	0.3	1.6	0.5
S4	0.1	0.5	0.5	0.2	0.1	0.6	0.1	0.2	0.4	0.3	0.1	0.5	0.4	0.3	0.1	0.8	0.1	0.5	0.8	0.4
S5	0.1	0.6	0.5	0.3	0.1	0.6	0.2	0.5	0.6	0.4	0.1	0.7	0.5	0.2	0.1	0.8	0.1	0.8	1.2	0.5
S6	0.1	0.6	0.5	0.4	0.1	0.5	0.2	0.3	0.6	0.4	0.1	0.5	0.5	0.3	0.1	0.5	0.1	0.3	0.8	0.3
S7	0.1	0.5	0.4	0.5	0.1	0.5	0.1	0.2	0.6	0.3	0.1	0.5	0.5	0.2	0.1	0.6	0.1	0.2	1.2	0.4
S8	0.1	0.6	0.5	0.5	0.1	0.5	0.1	0.9	0.6	0.4	0.1	0.5	0.4	0.3	0.1	0.5	0.2	0.3	0.8	0.4
S9	0.1	0.5	0.5	0.3	0.1	0.6	0.2	0.2	0.8	0.4	0.1	0.4	0.4	0.2	0.1	0.5	0.1	0.2	0.6	0.3
S10	0.1	0.6	0.5	0.3	0.1	0.5	0.1	0.2	0.7	0.3	0.1	0.6	0.5	0.4	0.1	0.7	0.2	0.3	1.1	0.4
S11	0.3	0.9	0.4	0.5	0.1	0.4	0.2	0.0	0.6	0.4	0.3	0.6	0.5	0.5	0.1	1.2	0.2	0.2	1.2	0.5
S12	0.1	0.7	0.6	0.3	0.1	0.7	0.1	0.3	0.7	0.4	0.1	0.6	0.5	0.4	0.1	0.9	0.1	0.2	0.9	0.4
S13	0.2	0.8	0.3	0.3	0.1	0.7	0.2	0.6	0.8	0.4	0.2	0.3	0.5	0.4	0.1	1.0	0.2	0.3	1.1	0.4
S14	0.1	0.4	0.4	0.2	0.0	0.5	0.1	0.2	0.8	0.3	0.2	0.6	0.5	0.4	0.1	1.1	0.1	0.3	2.7	0.7
S15	0.1	0.6	0.5	0.3	0.1	0.7	0.1	0.2	2.1	0.5	0.1	0.5	0.5	0.3	0.1	0.8	0.2	0.2	1.0	0.4
S16	0.1	0.6	0.5	0.3	0.1	0.7	0.1	0.3	0.8	0.4	0.1	0.5	0.4	0.6	0.1	0.7	0.1	0.3	1.0	0.4
S17	0.1	0.5	0.5	0.3	0.1	0.7	0.1	0.2	0.8	0.4	0.1	0.5	0.4	0.3	0.1	1.5	0.1	0.3	1.8	0.6
S18	0.1	0.6	0.5	0.5	0.1	1.2	0.2	0.3	1.3	0.5	0.1	0.6	0.5	0.5	0.1	1.3	0.2	0.3	1.3	0.6
Max	0.3	0.9	0.6	0.5	0.1	1.2	0.2	0.9	2.1	0.5	0.3	0.7	0.7	1.0	0.1	1.5	0.2	0.8	2.7	0.7
Min	0.1	0.4	0.3	0.2	0.0	0.4	0.1	0.0	0.4	0.3	0.1	0.3	0.4	0.2	0.1	0.5	0.1	0.2	0.6	0.3
Avr.	0.13	0.62	0.49	0.33	0.08	0.60	0.14	0.29	0.78	0.38	0.13	0.54	0.48	0.40	0.09	0.85	0.15	0.31	1.18	0.46
SD	0.0	0.1	0.1	0.1	0.0	0.2	0.0	0.2	0.4	0.1	0.0	0.1	0.1	0.2	0.0	0.3	0.0	0.2	0.5	0.1
CV	38	17	14	31	23	27	23	66	48	17	33.0	16.5	14.9	43.7	18.6	33.0	18.4	48.2	39.5	20.6

Table S5. The calculated data of the Igeo for heavy metals in outdoor and indoor dust samples.

Site	Geo-accumulation index																	
	Outdoor dust							Indoor dust										
	Fe	Ti	Mn	Cd	Co	Cu	Ni	Pb	Zn	Fe	Ti	Mn	Cd	Co	Cu	Ni	Pb	Zn
S1	-4	-1	-1	-3	-3	-1	-3	-3	1	-4	-1	-1	-3	-3	-1	-2	-3	1
S2	-4	-1	-1	-3	-3	-1	-3	-3	1	-3	-1	-1	-1	-3	0	-2	-2	2
S3	-4	-1	-1	-4	-4	-1	-4	-4	0	-3	-1	-1	-3	-3	0	-3	-3	2
S4	-4	-1	-2	-3	-3	-1	-3	-3	0	-4	-1	-2	-3	-3	0	-3	-2	1
S5	-3	-1	-1	-3	-3	-1	-3	-2	1	-3	-1	-1	-4	-3	0	-3	-1	2
S6	-4	-1	-1	-2	-3	-1	-3	-3	1	-4	-1	-2	-3	-3	-1	-3	-3	1
S7	-4	-1	-2	-2	-4	-1	-3	-3	1	-4	-1	-2	-3	-3	-1	-3	-3	2
S8	-3	-1	-1	-2	-3	-1	-3	-1	1	-4	-1	-2	-3	-3	-1	-3	-3	1
S9	-4	-1	-2	-3	-3	-1	-3	-3	1	-4	-2	-2	-3	-4	-1	-3	-3	1
S10	-4	-1	-2	-3	-3	-1	-3	-3	1	-3	-1	-2	-3	-3	-1	-3	-3	2
S11	-2	0	-2	-2	-3	-1	-2	-7	1	-2	-1	-2	-2	-3	0	-3	-3	2
S12	-3	-1	-1	-3	-3	0	-3	-3	1	-3	-1	-1	-3	-3	0	-3	-3	1
S13	-3	-1	-2	-3	-3	0	-3	-2	1	-3	-2	-2	-3	-3	0	-3	-3	2
S14	-4	-1	-2	-3	-4	-1	-4	-3	1	-3	-1	-2	-2	-3	0	-3	-3	3
S15	-3	-1	-1	-3	-3	-1	-3	-3	2	-4	-1	-2	-3	-3	0	-3	-3	1
S16	-3	-1	-1	-3	-3	-1	-3	-3	1	-4	-1	-2	-2	-3	0	-3	-3	1
S17	-4	-1	-2	-3	-3	0	-3	-3	1	-3	-1	-2	-3	-3	1	-3	-3	2
S18	-4	-1	-2	-2	-3	0	-3	-3	2	-4	-1	-2	-2	-3	0	-2	-3	2
Max	-2	0	-1	-2	-3	0	-2	-1	2	-2	-1	-1	-1	-3	1	-2	-1	3
Min	-4	-1	-2	-4	-4	-1	-4	-7	0	-4	-2	-2	-4	-4	-1	-3	-3	1
average	-3	-1	-2	-3	-3	-1	-3	-3	1	-4	-1	-2	-3	-3	0	-3	-3	2
SD	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	

Table S6. The calculated data of the enrichment factor (EF) for heavy metals in outdoor and indoor dust samples.

Site	Enrichment factor (EF)															
	Outdoor dust							Indoor dust								
	Ti	Mn	Cd	Co	Cu	Ni	Pb	Zn	Ti	Mn	Cd	Co	Cu	Ni	Pb	Zn
S1	6.3	6.1	3.9	0.8	6.0	1.4	1.9	7.3	5.4	5.6	3.7	1.1	6.3	2.0	2.6	6.5
S2	6.3	5.3	2.2	0.7	4.8	1.2	1.9	4.6	5.2	5.3	7.9	1.0	6.1	1.7	3.7	11.1
S3	5.4	4.7	1.4	0.4	4.4	0.7	1.3	3.9	4.7	4.5	2.9	0.6	7.7	1.2	2.1	12.1
S4	4.8	4.1	1.8	0.6	5.0	1.0	1.7	3.5	5.8	4.6	3.2	0.9	8.5	1.7	5.4	8.9
S5	5.1	4.1	2.1	0.6	5.0	1.4	3.8	4.6	5.1	4.0	1.4	0.5	6.0	1.0	6.3	8.9
S6	5.4	4.4	3.8	0.9	4.1	1.6	2.4	5.4	4.3	4.1	2.4	0.8	4.2	1.3	2.3	7.1
S7	5.3	4.7	5.3	0.7	4.9	1.2	2.3	6.3	5.9	5.3	2.5	0.7	6.6	1.3	2.3	12.9
S8	5.0	4.1	3.7	0.6	3.6	1.0	6.7	5.0	4.1	3.6	3.0	0.9	4.9	1.5	2.6	7.6
S9	4.7	4.4	2.9	0.8	5.1	1.4	2.1	7.5	4.8	4.5	3.1	0.8	6.0	1.4	2.4	7.8
S10	6.0	4.4	2.6	0.7	4.9	1.2	2.3	6.9	4.7	4.0	3.2	0.7	5.3	1.2	2.5	9.1
S11	2.9	1.4	1.5	0.4	1.4	0.6	0.0	1.8	2.2	1.7	1.9	0.3	4.4	0.6	0.7	4.4
S12	4.6	3.9	1.9	0.5	4.8	0.9	1.8	4.9	4.6	3.9	2.9	0.5	7.0	0.9	1.8	7.0
S13	4.4	1.9	1.8	0.5	3.9	0.9	3.6	4.7	1.9	2.9	2.4	0.6	6.4	1.1	1.6	7.1
S14	3.8	3.1	2.1	0.4	4.6	0.7	1.5	7.3	3.0	2.2	2.2	0.4	5.6	0.7	1.3	13.2
S15	4.5	3.8	1.9	0.5	4.8	0.9	1.4	15.3	5.2	4.9	3.5	0.9	8.1	1.6	2.2	10.3
S16	4.6	3.9	1.9	0.5	4.9	0.9	1.9	5.9	4.7	4.0	5.8	0.7	6.4	1.3	2.7	9.3
S17	6.2	5.1	3.6	0.9	8.3	1.6	2.6	9.5	4.1	3.3	2.8	0.7	12.0	1.1	2.3	14.5
S18	5.0	4.1	4.1	0.8	9.7	1.4	2.6	11.2	5.1	4.2	4.4	0.9	11.3	1.6	2.6	11.0
Max	6.3	6.1	5.3	0.9	9.7	1.6	6.7	15	5.9	5.6	7.9	1.1	12.0	2.0	6.3	15
Min	2.9	1.4	1.4	0.4	1.4	0.6	0.05	1.8	1.9	1.7	1.4	0.3	4.2	0.6	0.70	4.4
Average	5.0	4.1	2.7	0.6	5.0	1.1	2.3	6.4	4.5	4.0	3.3	0.7	6.8	1.3	2.6	9.4
SD	0.9	1.1	1.1	0.2	1.7	0.3	1.3	3.0	1.1	1.0	1.5	0.2	2.0	0.4	1.3	2.6
CV	17	26	40	28	34	28	57	47	24	25	45	28	30	28	50	28

Table S7. Average the single potential ecological risk (Ei) and integrated potential ecological risk (IR) of outdoor and indoor dust in Riyadh.

Site	Outdoor dust samples					RI	Indoor dust samples					RI		
	Ei-Ti fi						Ei-Ti fi							
	Cd	Cu	Ni	Pb	Zn		Cd	Cu	Ni	Pb	Zn			
S1	11.3	2.9	0.7	0.9	0.7	16	11.9	3.3	1.1	1.4	0.7	18		
S2	7.7	2.8	0.7	1.1	0.5	13	29.1	3.7	1.0	2.3	1.4	38		
S3	4.6	2.4	0.4	0.7	0.4	9	11.2	4.9	0.8	1.4	1.6	20		
S4	6.1	2.8	0.6	0.9	0.4	11	8.6	3.8	0.7	2.4	0.8	16		
S5	7.9	3.1	0.9	2.4	0.6	15	5.5	4.0	0.7	4.2	1.2	16		
S6	13.1	2.3	0.9	1.4	0.6	18	8.1	2.4	0.7	1.3	0.8	13		
S7	14.9	2.3	0.6	1.1	0.6	19	6.8	3.0	0.6	1.0	1.2	13		
S8	14.2	2.3	0.6	4.3	0.6	22	9.8	2.7	0.8	1.4	0.8	16		
S9	9.7	2.9	0.8	1.2	0.8	15	7.3	2.4	0.5	1.0	0.6	12		
S10	8.0	2.5	0.6	1.2	0.7	13	11.8	3.3	0.8	1.6	1.1	18		
S11	13.7	2.1	1.0	0.1	0.6	17	14.6	5.8	0.8	0.9	1.2	23		
S12	8.1	3.4	0.6	1.3	0.7	14	11.6	4.6	0.6	1.2	0.9	19		
S13	9.4	3.5	0.8	3.2	0.8	18	11.4	5.1	0.9	1.3	1.1	20		
S14	7.3	2.7	0.4	0.9	0.8	12	13.2	5.6	0.7	1.3	2.7	23		
S15	7.9	3.3	0.6	1.0	2.1	15	10.5	4.0	0.8	1.1	1.0	17		
S16	7.9	3.4	0.6	1.3	0.8	14	19.3	3.5	0.7	1.5	1.0	26		
S17	9.5	3.6	0.7	1.1	0.8	16	10.2	7.4	0.7	1.4	1.8	21		
S18	14.5	5.8	0.9	1.5	1.3	24	15.5	6.7	0.9	1.5	1.3	26		
Max	14.9	5.8	1.0	4.3	2.1	23.9	29.1	7.4	1.1	4.2	2.7	37.5		
Min	4.6	2.1	0.4	0.1	0.4	8.6	5.5	2.4	0.5	0.9	0.6	11.8		
average	9.8	3.0	0.7	1.4	0.8	15.7	12.0	4.2	0.8	1.6	1.2	19.7		
SD	3.0	0.8	0.2	0.9	0.4	3.7	5.3	1.4	0.1	0.8	0.5	5.9		
CV	30.9	26.6	23.4	66.4	48.3	23.6	43.7	33.0	18.4	48.2	39.5	30.1		