

Supplementary Data

Figure S1: Correlation between arsenic contents in water and arsenic level in human hair and nails.

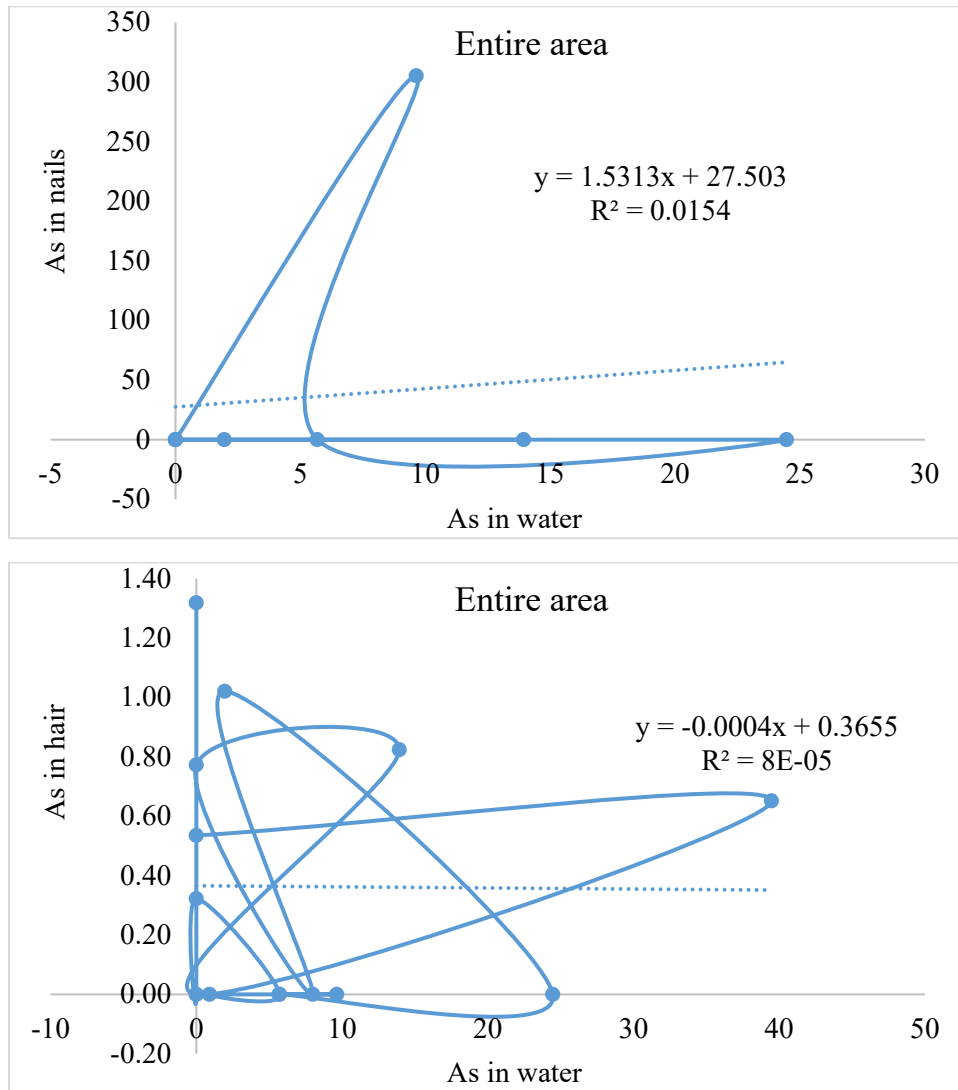


Table S1: Details of groundwater, animal mil and human nail and hair samples.

Districts	Area	Water	Milk	Nail	Hair
Vehari	Tibba Sultanpur	30	5	2	5
Lodhran	Kehror Pakka	17	2	4	5
	Lodhran	32	5	2	5
Total		79	12	8	15

Table S2: The description and values used for each parameter in risk indices.

Parameter	Limits	Reference
RfD	0.0003 mg/kg/day	(US-EPA, 2005)
EF	365 days/year	(Shahid et al., 2018)
CSF	$(1.5 \text{ mg. kg}^{-1}.\text{day}^{-1})^{-1}$	(US-EPA, 2005)
IR (Adult)	2 L/day	(Solgi and Jalili, 2021)
IR (Child)	1 L/day	(Solgi and Jalili, 2021)
ED (Adult)	64.4 years	(WHO, 2015)
ED (Child)	5 years	(Rahman et al., 2021)
BW (Adult)	70 kg	(WHO, 2016)
BW (Child)	18.6 kg	(Zeng et al., 2015)

RfD: Reference dose; AT: Average time of exposure; EF: Exposure frequency; IR: Ingestion rate; ED: Exposure duration; BW: Body weight

Table S3: Arsenic-based risk indices values for children in study area.

Risk indices	Mean	SD	Min	Max
Total				
ADD	0.00022	0.00027	0.00000	0.00118
HQ	0.7	0.9	0.0	3.9
CR	0.0003	0.0004	0.0000	0.0018
Tibba Sultanpur				
ADD	0.00008	0.00012	0.00000	0.00046
HQ	0.3	0.4	0.0	1.5
CR	0.0001	0.0002	0.0000	0.0007
Kehror Pakka				
ADD	0.00043	0.00033	0.00000	0.00118
HQ	1.4	1.1	0.0	3.9
CR	0.0006	0.0005	0.0000	0.0018
Lodhran				
ADD	0.00024	0.00027	0.00000	0.00102
HQ	0.8	0.9	0.0	3.4
CR	0.0004	0.0004	0.0000	0.0015

Table S4: Percent of water samples with risk indices values for children greater than limit in study area.

Area	n	HQ		CR	
		# obs > 0.0001	% obs > 0.0001	# obs > 1.0	% obs > 1.0
Tibba Sultanpur	30	3	10	11	37
Kehror Pakka	17	10	59	14	82
Lodhran	32	13	41	18	56
Total	79	26	33	43	54

Obs. indicates observations

Table S5: Physicochemical values for groundwater samples of study area.

Variable	pH	EC	TDS	CO ₃	HCO ₃	Ca + Mg	Cl
All							
Average	7.6	1133	562	0.8	5.7	13.1	239
SD	0.2	224	109	1.0	1.7	3.5	64
Minimum	6.6	150	70	0	0	4	76
Maximum	8.2	2270	1130	8	11	29	891
Median	7.6	1167	580	0.3	5.6	13.9	229
Tibba Sultanpur							
Average	7.5	1584	784	1.4	2.6	16.8	301
SD	0.3	406	202	2.2	1.8	6.3	132
Minimum	6.6	150	70	0.0	0.0	3.6	103
Maximum	7.9	2270	1130	8.1	6.2	28.7	891
Median	7.5	1715	850	0.0	2.2	19.2	277
Kehror Pakka							
Average	7.3	1179	580	0.0	7.9	12.6	291
SD	0.1	36	19	0.0	1.6	1.4	20
Minimum	7.2	1130	550	0.0	3.8	9.9	258
Maximum	7.6	1230	610	0.0	9.3	14.7	326
Median	7.3	1180	580	0.0	8.4	12.8	294
Lodhran							
Average	7.9	638	323	1.0	6.6	9.7	125
SD	0.2	229	106	0.8	1.7	2.7	40
Minimum	7.6	190	110	0.0	3.6	4.7	76
Maximum	8.2	1010	500	2.5	11.2	15.0	261
Median	7.9	605	310	0.8	6.2	9.7	116

Table S6: PCA-based cumulative variability and eigenvalue of the water samples.

Element	F1	F2	F3	F4	F5
As	0.02	0.09	0.34	0.45	0.08
pH	0.03	0.40	0.24	0.00	0.30
EC	0.77	0.00	0.13	0.07	0.02
TDS	0.77	0.00	0.14	0.07	0.02
CO ₃	0.25	0.45	0.02	0.05	0.13
HCO ₃	0.00	0.75	0.01	0.07	0.05
Ca + Mg	0.44	0.07	0.27	0.02	0.01
Cl	0.50	0.05	0.02	0.25	0.05
Eigenvalue	2.8	1.8	1.2	1.0	0.7
Variability (%)	35	23	15	12	8
Cumulative %	35	57	72	84	92

Table S7: Pearson correlation matrix of water sample variables.

Variables	As	pH	EC	TDS	CO3	HCO3	Ca + Mg
As							
pH	0.0						
EC	0.1	0.0					
TDS	0.1	0.0	1.0				
CO3	-0.1	-0.4	0.3	0.2			
HCO3	0.1	0.4	-0.1	-0.1	-0.5		
Ca + Mg	0.3	-0.2	0.4	0.4	0.2	0.2	
Cl	0.0	0.0	0.4	0.4	0.3	0.2	0.5

Values in bold are different from 0 with a significance level $\alpha=0.05$

References

1. Rahman, M.A., Islam, M.R., Kumar, S., Al-Reza, S.M., 2021. Drinking water quality, exposure and health risk assessment for the school-going children at school time in the southwest coastal of Bangladesh. *Journal of Water, Sanitation and Hygiene for Development* 11(4), 612-628.
2. Shahid, M., Khalid, M., Dumat, C., Khalid, S., Niazi, N.K., Imran, M., Bibi, I., Ahmad, I., Hammad, H.M., Tabassum, R.A., 2018. Arsenic Level and Risk Assessment of Groundwater in Vehari, Punjab Province, Pakistan. *Exposure and Health* 10, 229–239. <https://doi.org/10.1007/s12403-017-0257-7>.
3. Solgi, E., Jalili, M., 2021. Zoning and human health risk assessment of arsenic and nitrate contamination in groundwater of agricultural areas of the twenty two village with geostatistics (Case study: Chahardoli Plain of Qorveh, Kurdistan Province, Iran). *Agricultural Water Management* 255, 107023.
4. US-EPA, 2005. Guidelines for Carcinogen Risk Assessment; EPA/630/P-03/001F; Risk Assessment Forum: Washington, DC, USA. Accessed, December, 14, 2022.
5. WHO, 2015. Life expectancy at birth (2002-2015). World Health Organization.
6. WHO, 2016. Global database on body mass index. World Health Organization.
7. Zeng, X., Wang, Z., Wang, J., Guo, J., Chen, X., Zhuang, J., 2015. Health risk assessment of heavy metals via dietary intake of wheat grown in Tianjin sewage irrigation area. *Ecotoxicology* 24(10), 2115-2124.