

Fluoride and IQ deficits – A Research and Policy Review

SUPPLEMENTAL MATERIAL PART 1

XIANG ET AL. 2003a

In this study Xiang et al. show that there is an inverse relationship between exposure to fluoride via drinking water and children's IQ, and that exposure to iodine was not a co-factor in their observation. Data Tables 2 – 5 from this study shown here establish that there was no statistically significant difference between the urine iodine levels, while there was such a difference between the urine fluoride levels, among the children from the two villages. Thus it appears that iodine was not a significant contributor to IQ difference observed between the two villages. Table 9 establishes that there was a statistically significant relationship between fluoride levels in drinking water and urine for both villages.

Table 2. Urinary fluoride in children in Wamiao and Xinhuai

Village	No. samples	Urinary fluoride (mg/L)		t	p
		Mean \pm SD	Range		
Wamiao	155	3.47 \pm 1.95	0.90–12.50	13.82	<0.001
Xinhuai	135	1.11 \pm 0.39	0.37–2.50		

Table 3. Ratio of urinary fluoride to creatinine in children in Wamiao and Xinhuai

Village	No. samples	Urinary fluoride/Cre (mg F/mmol Cre)		t	p
		Mean \pm SD	Range		
Wamiao	155	0.82 \pm 0.75	0.13–4.69	8.96	<0.001
Xinhuai	135	0.24 \pm 0.10	0.09–0.71		

Table 4. Urinary iodine in children in Wamiao and Xinhuai

Village	No. samples	Urinary iodine ($\mu\text{g/L}$)		t	p
		Mean \pm SD	Range		
Wamiao	46	280.70 \pm 87.16	131.31–497.05	1.04	>0.3
Xinhuai	40	300.96 \pm 92.88	148.46–460.89		

Table 5. Ratio of urinary iodine to creatinine in children in Wamiao and Xinhuai

Village	No. samples	Urinary iodine/creatinine ($\mu\text{g I/mmol Cre}$)		t	p
		Mean \pm SD	Range		
Wamiao	46	93.24 \pm 46.86	36.86–251.03	1.07	>0.28
Xinhuai	40	81.27 \pm 55.91	22.76–298.74		

Table 9. Fluoride in drinking water and in urine (Mean \pm SD)

No. samples	Drinking water F (mg/L)	Urinary fluoride	
		(mg/L)	mg/mmol Cre
142	0.39 \pm 0.15	1.14 \pm 0.49	0.25 \pm 0.22
32	1.15 \pm 0.29	2.59 \pm 1.70	0.61 \pm 0.47
80	2.44 \pm 0.30	3.67 \pm 1.97	0.85 \pm 0.67
32	3.22 \pm 0.18	3.77 \pm 1.86	0.86 \pm 0.81
4	4.05 \pm 0.01	4.65 \pm 2.39	2.17 \pm 1.73

The authors noted, as shown in Table 10 and by correlation analysis, that there was a significant relationship between IQ and age in Xinhuai village ($p < 0.001$) but not in Wamiao ($p = 0.218$). When data from the two villages were combined there was a

significant relationship ($p < 0.01$). No further discussion of the relationship was offered.

Table 10. Mean IQ by age in Wamiao and Xinhuai

Age (yrs)	Wamiao		Xinhuai	
	No. children	IQ(Mean±SD)	No. children	IQ (Mean±SD)
8	11	94.09±16.50	39	103.39±11.58
9	20	91.25±14.81	46	104.04±13.80
10	20	96.35±14.04	31	105.45±10.57
11	43	92.77±12.43	60	97.45±14.60
12	60	91.15±12.74	61	99.41±14.20
13	68	90.94±12.27	53	96.64±10.47
Total	222	92.02±13.00	290	100.41±13.21

The graph representing a benchmark analysis of the relationship between fluoride levels in drinking water and the rate of IQ < 80 that was discussed in our paper is shown here.

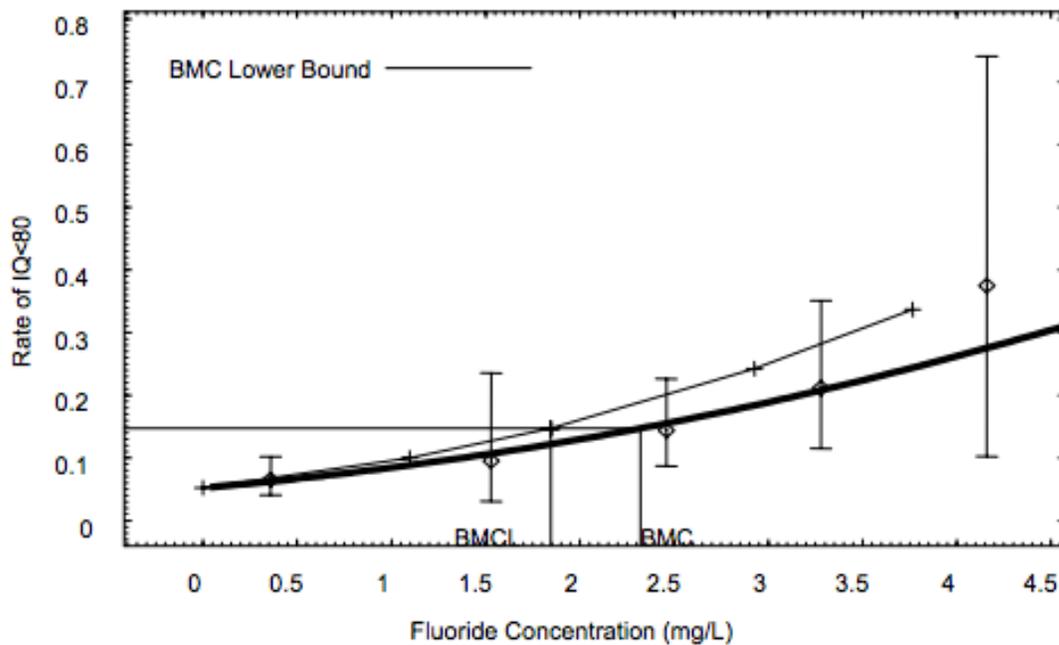


Figure 1. Concentration-response relationship between an IQ < 80 score and the level of fluoride in drinking water

We discuss why in our paper we go beyond this benchmark study; in short this graph and its supporting data deal only with the relationship between the rate of IQ < 80, and not with the loss of IQ seen in high fluoride exposure groups vs. low fluoride exposure groups.

XIANG ET AL. 2003b

In this study, the authors measured blood-lead levels in order to determine whether differential lead exposures were involved in their observations published earlier. Blood samples (80 µL) were taken from randomly selected 8 – 13 year olds from the two villages. The results show no statistically significant difference between blood-lead levels in the two villages, establishing that lead was not a co-factor in the observed effect.

Table. Blood lead levels of children in Wamiao and Xinhuai

Village	No. Samples	Blood lead (µg/L)		t	p
		Mean ± SD	Range		
Wamiao	71	21.95 ± 13.65	1.36 - 54.96	0.698	>0.48
Xinhuai	67	23.61 ± 14.17	1.36 - 61.12		

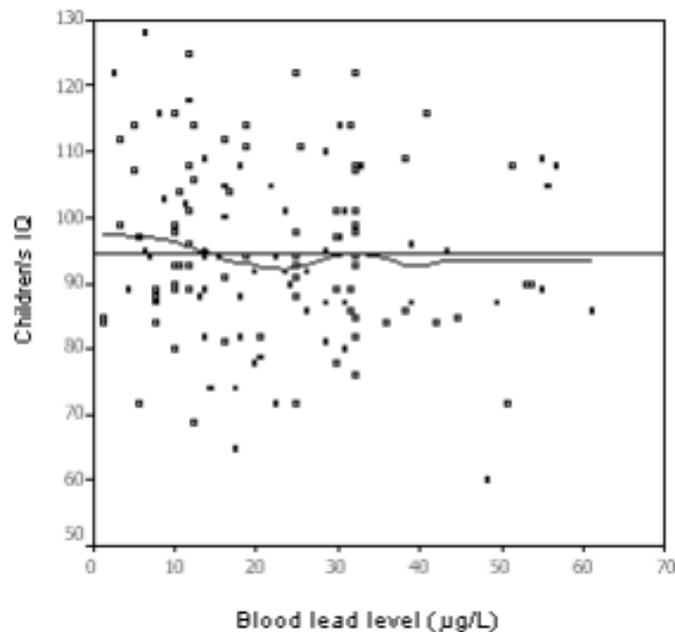


Figure. Correlation between children's IQ and blood lead level of all samples.

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DISCUSSION

In this follow-up study, on fluoride exposure and children's IQ, we found that the arsenic levels in the household shallow well water in the high-fluoride Wamiao village were very low, with the highest level of arsenic being only 0.50 µg/L. In low-fluoride Xinhuai village, the average level of arsenic was significant higher (16.40 ± 19.11 µg/L) than that in Wamiao (0.24 ± 0.26 µg/L). The highest level of arsenic in Xinhuai was 48.50 µg/L, which was lower than the former national standard of China of 50.00 µg/L. In our 2003 study, in high-fluoride Wamiao (mean drinking water F=2.47 mg/L) the average IQ was 8.4 points lower (92.02 vs. 100.41) than in the low-fluoride Xinhuai (mean drinking water F=0.36 mg/L). These results make it very unlikely that the differences in IQ of the children living in Wamiao and Xinhuai are the result of differences in exposure to arsenic rather than to fluoride.

DING ET AL. 2011 In this study, children from four different districts in Hulunbuir City, Inner Mongolia, where drinking water fluoride levels were (means, mg/L±S.D., max.): 0.28±0.02, 0.31; 0.79±0.33, 1.32; 1.78±0.60, 2.58; 1.82±1.00, 2.84), were studied. The aim of the study was to investigate any relationship among IQ, urine fluoride level, and dental fluorosis (Dean Index). The authors found a decrement of 0.59 IQ points per mL urine fluoride. We discuss in our paper why we think this study has only qualitatively descriptive value for our analysis. A Table and Figure from the study are reproduced below.

Table 3
The relationship between dental fluorosis and urine fluoride levels.^a

	Quartiles of urine fluoride (mg/L)			
	Q1	Q2	Q3	Q4
	0.389 ± 0.12	0.676 ± 0.07	1.035 ± 0.15	2.058 ± 0.62
Sample number				
Dental fluorosis	22	32	40	47
Normal ^b	61	50	43	36
OR value	-	1.77	2.58	3.62
95% CI	-	0.92-3.43	1.35-4.94	1.88-6.95

^a Cochran-Armitage test for trend was used to evaluate the association between dental fluorosis and urine fluoride levels ($Z = 4.099, P < 0.0001$).

^b Normal group included normal and questionable status of dental fluorosis.

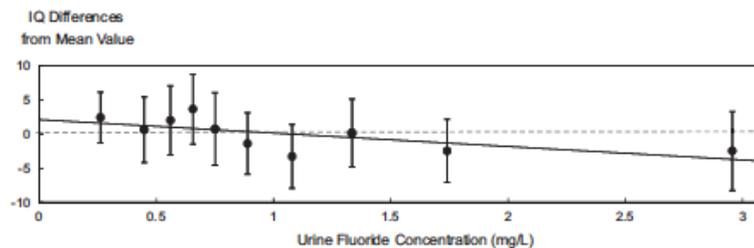


Fig. 2. The relationship between IQ differences and urine fluoride concentrations. Multiple linear regression model was carried out to confirm the association of urine fluoride exposure with IQ scores ($F = 9.85, P < 0.0001$).

SUPPLEMENTAL MATERIAL PART 2

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