

## EFFECT OF A HIGH FLUORIDE WATER SUPPLY ON CHILDREN'S INTELLIGENCE

L B Zhao,<sup>a</sup> G H Liang,<sup>a</sup> D N Zhang<sup>b</sup> and X R Wu<sup>b</sup>  
Lu-Liang, Shanxi, China

**SUMMARY:** In Shanxi Province, China, children living in the endemic fluoride village of Sima (water supply  $F = 4.12$  mg/L) located near Xiaoyi City had average IQ (97.69) significantly lower ( $p < 0.02$ ) than children living to the north in the nonendemic village of Xinghua ( $F = 0.91$  mg/L; average IQ = 105.21). These differences were not associated with gender, but the IQ scores were directly related to educational level of the parents.

**Key words:** Intelligence; IQ; Parents' education; Shanxi; Sima; Water fluoride; Xinghua.

### Introduction

It has been reported that fluoride can penetrate the fetal blood-brain barrier and accumulate in cerebral tissue before birth,<sup>1</sup> thereby apparently affecting children's intelligence.<sup>2</sup> In the present study, conducted in April 1993, this hypothesis was further investigated by comparing the performance on IQ tests administered to 320 randomly selected children, age 7 to 14, residing in central Shanxi Province, China, in two suburban villages with significantly different fluoride content in the drinking water.

### Materials and Methods

The two sites in Shanxi Province selected for study were Sima Village located 5 km northeast of Xiaoyi City and Xinghua Village situated 13 km northeast of Fenyang City which, in turn, is about 15 km north of Xiaoyi City. In Sima the average fluoride content of the drinking water is 4.12 mg/L, 86% of the population have clearly evident dental fluorosis, and 9% have clinically diagnosed skeletal fluorosis. In Xinghua the fluoride content of the drinking water is 0.91 mg/L, the dental fluorosis rate is 14%, and the bone fluorosis rate is 0%. The occupations, living standards, and social customs of the residents in the two villages are similar. Only children whose mothers lived in the survey location while pregnant were included for testing. A total of 160 children, age 7 to 14, half male and half female, were randomly selected from each village. Official intelligence quotient (IQ) tests lasting 40 minutes<sup>3</sup> were taken by each child in groups of 20. Besides this common parameter, the educational level of the parents of each child was also recorded.

### Results and Analysis

#### 1 *Average IQ of children in each village*

In Sima, where the children were exposed to higher water-borne fluoride in embryo, the average IQ was 97.69, and in the lower fluoride village of Xinghua it was 105.21. This difference is statistically significant ( $p < 0.01$ ), but there was no significant difference between male and female IQ in the two areas. The details are recorded in Table 1.

<sup>a</sup> Lu-Liang Public Health Bureau, Shanxi 033000, China. <sup>b</sup> Lu-Liang Epidemic Station.

TABLE 1. IQ findings for children in Sima and Xinghua

Village	Number (n)	IQ (range)	$\bar{X} \pm SD$		
			male	female	mean
Sima	160	60-133	98.11±13.21	97.32±12.93	97.69±13.00
Xinghua	160	69-141	105.81±15.04	104.98±14.96	105.21±14.99

### 2 Frequency distribution of IQ in each village

As shown in Table 2, most children in both Sima and Xinghua had IQ scores in the normal range of 90-109 or above. At the low end, however, 6 children (3.75% of the total) in Sima had scores of 69 or below (low intelligence), whereas only one child (0.62%) in Xinghua was in this category. On the other hand, the number of children with IQ scores of 120 or higher (superior intelligence) was 27 (17%) in Xinghua but was only 20 (12%) in Sima.

TABLE 2. IQ distribution of children in Sima and Xinghua

IQ	Sima				Xinghua			
	male	female	total	(%)	male	female	total	(%)
130 or higher	1	2	3	(1.88)	4	3	7	(4.38)
120-129	9	8	17	(10.62)	9	11	20	(12.50)
110-119	11	14	25	(15.62)	22	21	43	(26.88)
90-109	36	33	69	(43.12)	31	27	58	(36.25)
80-89	10	11	21	(13.13)	10	13	23	(14.37)
70-79	10	9	19	(11.88)	4	4	8	(5.00)
69 or lower	3	3	6	(3.75)	0	1	1	(0.62)
Total	80	80	160	(100)	80	80	160	(100)

### 3 Comparison of children's IQ by age in each village

As shown in Table 3, the average IQ of the children in each age group, 7 through 14 years, was lower in Sima than Xinghua. Although IQ increased with age, it did not go as high in Sima as in Xinghua.

TABLE 3. Average IQ by age in Sima and Xinghua

Age	Sima	Xinghua
7	89.47 ± 10.62	95.26 ± 12.31
8	90.92 ± 12.04	100.47 ± 15.01
9	92.34 ± 13.17	102.90 ± 12.34
10	98.28 ± 12.46	104.34 ± 14.18
11	100.08 ± 11.77	105.99 ± 13.97
12	100.99 ± 12.31	108.03 ± 14.22
13	103.36 ± 11.82	111.19 ± 13.36
14	105.83 ± 10.98	113.28 ± 10.44

#### 4. Correlation between IQ of children and educational level of parents

For this comparison, the children were divided into three groups according to the educational level of their parents: primary school only, junior high school, and senior high school and above (Table 4). The results show that the IQ scores of the children are closely related to the educational level of their parents, irrespective of which village they lived in. Children of parents with higher education showed a statistically significant higher IQ than the other children ( $p < 0.01$ ).

TABLE 4. Educational level of parents and children's IQ

Parents education	Sima		Xinghua	
	number	IQ	number	IQ
Primary school and below	23	89.97 ± 11.42	27	92.43 ± 10.89
Junior high school	99	98.11 ± 9.63	87	104.37 ± 11.44
Senior high school and above	38	105.93 ± 10.54	46	110.32 ± 10.02

### Discussion

The results of this study indicate that intake of high-fluoride drinking water from before birth has a significant deleterious influence on children's IQ in one of two similar villages. No real differences were found for gender. In the high-fluoride village of Sima the number of children with IQ of 69 or below was six times that in the healthier low-fluoride village of Xinghua. There were also fewer children (20) in Sima with superior IQ scores of 120 or higher than the number (27) in Xinghua. Moreover, the fact that the IQ scores increased more slowly with age in Sima than in Xinghua supports the view that exposure to high levels of fluoride *in utero* exerts a cumulative adverse effect that is not overcome with increasing age in a high-fluoride community.

As expected, and also found here, the educational level of the parents has a significant positive influence on the children's IQ. However, other factors that might affect children's IQ need to be considered as well, and further studies are therefore needed both to confirm the present findings and to elucidate the mechanism of fluoride involvement.

### References

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