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REPORT ON THE INTELLECTUAL ABILITY OF CHILDREN LIVING IN HIGH-FLUORIDE WATER AREAS

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[SUMMARY: Sixty children, aged 10 to 12, were randomly selected for IQ testing from an area with high fluoride (3.15 mg F/L) in the drinking water along with 58 control children of the same age from a nearby low fluoride (0.37 mg F/L) area. The two areas are located approximately 5 km apart in the Tianjin Xiqing District, and both have similar normal iodine levels, living standards, access to medical facilities, economic development, educational level, etc. A single individual using the C2 version of the Chinese Raven Test did the IQ testing. The mean IQ scores were significantly different: 92.27±20.45 in the high F area and 103.05±13.86 in the low F area (P<0.01). Within the seven categories of the scores, there were significantly more borderline and low IQs in the high F area (13/60) than in the low F area (2/58) (p<0.01).]

[Keywords: Brain effects; Chinese children; Chinese Raven IQ test; Fluoride and IQ; High F water; Low F water; Tianjin Xiqing District.

INTRODUCTION

Localized fluoride poisoning is rampant in China, caused by high intake of fluoride. Its primary clinical manifestation is damage to the bones and teeth. Continued research into the nature of fluoride poisoning has revealed its negative impact on various organ systems, including the immune system, the circulatory system, the liver and kidneys, the reproductive system, and the brain.[1-4] In the present research we have investigated the link between intellectual ability and exposure to fluoride by looking at the IQ scores of children living in an area of high fluoride in the drinking water.

MATERIALS AND METHODS

Choice of the subject groups: Research subjects were chosen from children living in a village area [of the Tianjin Xiqing District] with high fluoride (3.15 mg/L) in the drinking water, while children in a nearby village area whose drinking water had relatively low levels of fluoride (0.37 mg/L) served as the control. In both the high and low fluoride areas, children attending school between ten and twelve years of age were chosen randomly from the available population, with a total of 60 subjects coming from the high fluoride area, and 58 from the low fluoride area. The villages of the two areas are approximately five kilometers apart, neither area is iodine deficient, and both areas have similar standards of living, medical facilities, levels of development, educational quality, etc.

IQ testing: Subjects were tested collectively by the Chinese Raven Test (CRT-C2), with the requirements of the exam being rigorously enforced in regard to the testing conditions and the language of the instructions. A single person conducted

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the testing of children from both areas, with four others assisting. The seven grading levels of the CRT-C2 IQ test are shown in Table 1.

Table 1. Chinese Raven Test Scoring Standard

IQ	Level
> 130	Outstanding
120–129	Excellent
110–119	Above average
90–109	Average
80–89	Below average
70–90	Borderline
<69	Low

Urine Testing for fluoride levels: Urine samples were taken from the subjects' first urination of the day. Fluoride levels were determined using the fluoride ion selective electrode method (95% reproducibility).

RESULTS

Fluoride content of the subjects' urine: For the fluoride levels of the urine taken from subjects in each area, see Table 2.

Table 2. Urine fluoride content by area (mg/L, mean±SD)

Area	N	F^-
High fluoride	60	4.99±2.57
Low fluoride	58	1.43±0.64

U = 10.07, p<0.001.

The difference in urine fluoride levels between children living in the two areas is clearly highly significant (p<0.001). The children in the high fluoride area have much higher urine fluoride levels than those in the low fluoride area.

Subjects' IQ score: For the mean Q scores of subjects from each area, see Table 3.

Table 3. Mean IQ score by area (mean±SD)

Area	N	IQ
High fluoride	60	92.27±20.45
Low fluoride	58	103.05±13.86

U = 3.93, p<0.01.

The difference in IQ between children living in the two zones is very significant (p<0.01). The average IQ scores of the children in the high fluoride zone are considerably lower than those of the children in the low fluoride zone.

Distribution of IQ scores for subjects from each zone: For the distribution of IQ scores for the subjects from each zone, see Table 4.

Table 4. Distribution by area of IQ scores

Area	>130	120-129	110-119	90-109	80-89	70-79	<69
High fluoride	0	2	7	26	12	8	5
Low fluoride	2	5	12	31	6	2	0

U=3.51, p<0.05.

The difference in distribution between the IQ scores of children from the two areas is significant ($p<0.05$). The children living in the high fluoride area have obviously lower IQs than those living in the low fluoride area. For the distribution of subject IQs at or below the borderline level, see Table 5.

Table 5. Distribution by area of borderline or lower IQs

Zone	N	IQ <70 (%)
High fluoride zone	60	13 (21.7)
Low fluoride zone	58	2 (3.4)

U = 8.82, p<0.01. [Editor's note: this "U" value is the Chi-square calculated without the Yates correction for continuity, which reduces it to 7.26 but still p<0.01.]

The difference in the distribution of borderline or lower IQ scores between the two areas is very significant ($p<0.01$). There are obviously many more children with borderline or lower IQs in the high fluoride area than in the low fluoride area.

The relation between urine fluoride levels and IQ: A one-factor correlation analysis was carried out to determine the relation between the urine fluoride content and the IQ scores of the subjects from each area. The simple correlation coefficient was determined to be $r = –0.3186$, $p<0.01$, showing that the IQ scores and urine fluoride level of the children from each area showed a certain amount of negative correlation.

DISCUSSION

Research on fluoride poisoning in the last few years has revealed that high fluoride intake can damage the central nervous system, and that fluoride can pass through the placental barrier to damage the fetus. The negative effects of fluoride on children in the high fluoride area of this research could come from two sources: (1) disruption of proper development in the womb due to the mother's intake of fluoride being passed to the fetus through the placenta, or (2) childhood in a high fluoride environment. Either or both of these could lead to neuron damage, developmental difficulties, or neurotransmitter dysfunction.[5,6]

IQ has been used to measure intellectual ability for almost one hundred years, and there are many standards of measuring IQ. This research used the Chinese Raven Test (CRT-C2), which is based on the Raven Intelligence Test and adapted by Tianjin Medical University's Psychology Teaching and Research Section. Differences in factors such as racial, cultural, and linguistic background have very little if any effect on the results, so it is suitable for generalized testing.

The results of our research show that children living in an area with highly fluoridated drinking water have a markedly increased body burden of fluoride ($p<0.001$). This kind of fluoride-burdened child demonstrates an obvious IQ deficit when compared with children from the low fluoride area ($p<0.01$). In addition, the proportion of high fluoride area subjects with borderline or lower IQs is clearly higher than those subjects from the low fluoride area. The results of a correlation analysis show a negative correlation between individual urine fluoride levels and IQ scores ($r = –0.3186$, $p<0.01$). This shows that high fluoride absorption could have a negative effect on a child's intellectual ability and proper nervous system development. This result is consistent with reports in the literature of results of experiments on animals.[7]

There are many factors that influence intellectual development, and fluoride is only one of them. Our research has compared only urine fluoride levels and IQ scores, and the negative correlation coefficient of the two is relatively small. Therefore, it is very difficult to determine the strength of the relation between them. Further research is required to clarify how serious is the adverse influence of fluoride absorption on intellectual ability.

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