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A STUDY OF THE IQ LEVELS OF FOUR- TO SEVEN-YEAR-OLD CHILDREN IN HIGH FLUORIDE AREAS

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SUMMARY: Using the Wechsler Preschool and Primary Scale of Intelligence, we conducted a study to determine the intellectual ability of 147 four- to seven-year-old preschool children in a high fluoride zone [of a rural area of Shehezi in Xinjiang Province, China] and 83 similarly-aged children from a low fluoride zone in the same region. The results show that a high fluoride intake has a clear influence on the IQ of preschool children, manifesting itself primarily as damage to performance intelligence. The study also indicates that the proportion of preschool children living in the high fluoride area that have retarded head development (based on measurement of the circumference) is significantly greater than in the low fluoride control group, and that children with this developmental deficiency demonstrate a lower IQ than children with normal head development.

Keywords: Children's IQ; Fluoride and head circumference; Fluoride and IQ.

INTRODUCTION

The dangers that high amounts of fluoride pose to the human body have been proven by numerous studies. However, in the past the focus has been limited to the effects of high fluoride on the teeth and the skeleton; the body of research done on adverse effects of fluoride not related to bone is relatively small. In particular, very few reports are available on the influence of high fluoride intake on the intellectual ability of preschool age children. As a response to this lack, we have selected two rural areas in Shehezi, Xinjiang: one a high fluoride zone and the other a low fluoride zone (the control), and have undertaken a study of the IQ levels of Han Chinese preschool-age children in these two areas. We now report the results.

SUBJECTS AND METHODS

Selection of zones: The cases of fluoride poisoning in our region are primarily due to high fluoride drinking water, contaminated food, and coal burning. The region from which to draw subjects was chosen on the basis of the fluoride content of the water and recorded cases of fluoride-related bone and dental diseases in previous endemic disease studies. The range of fluoride content in the well water throughout the region was found to be 0.58–8.60 mg/L, and, with reference to *Local Fluoride Poisoning Prevention Guidelines (Trial Version)*. Accordingly, the region was divided into a two zones, a high fluoride zone (water fluoride > 1.0 mg/L) and a low fluoride zone (water fluoride ≤ 1.0 mg/L). The work units in these zones were further screened, with the principle of keeping the background conditions, for example level of economic and cultural development, standard of living, transportation access, etc., as uniform as possible. From this group, 62 work groups from five different farms were chosen randomly to be the subjects of this study, and the water from these work units were retested for fluoride and iodine content.

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Subjects of the study: For the work units selected by the above selection method, all families with four- to seven-year-old preschool children were visited and asked to fill out a form. The intention was to screen out children who might have low intellectual ability due to genetic inheritance, past illness, malnutrition, use of medication, or other reason, or those who lacked proper examination records. After this process, 147 children remained from the high fluoride zone and 83 children from the low fluoride zone, and these children became the subjects of this study.

Testing methods and quality control: The IQ testing was carried out in strict accordance with the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) guidelines.[1] Prior to the test, the personnel in charge of giving the test were given a thorough training; the requirements of the test requires patience from the test-giver, as well as careful, clear pronunciation in a quiet environment. After the test, each of the exam "papers" was reviewed three times: individually, cooperatively, and then collectively. The reliability indices for this examination: the consistency of the IQ scoring was 99.92%, the consistency of judgment on test questions was 99.09%, and the corresponding retest $r = 0.743$.

Fluoride testing was done by taking samples of the well water from all selected work units and tested the same day using the fluoride ion selective electrode method. Each batch of samples was checked for uniformity and tested against a control sample.

ANALYSIS OF RESULTS

Basic characteristics of the IQ distribution: The study looked at a total of 230 four- to seven-year-old preschool children. The average IQ score for the entire subject group was 97.66. The group included 117 boys, who averaged a score of 99.05, and 113 girls, who averaged a score of 96.21; the gap between these scores is not statistically significant ($U = 1.399$, $P > 0.05$). The IQ distribution by age shows no particular pattern, the comparative difference is not significant ($F = 0.222$, $P > 0.05$). If age groups are divided and compared, the difference between the relatively high IQ 4½-year-old group (with an average IQ of 99.40) and the low IQ 5½-year-old group (with average IQ of 95.88) is not statistically significant ($t = 0.8391$, $P > 0.05$); using the moment method to test the normality of the distribution yields a skewness coefficient of 0.095, $P > 0.6$ and a kurtosis coefficient of 0.309, $P > 0.3$, which is essentially a normal distribution.

Relation between high fluoride and subject IQ: The results in Table 1 show that not only is the proportion of children from high fluoride zones with IQs less than 90 higher than in those from the control area, but the average IQ is significantly lower. Statistically, the difference is very significant, which demonstrates that living in high fluoride areas for a long period of time and the corresponding high intake of fluoride has a definite effect of the intellectual development of the child.

Table 1. Comparison of IQ in high fluoride zone vs control

Group	No. of subjects	Average IQ		IQs less than 90	
		Mean	SD	No.	%
High fluoride	147	95.64	14.34	52	35.4
Control	83	101.23	15.84	17	20.5

Note: t = 2.733, P < 0.01, mean in IQ between high fluoride and control groups = 5.602, P < 0.05

Analysis of the effects of high fluoride on the children's intellectual performance: The intelligence quotient of the children can be divided into two categories, namely, verbal IQ and performance IQ, to investigate the effects of high fluoride on each (Table 2). The results show that fluoride primarily affects the performance intelligence of preschool children, bringing down the IQ scores as a whole. This suggests that we should pay special attention to the damage to performance intelligence when studying the effects of high fluoride on intellectual ability.

Table 2. Comparison of effects of high fluoride on types of intelligence

Group	No. of subjects	Performance IQ	Verbal IQ	Full Scale IQ
		Mean+SD	Mean+SD	Mean+SD
High fluoride	147	94.33 + 14.76	97.58 +14.91	95.64 +14.34
Control	83	101.77 + 18.12	100.52 +14.52	101.22+15.84

Note: Performance IQ t = 3.376, P < 0.01 ; verbal IQ t = 1.450, P > 0.05; total IQ t = 2.733, P < 0.01.

Comparison of the distribution of the IQ scores of children in the high fluoride zone versus the control zone: When the distribution of IQ scores for children in the fluoride poisoned area and the distribution of IQ scores for children in the control group are each subjected to a moment method test of normal distribution, the IQ scores of the preschool children in the high fluoride areas show a flattened distribution, with a skewness coefficient of – 0.027, P = 0.892, and kurtosis coefficient of – 0.557, P = 0.146; The distribution of the IQ scores of the children in the control zone show a slight negative skew, when a skewness coefficient of – 0.330, P = 0.212, a kurtosis coefficient of 0.234, P = 0.655.

Inquiry into possible factors in intellect-development deficits of children in the high fluoride zone: Besides the effects of high fluoride on RNA and protein synthesis in the child's brain,[2] it is possible that there is a distinct relationship between physical abnormalities in brain shape development and the prevalence of children with intellectual developmental deficits in high fluoride areas. As part of this study a correlative analysis of head circumference was carried out on the children from each zone with the detailed results shown in Table 3.

In Table 3 the percentage of children in the high fluoride zone showing a developmental deficit with regard to head size (head circumference < mean–SD*)* is 18.37%, which is 0.91 times higher than the low fluoride zone (9.64%). Also, when comparing children within the high fluoride zone, the average IQ score of children with below normal head circumferences (89.07 + 15.69) is clearly lower than average IQ rating of children with normal head development (97.13 + 8.06); the difference is very significant (t = 2.6961, P < 0.01).

Table 3. Comparison of head circumference and IQ scores

Group	No. of subjects	Head circumference less than mean–SD		Head circumference greater than mean–SD		t value
		No. of subjects	IQ score (mean+SD)	No. of subjects	IQ score (mean+SD)	
High fluoride	147	27	89.07 +15.69	120	97.13 + 13.16	2.6961
Control	83	8	95.88 +16.03	75	101.80 +15.83	1.0047

DISCUSSION

In China studies have been carried out on the effects of high fluoride on the intellectual ability of children, with varying results. Yang Delong et al. demonstrated that such aspects as the fluorosis of teeth and even delay of skeletal development can be predicted from time spent living in a high fluoride area, showing also that chronic fluoride poisoning can create deficits in intellectual development in preschool children.[3] But Yunsun Hu's report suggests that the relationship between high fluoride exposure and variations in the IQs in the case of school-age children is not significant.[4] Since the factors that influence the IQ scores of children are difficult to unravel, particularly the major role that environment, education, and other acquired factors might play, we have chosen preschool-age children as the subjects of our study in hopes that we may lessen the interference from these kinds of factors and express the relationship between high fluoride and child IQ as objectively as possible.

Through examination and analysis of the performance IQs of 147 four- to seven-year-old children from a high fluoride zone contrasted with the 83 children forming the control group, this study has brought to our attention that damage to performance intelligence is an important aspect to be considered when doing research on the relationship between high fluoride and child IQ.

Differences between children in the high fluoride zone and those from the control zone are also apparent in the distribution; the IQ scores of children from the high fluoride zone have a flattened distribution, while the IQ distribution of the control shows a negative skew.

While looking for possible causes for the deficits in intellectual development, we found that, when compared with the control group, preschool children from the high fluoride area showed, on average, a clearly diminished head circumference, and the children who had fallen behind in this measure of physical development also tended to manifest decreased intellectual ability, suggesting that damage to either of these developmental facets could be an important marker to guide the further study of chronic fluoride poisoning.

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