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The effect of high fluoride exposure on the level of intelligence in children

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Abstract: **The Objective.** Looking into the effect of high fluoride exposure on the level of intelligence in children. **Method.** In May 2006, 42 children from a high endemic fluorosis group and 37 children from the control area (who have been consuming low-fluoride water after water improvement schemes) were chosen for the test. They are all from a primary school in Pucheng county, Shaanxi province. Their level of intelligence was tested, and a test for dental fluorosis using the Dean's method, with fluoride ion selective method was used to test the level of fluoride in their urine samples. **Results.** The average level of intelligence of the children in the high fluoride group (96.11 +- 12.00) was lower than that of the control group (98.41 +- 14.75). We have not found any children with an intelligence level exceeding a level deemed as excellent; as for the intelligence distribution in these groups, there is little statistical significance associated. There was a negative correlation between the urine fluoride concentration and the level of intelligence in children (P>0.05). **Conclusion.** Exposure to high levels of fluoride is likely to cause a certain level of harm to a child's level of intelligence.

Keywords: fluoride, children, intelligence level

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Recently, there has been more research material discussing the negative correlation between high fluoride exposure (over an extended period of time) and its harm on the level of intelligence in children, both at home and abroad. Different conclusions were raised; as well, there is not too much material within the field of epidemics. (1-3) For this reason, we have performed a random sampled research in a primary school in Pucheng county, Shaanxi province.

1. Content and methodology

1.1 Basic information of the point of research

This certain village in Pucheng county is a region severely impacted by endemic fluorosis. There are 9 groups in the village. From 1988 to 1992 groups 1, 2, 8 and 9 are switched over to consuming low-fluoride water, whose actual fluoride content is measured at 1.03 mg/L; groups 3, 4, 5, 6 and 7 have yet to have water improvement schemes put in place at their location, and

the fluoride contained in their water (source) is measured at 3.15 mg/L. The entire village shares common habits and lifestyles in terms of cuisine, economy (source of income), living environment, culture and education, agricultural goods etc. There are no chemical factories around the area, and this village is considered an area covered by iodine salt, and whose consumerable iodine salt is deemed to be satisfactory in terms of the national qualification standards.

1.2 Choosing the endemic fluorosis group

Amongst groups 3, 4, 5, 6 and 7 (who have yet to have water improvement schemes put in place), we have randomly selected 42 school children between the ages of 7 to 14 as the high/endemic fluorosis group's subjects, and from groups 1, 2, 8 and 9 (who have had water improvement schemes put in place and are now consuming low-fluoride water), we have randomly selected 37 school children between the ages of 7 to 14 as subjects of the control group.

1.3 Methodology

To research into the (conditions of) dental fluorosis in the children, we have used Dean's method. We have used plastic polyethylene bottles to collect urine samples from the children. The inspection of the level of fluoride in these urine samples are performed with the fluoride ion electrode selection method. To test the level of intelligence of these children, we have used the CRT-C2 image book; with the CRT-C2 intelligence module, we have then concluded the IQ values of each of the subjects. Different levels of intelligence are determined as per the following standard: IQ greater or equal to 130: outstanding; 120-129: excellent, 110-119: higher than average, 90-109: average, 80-89: lower than average, 70-79: subsistent intelligence; lower or equal to 69: low intelligence

1.4 Statistical analysis

We have used the Epi info 2002 (software) to analyze the data. The data are shown in -X +S, and the data measure the detection rate. The correlation between fluoride levels in urine (samples) and the level of intelligence has been evaluated and performed with single element related analysis. Inspection of the mean figure has been determined with the T-value; as for the comparison between the different rates gathered from the two groups, the X2-value has been used to perform the comparison.

2. Results

2.1 Fluoride in the urine samples

11 urine samples from the endemic group were found to contain fluoride measuring at 1.14~ 6.09 mg/L, and whose average is 2.89 +/- 1.97 mg/L; 7 urine samples from the control (comparative) group were found to contain fluoride measuring at 1.33 ~ 2.35 mg/L, and whose average is 1.78 +/- 0.46 mg/L. This difference bears no statistical importance ($t = 1.48$, $P > 0.05$).

2.2 Dental fluorosis in children

The endemic group has investigated a total of 42 school children from the endemic group and 35 cases of dental fluorosis have been found. The (successful) rate of inspection is 83.3%. 37 school children from the control group have been inspected and 11 cases of dental fluorosis have been found, and the (successful) rate of inspection is at 29.7%. The difference between the rate of disease between the two groups of children bears statistical importance (X = 23.24, P<0.01).

2.3 Results of inspection of the level of intelligence in children

From Table 1 below it can be seen that no school children having an "excellent" (or above) level of IQ have been found in the group impacted by endemic fluorosis, whereas 3 school children with such level of IQ were found in the control group. 4 school children with an IQ level which is deemed to be higher than average were found in the endemic group, which takes up 9.5% of the whole group. 8 such school children were found in the control group, taking up 21.6% of the whole group. Such difference bears no statistical importance (X2 =2.24, P>0.05). The average IQ of the endemic group is measured to be at 96.11, and this is lower by 2 points in comparison to the control group's 98.41; as per statistical analysis, this difference bears no particular statistical importance (t = 0.76, P>0.05).

Table 1. The distribution of the different levels of intelligence in the children amongst the endemic group and the control group

Group	**People (no.)**	**IQ rate (-X +S)**	**Outstanding**		**Excellent**		**Higher than average**		**Average**		**Lower than average**		**Fringe**		**Below par**	
			Ppl (#)	Constitute more than (%)	Ppl (#)	Constitute more than (%)	Ppl (#)	Constitute more than (%)	Ppl (#)	Constitute more than (%)	Ppl (#)	Constitute more than (%)	Ppl (#)	Constitute more than (%)	Ppl (#)	Constitute more than (%)
Endemic group	42	96.11 +/- 12.00	0	0	0	0	4	9.5	28	66.7	7	16.7	2	4.8	1	2.3
Control group	37	98.41 +/- 14.75	1	2.7	2	5.4	5	13.5	18	48.0	8	21.6	2	5.4	1	2.7

2.4 Relevant analysis of the correlation between fluoride content in urine (samples) and the level of intelligence

With the single element analysis method, we have investigated the correlation of the fluoride content in urine samples and the level of intelligence (in the subjects). There is a negative correlation between the two tokens, but the difference bears no statistical importance (the endemic group: r = 0.390, P>0.05; comparative group: r= -0.220, P>0.05).

3. Discussion

Fluoride can enter the brain tissue via the blood-brain barrier (4), and as doses of fluoride-contaminated matter increases, the amount of fluoride contained in the brain tissue likewise increases (5). The hippocampus, nerve fibers, nerve synapses and the blood-brain barrier of a lab rat which has consumed high-fluoride water over a long period of time are all seen to be harmed by such consumption (6). This research in particular has shown that no children with a level of IQ deemed as "excellent" or above have been found in the group, which has been

consuming water containing fluoride at 3.50 mg/L over an extended period of time. Additionally, the average IQ level of the endemic group has been found to be measuring 2 points lower than that of the control group. This difference bears no statistical significance (P>0.05), and this finding is in accordance to the conclusion found by the research team of Yuanshen Hu, who had performed a similar research in a village whose drinking water contained fluoride measuring at 7.00 mg/L (3). These are all indicative of the importance and necessity of rolling out the water improvement schemes in these affected areas. There is a significant and realistic importance to the improvement schemes in lowering the level of fluoride in drinking water, which subsequently protects and allows children to have a normal development of intelligence.

As the level of fluoride in the external area is way too high, subjects consumed fluoride from a variety of sources. Other than water, food items, vegetables and other items in the food chain all meant that subjects took in fluoride in various places. This could be a factor contributing to the rather inapparent difference between the average of fluoride in the urine samples and the IQ levels of the subjects from the two points of research. We therefore recommend that more extensive research be done on the actual basis and source of intake of fluoride in the affected endemic regions. As well, we recommend lowering the health standard of the amount of fluoride in drinking water at an endemic region (one where the overall intake of fluoride has exceeded the national health standard). We believe that it is realistic and important as a measure for endemic regions to proceed with a particular, regional fluoride standard in drinking water; as well, the method of food relocation (having food items produced in the south to be brought up north) would be affective in lowering the overall amount of fluoride consumption. As for the correlation between the level of fluoride in urine and the level of intelligence in children, the results are shown to be negative. It has been observed that as the level of fluoride content in urine increases, the level of intelligence in a child lowers. Therefore, focusing and increasing our (current) works of lowering the presence of fluoride in drinking water has far-reaching impact on the quality of our country's citizens.

The present research has also shown that while fluoride (consumption) has a certain level of impact on the level of intelligence in children, the difference is not apparent. Whether this is in relation to the relatively low number of samples collected, the overall level of fluoride consumption, or whether dental fluorosis is (or is not) under control (30%), such relation is yet to be confirmed. As the amount of fluoride in drinking water increases, as such contaminated water continues to be consumed over an extended period of time, the negative impact - and the scope of said impact- on the development of intelligence in children is very much worthy of further research and investigation.

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Our journal employs the measurement units as listed in the "Standard Measurement Units of the People's Republic of China", and we use symbols to show these units. For example we use "m" for metres and "kg" for kilograms. There cannot be any mix-up of the actual name of a measurement unit and its abbreviation and/or symbols. Fo example ng'kg 1 (day -1) should be regulated as ng'kg 1 d 1; if there is more than one forward slash shown in an abbreviation, it should be displayed in the negatives, such as ng/kg/min should be shown as ng'kg 1 min -1, or ng/(kg'min). Such strokes and negative data cannot be mixed together; for example the sample as given previously should not be shown as ng/kg' min -1, so to avoid confusion.

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