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# A PRELIMINARY INVESTIGATION OF THE IQS OF 7–13 YEAR-OLD CHILDREN FROM AN AREA WITH COAL BURNING-RELATED FLUORIDE POISONING

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**ABSTRACT: The *Chinese Binet IQ Test* was used to investigate the IQs of 7–13 year-old children suffering from dental fluorosis, living and attending school in an area with coal burning-related fluoride poisoning. The average IQ of these children was found to be markedly lower than in the control area, and the number of children classified as having low intelligence was significantly higher. For both groups, IQ and serum fluoride show a negative correlation (r = –0.205).**

[Keywords: Coal-Burning fluoride poisoning; Fluoride and IQ; IQ and environment.]

## INTRODUCTION

Prolonged excessive intake of fluoride can lead to nerve damage in humans, manifesting in deficits to motor, reflex, sensory, and autonomic function.[1] However, there are relatively few reports on the effects of excess fluoride intake on child intellectual ability. In order to investigate these effects, we selected three elementary schools in a area with endemic fluoride poisoning due to coal burning (the coal-producing township of Hongxi in Xinshao County, Hunan Province), with one elementary school in a area where wood is used as the primary fuel acting as the control, and tested the IQ of 121 children ranging in age from seven to thirteen. The results are as follows:

## MATERIALS AND METHODS

*Test areas:*

The residents of the endemic area use coal as their fuel, and their stoves lack proper exhaust piping. Every day approximately 15–25 kg of coal is burned, causing the surrounding air as well as the food to become contaminated. The coal burned has a fluoride content ranging from 118.11 to 1361.70 mg/kg; living in this type of environment for an extended period of time results ultimately in fluoride poisoning. Among adults, the rate of dental fluorosis was found to be 60.31%, and in 7–13 year-old children the rate was even higher, 86.46%. X-ray examinations of the adults did not reveal any instances of skeletal fluorosis. The fluoride content of the air indoors was tested to be 0.0298 mg/m$^3$, and the drinking water had less than 0.5 mg/L of fluoride.

The residents of the non-endemic control area use wood as their fuel, with only a small minority of residents in recent years switching to the use of small amounts of coal in the winter. The diagnosis rate of dental fluorosis among 7–13 year-old

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children was less than 5% (21/500), and thus the area is classified as a non-endemic control.

The endemic and control areas are two neighboring townships in Xinshao County, Hunan Province. Except for the aforementioned differences in the choice of fuel, the economy, culture, living standards, lifestyles, public health, and education of the two areas are very similar.

*Test subjects:*

The 465 students in the endemic area schools and the 500 students in the control school were subjected to an examination for dental fluorosis, and at the same time a basic physical examination (including measurements of height, weight, sitting height, and blood pressure as well as cardio, cerebral, and pulmonary function), sifting out subjects with diseases that might otherwise affect IQ. From the endemic region group, 428 children suffering from mild to severe dental fluorosis were selected, with 479 children eligible from the control school. These groups were divided and numbered based on their age and gender, and then 60 children were randomly chosen from the endemic region group, and 61 from the control group. A 1:1 male to female ratio was applied, and intelligence testing was conducted.

*Testing methods:*

*(i). IQ testing:* The testing was administered according to the standards of the *Chinese Binet IQ Test*, edited by Professor Tingmin Wu. The scores of each student tested were standardized using the conversion table for the Binet test.

*(ii). Intellectual ability ranking:* IQ = 69, low intelligence; 70-79, borderline low intelligence; 80-89, below average intelligence; 90-109, average intelligence; 110-119, above average intelligence.

## TEST RESULTS

*Comparison of the IQ levels of the 7–13 year-old children in the endemic and control groups:*

The average IQ of the endemic area children was 76.7, and the control group children had average IQs of 81.4; when compared, the difference is statistically significant ($p<0.05$). When the children are grouped by age, only the 7–9 year age groups show significant differences (see Table 1). However, when ranked according to the IQ ranking standard, each age group from the endemic area has an average IQ in the borderline low range, whereas the 7–11 year-old children from the control group are ranked as below average; only the 12–13 year-olds fall within the borderline range. This indicates that there is a meaningful difference between the IQ scores of the two groups.

**Table 1.** Comparison of the IQ levels of the 7–13 year-old children

| Age | Endemic group (n) | Control group (n) | p |
|---|---|---|---|
| 7–9 | 77.30±8.52 (20) | 83.95±8.53 (19) | <0.05 |
| 10–11 | 76.73±12.87 (20) | 81.15±10.21 (26) | >0.05 |
| 12–13 | 76.10±11.26 (20) | 78.75±12.00 (16) | >0.05 |

*Comparison of IQ scores between two groups by gender:*

Among the 121 elementary school students tested, there were 30 boys from the endemic area, average IQ score 78.2, and 30 girls from the endemic area, average IQ score 75.2. In the control group, there were 31 boys, average IQ 83.2, and 29 girls, average IQ 79.5. The gender-based IQ differences for each group are not statistically significant.

*Comparison of 7–13 year-olds in each group whose IQ scores fall into the ≤69 range:*

A total of 18 students in the endemic group have IQ scores that place them in the low intelligence classification range (≤69), 30% of all students tested. In the control group, only 7 students, or 11.5%, were so ranked. Comparing the two, the number of children with low IQs in the endemic regions is clearly higher, and the difference is significant ($p<0.05$, Table 2).

**Table 2.** Comparison of 7-13 year-olds in each group whose IQ scores fall into the ≤ 69 range

| Group | n | No. of students in low IQ range | Percentage (%) |
|---|---|---|---|
| Endemic Area | 60 | 18 | 30.0 |
| Control Area | 61 | 7 | 11.5 |

$u = 2.47$, $p< 0.05$, $\chi^2 = 5.25$ with Yates correction

*Distribution of IQ score rankings of the 7–13 year-olds in each group:*

As shown in Table 3, there were 41 children from the endemic area, or 68.3% of the total, whose IQ score was at or below the borderline low level, with 18 (30.0%) in the low range, in both cases markedly more than in the control. The number of children from the control area ranked with below average or better IQ was 35, or 57.4%, which is also significantly higher than the number (19, or 31.7%) from the endemic area. The differences in distribution of IQ rankings for the two groups are statistically significant ($\chi^2 = 11.48$, $p<0.05$).

**Table 3.** Distribution of IQ score rankings for the 7-13 year-olds in each group

| Group | Above average IQ (119-110) | Average IQ 109-90 | Below average IQ (89-80) | Borderline low IQ (79-70) | Mildly low IQ (69-55) | Moderately low IQ (54-40) | Total |
|---|---|---|---|---|---|---|---|
| Endemic | 0 | 10 | 9 | 23 | 17 | 1 | 60 |
| Control | 0 | 13 | 22 | 19 | 6 | 1 | 61 |

*Serum fluoride levels:*

For the endemic area children, the mean serum fluoride level was 0.1483±0.0473 mg/L, and for the control it was 0.1044±0.0652 mg/L. The difference between the groups is very significant ($p<0.01$).

## DISCUSSION

Research conducted in recent years has demonstrated conclusively that fluoride can cause direct damage to central nervous system function, and the rate of Down's Syndrome in regions with endemic fluoride poisoning is high.[2] The present study selected an endemic area and non-endemic whose other relevant factors such as economy, culture, living standards, lifestyles, public health, and

education were basically the same. In total, 121 elementary school students between the ages of seven and thirteen were tested to investigate the intellectual ability of children with dental fluorosis living in areas with coal burning-related fluoride poisoning. The results of this study show that the children living in high fluoride areas have lower IQs than the children from the non-endemic area. Also, there were many more children from the endemic area with an IQ score ranking of below the borderline low level as compared to the control; in the endemic area, there were 18 such subject, or 30% of the total, while in the non-endemic area there were only 7, or a rate of 11.5%. The difference between the two groups is significant. The overall distribution shows marked differences, with the scores in the control group on average one rank higher than in the endemic area. Neither group's average IQ score was in the average IQ range (90-109), which could be due to the isolation, poverty, low standard of living, and poor nutrition in the region selected for study contributing to a general decline in intellectual development. Nevertheless, the diminished IQ seen in the endemic area as compared to the control area is clear and significant.

As part of our investigation into whether or not there is a relation between IQ and fluoride, the serum fluoride levels of the test subjects were also measured, and a correlative analysis performed on the two data sets. In the endemic area, the correlation co-efficient $r = -0.25$ ($p<0.05$), and for the control area $r = -0.07$ ($p>0.05$), for the two combined $r = -0.205$ ($p<0.05$). These results indicate that there is a negative correlation between serum fluoride and IQ, and that the correlation is greater within the endemic group.

In summary, although diminished intellectual ability can result from a multitude of factors (both innate and acquired) that influence neural development and cell division in the cerebrum, the comparison conducted in this study of two areas where the other environment factors are basically the same shows clear differences in IQ, and it probable that this difference is due to a high fluoride environment. It is not clear whether the underlying mechanism is fetal exposure to fluoride resulting from the poisoning of the mother or intake of fluoride after birth (in either case causing a disruption nerve cell development leading to mental deficits); this matter awaits further study.

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2 Dai Ruiting, editor. *Control and Prevention of Fluoride Poisoning*. Beijing Science and Technology Publishing House; 1987. p. 29. [***Editor's note:*** The date given of 1937 in the original paper has been corrected to 1987.].