

Effect of coal – burning endemic fluorosis on children’s physical development and intellectual level

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Abstract: Objective To investigate the effect of coal burning endemic fluorosis on children’s physical development and intellectual level so as to provide data support for the protection the of children healthy growth in fluorosis area. **Methods** Ninety children with coal – burning endemic fluorosis were selected for the study, which were divided into heavy fluorosis area group middle fluorosis area group and light disease area group, 30 children in each group. Another 30 children were selected from non – fluorosis areas as normal group. The index of physical development and intellectual level of each group were compared. **Results** Dental fluorosis and urinary fluoride concentration of fluorosis area groups were higher than that of normal group ($P < 0.05$); index of height, weight and vital capacity in normal group children’s was significantly better than that of other 3 groups ($P < 0.05$); intelligence quotient (IQ) index in fluorosis groups was lower thn that of normal group ($P < 0.05$). **Conclusion** The coal – burning endemic fluorosis may have a serious impact on children’s physical growth and intellectual level; active preventive measures should be attached to protect children’s health.

Key words: Fluorosis; Children; Physical development; Intellectual level

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Fluorine, as a necessary micronutrient for the human body, is widely distributed in nature in many forms. The human body can come into contact with fluorides through water, air, and soil, etc.^[1]. However, since the normal adult needs very little fluorine (only 0.5 to 1.0 mg/d), long-term, large-dose contact with fluorine often causes fluorosis.^[2] Physiologic and pathologic change caused by fluorine overdose due to specific geographic environments is referred to as endemic fluorosis. Past research on fluorosis has been focused on its effect on organs such as bones and teeth. In recent years, an increasing amount of research is indicating that fluorosis also affects child physical development and intelligence^[3]. In this article, we use children in a coal-burning endemic fluorosis area as research subjects to discuss the effect of coal-burning endemic fluorosis on child physical development and intelligence.

1 Subjects and Methods

1.1 Subjects According to GB17018-1997 “Divide Standard of Endemic Fluorosis Areas,” 90 children from the Liupanshui City, Guizhou province coal-burning endemic fluorosis area were selected as research subjects. They were divided into severe endemic area group, moderate endemic area group, and mild endemic area group according to the type of endemic area they were selected from, with 30 in each group. In addition, 30 children from non-endemic areas were selected as the normal group. There were 15 males and 15 females in the

severe endemic area group, with an age range of 8–12 years old; there were 14 males and 16 females in the moderate endemic area group, with an age range of 7–13 years old; there were 16 males and 14 females in the mild endemic area group, with an age range of 8–13 years old; there were 15 males and 15 females in the normal group, with an age range of 7–12 years old. When comparing the general information between the populations in the two groups, the difference was not statistically significant ($P > 0.05$), the groups are comparable.

1.2 Methods Dean’s fluorosis index was used as a test for dental fluorosis. A fluoride ion selective electrode was used to test for urine fluoride concentration. The z-score was used to test for level of physical development. All research subjects had their physical indexes such as heights, weights, and chest circumferences as well as functional indexes such as lung capacity tested according to the standard test requirements for middle school student physical examination and health surveys. Intelligence was tested according to the Combined Raven’s Test: The Rural Edition in China (CRT-RC) on all research subjects, and the norm table was used to calculate each individual’s intelligence quotient. The intelligence quotient level standards were: ≥ 130 as very superior, 120–129 as superior, 110–119 as high average, 90–109 as average, 80–89 as low average, 70–79 as borderline, and ≤ 69 as extremely low.

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1.3 Evaluation indexes Disease conditions such as dental fluorosis and urine fluoride concentration as well as the relevant indexes to physical development and intelligence were observed and recorded for the children in each group.

1.4 Statistical analysis SPSS19 software was used to process data, measurement data was represented as mean ± standard deviation ($\bar{x} \pm s$), *t* test was used for comparison between groups, and the χ^2 test was used for count data, with $P < 0.05$ as statistically significant.

2 Results

2.1 Comparing dental fluorosis and urine fluoride concentration between the children in the various groups The dental fluorosis and urine fluoride concentration for children from severe endemic areas, moderate endemic areas, and mild endemic areas were all higher than those for the normal group, and the difference when comparing the groups was statistically significant ($P < 0.05$). The severe endemic area group had the most severe dental fluorosis and urine fluoride concentration ($P < 0.01$), and there was a positive correlation between dental fluorosis and urine fluoride concentration, as shown in Table 1.

2.2 Comparison of the physical development between the children in different groups The heights, weights, and lung capacities of children in the normal group were significantly better than those of children in the severe endemic area group, the moderate endemic area group, and the mild endemic area group, and the difference between groups was statistically significant ($P < 0.05$). The heights, weights, and lung capacities of children in

the severe endemic area were the lowest ($P < 0.01$). However, comparison of chest circumference between groups was not statistically significant ($P > 0.05$), as shown in Table 2.

2.3 Comparing the intelligence of children in different groups The intelligence quotients for children in the severe endemic area group, the moderate endemic area group, and the mild endemic area group were all lower than those for children in the normal group, and the difference between groups was statistically significant ($P < 0.05$). The children in the severe endemic area group had the lowest intelligence quotients ($P < 0.01$), as shown in Table 3.

Table 1 Comparison of dental fluorosis and urine fluoride concentration between children in different groups ($\bar{x} \pm s$)

Group	No.	Dental fluorosis [n(%)]	Urine fluoride concentration (mg/L)
Severe endemic area	30	26 (86.7) **	3.32 ± 1.02 **
Moderate endemic area	30	14 (46.7) *	2.41 ± 0.76 *
Mild endemic area	30	5 (16.7) *	1.54 ± 0.57 *
Normal group	30	1 (3.33)	0.83 ± 0.71

Note: Compared to the normal group, * $P < 0.05$, ** $P < 0.01$.

Table 2 Comparison of physical development-related indexes between the children in the different groups ($\bar{x} \pm s$)

Group	No.	Height	Weight	Chest circumference	Lung capacity
Severe endemic area	30	1.24 ± 1.02 * 0.91 ± 0.11	0.09 ± 0.24	1.01 ± 0.41 **	
Moderate endemic area	30	0.78 ± 0.13 * 0.62 ± 0.20	0.10 ± 0.23	0.52 ± 0.23 *	
Mild endemic area	30	0.37 ± 0.12 * 0.21 ± 0.12	0.11 ± 0.17	0.12 ± 0.25 *	
Normal group	30	0.16 ± 1.10	0.14 ± 0.32	0.12 ± 0.24	0.13 ± 0.14

Note: Compared to the normal group, * $P < 0.05$, ** $P < 0.01$.

Table 3 Comparison of the intelligence quotients of the children in different groups ($\bar{x} \pm s$)

Group	No.	Intelligence quotient	Frequency distribution of intelligence quotients [n(%)]						
			≥130	120 ~ 129	110 ~ 119	90 ~ 109	80 ~ 89	70 ~ 79	≤69
Severe endemic area group	30	90.52 ± 10.37 **	0 (0)	1 (3.33)	4 (13.3)	7 (23.3)	7 (23.3)	8 (26.7)	3 (10)
Moderate endemic area group	30	94.01 ± 11.24 *	1 (3.33)	1 (3.33)	6 (20)	8 (26.7)	7 (23.3)	5 (16.7)	2 (6.67)
Mild endemic area group	30	97.89 ± 12.43 *	2 (6.67)	2 (6.67)	6 (20)	9 (30)	6 (20)	3 (10)	2 (6.67)
Normal group	30	110.34 ± 11.52	3 (10)	2 (6.67)	10 (33.3)	11 (36.7)	3 (10)	1 (3.33)	0 (0)

Note: Compared to the normal group, * $P < 0.05$, ** $P < 0.01$.

3 Discussion

Along with more thorough research on coal-burning endemic fluorosis, it has been discovered that fluorine not only causes significant damage to hard tissue such as bones and teeth, but it can also cause varying damage on soft tissue such as the central nervous system.

In this article, we first compared the differences in dental fluorosis and urine fluoride concentration between children in different coal-burning endemic fluorosis areas. We found that the severe endemic area group, the moderate endemic area group, and the mild endemic area group all had higher dental fluorosis and urine fluoride concentration compared to the normal group ($P < 0.05$). Also, dental fluorosis and urine fluoride concentration were positively correlated, indicating that the more severe the endemic fluorosis, the higher the dental fluorosis and urine fluoride level was. This is consistent with what is found by most research scholars. In addition, comparing the physical development-related indexes between the children in different groups, we found that the heights, weights, and lung capacities of children in the normal group were significantly better than those in severe endemic areas, moderate endemic areas, and mild endemic areas ($P < 0.05$). The children in the severe endemic area had the lowest heights, weights, and lung capacities ($P < 0.01$). However, the differences between the chest circumferences of the groups were not statistically significant ($P > 0.05$). This indicates that the physical development of children in coal-burning endemic fluorosis areas is severely impaired. Finally, by comparing the intelligence between the children in different groups, we found that the children in the severe endemic area group, the moderate endemic area group, and the mild endemic area group all had lower intelligence quotients compared to the control group ($P < 0.05$), with the children in severe endemic areas having the

lowest intelligence quotients ($P < 0.01$). These results reflect the significant damage that coal-burning endemic fluorosis has on the intelligence development of children, and that child intelligence quotient and degree of fluorosis are negatively correlated.

In summary of the above, coal-burning endemic fluorosis can severely affect the physical development and intelligence of children. We should pay close attention to health service and be aggressive in the prevention and treatment of coal-burning endemic fluorosis, which will help further push forward continuous progress in society and the economy.

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