

Effects of High Iodine and High Fluorine on Children's Intelligence and Thyroid Function

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Abstract:

Objective: Try to find out the effects of high iodine and high fluorine on children's intelligence and thyroid function.

Methods: We selected in Qingyun County the Lidian Primary School, where the iodine and fluorine in the water are relatively high in concentration as the investigative point and Dading Primary School where the iodine and fluorine in the water have normal concentration as the control point. The high iodine goiter rate, dental fluorosis, IQ and thyroid metabolism indicators of the students aged 8 to 12 from the two schools were examined.

Results: In high iodine and high fluorine areas, the goiter rate and dental fluorosis of 8~12 years children were 29.8% and 72.98%. The children's average intelligence quotient (IQ) was 76.67 ± 7.75 , slightly lower than comparison point, but low intelligent pupil was 16.67%. The urinary iodine and urinary fluoride were $(816.25 \pm 1.80) \mu\text{g/L}$ and $(3.08 \pm 1.03) \text{mg/L}$ separately, clearly higher than comparison point. The thyroid iodine-131 uptake rates were visible lower. The value of 3h and 24h were respectively $(9.36 \pm 1.55)\%$ and $(9.26 \pm 4.63)\%$. The serum TSH level was obviously higher than comparison point.

Conclusions: High iodine and high fluorine have certain influence on children's intelligence and thyroid function.

Keywords: High iodine goiter; Dental fluorosis; Intelligence quotient; Thyroid hormone

Iodine and fluorine are necessary trace elements in the life activities of the body; both are in the halogen family, with similar chemical natures[1] and accompany each other in the water environment. In the cities of Binzhou and Dezhou in Shandong Province, people are sick with high-iodine goiter and dental fluorosis, because the iodine and fluorine in the water of deep wells are higher than the normal standard. To find out the effects of high iodine and high fluorine on children's intelligence and thyroid function, we carried out comparison investigations on children in primary schools of the key villages in Qingyun County. The results are reported as follows.

1. Object and Methods

1.1 Investigation Areas:

We selected Lidian Primary School (with water iodine of $1,100 \mu\text{g/L}$ and water fluorine of 2.97mg/L) as investigative point and Dading Primary School (with water iodine of $128.67 \mu\text{g/L}$ and water fluorine of 0.5mg/L) as the control point.

1.2 Investigation Objects and Content

We investigated the thyroid and dental status of the children in the age of 8-12 of two primary schools, about 30 children in Grade 4 were selected randomly in each

school for the examination of intelligence, urinary iodine, urinary fluoride, the thyroid iodine-131 uptake rates and the serum TSH level.

1.3 Examination Methods for Each Indicator

1.3.1 *The Diagnosis of Thyroid Goiter and Dental Fluorosis:* The diagnosis was executed according to the national prevention standard. The examination of thyroid used Palpation and the examination of dental fluorosis used the Dean method.

1.3.2 *Intelligence Test:* The test used was the atlas and norm of Combined Raven's Test (Chinese village version). The descriptive classifications of intelligence quotients were as follows: IQ scores above 130 indicate very superior, scores between 120 and 129 indicate superior, scores between 110 and 119 indicate high average, scores between 90 and 109 indicate average, scores between 80 and 89 indicate low average, scores between 70 and 79 indicate borderline, scores below 70 indicate extremely low.

1.3.3 *Physical and Chemical Indicator:* Water iodine applies $\text{Na}_2\text{S}_2\text{O}_3$ titration, the urinary iodine applies acid digestion, represented by $\mu\text{g/L}$; water fluorine and urinary fluorine applies fluorine ion selective electrode, represented by mg/L .

1.3.4 *Test of Thyroid Iodine-131 Uptake Rates:*The test used FH-458 thyroid at site.

1.3.5 *Test of Serum Hormone:*To test TSH we used the immunoradiometric assay (IRMA), while to test T₃ and T₄ we used Radioimmunoassay(RIA).

2. Results

2.1 Conditions of Children’s Thyroid Goiter and Dental Fluorosis

In high iodine and high fluorine areas, the goiter and dental fluorosis rates of children aged from 8 to 12 were clearly higher than the control point, indicating that high iodine and high fluorosis have worse effects on children’s thyroid and teeth (See Table 1).

Items	No. Children Examined	Thyroid Goiter		Dental Fluorosis	
		No.	Rate (%)	No.	Rate (%)
Investigative Point	322	96	29.81	235	72.98
Control Point	193	31	16.07	35	18.13

2.2 Children’s Intelligence and Distribution

There are no obvious differences of children’s average intelligence quotients between the high iodine/high fluorine areas and comparison point (P>0.05). But the proportion of children at the level of borderline and extremely low is obviously increased (See Table 2) .

Items	Number	IQ value (x±s)	Distribution of different IQ values (%)						
			≤69	70~79	80~89	90~109	110~119	120~129	≥130
Investigative Point	30	76.67±7.75	16.67	36.67	20.00	13.33	10.00	3.33	0
Control point	30	81.67±11.97	10.00	16.67	30.00	26.67	10.00	6.67	0

2.3 Test Results of Children’s Urinary Iodine and Urinary Fluoride

Urinary iodine and urinary fluorine of the children in the endemic areas were obviously higher than control point (P<0.001), indicating that children took a large amount of iodine and fluorine from the drinking water, and the metabolism of iodine and fluorine in the internal environment of the body was relatively high (See Table 3).

Group	Number of Cases	Urinary Iodine (µg/L)	Urinary Fluoride (mg/L)
Investigative Point	30	816.25±1.80	3.08±1.03
Control point	29	212.04±1.95	0.82±0.56

2.4 Test Results of Children’s Thyroid-131 I Uptake Rates (RIAU)

The average thyroid-¹³¹I uptake rates of children in the high-iodine/fluorine area at 3h and 24h are similar and visibly lower than the comparison point, with the peaks occurring earlier (See Table 4).

Items	Number	Thyroid Iodine Uptake Rates (x±s)	
		3h	24h
Investigative Point	27	9.36±1.55	9.26±4.63
Comparison Point	31	13.42±2.88	22.79±5.29

2.5 Test Results of Children's Serum TSH Level

The serum TSH level was obviously higher than comparison point (See Table 5).

Items	No.	T ₃ (nmol/L)	T ₄ (nmol/L)	TSH (mU/L)
Investigative point	29	0.76±0.36	147.83±48.31	3.37±2.16
Control point	33	0.74±0.43	128.46±38.12	0.82±0.51

3. Discussion

In high iodine and high fluorine areas, the goiter and dental fluorosis rates of children aged from 8 to 12 were 29.8% and 72.98%. The children's average intelligence quotient (IQ) was 76.67±7.75, slightly lower than the control point. The rate of low intelligence and borderline intelligence were 16.67% and 36.67% respectively, obviously higher than the control point. This is consistent with the other reports[2,3] on the effects of high iodine and fluorine on children's intelligence. The number of children tested is not enough in this intelligence investigation so further research is needed into the effects of high iodine and high fluorine on children's intelligence.

The urinary iodine and urinary fluorine of children in high iodine and high fluorosis areas are obviously higher than the control point, showing that metabolism of iodine and fluorine in the internal environment of the body is at a high level. The thyroid-¹³¹I uptake rates (RAIU) is also one of the sensitive indicators for the iodine metabolic

level of body. The RAIU value at 3h and 24h were close and the peak occurred early, indicating that high iodine and high fluorine may suppress the thyroid-¹³¹I uptake function. High iodine is the main reactor[4]. As for the effects of fluorine on thyroid-¹³¹I uptake function, different opinions appear in the literature. Fluorine is believed to have no effect on thyroid [5], while it is also believed that fluorine and iodine are competitive or collaborative for target organs and that fluorine suppresses thyroid to uptake ¹³¹I [6].

TSH value was obviously higher than the control point, indicating that, under high iodine and high fluorine condition, T₃ and T₄ secreted by the thyroid are in the normal range, while TSH value secreted by the pituitary clearly increased. This is probably because high iodine and high fluorine suppress the synthesis and secretion of the thyroid peroxidase and thyroid hormones and other circles. The body accelerates the Hypothalamic TRH secretion by negative feedback regulation, thus increasing the secretion of TSH, stimulating the composition of T₃ and T₄ of the thyroid. As a result, the TSH in the peripheral blood circulation is high while T₃ and T₄ are not clearly reduced.

In conclusion, high iodine and high fluorine in the drinking water have, to some extent, effects on children's intelligence and thyroid function. For the diseases induced by high iodine and high fluorine, the change of water resources is an important prevention. In addition, we should seek new water sources, limit the intake and absorption of high iodine and high fluorine, and accelerate the drainage of iodine and fluorine from the body. The health sector should look for and monitor new water resources.

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