

The Effects of High Levels of Fluoride and Iodine on Child Intellectual Ability and the Metabolism of Fluoride and Iodine

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Abstract: The authors carried out a study on the intellectual abilities and fluoride/iodine metabolisms of children living in a high fluoride, high iodine area. Among the results: the percentage of the general population living in this fluoride/iodine contaminated region that suffered from goiter (clinical thyroid enlargement) was 3.8%, the rate of children already showing some thyroid enlargement was 29.80%. Similarly, the rate of dental fluorosis for the general population was 35.48%, while for children it was 72.98%. Student subjects had average IQs of 76.67 ± 7.75 , with the 16.67% of the IQs in the "low" category. The iodine content and fluoride content of the children's urine were $816.25 \pm 1.80 \mu\text{g/L}$ and $2.08 \pm 1.08 \text{ mg/L}$ respectively, significantly higher than the control. The thyroid glands of the subjects showed a markedly lower uptake rate of iodine-131 when compared with the control, the values after three hours and twenty-four hours were $9.36 \pm 1.55\%$ and $9.26 \pm 4.63\%$ respectively, and the blood serum levels of thyroid stimulating hormone (TSH) were significantly higher than the control. The results indicate that high levels of fluoride and iodine have a serious damaging effect on the body, and should be given greater attention.

Key Words: Iodide Goiter, Dental Fluorosis, Thyroid Stimulating Hormone

The subjects of the study were residents of the Huimin and Dezhou regions

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of Shandong Province, on the lower reaches of the Yellow River. In 1976, in a response to increasingly bitter, salty water, they began to drill much deeper wells; the fluoride and iodine content of this deep well water was found to be much higher than the standards for drinking water, resulting in a high prevalence of iodide goiter and fluoride poisoning. The area is known locally as the “twin contamination zone.” In order to investigate the effects of high iodine and fluoride on child intellectual ability and the metabolic characteristics of iodine and fluoride, we carried out a contrasted study of a two villages in Qingyun County. The results are as follows.

Materials and Methods

1. Lidian Village of Qingyun County was selected as the site of our study; its drinking water was tested to have an iodine content of 1,100 $\mu\text{g/L}$ and a fluoride content of 2.97 mg/L . The non-disease control area was Dading village of the same county; its drinking water showed an iodine content of 128.6 $\mu\text{g/L}$, and a fluoride content of 0.5 mg/L

2. The diagnoses of goiter and dental fluorosis were both carried out based on national standards for endemic disease control^[1,2]. Intelligence testing was done using the Chinese Comparative Scale of Intelligence Test (Third Edition), as revised by Wu Tianming^[3].

3. The determination of iodine and fluoride levels in the drinking water was accomplished by conventional physicochemical analysis techniques, with their expressed values in units of $\mu\text{g/L}$ and mg/L respectively. The incineration method was used to determine urine iodine, again expressed as $\mu\text{g/L}$, while the electrode method was used for urine fluoride, expressed as mg/L . The measure of the thyroid gland's absorption rate of iodine-131 was done on site using a type 44-1 thyroid function indicator from the Hefei Wireless Electronics Factory. T_3 , T_4 , and the thyroid stimulating hormone

(TSH) were measured using radioimmunoassay.

Results

I. Rates of Goiter and Dental Fluorosis.

1. For prevalence of goiter and dental fluorosis in the studied population, see Table 1:

Table 1 : Comparison of the Number of Suffers of Thyroid Gland Enlargement and Dental Fluorosis in Groups with Different Water Sources

Group	Sample Size	Thyroid Gland Enlargement			Dental Fluorosis	
		No. with Physical Swelling	Clinical Goiter Sufferers	Disease Rate (%)	Clinical Sufferers	Disease Rate (%)
Subject	1102	217	42	3.80	391	35.48
Control	416	42	2	0.48	57	13.7
				P<0.01		P<0.01

Table 1 shows that the subject group ingesting water with high levels of fluoride and iodine show significantly increased disease rates for goiter and dental fluorosis when compared with the control, and the rates are sufficient to classify these diseases as endemic to the area.

2. Results for children 15 or younger: The rate of thyroid swelling among children 15 or younger was found to be 29.8% (96/322), and the rate of dental fluorosis reached 72.98% (235/322). In the control group, the rates were 16.13% (15/93) and 18.28 (17/93) respectively, with P<0.01 in all cases, indicating that the harm caused by a high fluoride, high iodine environment is particularly serious in the case of children.

II. Intelligence Testing for 8-14 Year-old Children:

The average IQ scores of children in the high fluoride, high iodine area

and the control area were 76.67 ± 7.75 and 81.67 ± 11.97 respectively. This difference is not significant, however the number of children showing moderately low IQ scores in the subject population is significantly higher than the control. See Table 2.

III. Urine Iodine, Urine Fluoride Test Results:

See Table 3. The results show that school-age children in the endemic region have urine iodine and urine fluoride levels significantly higher than the control ($P < 0.01$), indicating that the body is absorbing large quantities of iodine and fluoride from the drinking water, and that the body load of these two substances is high.

Group	n	Average IQ	<60	70-79	80-89	90-100
Subject	30	76.67 ± 7.75	16.67	60.00	6.67	16.66
Control	30	81.67 ± 11.97	10	26.67	40.00	23.33
		$P > 0.05$				

Group	Urine Iodine ($\mu\text{g/L}$)		Urine Fluoride (mg/L)	
	n	$\bar{x} \pm \text{SD}$	N	$\bar{x} \pm \text{SD}$
Subject	25	818.25 ± 1.80	23	2.03 ± 1.03
Control	29	212.04 ± 1.95	27	0.82 ± 0.55
		$P < 0.01$		$P < 0.01$

IV. Thyroid Gland Iodine Absorption Rate of Child Subjects

The results show that the average values of the thyroid gland iodine-131

uptake rate for children in the disease endemic areas, tested at 3 and 24 hours (9.36 ± 1.55 and 9.26 ± 4.63 respectively) are significantly lower than the average values of the control (13.34 ± 2.88 , 22.79 ± 5.29) ($P < 0.01$), and near identical values at 3 and 24 hours after exposure suggest a backwards shifting of the peak value.

V. Blood Serum Levels of Hormones

The results show that the general increase in the average levels of T_3 , T_4 , and TSH in children from the endemic area compared to the control, however only the TSH value shows a statistically significant difference ($P < 0.01$).

Group	T_3 ($\mu\text{g/dl}$)		T_4 (ng/dl)		TSH($\mu\text{IU/ml}$)	
	n	$\bar{x} \pm \text{SD}$	n	$\bar{x} \pm \text{SD}$	n	$\bar{x} \pm \text{SD}$
Subject	23	0.76 ± 0.36	24	147.83 ± 88.31	4	3.37 ± 2.16
Control	33	0.74 ± 0.43	33	128.46 ± 38.12	10	0.82 ± 0.51
		$P > 0.05$		$P > 0.05$		$P < 0.01$

Discussion

Iodine and fluoride are necessary trace elements for organic life, but if the ingestion is too high or too low, disease is the result. In this study, the prevalence of goiter in the subject population from a high iodine, high fluoride zone was 3.8%, with thyroid swelling present in 29.81% of the children 15 and under, and the rate of dental fluorosis in the subject population was 35.48%, reaching 72.98% in the children 15 and under, in all cases the rates for the subject group were significantly elevated compared to the control. This suggests that the separate harm caused by an excess of each of the two elements is compounded when iodine and fluoride are found together in a single region, their ingestion leading to a serious array of health problems.

An excess of fluoride and a lack of iodine in the same environment has been shown to have a marked effect on child intellectual development, causing a more significant intellectual deficit than lack of iodine alone^[4]. The subject group of children from the high fluoride, high iodine zone have an average IQ of 76.67 ± 7.75 , which was somewhat less than the control (IQ = 81.67 ± 11.9), though the difference is not significant ($P > 0.05$). However, the percentage of subject children in the low range (16.67%) is higher than the control, suggesting that a high iodine, high fluoride environment also has a definite negative influence on child intellectual ability.

The urine iodine and urine fluoride levels for children living in the high iodine, high fluoride zone were $816.25 \pm 1.80 \mu\text{g/L}$ and $2.08 \pm 1.03 \text{ mg/L}$, respectively, clearly elevated by comparison to the control, reflecting the high body load of iodine and fluoride. Elemental iodine is a key component of thyroid hormones, and also influences several stages of their formation and excretion^[5]. Fluoride, on the other hand, is toxic to living cells, and is a powerful inhibitor of certain enzymes. Excessive uptake of fluoride can

cause decreased functioning of the thyroid gland in direct relation to the blood level. Of course, iodine is the primary factor here; what exact role that fluoride is playing requires further study.

The serum levels of T_3 and T_4 for the children from the high iodine, high fluoride zone were only slightly higher than the control ($P>0.05$), but the level of TSH was clearly elevated ($P<0.01$). That the thyroid gland excretion of T_3 and T_4 for the “twin contamination zone” children was in the normal range but the pituitary gland’s excretion of TSH was significantly elevated makes it probable that reverse feedback is promoting the hypothalamus’ excretion of TRH, causing an corresponding increase in the excretion of TSH, which stimulates compensating production of T_3 and T_4 by the thyroid gland.

The results of this study indicate the following: (1) areas that have long-term, serious iodine and fluoride contamination can cause goiter and fluoride poisoning in the population; this problem should be taken seriously. (2) The clinical characteristics of children from this region include high urine iodine, high urine fluoride, poor thyroid iodine-131 absorption and similar values at 3 and 24 hours (possibly a backward peak value shift), and high TSH values. (3) With regards to the diseases endemic to this high iodine, high fluoride zone, the only fundamental means of control is to change the source of water, limit the ingestion and absorption of iodine and fluorine, and promote their excretion from the body.

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