

Effect of high-fluoride water on 7-11 year-old-children's intelligence

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Running title: Drinking water fluoride and intelligence

Summary

In order to investigate the relationship between fluoride in drinking water and Intelligence Quotient (IQ) of children we enrolled 126 children aged 7-11 years in the study who were life-long residents in two village near the Qazvin in Iran with different level of fluoride in drinking water. (Najmabad : 2.5 ppm and zoyar: 0.4 ppm) The children in the high fluoride area had significantly (P =0.000) lower IQ (87.9 ± 11) than the children in low fluoride area (98.9 ± 12.9) more children in the high fluoride area (56.1 %) were in the retardation (<70), border line (70-79) or dull normal (80-89) categories of IQ than children in the low fluoride area (16.5 %). high level of fluoride may be associated with impaired development of intelligence.

Key words: Intelligence Quotient, fluoride, children's Intelligence

Introduction

Fluoride has been widely used in dentistry and public because it is an effective carries prophylactic agent [1,2] and an element in the prevention of some disease [1,3]. In view of increased fluoride levels in many foods and water supplies, it is urgent that further studies be conducted to examine whether there is a link between fluoride and disturbances of the development and function of the central nervous system [4] and genetic apparatus [2,5] in animal and human.

Dental caries, cancer and possibly other disease can be prevented by fluoride in nutrition [1], although some studies have showed that fluoride in drinking water has no significant effect on dental caries [6,7].

Despite Roholm noting that "man is much more sensitive to fluoride than the rat"[8], rats have been used in animal studies disclosing significant changes from fluoride effects on the central nervous system. The earlier studies have shown that neurotoxicity in rats with fluoride exposure causing sex and dose specific behavioral deficits [9], and chronic administration of aluminum fluoride and sodium fluoride in drinking water of rats resulted in distinct morphological alteration in the brain including effects on neurons and cerebrovasculature [10]. Other studies have showed that fluoride has adverse effects on the brain and explored the actions of protective agents. [11,12]

In fact one of the main manifestation of fluorosis is injury to the central nervous system [9]. In affected population neurological symptoms have been reported such as partial paralysis of arm and legs, headache, spasticity in extremities, visual disturbances, mental retardation[13], difficulty in swallowing and leg muscle soreness [14].

In this study we have investigated the relationship between fluoride in drinking water and IQ of Iranian schoolchildren.

Methods

The study was cohort and undertaken on schoolchildren from Najmabad and Zoyar in Iran. According to the information was obtained from the housing and urban planning ministry of Qazvin, in these two village occupational status and socioeconomic background was similar, but they had different fluoride concentration in drinking water. Each village had only one primary school. All children that were life-long residents of these two village and studied in primary school were chosen.

This study was approved by Ethics Comity of Tehran University of Medical Science (TUMS).After description of the procedure and the purpose of the study, written informed consent were obtained from parents or guardians. Investigator-administered questionnaire about age, sex, residential history, past history of illness were completed by parents or guardians.

Children which had the history of sever infectious febrile disease in childhood, head-trauma, hard delivery and illness affecting the nervous system were excluded. Finally 41 children were chosen from the high fluoride area (2.5ppm) and 85 children were chosen from low fluoride area (0.4ppm).

Information about fluoride level in drinking water was gained from hygiene faculty of Qazvin university and samples were confirmed with hygiene faculty of Tehran university with Alizarin Visual Method.

The IQ was measured with the Raven's Test according to the recommended method [15].

The seven categories were distinguished by the IQ were: <70 retarded (low); 70-79 borderline (below average) ; 80-89 dull normal (low average) : 90-109 normal (average) ; 110-119 high normal (high average) ; 120-129 superior (good) ; 129< very superior (excellent).

Resulted are presented by mean \pm SD.

Results

The mean age of children was 8.53 years old and the percentage of girls and boys was 51.6 and 48.4 respectively. The mean IQ of the children living in the high fluoride area was significantly ($p = 0.000$) lower than that of children living in low fluoride area. (Table 1)

The distribution of IQ is presented in table 2. The proportion of children in the retardation, borderline or dull normal categories of IQ was higher for the children living in the high fluoride area than the children living in the low fluoride area. The proportion of children in the normal, bright normal or superior categories of IQ was lower for the children living in area with high fluoride than the children living in area with low fluoride.

Discussion

Fluoride is an essential material but the beneficial range is so narrow that health may be influenced adversely if excessive fluoride is supplied [5]. This study found a significant inverse concentration-response relationship between the fluoride level in drinking water and the IQ of children. As the fluoride level in drinking water

increased, the IQ fell and the rates of mental retardation and borderline intelligence increased.

The findings of this study replicate that of the earlier studies. Li Y et al, Xs Li et al and Zhao LB et al found that fluoride has an adverse effect on children intelligence [16, 17, 19]. Lu Y et al and Xiang Q et al showed that the children living in high fluoride area have lower IQ than the children living in low fluoride area [4, 18].

Excessive fluoride intake since early childhood would reduce mental work capacity [16,17]. Fluoride can go through the blood brain barrier [20, 21] and accumulate in rat hippocampus [22], and its concentration is correlated with concentration of this ion in the plasma [23]. fluoride is a potent enzyme poison and increases the level of lipid peroxides along with a concomitant decrease in the activities of superoxide dismutase (SOD), and this altered antioxidant status may be attributed to the increased generation of free radicals[24], and it can induce a wide range of damage including lipid peroxidation[23]. Cholinesterase activity has negative correlation with fluoride concentration in rat hippocampus [22].

High fluoride concentration can decrease the number of neuronal nicotinic acetylcholine receptors (nAChRs) in the brain of rats. Since nAChRs play major roles in cognitive process such as learning and memory, the decrease in number of it may be an important factor in the mechanism of brain dysfunction [16,23]. Recently, it has been indicated a connection of nAChRs with certain disorder that are associated with dementia, such as schizophrenia [25,26], and Down syndrome[27].

High fluoride concentration can modify contents of phospholipid and ubiquinone[5], and fatty acid composition [28] in brains of rats. Metabolism of brain phospholipid might be interfered by fluoride accumulation in brain tissue, which is related with

degeneration of neuron and it can be involved in the pathogenesis of chronic fluorosis[3,5].

Fluoride exposure caused sex and does specific behavioral effects with a common pattern, male were more sensitive to prenatal days 17-19 exposure of fluoride whereas female were more sensitive to weanly and adult exposure[9].

Further investigations are needed to get more information about the effects of fluoride on the brain and more detail explanation for it's mechanism.

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Table 1. IQ of children living in areas with high and low levels of fluoride in drinking water

Levels of fluoride in drinking water	No. of children examined	Mean IQ mean \pmS.D.
High (2.5ppm)	41	87.9 \pm 11
Low (0.4ppm)	85	98.9 \pm 12.9

Table 2. The distribution of IQ scores for children living in areas with high and low levels of fluoride in drinking water

Water fluoride	IQ<70 (low)	IQ70-79 (below avg)	IQ 80-89 (low avg)	IQ 90-109 (average)	IQ 110-119 (high avg)	IQ 120-129 (good)	IQ >129 (excellent)
High	1 (2.4%)	9 (22%)	13 (31.7%)	16 (39%)	2 (4.9%)	-	-
Low	1 (1.2%)	6 (7.1%)	7 (8.2%)	51 (60%)	14 (16.5%)	6 (7.1%)	-