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Research Article

Exploration of Relationship Between Fluoride and Intelligence Quotient in Children of Fluoride Contaminated Districts of Rajasthan

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ABSTRACT

Present study shows the relationships between drinking water fluoride, urinary fluoride, and IQ. Fluoride (F) in drinking water is usually the main source of F intake, and excessive consumption of F can cause a wide range of adverse health effects. In the water bodies, the toxicity of the fluoride ion (F) is depends on several parameters, such as pH, temperature, and water hardness. In uncontaminated surface waters, F concentrations are usually 0.01-0.3 mg/L, although higher concentrations may occur in contaminated water. Anthropogenic activities can also increase F in water bodies by the discharge of industrial effluent into recipient water bodies.

The regular intake of high levels of F can cause dental and skeletal fluorosis as well as non skeleton fluorosis like damaging organs including the kidney, liver, and brain. In aquatic ecosystem, a high level of F has toxic effects on organisms such as algae, plants, fish, and marine crustaceans. Kota, Jodhpur, Bikaner, Nagore, Udaipur, Jaisalmeir, Barmer districts choosen as study area. Ion selective meter used to analyze fluoride content in water and urine and mental ability based questioner used for IQ test. The results showed that, the mean IQ of children living in the high drinking water F region was lower (72.02±15.17) than that of children in the low drinking water F region (120.15±12.33)

Keywords: Fluoride; Fluorosis; Intelligence Quotient

Introduction

High intake (above 1.5 mg/l) of fluoride create health hazard leading to stiffening of body joints , deformation of bones mottled or chipped teeth, aches and pain in joints. Fluorosis may categorized as dental, skeletal and even non skeletal fluorosis [15,16]. Fluoride has a tendency to cycle in the environment, which also includes the animals and human beings thereby causing toxicity in them [17, 18].

It cycles from vegetation through grazing of animals and ultimately use of animal milk by human beings. Incorporation of fluoride in vegetation and associated biochemical changes due to fluoride contamination in water and soil. A high bio concentration factor (BCF) of fluoride in vegetables imposes a high health risk due to fluoride intake both from water and vegetation. [2] exposed developmental neuro toxicity of fluoride The outcome of this research article support the possibility of an adverse effect of high fluoride exposure on children's brain development. Consumed Fluoride rapidly dissolve in blood stream and across the blood-brain barrier. Some researchers found that the toxicity of fluoride in brain may be due to excitotoxicity [4] or free radicals and lipid peroxidation products generated by excitotoxicity have been shown to damage dendrites of neurons and lead to neuronal destruction [5,7].

The brain is affected to oxidative stress due to the presence of high levels of polyunsaturated fatty acids, relatively low antioxidant level, the presence of redox metal ions and high oxygen [12]. The free radical productions, lipid peroxidation, and distorted antioxidant defense systems are considered to play an important role in the toxic effects of fluoride [15,17].

The objective of this paper is to explain such research question: whats the relation between low IQ and fluoride? How strong is the relation between these two variables? The data are combined statistically to provide a quantitative estimate of the size of effect of exposure and risk of disease.

Material and Method

Fluoride Contamination in Rajasthan

High fluoride contaminated, more than WHO permissible limit is very common problem in Northern Rajasthan. Fluoride content in villages of Bhilwara district of central Rajasthan varies from 0.2 to 13.0 mg/l [9]. Fluoride distribution was observed in groundwater (1.1 to 8.5 mg/l) and survey of dental fluorosis in villages of Didwana Tehsil of Nagaur district of Rajasthan [9]. Villages of Bhakra canal catchment area has fluoride concentration 1.00 to 5.75 mg/l, villages of Indira Gandhi canal catchment area having fluoride concentration from 1.50 to 3.50 mg/l. The Ground water quality assessment of Nawa Tehsil area ground water having high fluoride contamination between 14.62 to 24 ppm. Fluoride contamination in some villages of Nagaur district, is upto 28.09ppm [4].

Sampling A cross-sectional study was designed to analyze the effect of fluoride in drinking water on the IQ among 4-14 years children who are living in high fluoride areas of study area.

Intelligence quotient was tested using Seguin Form Board (SFB) Test to assess visual discrimination, matching and eye-hand coordination. Test materials included ten differently shaped wooden blocks and a large board with recesses corresponding to these shapes.

Prior to administering the test, an explanation of the nature of the test and instructions was given to the children regarding the method of writing the answers in the required form. Raw score obtained by children was converted into the standard score (based on the age of the children) by the psychologist and comparison was done on the basis of these standard scores.

Socio-demographic information

Socio-economic status was recorded using Modified Prasad's classification. Possible confounding factors were investigated by assessing the questionnaires that the children's parents completed. This was done by following proper guidelines.

Inclusion criteria

➢ Children for whom ground water is the only source as drinking water since their birth

➢ Children who have about to similar social and economic status

Exclusion criteria

➢ Children with birth defects, any form of neurological injury, brain wound, injury to the brain or any systemic medical problem.

Anthropometric measurements

Body weight was recorded in kg using a standard beam balance scale with the subject barefoot and wearing light clothes. The balance was calibrated at the beginning of each working day and at frequent intervals throughout the day. Body height was recorded to the nearest 0.5 cm according to the following protocol: no shoes, heels together and head touching the ruler with line of sight aligned horizontally. To avoid subjective errors, all the measurements were done by the same person and by one recording assistant. BMI was calculated using the formula: Weight [kg]//Height2 [m]. Respondents were categorised into 4 levels: underweight (BMI < 18.5 kg/m2), normal (18.5 < BMI < 24.5 kg/m2), overweight (25 < BMI < 29.5 kg/m2) and obese (BMI > 30 kg/m2).

Fluoride estimation

Drinking water (bore well water) from both the areas was collected in polypropylene bottles (nonreactive) and were brought to the laboratory in an icebox to preserve majority of its physical, chemical and biological characteristics. Fluoride levels were measured using a fluoride ion selective electrode in the drinking water of the children.

Statistical analysis

The data was coded and entered into Microsoft Excel spreadsheet. The results obtained from the study are expressed as mean ± SD. The statistical significance was determined by Mann-Whitney p-test. Probability, p-value less than 0.05 were considered statistically minimum significant. Analysis was done using Statistical package for social science (SPSS) version 15 (SPSS Inc. Chicago, IL, USA) Windows software program.

Result

The socio-demographic distribution in term of age and BMI in table-1. The concentration of fluoride in drinking water and urine samples of selected districts presented in table-2. Significant ($p<0.001$) difference were observed in urine fluoride levels and fluoride in their drinking water.

The fluoride concentration urine was directly proportional to the concentration of fluoride in drinking water. The IQ scores of the children has significant relationship with fluoride in drinking water. The maximum children exhibited the range 90-99 (48.69%) followed by 75-89 (40.14%) and <75 (7.97%), while, the maximum IQ range 100-129 found only in 4.63% children. Out of 690 children 40 (5.79%) children were affected from severe fluorosis, 249 children were in normal category while 202(29.27%) were in initial stage of fluorosis (questionable). Most of the children belonged from low socio economic group, their BMI(Kg/m2) ranges from20.17 to 24.09. Table 3 illustrates association between range scores of IQ and category of children.

BMI index was statistically significant ($p < 0.05$) among districts and fluoride concentration in drinking water. Sociodemographic and anthropometric measurements of school going children denoted in Table1 and level of fluoride in drinking water, urine and children's IQs in Table2 respectively.

No	Variables	Kota	Bikaner	Nagore	Jodhpur	Udaipur	Barmer	Jaisalmer
1	Age(yr)	6.11±4.121	5.25±4.157	7.21±3.563	8.01±3.328	6.57±4.714	5.81±5.272	6.19±3.715
2	Children	89	109	107	101	108	88	88
	Male	52	48	65	57	68	56	60
	Female	37	61	42	44	40	32	28
3	Weight(kg)	29.12±10.110	27.51±11.256	28.02±12.524	31.09±8.971	26.15±7.126	30.25±10.271	25.71±11.516
4	Height(cm)	127.29±12.15	130.15±15.67	125.14±20.19	136.42±11.71	129.05±10.91	125.21±12.75	131.10±14.57
5	BMI	23.15	22.29	20.17	24.09	22.15	20.19	21.72
6	Nutritional status							
	Under weight	12	10	14	8	10	13	7
	Healthy weight	50	62	70	65	57	55	45
	Overweight	25	26	20	27	37	18	31
	Obese	2	1	3	1	4	2	5
7	Education level							
	Primary	20	38	35	20	30	24	15
	Middle Primary	29	36	30	34	40	32	33
	Secondary	40	35	42	47	38	32	40
8	Fluorosis Index							
	Normal	70	38	7	40	41	25	28
	Questionable	14	41	12	21	35	42	37
	Very mild	2	8	34	12	17	5	5
	Mild	3	7	14	10	15	8	6
	Moderate	-	7	20	12	-	6	8
	Severe	-	8	20	6	-	2	4

Table 1: Sociodemographic and anthropometric measurements of school going children (± denotes std. deviation)

Sr. N.	Districts	Water Fluoride	Urinary Fluoride	Number of Children	INTELLIGENCE QUOTIENT				
					>130	100-129	90-99	75-89	<75
1	Kota	2.482±1.039	3.01±1.214	89	-	8	55	22	4
2	Bikaner	4.221±3.147	5.29±2.012	109	-	6	57	40	6
3	Nagore	14.168±7.929	17.40±8.141	107	-	-	39	58	10
4	Jodhpur	5.409±6.327	6.57±5.231	101	-	6	48	40	7
5	Udaipur	3.904±2.172	4.61±1.542	108	-	7	50	40	11
6	Barmer	3.947±3.264	5.09±2.945	88	-	-	47	33	8
7	Jaisalmer	3.854±3.188	4.72±2.092	88	-	5	40	34	9

Table 2: Level of fluoride in drinking water, urine and children's IQs

Sr. N.	IQ VALUE	IQ CATEGORIZATION
1	<70	Retarded (low)
2	70-79	Borderline (below average)
3	80-89	Dull normal (low average)
4	90-109	Normal (average)
5	110-119	Bright normal (high average)
6	120-129	Superior (good)
7	>129	Very superior (excellent)

Table 3: Intelligence Quotient Index

Discussion

As we all know very well that fluorine is an essential trace element for the body, but excessive fluoride intake of a long period may result in dental and skeletal fluorosis, as well as the decline of the learning and memory ability and reduced IQ (1,2).

In addition, fluoride neurotoxicity is supported by various animal studies, which show cognitive disorders are associated with fluoride exposure and behavioral change and delayed learning and memory ability (20,22,23) Moreover, Sharma et al. (14) reported that the headache, lethargy and insomnia in population of high fluoride regions.

In this study, we found the relation between fluoride exposure with decline IQ level and nutritional index of children, mean weight and height.

Conclusion

Fluoride has been long advocated as the ideal preventive, therapeutic agent for dental caries. High F concentration in the drinking water has severe effects on the IQ of children. Although the exact mechanism by which F crosses the neuron cells in brain is still not clear; but here is lot of literature available that illustrate the influence of F intake via drinking water, food and low IQ of the child.

Apart from fluoride there are other factors which also affect IQ of children. On the basis of the results it is concluded that the correlation between the drinking water and urinary fluoride and IQ level is significantly positive. However, further studies are required for the understanding of pathophysiology of Fluorosis.

Recommendation

From the above studies, in order to reduce the risk of human exposure to fluoride, the use of Fluoride contaminated water, especially for drinking purpose should be reduced as much as possible. It is therefore very important, if possible, use defluoridated water for drinking and cooking purpose. However, in areas fluoride contaminated irrigation water, it is advisable to grow crops with relatively low capacities to enrich fluoride, such as those with seeds or tubers as the main edible parts. Future mitigation attempts should consider alternative fluoride-free water sources for drinking and irrigation purposes.

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