

Correlation between dental fluorosis and intelligence quotient in 11–13-year-old children in Modinagar, Ghaziabad -A survey study

¹Dr. Nidhi Agarwal, Professor and Head, Department of Pediatric Dentistry, Institute of Dental Studies and Technologies, Modinagar.

²Dr. Zohra Jabin, Professor, Department of Pediatric Dentistry, Institute of Dental Studies and Technologies, Modinagar.

³Dr. Ashish Anand, Reader, Department of Pediatric Dentistry, Institute of Dental Studies and Technologies, Modinagar.

⁴Dr. Sunil Datt Verma, Post Graduate student, Department of Pediatric Dentistry, Institute of Dental Studies and Technologies, Modinagar.

Corresponding Author: Dr. Nidhi Agarwal, Professor and Head, Department of Pediatric Dentistry, Institute of Dental Studies and Technologies, Modinagar.

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Abstract

Aim: The aim of the present study was to evaluate the correlation between dental fluorosis and children’s intelligence quotient (IQ) in Modinagar, Uttar Pradesh.

Methodology: This study was conducted on 80 children, 11-13 year of age. Dental fluorosis in children was measured by Dean’s fluorosis index and Raven’s Standard Progressive Matrices test was used for determining the IQ level. Data analysis was done by using Chi-square. P-value <0.001 was considered statistically significant.

Results: statistical analysis revealed that mean IQ level of children with dental fluorosis (across all grades) was lower than the IQ of children without dental fluorosis and the result was statistically significant.

Conclusion: High levels of fluoride in water affects IQ levels in children.

Keywords: Dental fluorosis, Intelligence quotient (IQ)

Introduction

Water is available in abundance and is a free gift of nature. Water contains many minerals which are essential and valuable natural resource for sustaining life and environment. Research conducted on fluoride found that India lies in a geographically high fluoride belt zone, extending from Turkey up to China and Japan through Iraq, Iran and Afghanistan.^[1] Fluorosis is an endemic condition prevalent in 17 states of India. Out of 6 lakh villages in India at least 50% have fluoride content in drinking water exceeding 1.0 ppm.^[2] As per UNICEF in 1999, it was estimated that about 66.62

million people are at risk of consuming fluoride-contaminated water in 19 states of India including 6 million children below the age of 14 years.^[3] Though mortality by chronic fluoride exposure of more than 1.0 ppm is quite low but morbidity is high, ranging from 9.3-27.7% for skeletal fluorosis and 35.0-69.0% for dental fluorosis.^[4] The drinking water fluoride so far detected in the country ranges from 0.2 to 48 mg/ litre. Whereas prevalence of dental fluorosis ranges from 8.2% in Himachal Pradesh. to 96.52% in Uttar Pradesh. With Andhra Pradesh (45 - 85.4%), Telangana (30.6 - 74.8%), Rajasthan (18.89 - 89.1%), Karnataka (31.05 - 69.9%), Punjab (46.15 - 91.12%), Madhya Pradesh (69.6 - 85.96%) and Haryana (54.4 - 79.5%) affected most. Due to consumption of fluoridated water approximately 200 districts of 20 states in India are categorized as the endemic areas of fluorosis.^[5]

Excessive exposure of fluoride can give rise to a number of harmful or adverse effects such as skeletal fluorosis, dental fluorosis and various neurological manifestations. During pregnancy, if the mother has taken excessive amount of fluoride, she can transmit it through the placenta to the fetus thus affecting child's IQ. As fluoride can penetrate the blood brain barrier and accumulate in cerebral tissue before birth of the fetus.^[6]

In 2009, R. Srikanth stated that in India, 6 million children are affected from various levels of fluorosis below the age of 14 years.^[7] Number of Literature has mainly focused on the prevalence of fluorosis and its effect on bones and teeth; apart from it evidences across the world showed that children exposed to excessive fluoride in water be prone to have lower intelligent quotient (IQ). Studies by Yang et al and Pang et al reported adverse effect of fluoride on the fetal cerebral function and neurotransmitters. Also, the existing literature reports the neurological consequences

associated with exposure to fluoride. Most common effects in children were found on the cognitive capacities, particularly intelligence reduction.^[8]

Therefore, the present short study was conducted to assess the evaluation and correlation between the degree of dental fluorosis and intelligence quotient (IQ) in 11-13 years old children in Modinagar, district Ghaziabad district in Uttar Pradesh, India.

Materials and methods

This study was conducted in the Department of Pedodontics and Preventive Dentistry in Institute of Dental Studies and Technologies, Modinagar, district Ghaziabad in Uttar Pradesh on 80 school going children, the aged group between 11- 13 years. A total sample size was selected by using the formulae $N = Z_{\alpha}^2 P q / d^2$. Ethical clearance was obtained from the IDST Ethical committee. The written informed consent was obtained from the parents and respective school authorities. [Table-1]

Inclusion Criteria

1. The children aged between 11-13 years
2. Permanent resident of the area

Exclusion Criteria

1. Any history of head injury.
2. Mental disability due to any reason

Dental examination

All the children were made to sit on the chair and the teeth were examined by using a plane mouth mirror and explorer under natural light. Dental fluorosis status was noted by using the Dean's fluorosis index, 1945. (Table-1)

Intelligence quotient estimation

Assessment of intelligence was conducted by Raven's Standard Progressive Matrices test (RSPM). This test consists of 60 multiple choice questions to be done in 40 minutes which are arranged in the easy to difficult order.

Each question consists of a missing element which the child has to identify and complete the pattern from the options.

The test was performed under the direction of an investigator. Reliability was assessed by retesting the questionnaire on 10 children. The total scores were transformed into percentile and this percentile used for specific IQ grades.

(Table-2). Specific grades were given as follows:

Statistical analysis of the data was done by using Chi-Square test. P- value <0.001 was considered statistically significant.

Results

It was observed that out of 80 study participants, 34 did not have fluorosis whereas 46 children had varying grades of fluorosis. The proportion of children in various IQ categories revealed that 56.52% of children with fluorosis had intellectually average or definitely above average IQ scores. Then, only 43.48% of children with dental fluorosis had definitely below average or intellectually impaired IQ scores whereas 47.05% of children without dental fluorosis had intellectually superior or definitely above average IQ scores and 52.94% had intellectually average IQ scores. (Table-3).

The mean IQ of the children having fluorosis was found to be 33.35 with SD \pm 23.44 whereas of the children having not fluorosis was 75.00 with SD \pm 16.69. Statistical analysis revealed that the difference between the IQ was statistically significant with the p-value of 0.001 (Table-4).

The Odds ratio was showing negative correlation between dental fluorosis and intelligence quotient (IQ) in children in which shows that the Fluorosis group has 0.76 times higher chances for having low IQ level (below 25%) as compare to IQ level of average (75.25%) of non-fluorosis group (Table-6).

Discussion

The present study was undertaken to determine the effect of excess fluoride in water on the IQ levels in children. The western region of Uttar Pradesh is a high fluoride belt and excess fluoride found in underground water. The local thrive mostly on underground water source as there is no central supply of treated water. For this reason, fluorosis incidence is high amongst children.

The present study evaluated fluoride levels using Dean's fluorosis index which is a standardized method. Kumar et al and Shivaprakash PK et al also used Dean's index for fluoride assessment in their studies and they found good results. For the assessment of IQ levels of children, Raven's Standard Progressive Matrices test (RSPM) was used. In the present study, the percentage of children with below average IQ, i.e., Grade IV was 36.96% and intellectually impaired IQ, i.e., Grade V was 6.52%. The proportion of children with IQ Grades II and III were 6.52% and 50% respectively. As compared to non-fluorosis group children, the percentage of children with below average IQ, i.e., Grade IV and V was 0 and the proportion of children with IQ Grades I, II and III were 20.58%, 26.47% and 52.94% respectively.

It is stipulated and proved by several researchers that excess amount of fluoride levels affect dentition but it can also be detrimental on children IQ. Razdan et al ^[11] and Shivaprakash et al ^[14] in their study have also demonstrated that intellectual capacity of children decreases with increase in the fluorosis grade Now it is seen that the results of the present study also proves that fluorosis does have detrimental effect on the mental ability of the child.

In India 30% of urban and 90% of rural people are dependent on untreated water source of which 80% is groundwater.^[9] Fawell et al ^[10] reported excessive fluoride in water to be neurotoxic. They also stated that

consumption of untreated underground water has various toxic effects like it caused nephrosis, increased hepatic cell size, myocardial mineralization and degeneration of seminiferous tubules in testes in controlled animal studies. Eswar et al [12] stated in their study that exposed to high level of fluoride leading to lowering of IQ in children is mainly due to biochemical and functional damage to the nervous system during the prenatal development periods of infancy and childhood since fluoride can cross the blood-brain barrier. According to Blaylock [13], the structural and functional alterations in central nervous system, in the fetal period and the first 8 years of child's life may lead to learning and intellectual deficits.

In the present study, significant negative correlation was found between dental fluorosis and intelligence quotient (IQ) in children. High levels of fluoride in water deteriorate learning ability in children. The impact of fluoride on IQ has been observed by a number of studies.

In a meta-analysis between 1988 and 2008, performed in China to review studies on fluoride and IQ, a strong association between exposure to fluoride and low IQ was found and it was also reported that children who live in fluorosis area have five times higher odds of developing a low IQ than those who live in non-fluorosis area.[15] Other studies done separately by Y Lu,[16] Shulin Liu,[17] QW Xiang,[18] Guo Jian Wang [19] and Seraj B [20] also found similar results. In the other hand Broadbent et al demonstrated in their study that there was no apparent

difference in IQ because of fluoride exposure.[21] Guan et al [22] reported that the phospholipids and ubiquinone are altered in the brain of rats affected by chronic fluorosis which lead to cause of this disorder. In the year 2011, Xiang et al [23] discussed about decreasing IQ with increasing age. Perhaps, the main cause was the total intake of fluoride/kg body weight per day or lifetime; also, adolescence is a sensitive time period for the effect of fluoride on children's intelligence development.

Tables

Table 1: Criterion for Dean's fluorosis index.

Fluorosis Level	Score
Normal	0
Questionable	0.5
Very mild	1.0
Mild	2.0
Moderate	3.0
Moderately severe	3.0
Severe	4.0

Table 2: Grading criterion for IQ scores according to Raven's Standard Progressive Matrices test.

Intelligent quotient (iq)	Iq classification
Grade 1	Intellectually superior (IQ score ≥ 95%)
Grade 2	Definitely above average (IQ score >75%)
Grade 3	Intellectually average (IQ score 75–25%)
Grade 4	Definitely below average in intellectual Capacity (IQ score ≤ 25%)
Grade 5	Intellectually impaired (IQ score ≤ 5%)

Table 3: Distribution of study subjects according to study groups and IQ categories.

IQ Category	Fluorosis	%	Non-fluorosis	%	Total	%
Intellectually superior (IQ score $\geq 95\%$)	0	0	7	20.58	7	8.75
Definitely above average (IQ score $> 75\%$)	3	6.52	9	26.47	12	15
Intellectually average (IQ score 75–25%)	23	50	18	52.94	41	51.25
Definitely below average in intellectual Capacity (IQ score $\leq 25\%$)	17	36.96	0	0	17	21.25
Intellectually impaired (IQ score $\leq 5\%$)	3	6.52	0	0	3	3.75
Total	46	100	34	100	80	100

Table 4: Comparison of IQ among fluorosis and non-fluorosis groups.

	Total No. of students (80)	Mean IQ	SD	t-value	p-value
Fluorosis	46	33.35	23.441	8.832	0.001
Non-Fluorosis	34	75.00	16.690		

Table 5: Gender wise comparison.

Gender	Fluoride levels	Mean IQ	SD	t-value	p-value
Males [n=61]	Fluorosis	33.05	26.835	7.732	0.038
	No Fluorosis	74.27	18.271		
Females [n=19]	Fluorosis	33.63	20.430	8.305	0.002
	No Fluorosis	76.33	13.976		

Table 6: Odds ratio between Fluorosis and Non-fluorosis group.

Total (n=80)	Fluorosis (Case=46)	Non- fluorosis (Control= 34)
IQ < 25%	43.48% (n=20)	25 % (n=0)
IQ > 25 %	56.52 % (n=26)	75 % (n=34)
Final Odds ratio	0.76	

Conclusion

This study has shown that children exposed to increased levels of fluoride in drinking water are at risk for impaired development of intelligence. Since harmful effects of excessive fluoride intake are well documented and the short study further reinforce the need to reduce the fluoride level of drinking water.

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