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## Original Research

### Dental fluorosis and IQ level of school going children- A correlation study

<sup>1</sup>Dr. Neha Minocha, <sup>2</sup>Dr. Mitrasen Raj, <sup>3</sup>Dr. Tanya Batra, <sup>4</sup>Dr. C.Chandra Lekha, <sup>5</sup>Dr. P. Bravin Paul, <sup>6</sup>Misba Kadri

<sup>1</sup>MDS Public Health Dentistry, Private Practitioner, Dehradun, Uttarakhand, India;

<sup>2</sup>Postgraduate student, Department of Orthodontics and Dentofacial Orthopaedics, New Horizon Dental College and Research Institute, Sakri, Bilaspur, Chhatisgarh, India;

<sup>3</sup>Post graduate student, Department of Pediatric and Preventive Dentistry, ITS Dental College, Muradnagar, Uttar Pradesh, India;

<sup>4</sup>Post Graduate, Department of Orthodontics and Dentofacial Orthopedics, Rajas Dental College and Hospital, Kavalkinaru 627105, Tamil Nadu, India;

<sup>5</sup>Post Graduate, Department of Orthodontics and Dentofacial Orthopedics, CSI College of Dental Sciences and Research, Madurai, Tamil Nadu, India;

<sup>6</sup>2nd year BDS, RR Dental College and Hospital, Udaipur, Rajasthan, India

#### ABSTRACT:

**Background:** Fluoride has beneficial effects on teeth at low concentrations in drinking water, but excessive exposure to fluoride in drinking water, or in combination with exposure to fluoride from other sources, can give rise to a number of adverse effects. The present study was conducted to assess relation of dental fluorosis and IQ level in children. **Materials & Methods:** 158 children age ranged 9- 13 years diagnosed with dental fluorosis of both genders were recruited. Modified Dean's index was used for diagnosing dental fluorosis. Intelligence level was assessed by conducting the Raven's Standard Progressive Matrices test. **Results:** Out of 158 children, boys were 90 and girls were 68. 45 were from low fluoride area, 60 from medium and 53 from high fluoride area. The difference was non- significant ( $P > 0.05$ ). The mean IQ level in low Fluoride level area children was 15.6, in medium was 12.4 and in high was 9.1. The difference was significant ( $P < 0.05$ ). **Conclusion:** The overall IQ levels in children exposed to high fluoride level significantly lower than the low fluoride areas.

**Key words:** Fluoride, IQ, School Children

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**Corresponding author:** Dr. Neha Minocha, MDS Public Health Dentistry, Private Practitioner, Dehradun, Uttarakhand, India

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#### INTRODUCTION

Water is an essential valuable natural resource for sustaining life and environment which we have always thought to be available in abundance and free gift of nature.<sup>1</sup> However, chemical composition of surface water or subsurface, geothermal or non-thermal, is one of the prime factors on which the suitability of the water for domestic, industrial or agriculture purpose depends.<sup>2</sup> In India, high groundwater fluoride concentrations associated with igneous and metamorphic rocks such as granites and gneisses have been reported.<sup>3</sup> As a result, people of 19 states in India are drinking fluoride contaminated

water above WHO's maximum allowed concentration of 1.5 mg/l.<sup>4</sup>

Fluoride has beneficial effects on teeth at low concentrations in drinking water, but excessive exposure to fluoride in drinking water, or in combination with exposure to fluoride from other sources, can give rise to a number of adverse effects.<sup>5</sup> These range from mild dental fluorosis to crippling skeletal fluorosis as the level and period of exposure increases. The concentration of fluoride level in most of the Asian countries including India is more than the WHO Guidelines values.<sup>6</sup> Sixty million Indians are

residing in approximately 200 districts of twenty states categorized as the endemic areas of fluorosis, and about 66 million people in India suffer from dental and skeletal fluorosis, out of these six million are children below the age of 14 years.<sup>7</sup>

Fluoride poisoning in humans can affect the activation of the central nervous system (CNS), typical sufferers of fluoride poisoning present with symptoms such as headache, dizziness, memory deficits, lethargy, fatigue, insomnia, upper respiratory inflammation, stomach pain, joint pain, rhinitis, dermatitis, and gingivitis.<sup>8</sup> The present study was conducted to assess correlation of dental fluorosis and IQ level in children.

**MATERIALS & METHODS**

The present study comprised of 158 children age ranged 9- 13 years diagnosed with dental fluorosis of both genders. The study was conducted in schools. The consent for the study was obtained from all parents of children.

Data such as name, age, gender etc. was recorded. Demographic data, source of drinking water, duration

of use, staple food, liquids routinely consumed, and aids used for oral hygiene maintenance (fluoridated or nonfluoridated) was recorded.

Socioeconomic status was recorded by Modified Kuppa Swamy socioeconomic status scale.

The WHO 1997 recommended Modified Dean's index was used for diagnosing dental fluorosis. Intelligence level was assessed by conducting the Raven's Standard Progressive Matrices test. Raven's test consists of sets A, B, C, D, and E each set having s multiple choice questions. The total scores were transformed into percentile and specific grades were given as follows- Grade I: Intellectually superior (IQ score  $\geq$  95%), Grade II: Definitely above average (IQ score  $>$  75%), Grade III: Intellectually average (IQ score 75%–25%), Grade IV: Definitely below average in intellectual capacity (IQ score  $\leq$  25%) and Grade V: Intellectually impaired (IQ score  $\leq$  5%). Results thus obtained were subjected to statistical analysis. P value less than 0.05 was considered significant.

**RESULTS**

**Table I Distribution of children**

Total- 158		
Gender	Boys	Girls
Number	90	68

Table I shows that out of 158 children, boys were 90 and girls were 68.

**Table II Children classification based on total level of fluoride**

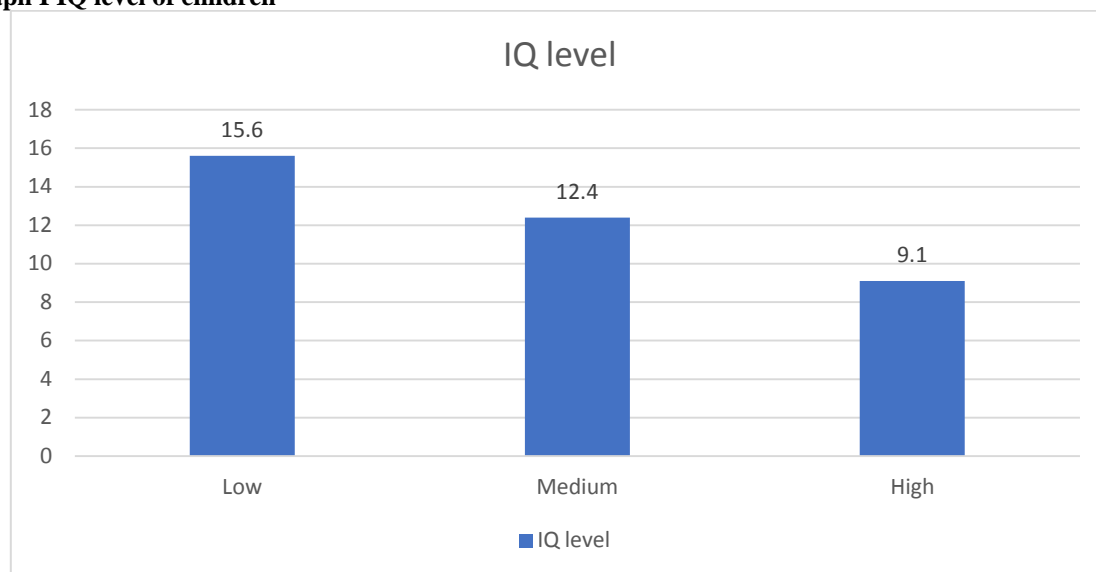
Fluoride level	Number	P value
Low	45	0.12
Medium	60	
High	53	

Table II shows that 45 were from low fluoride area, 60 from medium and 53 from high fluoride area. The difference was non- significant ( $P > 0.05$ ).

**Table III IQ level of children**

F level	IQ level	F	P value
Low	15.6	25.7	0.021
Medium	12.4		
High	9.1		

Table III, graph I shows that mean IQ level in low Fluoride level area children was 15.6, in medium was 12.4 and in high was 9.1. The difference was significant ( $P < 0.05$ ).

**Graph I IQ level of children**

## DISCUSSION

Fluoride can prevent dental caries and it is beneficial to bone metabolism as an essential trace element in the body. However, the safe dose range of fluoride is limited.<sup>9</sup> Increasing evidences have shown that long-term exposure to excessive fluoride will not only increase the risk of dental fluorosis and skeletal fluorosis, but also impair neural development by influencing gene and protein expression, enzyme activity and inducing oxidative stress.<sup>10</sup> Chronic high fluoride exposure of maternal mice in drinking water during pregnancy and lactation may have harmful influences on learning and memory of young mice. Studies indicated that fluoride ingested by the mother can cross the placental barrier and the blood-brain barrier to affect the offspring's cognitive function development.<sup>11</sup> The present study was conducted to assess correlation of dental fluorosis and IQ level in children.

In present study, out of 158 children, boys were 90 and girls were 68. We found that 45 were from low fluoride area, 60 from medium and 53 from high fluoride area. Kumar et al<sup>12</sup> assessed the intelligence quotient (IQ) of school-going children aged 10–12 years in villages of Nalgonda district with different fluoride levels. A total of 480 government schoolchildren aged 10–12 years were selected by stratified random sampling from three different areas with different levels of naturally occurring fluoride in drinking water. Intelligence levels were assessed by conducting the Ravens standard progressive matrices test (1991 edition). The mean IQ levels were more in the villages with low fluoride concentration in drinking water (15.26) compared to villages with medium fluoride content (12.91) and high fluoride content (9.1). A significant statistical association was found ( $P < 0.001$ ).

We found that mean IQ level in low fluoride level area children was 15.6, in medium was 12.4 and in

high was 9.1. Shivaprakash et al<sup>13</sup> in their study children were categorized as, those suffering from dental fluorosis and those not suffering from dental fluorosis and for all children in both categories, Intelligence testing was done using the Raven's Coloured Progressive Matrices. The following observations were made from the data gathered: The mean IQ score of children without dental fluorosis was significantly higher than those children who had dental fluorosis. The mean IQ scores did not vary with the severity of dental fluorosis as classified by Dean's fluorosis index. Also it was noticed that the percentage of children with dental fluorosis was more in Extremely Low and Low IQ categories whereas the percentage of children without dental fluorosis was more in Average and High Average IQ categories. Previous studies had indicated toward decreased Intelligence in children exposed to high levels of fluoride and our study also confirmed such an effect.

Xu K et al<sup>14</sup> recruited 633 local children aged 7–13 years old randomly from four primary schools in Kaifeng, China in 2017. The children were divided into four groups, of which included: control group (CG, n = 228), only prenatal excessive fluoride exposure group (PFG, n = 107), only childhood excessive fluoride exposure group (CFG, n = 157), both prenatal and childhood excessive fluoride exposure group (BFG, n = 141). The concentrations of urinary fluoride (UF) and urinary creatinine (UCr) were determined by fluoride ion-selective electrode assay and a creatinine assay kit (picric acid method), respectively. The concentration of UCr-adjusted urinary fluoride (CUF) was calculated. IQ score was assessed using the second revision of the Combined Raven's Test. Threshold and saturation effects analysis, multiple linear regression analysis and logistic regression analysis were conducted to analyze the association between fluoride exposure and IQ. The mean IQ score in PFG was respectively lower than

those in CG, CFG and BFG ( $P < 0.05$ ). The odds of developing excellent intelligence among children in PFG decreased by 51.1% compared with children in CG (OR = 0.489, 95% CI: 0.279, 0.858). For all the children, CUF concentration of  $\geq 1.7$  mg/L was negatively associated with IQ scores ( $\beta = -4.965$ , 95% CI:  $-9.198, -0.732$ ,  $P = 0.022$ ). In children without prenatal fluoride exposure, every 1.0 mg/L increment in the CUF concentration of  $\geq 2.1$  mg/L was related to a reduction of 11.4 points in children's IQ scores (95% CI:  $-19.2, -3.5$ ,  $P = 0.005$ ).

Blaylock et al<sup>15</sup> found this association was attributed to high levels of fluoride absorbed in the blood forms lipid-soluble complexes, which cross the blood-brain barrier and accumulate in the cerebral tissues. The penetrated fluoride complexes adversely affect the CNS development by different neurotoxic and excitotoxic mechanisms such as free radical generation, inhibition of antioxidant and mitochondrial energy enzymes, and inhibition of glutamate transporters. The structural and functional alterations in CNS, specifically in the fetal period and the first 8 years of life may lead to learning and intellectual deficits and cognitive dysfunctions.

## CONCLUSION

Authors found that the overall IQ levels in children exposed to high fluoride level significantly lower than the low fluoride areas.

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