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Original Research Article

Dental Fluorosis and Fluoride in Urine in School Students Living in a Rural Area of West Bengal, India

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ABSTRACT

Background: Excessive fluoride in drinking water causes dental, skeletal and non-skeletal fluorosis which is encountered in endemic proportions in several parts of the world including India. As per WHO guide line and the Bureau of Indian Standard (BIS), the permissible upper limit of fluoride in drinking water is 1.5 mg/L. Presence of Dental fluorosis along with elevated urinary fluoride level is generally accepted as one of the best and reliable indicator of fluoride exposure.
Objective: To determine the prevalence of Dental Fluorosis among school children taking water with fluoride concentration above permissible limit, to determine the urinary fluoride level of school children having Dental fluorosis and to provide supportive and symptomatic treatment of children suffering from Fluoride toxicity.
Materials and Methods: A cross sectional study was conducted in February 2019 in Gobindanagar Primary School and Bhagabandh Primary School of Purulia District of West Bengal to assess the occurrence of Dental Fluorosis among school children taking water with fluoride concentration above permissible limit and to determine the urinary fluoride level of school children having Dental fluorosis. Total 136 school children in both the schools were examined and screened for Dental fluorosis. Urine of school students having Dental fluorosis were collected for urinary fluoride analysis. Counseling, advice and treatment of Fluoride toxicity were also given to school children.
Results: Out of 136 children 33.82% children had Dental fluorosis (80% mild and 20%- Mod) in both the schools. Overall Dental Fluorosis was found to be more common in the age group of 12-14 yrs (36.9%) and males (52.2%) are more commonly affected than females (47.8%).Fluoride level in urine of school children having Dental fluorosis was 0.08-6.7 mg/L and 1.5-7.9mg/L in Gobindanagar and Bhagabandh primary school which exceeds the limits stipulated by national and international norms.
Conclusion: Prevalence of Dental fluorosis was quite high among school students. Water and Urine fluoride concentration of this population exceeds the limits stipulated by national and international norms and urinary fluoride concentration is also high and it is related with Dental fluorosis.. Immediate actions are needed to decrease the exposure of Fluoride to prevent the potential of adverse health effects among children.
Key words: Dental Fluorosis, Urinary fluoride, Safe water, School Children

INTRODUCTION

Fluoride is one of the important factors in water quality management due to its adverse health effects. The problem of high fluoride concentration in groundwater resources has become one of the most important toxicological and geo-environmental issues in India. Excessive fluoride in drinking water causes dental, skeletal and, non-skeletal fluorosis which is encountered in endemic proportions in several parts of the world. [1] Twenty out of 35 States and Union Territories of India were identified as endemic for fluorosis [2] and about 66 million people in these regions are at risk of fluoride contamination

including 6 million children below 14 years of age and affecting about 25 million people. [3]

Fluoride ingestion through water is the major cause of fluorosis. Dental fluorosis affects the permanent teeth of children with clearly visible discoloration on the teeth of children after 8 years of age. Dental fluorosis among school children is a good indicator of exposure to excessive amounts of fluoride. Fluoride leaches from the geological crust contaminating drinking water. Fluorides are released into the environment naturally through the weathering of minerals, emissions from volcanoes and marine aerosols. The main natural source of inorganic fluorides in soil is the parent rock. Fluorosis is a crippling disorder / condition known to occur due to the entry of fluoride into the body. It is a slow, progressive, crippling malady that affects every organ, tissue and cells in the body and results in health complaints that overlap with several other disorders. The extent of morbidity may vary depending upon the chemical constitution of the tissue / organ. The disease manifestations occur over a period of time. The time / duration required for clinical manifestations to appear varies depending on several factors, viz., age, hormonal status, nutritional status, efficiency of the kidney to excrete fluoride, the quantum of fluoride entry into the body, climatic conditions and perhaps other factors that are presumably not so pronounced. [3] Most of the fluorides are readily soluble in water. WHO guideline value and the permissible upper limit of fluoride as per Bureau of Indian Standard (BIS) is 1.5 mg/L. [3]

Fluoride ingested remains for a long time in the human body, however, approximately 80% of fluoride entering the body is excreted mainly through urine; the rest of it is absorbed into body tissues from where it is released very slowly. [4]

Excreted fluoride can be monitored by biomarkers of fluoride, which are values that serve to identify deficient or excessive consumption and bioavailability of fluoride in the body. WHO defines different fluoride biomarkers; current (urine, plasma, and saliva), recent (nails and hair), and historical biomarkers (bones and teeth). [5] Urine fluoride concentration among the biomarkers of fluoride exposure is generally accepted as the best indicator of fluoride exposure [6] because it can be recollected noninvasively and systematically reflects the burden of fluoride exposure from drinking water.

In the states of Assam, Jammu & Kashmir, Kerala, Chhattisgarh and West Bengal10-40% of districts are affected. [3] In West Bengal fluoride was first detected at Bhubanandapur in Nalhati I block of Birbhum district in 1996. During last habitation survey conducted by Public Health Engineering Department (PHED), Government of West Bengal in the year 2003, fluoride was found in 663 habitations in West Bengal spread over 45 blocks in 9 districts. Subsequently by rapid assessment survey (2005), 729 sources were found contaminated with fluoride above 1.5 mg/L in 43 Blocks of seven Districts of West Bengal with affected population of approx. 2.26 lakhs with fluoride level varying from 1.1-4.47 mg/L. [7]

The study was conducted in Purulia one of the fluorosis affected districts in West Bengal, with the following objectives

- To determine the prevalence of Dental fluorosis, among school children taking water with fluoride concentration above permissible limit.
- To determine the urinary fluoride level of school children having Dental fluorosis.
- To provide supportive and symptomatic treatment of children suffering from Dental fluorosis.

METHODOLOGY

A cross sectional study was conducted in February 2019 in Gobindanagar Primary School and Bhagabandh Primary School in Gobindanagar and Bhagabandh village of Purulia District of West Bengal to assess the

occurrence of Dental Fluorosis among school children taking water with fluoride concentration above permissible limit and to determine the urinary fluoride level of school children having Dental fluorosis.

Seventeen blocks of Purulia district of West Bengal were endemic for fluorosis. Out of these seventeen blocks two blocks i.e Manbazar Block and Para Block have been selected randomly for the study. Within these blocks one endemic village from each Block i.e Gobindanagar village in Manbazar Block and Bhagabandh village in Para Block was selected randomly. One school from each of the above villages' i.e Gobindanagar Primary School in Gobindanagar village and Bhagabandh Primary School in Bhagabandh village was selected as Fluoride content of the school tube wells varied from 0.494 – 3.52 mgm/lit in Bhagabandh Primary school and 1.73 – 1.85 mgm/lit in Gobindanagar primary school whereas permissible limit of Fluoride in drinking water is <1.5mg/lit (WHO). The water samples were tested by Indian Institute of Engineering Science and Technology (IIEST), Shibpur. The same school tube well water sources were also used for drinking as well as cooking of mid day meals of the school children..

Total 136 school children (36 in Gobindanagar Primary school and 100 in Bhagabandh primary school) were examined and screened for Dental fluorosis by expert trained by Fluorosis Research & Rural Development Foundation, New Delhi.

Ethical clearance was taken prior to the initiation of the study. After taking consent from the Head Master and parents of the school children attending camp in the school and explaining the purpose of the visit, the school children of selected schools were screened regarding presence or absence of various signs and symptoms of Dental fluorosis. All school children were taking water solely from school tube wells with Fluoride level much above the permissible level. The same sources of water were also used for cooking their mid day meals. Dental fluorosis, skeletal fluorosis and non-skeletal fluorosis was assessed by case definitions and diagnostic criteria developed by Fluorosis Research & Rural Development Foundation, New Delhi. [8,9,10]

Urine of school students having Dental fluorosis patients were collected for urinary fluoride analysis.

Counseling and advice for prevention and treatment of Fluoride toxicity and treatment of minor ailments were also given to family members of the accompanying students.

RESULTS

Total number school children examined and screened for Dental fluorosis was 136 (36 in Gobindanagar Primary school and 100 in Bhagabandh primary school). Majority of the children belonged to 12 -14 yrs of age (33.8%) followed by 6-8yrs (30.1%) (Table I and Fig I). More children were female (55.9%) in comparison to males (44.1%). (Table II and Fig II)

In Gobindanagar Primary school out of total 36 school children 18 were male (50%) and 18 were female (50%). Majority of children belong to the age group 6-8 yrs in Gobindanagar Primary school (69.5%) and 12-14 yrs in Bhagabandh primary school (43%). (Table I and Fig I) In Bhagabandh primary school out of 100 school children 42 were male (42%) and 58 were female (58%). (Table II and Fig II)

Out of 136 children 46 (33.82%) children had Dental fluorosis (80% Mild and 20%- Mod) in both the schools. 13 school children in (28.3%) in Gobindanagar Primary school and 33 (71.3%) school students in Bhagabandh primary school were found to be having Dental fluorosis. (Table III). Only yellowish-brown discoloration of teeth with horizontal streaks was taken as mild case and blackening/pitting of teeth was taken as moderate case. [3]

Overall Dental Fluorosis was found to be more common in the age group of 12-14 yrs (36.9%) followed by 9-11yrs (30.4%). In Gobindanagar Primary school out of total 13 school children having dental

fluorosis, 8 (61.5%) were male and 5 (38.5%) were female. In Bhagabandh primary school out of 33 students having Dental Fluorosis 16 (48.5%) were male and 17 (51.5%) were female. Overall Dental Fluorosis is more common in male (52.2%) in comparison to females (47.8%) (Table III, Fig IIIa and IIIb).

Fluoride level in urine of school children having manifestations of fluorosis was 0.08 – 6.7 mg/L and 1.5 – 7.9mg/L in Gobindanagar and Bhagabandh primary school *(normal range of fluoride in urine 0.1 -1mg/L)*[3].

Table I Distribution of school children screened for Dental Fluorosis according to Age N=136

Age in yrs	Gobindanagar school n=36		Bhagabandh school n=100		Total
	No	%	No	%	No (%)
6-8	25	69.5	16	16	41 (30.1)
9-11	8	22.2	31	31	39 (28.6)
12-14	3	8.3	43	43	46 (33.8)
15-17	Nil	0	10	10	10 (7.5)
Total	36	100	100	100	136(100)

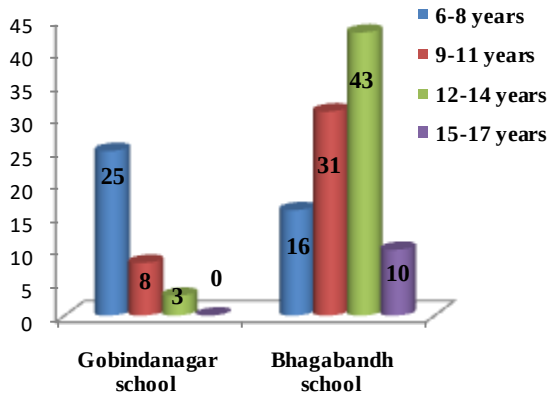
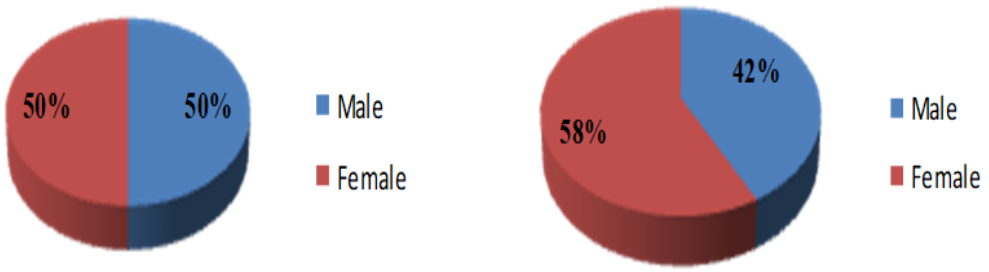


Fig I: Distribution of school children screened for Dental Fluorosis according to Age N==136

Table II Distribution of school children screened for Dental Fluorosis according to Sex N==136

Sex	Gobindanagar school n=36		Bhagabandh school n=100		Total
	No	%	No	%	No (%)
Male	18	50	42	42	60(44.1)
Female	18	50	58	58	76 (55.9)
Total	36	100	100	100	136 (100.0)



Gobindanagar school N =36 **Bhagabandh school N=100**

Fig II: Distribution of school children screened for Dental Fluorosis according to Sex N==136

Table III Distribution of school children having Dental Fluorosis according to Age and Sex N==46

Age in yrs	Gobindanagar school n=13		Bhagabandh school n= 33		Total n= 46		
	Male Female		Male Female		Male Female		Total No(%)
	No %	No %	No %	No %	No (%)	No (%)	
6-8	3 37.5	4 80	1 6.25	5 29.4	4 16.6	9 40.9	13(28.4)
9-11	2 25	1 20	7 43.75	4 23.5	9 37.6	5 22.7	14(30.4)
12-14	3 37.5	0 0	8 50.00	6 35.3	11 45.8	6 27.3	17(36.9)
15-17	0 0	0 0	0 0	2 11.8	0 0	2 09.1	2(4.3)
Total	8 61.5	5 38.5	16 48.5	17 51.5	24 52.2	22 47.8	46(100)

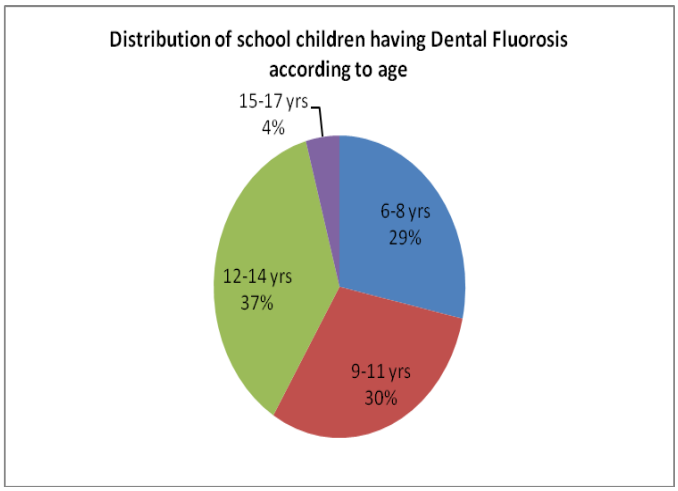


Fig IIIa : Distribution of school children having Dental Fluorosis according to Age N==46

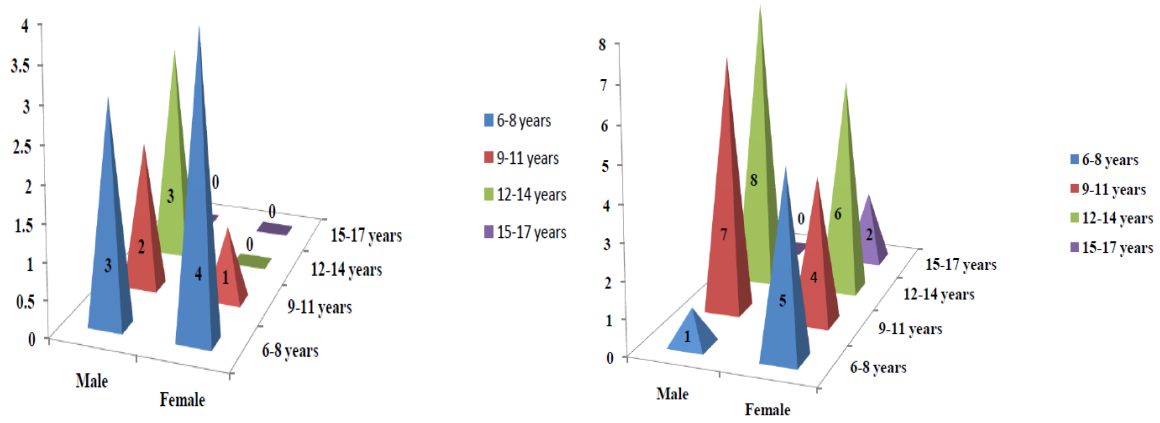


Fig IIIb: Distribution of school children in two schools having Dental Fluorosis according to Age and Sex N==46

DISCUSSION

In the present study 33.82% children had Dental fluorosis (80% mild and 20%-Mod) in both the schools. Choubisa in his study in southern Rajasthan found that overall prevalence of dental fluorosis was 45.7%. [11] Pushpa Bharati et al in their study in Gudag & Bagalkot districts of Karnataka found prevalence of dental fluorosis to be 35%. [12] Gudag and Bagalkot districts of Karnataka are reported to be endemic for fluorosis with a fluoride level of upto 18.0 mg/lit. The most common symptom of Dental fluorosis is yellowish-brown discoloration of teeth with horizontal streaks followed by blackening/pitting/ chipping of teeth. So Bharati *et al*. reported browning of teeth in 64.29% and pitting of teeth in 32.4% subjects. [12] Similar positive correlation between fluoride concentration and DFI (Dental Fluorosis Index) score was also found in other studies. [13-17]

Five hundred and twenty-five 5- to 12-year-old school children studying in six primary schools of six villages in Chidambaram were surveyed. The overall

dental fluorosis prevalence was found to be 31.4%. Dental fluorosis increased with age (P< 0.001), whereas gender difference was not statistically significant. [18] In this study Dental Fluorosis was found to be more common in the age group of 12-14 yrs (36.9%) followed by 9-11yrs (30.4%) and Dental Fluorosis is more common in males (52.2%) in comparison to females (47.8%). It is evident from the results that the population in the study area is chronically exposed to higher levels of fluoride from drinking water as Fluoride content of the school tube wells in that area varied from 0.494-3.52 mgm/lit in Bhagabandh Primary school and 1.73-1.85 mgm/lit in Gobindanagar primary school whereas permissible limit of Fluoride in drinking water is <1.5mg/lit (WHO). [3]

The fluoride level in biomaterials such as urine has been regarded as one of the most reliable indicator of exposure to fluoride. [6] Range of fluoride content in urine was similar to that reported in other Mexican children population, aged 6-12, authors reported a range of urinary fluoride concentration of 11.1 to 5.9 mg/L; with a mean of urinary fluoride content of (3.14 ± 1.09mg/L). [19-21] Similar studies in India among individuals aged 6 to 18, the highest urinary fluoride concentration recorded was 17 mg/L when fluoride water concentration was of 2.11 mg/l. [22] In other study in Indian population, in individuals aged 11-16 years, fluoride concentration found in urine samples ranged from 0.90 to 3.25 mg/L with an average of 2.35 mg/L. [23] These variations might be due to different consumption practices and use of water and other dietary sources of fluoride among population besides variation on water fluoride content. In the present study Fluoride level in urine of school children having manifestations of fluorosis was 0.08-6.7 mg/L and 1.5-7.9mg/L in Gobindanagar and Bhagabandh primary school respectively (normal range of fluoride in urine 0.1 -1mg/L)[3]. Elevated concentration in urine supported a clinical diagnosis of fluorosis. [24]

Although the description of disease was done long back in early 1930 by eminent Indian physicians, [25] not much has been done till date regarding its mitigation measures. However in order to address the problem of fluorosis in the country, National Programme for Prevention and Control of Fluorosis was launched in 2008-09 with an objective to collect, assess and use the baseline survey data for fluoride mapping along with comprehensive management and capacity building. [26,27] Increased provision of alternate safe water source by treatment of surface water, rain water harvesting, ground water recharge along with community participation, awareness generation and nutritional intervention can solve the problem of fluorosis to a great extent on a long term basis.

CONCLUSION AND RECOMMENDATIONS

It was evident from this study that Dental fluorosis is a definite public health problem among school children in the selected blocks of Purulia district. Prevalence of Dental fluorosis was quite high among school students. Water and Urine fluoride concentration of this population exceeds the limits stipulated by national and international norms and urinary fluoride concentration is also high and it is related with Dental fluorosis. Immediate actions are needed to decrease the exposure of Fluoride to prevent the potential of adverse health effects among children who are the representatives of future generation of India.

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