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Dental Fluorosis in Northern Rural Delhi : Revisiting the Persistent Mottling Scenario

KEYWORDS: Dental fluorosis, urinary fluoride levels, Dean's Index

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ABSTRACT *BACKGROUND:Excessive fluoride consumption in drinking water has put global population at risk of fluorosis. The present study was conducted to find the prevalence and severity of dental fluorosis and observing its association with urinary fluoride levels. METHODS:Two government schools were randomly selected. Out of 200 students, 194(97.0%) participated. A pre-structured questionnaire was used. The students underwent oral examination and were classified by Dean's index. This was followed by collection of water and 24-H urine samples for fluoride levels measurement. RESULTS:The mean age of students was 11.1 years(SD=1.5) with 117(60.3%) males and 77(39.7%) females. Prevalence of dental fluorosis was observed as 65.5% with majority having mild variant(30.9%). On multivariate analysis, non-participation in dental health programmes and higher urinary fluoride levels were found as significant predictors.CONCLUSIONS:The present research reflects dental fluorosis of high public health concern and appropriate time for defluoridation of supply water and implementation of school dental health programmes in this region.*

Introduction
Oral disorders are one of the most prevalent chronic morbidities worldwide accounting for an appreciable burden on the health care delivery system.1 Global estimates account for about 5 billion people experiencing dental caries in most of the developing and under developed nations.1 The scenario is varied in developed nations (European countries) where dental caries has substantially declined.2,3 Fluoride has been recognized as one of the most important factor responsible for this decline. However, excessive consumption of fluoride in drinking water has put the communities at risk of developing fluorosis.4

In 1930, Dean demonstrated the relationship between the presence of dental mottling and excessive fluoride in drinking water.5 Fluorosis has, therefore, become an important public health challenge where dental fluorosis is the most sensitive sign of prolonged fluoride exposure. When assessing the optimal levels of fluoride exposure, it is imperative to consider all the potential sources like drinking water, fluoride oral care products (like toothpaste, mouth wash etc.), the environment as well as food and beverages.6 Since urine is the major excretory pathway for ingested fluorides, analysis of urinary fluoride level is rational to estimate the cumulative fluoride exposure of a community.7

Globally, India is among the 23 nations experiencing endemic fluorosis due to excessive fluoride in drinking water.8 About 20 states have been identified with excessive fluorides in the groundwater.9 In rural India, about 62 million people are at risk of developing fluorosis from drinking water.9,10 Surprisingly, about six million children below the age of 14 years are already affected by fluorosis.8,10

Since the late 1980s, Government of India along with various non-government agencies has launched several projects to contain the spread of fluorosis. Despite these efforts, there has been substantial increase in the spread of fluorosis.8

Pathophysiology of fluorosis
Fluoride plays an important role in the formation of dental enamel and mineralization in bones.11,12 During the process of teeth formation, lower levels of soluble fluoride (<2 mg/ml) in the drinking water may initiate mottling of enamel while higher levels lead to dental fluorosis.13 It further progresses to skeletal and then systemic fluorosis.14 Since the changes induced by high fluoride are irreversible, early detection of fluorosis is indispensable.6

Status of Fluorosis in Delhi
The City of Delhi - capital of India - is also suspected as an endemic state for fluorosis.15 As against the acceptable limit of 1.00 ppm, average fluoride levels in drinking water range from 1.1 to 32.46 ppm.10 A large number of cases have been reported from the districts of North-West, North, South and South-West due to excessive utilisation of ground water for drinking.

Objectives
The objectives of the present study were: (1)To study the prevalence and severity of dental fluorosis in school children 7 to 15 years of age (2) To study the association between urinary fluoride levels and dental fluorosis in the same population.

Methodology
The present study has been undertaken in continuum of the previous study in the same region.16 The study was conducted among the middle school students studying in two government schools located in North-West district of rural Delhi i.e. Pooth Khurd (latitude=28.7960 and longitude=77.01731) and Barwala (latitude=28.7959 and longitude=77.01727) which are endemic areas for Fluorosis.15 These two schools were randomly selected from the study areas. As secondary dentition phase lies between 6-12 years of age, middle school children were selected as study subjects for this study.

Permission was taken from the Principals of the two schools and the teachers were informed about the visit in advance. Clearance was taken from the ethics committee of the institution. The children underwent oral examination in broad daylight by the senior resident dentist posted from Maulana Azad Medical College and were classified by Dean's index for severity of fluorosis. Following visits comprised of collection of water samples from children's residences and collection of 24-H urine samples from children diagnosed with fluorosis.

A pre-tested, pre-structured, semi-quantitative questionnaire was used to obtain data regarding socio-demographic characteristics, persistency of brushing, type of toothpaste, potential sources of drinking water, consumption of manufactured beverages etc. The severity of dental fluorosis was assessed and graded using Dean's Index.5 All the students diagnosed with dental fluorosis were referred to MAMC for expert management. Health education regarding healthy oral habits was also provided to them in the school.

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The Fluoride Ion-Selective Electrode Method
We used an Orion 720A potentiometer equipped with a combined Termo Orion 9609BN electrode for estimating the fluoride concentration in urine and water samples.

Collection and Analysis of the Urine Samples
After the oral examination, urine samples from children detected with any degree of fluorosis were requested. The instructions for the correct method of collection in sterile containers were given to the parents. Each sterile container was labeled with the respective child's name and age and parents were instructed to store the urine at 4 °C after collection. The samples were sent to the laboratory and total volume and pH were immediately measured. The children who refused or lost part of the 24-h urine collection samples were excluded.

Collection and Analysis of Home and School water Samples
Three previously washed plastic bottles were provided to the parents to collect three water samples from their homes in three different days. These samples were stored at 4 °C until the chemical analysis. Similarly, water samples from the respective schools were collected.

Statistical Analysis
Study data collected was coded and analyzed with SPSS 16.0. Frequencies, means, standard deviations, and percentages were obtained. Chi-square test was used for comparing groups with and without dental fluorosis with respect to individual risk factors followed by multivariate logistic regression modeling.

Results
A total of 200 students were enrolled in these two schools and 194 students participated (97.0% responders) while 6 were labeled as non-responders due to absence at the time of examination. The mean age of the students was 11.1 years (SD=1.5) with distribution as: 7-9(11.8%) years, 10-12(72.7%) years and 13-15(15.4%) years respectively. Out of this, males and females constituted 60.3%(117) and 39.7%(77) of the study population. The subjects were uniformly distributed (54.6% in Barwala and 45.4% in Pooth Khurd) among the two study areas. Majority of the students had illiterate mothers (57.2%) and fathers with secondary education (38.7%).The occupation of fathers was found to be of laborer type (32.5%) in the majority. From socio-economic perspective, majority of the subjects belonged to poor and lower middle class (96.9%).

Table 1: Socio-demographic profile of the study subjects:

Socio-demographic characteristics	Number (%)
Age (in years)	
7-9	23 (11.8)
10-12	141 (72.7)
13-15	30 (15.5)
Gender	
Male	117 (60.3)
Female	77 (39.7)
School	
Govt school, Barwala	106 (54.6)
Govt school, Pooth	88(45.4)
Education of Mother	
Illiterate	111 (57.2)
Primary	24 (12.4)
Secondary	47 (24.2)
Senior Secondary	10 (5.2)
Graduate	2 (1.0)
Education of Father	
Illiterate	41 (21.1)
Primary	30 (15.5)
Secondary	75 (38.7)
Senior Secondary	38 (19.6)
Graduate	8 (4.1)
Occupation of father	
Laborer	63 (32.5)
Factory worker	44 (22.7)
Other	55 (28.3)
Driver	17 (8.8)
Shopkeeper	15 (7.7)
Income class (B G Prasad classification) *	
>16900 (Upper High)	-
8450-16899 (High)	-
5000-8449 (Upper Middle)	4(1.1)
2500-4999 (Lower Middle)	9 (3.6)
<2500 (Poor)	181 (93.3)

*** B G Prasad classification (Modified as per AICPI (All India Consumer Price Index)-2012, Appendix 1)**

Appendix 1
B G PRASAD CLASSIFICATION
(Original) (Revised)

Base year=100

	1960	2004	2012
UH	>100	>10,000	>/=16900
H	50-99	5000-9999	8450-16899
UM	30-49	3000-4999	5000-8449
LM	15-29	1500-2999	2500-4999
Poor	<15	500-1499	<2500

UH= Upper High class, H=High class, UM=Upper Middle class, LM=Lower Middle class

Study sample characteristics
According to the parents, their children started brushing at 2-3.5 (84.1%) years and 3.5-5 (15.9%) years respectively. The frequency of brushing varied from irregular (6.7%) to regular i.e. once a day (77.8%) and twice a day (15.5%).Majority of the students used fluoridated toothpaste (80.4%) as compared to non-fluoridated (11.9%). Surprisingly, 7.7% of the study subjects also used neem-stem (an Indian herbal method from the stem of Azadirachta indica).

Only 8.8 % of children participated in dental health programs in past 1 year and underwent a dental examination. Moreover, 53.6% gave a history of consuming manufactured beverages from their local community.

Prevalence of dental fluorosis and associated risk factors
Dental fluorosis was found to be highly prevalent among the study subjects with 6.2% having severe fluorosis followed by 28.4% with moderate and 30.9% with mild variants. Only 18.6% of the subjects were found to have normal teeth. Henceforth, the Community fluoride index was calculated as 3.5 indicating dental fluorosis of high public health importance.

The source of drinking water for 68% of the subjects was supply water with 13.9% consuming water from bore well/jet pump, 3.1% from hand pump and 1.5% from open well. The prevalence of dental fluorosis was highest among subjects consuming supply water (65.9%). Also, drinking water from the open well was found to have higher odds of having dental fluorosis.

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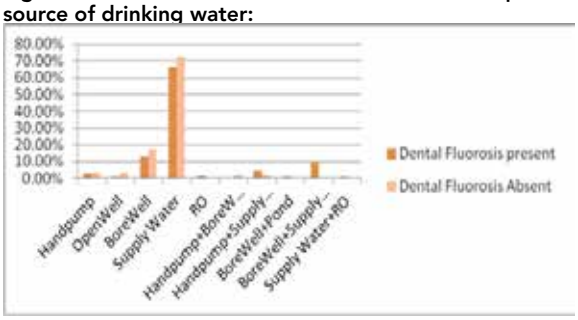
Figure 1 : Distribution of Dental Fluorosis with respect to source of drinking water:



Majority of the subjects diagnosed with dental fluorosis were found to have significantly higher urinary fluoride levels (0.98ppm-1.9ppm) (chi-square value = 67.47, p<0.001). A similar observation was made from those consuming supply water (60.9%) that suggests the association of supply water with dental fluorosis in this area.

Table 2: Distribution of dental fluorosis with source of water supply and urinary fluoride levels:

	Source of water supply	N	Urinary fluoride levels (ppm)		Chi square, df, p value
			0-0.97 (%)	0.98-1.9 (%)	
Dental Fluorosis present	Hand pump	4	6.1	1.1	19.28,8,0.01
	Open Well	1	2	0	
	Bore Well	17	10.2	13.8	
	Supply Water	90	75.5	60.9	
	Reverse Osmosis	2	4.1	0	
	Hand pump + Bore Well	0	0	0	
	Hand pump + Supply Water	6	2	5.7	
	Bore Well + Pond	1	0	1.1	
	Bore Well + Supply Water	14	0	16.1	
	Supply Water + Reverse Osmosis	1	0	1.1	

On univariate and multivariate logistic regression modelling, non-participation in dental health programmes and higher urinary fluoride levels was found to be significantly associated with dental fluorosis.

DISCUSSION

The present study was conducted in rural areas of Delhi (North-West district) endemic for fluorosis. The study aimed to find the prevalence and severity of dental fluorosis among middle aged school children. The prevalence of dental fluorosis was found to be nearly 3/5th (65.5%) as compared to another study done in South district of Delhi.17 Choubisa reported the prevalence of dental fluorosis as 45% among 21 different villages in southern Rajasthan.18 Also, the present prevalence is higher than that observed by Saravanan et al 19(i.e. 31.4%) in rural Tamil Nadu and Nanda in rural UP.20,21 Although, the prevalence recorded among school children of similar age group in Bhiwani district of Haryana was astonishingly high (i.e. 92.73%).22 This might be due to the increasing number of permanent teeth with age (with secondary dentition completing at 12 years) with cumulative effects of fluoride exposure.21

The present study reflected a positive association between dental fluorosis and use of fluoridated toothpaste. This might be due to the fact that fluoridated toothpaste further accelerated the risk in addition to environmental fluoride exposure.21

Not surprisingly, in the present study, dental fluorosis revealed no significant difference between genders. This is consistent with other studies conducted among rural school children in Haryana22 and Karnataka.23 Dental fluorosis was also found to be associated with sources of ground water (like bore well and hand pump) which is in affirmation to current scientific knowledge.24,25

Earlier studies have indicated the subsequent increase in urinary fluoride levels with increasing age.26,27 This has been further strengthened by our study findings. Also, higher urinary fluoride excretion could have been supplemented by fluoride levels in blood samples which can be stated as a limitation of this study.

Conclusions

Our findings reflect the gravity of the current situation of Fluorosis in rural Delhi. An early intervention in terms of defluoridation of drinking water and creating awareness regarding dental fluorosis as a primordial intervention is required. Also, it is suggested that school health programmes need to incorporate dental examination at regular intervals especially in this endemic zone.

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