

Frequency of Dental Fluorosis in Population Drinking Water with High Fluoride Level in Thar



Iftekhar Ahmed¹

MBBS, MCPS, FCPS

Anwar Ali²

BDS, FDSRCS

Marium Zaheer³

BDS, MDS

Ibraj Fatima⁴

Nazeer Khan⁵

PhD

OBJECTIVE: The objective of this study is to see the frequency of dental fluorosis in exposed area (Sammo Rind village of Thar District) and in unexposed area of Gadap town of Karachi and to find the association of fluoride level with dental fluorosis in both groups.

METHODOLOGY: The water samples were taken from both the sites and fluoride estimation in water and geometrical, was determined using Fluoride Ion Selective Electrode (FISE) method. By random selection 121 subjects from Sammo Rind village and 121 controls from Gadap Town Karachi were included in study after informed consent. The participants were clinically examined by an expert university teacher dentist in proper dental setups in examination lights.

RESULTS: A frequency of dental fluorosis of 100% was found among the study subjects with fluoride content as high as 6-8 mg/dl as compared to prevalence of dental fluorosis 17.4% in unexposed group with water fluoride content as low as 0.30mg/dl.

CONCLUSIONS: The high level of underground water fluoride level and cent per cent dental fluorosis in Thar area is an alarming situation that should be addressed immediately at national level.

KEYWORDS: Exposed area, Dental Fluorosis, Fluoride Level, Water Sample

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INTRODUCTION

Thar is the largest desert of Pakistan and seventh largest in the world.¹ This desert has the blessing of being the only fertile desert in the world where the rainfall brings the dead land to life. That is the reason why people live not only in the outskirts of desert but also in the desert area.² This semi-arid area seems not completely xeric because of the average rainfall of 200-300 mm which is usually erratic and non-consistent.³ The natural disaster is not always the drought but the polluted water when available contains lots of impurities and sediments.⁴ This leads the human growth and development towards imbalanced

proportions in majority of aspects of health. Thar desert is 120 meter elevated from sea level. The geographical proximity of the Great Rann of Kutch (the largest salt marsh) and Arabian Sea in the South of Thar Desert render the underground water of Thar a marine environment.⁵ Furthermore, the alluvial plains of Indus River and the coast make the underground water more salty.⁶ The volcano in the region of Rajasthan may be the source. Thar is a tropical area with maximum temperature as high as 48°C¹ thus giving the clue of presence of coal beneath its burning lands.

Thar is the largest district of Sind.⁴ It has a total population of 1.65 million scattered over an area of 19,638 km². Water, the most treasurable natural resource that is gifted to human beings, is under constantly increasing intimidation in this area. Therefore, inadequate access to safe drinking water has become the most critical and the most challenging environmental problem. Throughout history, people of this region have used groundwater as a source of drinking water and not only them, more than half of the world's population depends on it for existence. Groundwater constitutes 97% of global freshwater and in many regions, groundwater springs

1. Professor, Department of General Medicine, D.I.M.C, Dow University of Health Sciences, Karachi.

2. Professor, Department of Oral Surgery, Dr Ishrat ul Ebad Khan Institute of Oral Health Sciences Dow University of Health Sciences, Karachi.

3. Assistant Professor, Department of Oral Pathology, Dr Ishrat ul Ebad Khan Institute of Oral Health Sciences Dow University of Health Sciences, Karachi.

4. MBBS (student) Undergraduate Student, Department of General Medicine, D.I.M.C, Dow University of Health Sciences, Karachi.

5. Professor, Department of Biostatistics, Jinnah Sindh Medical University.

Corresponding author: "Dr. Iftekhar Ahmed" <dr_iftekharahmed@hotmail.com >

are the single principal source for serving drinking water.⁷ Thus the accessibility of uncontaminated groundwater is most vital, as it serves as the critical component in every sphere of human life. Scarcity of drinking water and moreover the increased mineral and ion concentration in water are crucial factors in keeping the health of Thar people blow the level of satisfaction. For example the higher concentration of nitrate in groundwater is hazardous, predominantly for newborn babies affected by 'blue baby syndrome'.⁸ The local population pulls the underground water from wells for their drinking, cooking and everyday utilization¹. The wells can be as deep as 3-90 m and pulling of water is aided by help of camels.

One of the most crippling biochemical diseases that emerge as a result of imbalanced ion concentration in water is fluorosis.⁹ That is caused by excess intake of fluoride ion. Along with many minerals present in water, one of the most important ions is fluoride ion.⁹ Fluoride is the ion of fluorine, the 17th most plentiful and most electronegative element on ecosphere. It is highly reactive that's why it is found in combination of other elements such as calcium fluoride or fluorspar. Rocks and soil are the main reservoir of fluoride that leaches out in the underground water. Drinking water, food, tea, air, medicaments and cosmetics are the sources of fluoride exposure in human beings. The drinking water or fresh water fluoride level (0.01-0.3 parts per million (ppm)) is different from sea water fluoride level (1.2-1.5 ppm). Concentration of fluoride in water depends upon the temperature that is very high in Thar Desert and sedimentary rocks, lime stone, sand stones and volcano rocks present in this area.¹⁰

Fluorosis affect many systems in body primarily teeth and bones.¹¹ The other systems include nervous system, reproductive system, liver, kidneys and cardiovascular system. Long term intake of fluoride during tooth development leads to enamel fluorosis. There is a linear relationship in dose and response. The recommended fluoride content in drinking water should not be more than 1 parts per million (ppm).¹² It is of interest that the fluorosis occurs due to local effects of fluoride on the mineralizing tooth germ, predominantly the maturation stage of enamel formation that is up to the age of 8 years.¹² Fluorosis clinical spectrum ranges from mild discoloration of tooth surface to severe staining and pitting.¹²

There have been various studies mentioning the excessive level of fluoride preset in the drinking water of Thar district.^{1,13-16} The native individuals are at high risk of developing dental fluorosis. However, the literature search reveals scarcity of data on dental fluorosis.^{17,18} prevalence and its characteristics in Thar district. Therefore we design a study to evaluate the fluoride estimation in drinking water and geometrical samples and to investigate the dental changes

associated with increased fluoride intake that is the dental fluorosis in Thar.

METHODOLOGY

This was a descriptive comparative cross-sectional study. Ethical approval was obtained by the Institutional Review Board of Dow University of Health Sciences (Ph-D-06/ERB-50/DUHS-08). The study was approved by Institutional Review Board, Dow University of Health Sciences. The study was conducted for dental fluorosis and sample size was calculated from WHO sample size calculator accordingly. A total of 242 participants were included 121 in each group. List of residents was made with the help of map of houses. The study site for exposed was the village Sammo Rind that is situated 40 km in the South East of Chachro Town in Thar District. The unexposed group comprised of age and sex matched individuals from three villages (Pathan Goth, Screane Goth and Bi Khori Goth) of Gadap Town. Gadap Town is situated in North West Karachi along the Hub River at the provincial border between Sindh and Baluchistan. Using systematic random sampling every fifteenth resident was recruited and consent was taken. If consent was refused then next fifteenth resident was called upon. Likewise for the control unexposed group, one out of thirty residents (age and sex matched) of three villages of Gadap Town was included. The study subjects' of age of 12 years and above were brought to Karachi from the case and control sites. Both male and female subjects, living in the area since birth were included. The only exclusion criterion was the immigrants of other areas. Complete history with thorough clinical examination in proper clinical settings were conducted in a tertiary care hospital in Karachi. Oral cavity was examined by a senior dentist in dental unit Enamel abnormalities were recorded according to Dean HT classification (Table 2) of mottled enamel diagnosis and Thylstrup & Fejerskov Index (TF index) (Table 3). Moreover photographs were also taken. Findings were recorded in printed Performa. Samples of underground water were taken from study and unexposed group sites. For fluoride estimation in water and geometrical (rock, soil, clay etc) samples, Fluoride Ion Selective Electrode (FISE) method was applied. The total Ionic Strength Adjustment Buffer (TISAB) was used for pH and fragmentation of aluminum fluoride complexes which might otherwise lessen the fluoride activity.

RESULT

Data Analysis

A data base was developed on SPSS for windows version 22.0. Mean and standard deviation were calculated for

quantitative variables like age, fluoride level etc.. A frequency with percentages was presented for qualitative variables like gender, fluorosis etc. Chi square test was applied and P-values <0.05 was taken as statistically significant.

Demographic Features

Of total 242 subjects, there were 121 exposed subjects and 121 unexposed subject. The mean age in exposed was 33.82± 14.10 years while the mean age in unexposed was found to be 33.33±11.67 years (Table-4). The mean difference

Table 1: Changes according to Deans index of the Cases and Controls

Changes according to dean index	EXPOSED		UNEXPOSED		P Value
	FREQUENCY	PERCENT	FREQUENCY	PERCENT	
NORMAL	0	0	100	82.6	
QUESTIONABLE	2	1.7	8	6.6	
VERY MILD	9	7.4	7	5.8	< 0.05
MILD	18	14.9	4	3.3	
MODERATE	69	57	1	0.8	
SEVERE	23	19	1	0.8	
TOTAL	121	100	121	100	

Table 2: Dean’s Index Classification

Dean’s Index	
Classification	Characteristics of enamel
Normal	Smooth, glossy, pale creamy-white translucent surface
Questionable	A few white flecks or white spots
Very Mild	Small opaque, paper white areas covering less than 25% of the tooth surface
Mild	Opaque white areas covering less than 50% of the tooth surface
Moderate	All tooth surfaces affected; marked wear on biting surfaces; brown stain may be present
Severe	All tooth surfaces affected; discrete or confluent pitting; brown stain present

was insignificant (p=0.7686), Moreover, the total number of males in exposed subject was 90 while the total number of males in unexposed subjects was found to be 84, which constitute about 74.4% and 69.4% respectively. Majority of the exposed subjects (n=88; 72.7%) and unexposed (n=96; 79.3%) were married (Table-5). While the occupation of most of the exposed (n=49; 40.5%) and unexposed subject (n=43; 35.5%) were farming. However, responsibility of majority females were taking care of household constituting 25.6% (n=31) and 26.2% (n=32) of cases and controls respectively (Table-6).

Table 2a: Changes according to T.F Smooth Surfaces index

	Exposed		Unexposed		p value
	Frequency	Percent	Frequency	Percent	
0	0	0	98	81	< 0.05
1	1	0.8	8	6.6	
2	5	4.1	8	6.6	
3	10	8.3	2	1.7	
4	25	20.7	2	1.7	
5	41	33.9	1	0.8	
6	23	19	1	0.8	
7	12	9.9	0	0	
8	4	3.3	1	0.8	
Total	121	100	121	100	

Table 2b: Changes according to T.F Occlusal Surfaces index

	Exposed		Unexposed		p value
	Frequency	Percent	Frequency	Percent	
0	-	-	98	98	< 0.05
1	1	0.8	8	8	
2	7	5.8	8	8	
3	10	8.3	2	2	
4	24	19.8	2	2	
5	40	33.1	1	1	
6	23	19	1	1	
7	12	9.9	0	0	
8	4	3.3	1	1	
Total	121	100	121	121	

Table 3: Clinical Criteria and Scoring for the TFI (Thylstrup-Fejerskov Index)

Score	Criteria
0	Normal translucency of enamel remains after prolonged air-drying
1	Narrow white lines corresponding to the perikymata.
2	<i>Smooth surfaces:</i> More pronounced lines of opacity that follow the perikymata. Occasionally confluence of adjacent lines.
	<i>Occlusal surfaces:</i> Scattered areas of opacity <2 mm in diameter and pronounced opacity of cuspal ridges.
3	<i>Smooth surfaces:</i> Merging and irregular cloudy areas of opacity. Accentuated drawing of perikymata often visible between opacities.
	<i>Occlusal surfaces:</i> Confluent areas of marked opacity. Worn areas appear almost normal but usually circumscribed by a rim of opaque enamel.
4	<i>Smooth surfaces:</i> The entire surface exhibits marked opacity or appears chalky white. Parts of surface exposed to attrition appear less affected.
	<i>Occlusal surfaces:</i> Entire surface exhibits marked opacity. Attrition is often pronounced shortly after eruption.
5	<i>Smooth surfaces and occlusal surfaces:</i> Entire surface displays marked opacity with focal loss of outermost enamel (pits) <2 mm in diameter.
6	<i>Smooth surfaces:</i> Pits are regularly arranged in horizontal bands <2 mm in vertical extension. <i>Occlusal surfaces:</i> Confluent areas <3 mm in diameter exhibit loss of enamel. Marked attrition.
	<i>Smooth surfaces:</i> Loss of outermost enamel in irregular areas involving <1/2 of entire surface.
7	<i>Occlusal surfaces:</i> Changes in the morphology caused by merging pits and marked attrition.
	<i>Smooth and occlusal surfaces:</i> Loss of outermost enamel involving >1/2 of surface.
9	<i>Smooth and occlusal surfaces:</i> Loss of main part of enamel with change in anatomic appearance of surface. Cervical rim of almost unaffected enamel is often noted.

Dental Changes

Out of 121 study subjects, all 121 subjects were found to have dental fluorosis that is 100%. In contrast, 82.6% in control area had normal teeth. According to Dean Index;



Dental fluorosis in a 14 years old boy

mild, moderate and severe changes were seen in 18 (14.9%), 69(57%) and 23(19%) exposed subject respectively (Table 1). Chi square test was applied and P value found to be < 0.05 . Given the p value < 0.05 there is significant association between exposure to water having high fluoride content and characteristics of enamel according to Dean index of classification. Moreover, evaluation according to T.F index grade for smooth surface index in 2, 3, 4, 5, 6, 7 and 8 changes were seen in 5(4.1%), 10(8.3%), 25(20.7%), 41(33.90%), 23(19%), 12(9.9%) and 4(3.3%), respectively with p value < 0.05 (Table 7a). TF scores for occlusal surface index for the same level were shown in table 2 b. Both T.F smooth surface index and occlusal surface index have statistically significant association with exposure group as per given p value of < 0.05 .

Water fluoride estimation

The well water consumed by the population of Sammo Rind has been analyzed for its fluoride content and was found to be 6-8 mg/dl, as compared to control area where fluoride levels are found to be 0.30 mg/L. World Health Organization (WHO) recommends fluoride concentration level in drinking water at 1.5mg/L or it can be documented as 0.8-0.9 ppm. The remaining trace elements in this area were normal.

DISCUSSION

Pakistan is one among the countries where fluorosis is endemic. Thar Desert areas of Sindh province are among the affected areas. The groundwater, especially the water in unconfined aquifers, is the main source of drinking water for people living in the rural desert areas of Sindh. Groundwater is mostly available in dug-wells, generally at the depth of 30 to 75 meters, which is brackish and highly contaminated by the presence of fluoride. A high prevalence of fluorosis is present in such areas including dental, skeletal, musculoskeletal and other forms of fluorosis.

There are numerous studies on the increased levels of fluoride in the ground water of Thar Desert. Many studies were conducted to find the prevalence of dental fluorosis in different parts of the country but there is a dearth of data on

dental fluorosis in Thar Desert. Studies from Lahore, MianWali and Murdan and Quetta reported the prevalence of dental fluorosis.¹⁹⁻²² Study by Rizwan et al in 2012 in Lahore dental Hospital, patients coming for dental problems were examined and the frequency of dental fluorosis was found to be 12%.²⁰ This result is much lower than the result of our study, may be due to level of fluoride ion in drinking water is not as high as in Thar area. Moreover, in a tertiary care hospital patients come from near and far, not confining to a particular locality. Another reason of this vast difference may be the fact that rural population usually live their whole lives in same place for decades while urban life is not so static, people move from one area to another area earlier as compared to rural life, hence changing the water for drinking. Moreover, the source of water is not always ground water in urban life style. However, some portion of population get affected by ground water but other sources of fluoride for example tea, food, supplements, fluoride containing tooth pastes, mouth washes and beverages may contribute to develop fluorosis in urban population. Another study from Quetta by Sami et al reported the prevalence of dental fluorosis as 63.3% in school going children of Quetta, most of it was of moderate type.²¹ The prevalence rate is much higher in this study; the higher fluoride level in the region may be the cause. The prevalence found in Quetta school children was found to be close to our study result. A study conducted in MianWali and Murdan stated the prevalence of dental fluorosis as 98%, this result is in approximation with our result.¹⁹ On more study with this outcome in children of 12 year of age.²³ As we examined the individuals not only from the Sammo Rind village but also the unexposed group of Gadap town of Karachi, the result showed that in spite of having similarity in eating style and life style of both groups of same ethnicity, the difference in the prevalence of dental fluorosis is due to the level of ground water fluoride ion concentration. Dental fluorosis was seen in 100% of subjects and only in 17.4% in unexposed group. Mild, moderate and severe changes were seen in 18 (14.9%), 69(57%) and 23(19%) exposed subjects according to Dean Index of grading system of dental fluorosis respectively whereas the severity of fluorosis in unexposed group was 0.8% only the majority of the positive patient in unexposed group fall into the category of either questionable (6.6%) or very mild (5.8%) The well water of Sammo Rind fluoride content was found to be 6-8 mg/dL, as compared to control area where fluoride levels are found to be 0.30 mg/L.

CONCLUSION

Fluorosis forays the Thar Desert so hard that no person had been found to have normal healthy teeth. The frequency

of dental fluorosis is significantly high in the area where flouride level in drinking water is higher than the recommended value when compared with the population drinking water with normal flouride.

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