

PREVALENCE OF DENTAL FLUOROSIS AND ITS ASSOCIATION WITH FLUORIDE CONTENT OF DRINKING WATER IN THE RURAL AREA OF DHARMAPURI DISTRICT, TAMILNADU

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ABSTRACT

BACKGROUND

Ground water is the major source of freshwater, hence protection of groundwater is critical for the welfare of humankind. The people living in rural areas are more exposed, since there is no centrally supplied water in these areas. The major source of fluoride in ground water is the fluoride-bearing rocks. Dental fluorosis which manifests as discolouration of teeth and skeletal fluorosis which are endemic are most early biomarkers of fluoride toxicity. Dharmapuri district in Tamilnadu is one such region where high concentration of fluoride is present in ground water. The present study was done to determine the occurrence of dental fluorosis in children belonging to Avarankattur village, Dharmapuri district and correlate to the fluoride content of the drinking water and other related factors.

MATERIALS AND METHODS

Hundred children residing in Avarankattur village in Dharmapuri district were selected in the study as this area drinking water was found to have high fluoride content. The study was conducted in the Dental Department of Dharmapuri Medical College & Hospital. The inclusion criteria was to take children belonging to this particular village in the age group of 6-14 yrs. These children or their guardians were asked to fill a questionnaire after evaluation of dental fluorosis using Dean's index. The data obtained was statistically analysed by chi-square test using the SPSS software version 16.

RESULTS

Children who consumed water from any ground source in that region had dental fluorosis. As per the estimation of fluoride done by TWAD, it was found that bore water with hand pump had the highest fluoride content of 6.1 mg/dL whereas the bore water with pressure pump had 5 mg/dL and the least was in well water which was 2 mg/dL. Thus, there is a significant correlation between the fluoride level in the drinking water and the occurrence of dental fluorosis. Dental fluorosis was seen almost in all the children and there was a definite correlation between the duration of stay and the presence of fluorosis. Dental fluorosis was found to occur in children who consumed black tea (71%) than those who did not consume black tea. Also among these children a higher percentage did not consume milk (96%) than those who did. There was a correlation between the usage of aluminium vessels for cooking and the occurrence of dental fluorosis which was statistically significant ($P < 0.000$).

CONCLUSION

In accordance with the geological mapping done by Joshua Amarnath et al, children belonging to Avarankattur Village in Pappireddipatti showed significantly high prevalence of dental fluorosis. Thus, an awareness about the toxicity of fluoride need to be made to these people.

KEYWORDS

Avarankattur Village, Fluorosis, Well Water, Bore Water.

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BACKGROUND

Water is one of most precious resources in Earth. In that, ground water is the major resource of fresh water to all living organisms. Since ground water is the major source of freshwater, protection of groundwater is critical for the welfare of humankind. The people living in rural areas are more exposed, since there is no centrally supplied water in these areas.

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The major source of fluoride in ground water is the fluoride-bearing rocks. The fluoride ion exhibits unique properties as its concentration in optimal dose in drinking water is advantageous to health and if the concentration exceeds the limit, it affects the health.^[1] High fluoride concentration in ground water and surface water in many parts of the world is a cause of great concern. It has been observed that there is relationship between Calcium, sodium and fluoride.^[2] The higher the fluoride level the lower is that of calcium.

Dental fluorosis which manifests as discolouration of teeth and skeletal fluorosis which are endemic are most early biomarkers of fluoride toxicity. Fluorosis was first reported by Shortt et al in Nellore district.^[3] Fluorides can mercilessly affect any age group but its affects are especially harmful to pregnant women and developing children.^[4] An estimated 62 million people including 6 million children below the age of

14 years in India die due to consumption of fluoridated drinking water.^[5] Fluorides are toxic agents that cause adverse health effects such as dental and skeletal fluorosis, reproductive, neurological and endocrine disorders.^[6-7]

In recent years, the prevalence of dental and skeletal fluorosis in India is increasing due to population overgrowth and erratic rainfall necessitating for more and more indiscriminate digging of tube wells leading to more usage of fluoridated drinking water and total unawareness of importance of water quality assessment and drinking from any and every source.^[8]

Dharmapuri district in Tamilnadu is one such region where high concentration of fluoride is present in ground water. Geological mapping done in parts of Pappireddipatti, Dharmapuri district to identify the lithological units responsible for fluoride concentration.^[9]

MATERIALS AND METHODS

The aim of this study is to evaluate the occurrence of dental fluorosis in children of Avarankattur village in Pappireddipatti block of Dharmapuri district and correlating it with fluoride content of drinking water and other related factors.

The study was conducted in the Department of Dental Surgery, Government Dharmapuri Medical College and Hospital. The study protocol was approved by the ethical committee of Govt. Dharmapuri Medical College and informed consent was obtained from the patient.

Study Design

The present hospital-based study was conducted to correlate the occurrence of dental fluorosis in children aged 6 – 14 years belonging to Avarankattur Village with that of fluoride content of drinking water from various sources and other related factors by convenient sampling technique since the duration of the study was 3 months. The sample size was determined by the statistician, based on the pilot study conducted in the village.

Study Population

A hospital-based study was carried out on 100 children aged 6 – 14 years belonging to Avarankattur Village in Pappireddipatti block, attending Dental OPD at GDMG. Those who fulfilled the inclusion criteria were selected and enrolled in the study.

Inclusion Criteria

- Children in age group of 6 – 14 years.
- Children who were born and brought up in that village.
- Children who agreed for the study.

Exclusion Criteria

Children with developmental defects of teeth and children not willing/cooperative were excluded.

Each Child/Parent was asked to fill a self-assessment Questionnaire with the following Questions-

1. Age and sex.
2. Place and duration of residence.
3. Source of water consumption.
4. Quantity of black tea and milk consumption per day.

Prior to investigation of the study, the selection of area of study was done in accordance with findings of geological mapping survey conducted by Joshua Amarnath et al.^[9]

Examination of teeth was done using mouth mirror and probe under natural day. Evaluation of dental fluorosis was done by using Dean's Fluorosis Index.^[10]

Drinking water from various sources of (well, bore well – pressure pump source) bore well hand pump sources was collected in polyethylene bottle and fluoride content of drinking water was estimated using ion-selective electrode, by TWAD Board, Water Testing Centre. The data obtained was statistically analysed by chi-square test using the SPSS software version 16.

RESULTS

A total of 100 children in the age group of 6-14 were examined out of which 71% were boys and the remaining 29% were girls. The sample size was determined after a pilot study was conducted in this village. The sample size estimation was also done by convenience. The data obtained by means of using a questionnaire was statistically analysed using SPSS version 16 and Chi-square test was used for analysis.

As shown in Table 1, all the age groups were equally affected by dental fluorosis and it was not statistically different among the groups. The incorporation of fluoride occurs in the developing tooth age, which is up to 6 yrs., hence we see the incidence of dental fluorosis among all age groups selected. Boys had a greater occurrence of dental fluorosis (97%) than girls (77.3%).

There was a definite correlation between the duration of stay and dental fluorosis as evident in Table 2. The longer the duration of the stay the dental fluorosis was a definite finding. As in Table 2, those living for more than 10 years had dental fluorosis which was statistically significant ($P < 0.000$).

Children who consumed water from any ground source in that region had dental fluorosis. As per the estimation of fluoride done by TWAD, it was found that bore water with hand pump had the highest fluoride content of 6.1 mg/dL whereas the bore water with pressure pump had 5 mg/dL and the least was in well water which was 2 mg/dL. As per statistical analysis, the bore water consumption with hand pump was not significant but it can be noted that as in Table 3 all those who consumed bore water with hand pump had dental fluorosis. Thus, there is a significant correlation between the fluoride level in the drinking water and the occurrence of dental fluorosis. Dental fluorosis was found to occur in children who consumed black tea (71%) than those who did not consume black tea (Table 4). Also among these children a higher percentage did not consume milk (96%) than those who did. (Table 5). Table 6 shows a correlation between the usage of aluminium vessels for cooking and the occurrence of dental fluorosis which was statistically significant ($P < 0.000$).

Age (Yrs.)	Dental Fluorosis Present (%)	Dental Fluorosis Absent (%)	Chi-Square Test	P Value
9	46	4	0.393	0.531
10	95	6	0.000	0.987
11	80	20	1.27	0.259
12	96	4	0.66	0.415
13-14	89	11	0.429	0.513
Table 1. Correlation between Age and the Occurrence of Dental Fluorosis				

Duration of Residence (Yrs.)	Dental Fluorosis Present (%)	Dental Fluorosis Absent (%)	Chi-Square Test	P Value
Up to 9	100	0	9.31	0.010
9-10	95	5	8.5	0.014
11-12	92	8	27	0.000
Above 13	78	22	25	0.000

Table 2. Correlation between the Duration of Residence and Dental Fluorosis

Source of Drinking Water	Fluoride Content (mg/dL)	Dental Fluorosis Present (%)	Dental Fluorosis Absent (%)	Chi-Square Test	P
Well Water	2	71	29	51	0.000
Bore Well with Pressure Pump	5	93	7	19	0.000
Bore Well with Hand Pump	6.1	100	0	5.3	0.021

Table 3. Correlation between the Source of Drinking Water at Home and the Occurrence of Dental Fluorosis

Black Tea Consumption (in Glass)	Dental Fluorosis Present (%)	Dental Fluorosis Absent (%)	Chi-Square Test	P Value
Nil	71	29	70	0.000
1	98	2		

Table 4. Correlation between Black Tea Consumption and the Occurrence of Dental Fluorosis

Milk Consumption (in Glass)	Dental Fluorosis Present (%)	Dental Fluorosis Absent (%)	Chi-Square Test	P Value
Nil	96	4	60	0.000
1	77	23		

Table 5. Correlation between the Consumption of Milk and the Occurrence of Dental Fluorosis

Usage of Aluminium Vessels for Cooking	Dental Fluorosis Present (%)	Dental Fluorosis Absent (%)	Chi-Square Test	P Value
Yes	99	1	52	0.000
No	50	50		

Table 6. Correlation between the Usage of Aluminium Vessels and the Occurrence of Dental Fluorosis



Figure 1. Case of Dental fluorosis



Figure 2. Sample of the sources of drinking water in Avarankattur Village



Figure 3. Instrument for Measuring Water Fluoride Level



Figure 4. Instrument in use for Measuring Water Fluoride Level

DISCUSSION

In this study, children belonging to Avarankattur village in Pappireddipatti block of Dharmapuri were selected in accordance with the geological mapping done in part of Pappireddipatti block of Dharmapuri district to identify the lithological units responsible for fluoride concentration and also helps in decision making process to identify the most sensitive zones that needs immediate attention.^[8]

The Dean's fluorosis index was used to evaluate the dental fluorosis because it remains popular for its simplicity and ability to make it compare with numerous early studies. In this study of assessment of examines reliability of index. Kumar et al showed good-to-excellent agreement beyond

chance in use of index.^[8] Moreover, it requires only natural light and no prior cleaning and drying is needed.

Fluorosis can attack mercilessly any age group. But its effects are especially harmful in pregnant women and developing children.^[4] The adverse effects are irreversible ranging from mild dental fluorosis to crippling from skeletal fluorosis.^{[11][12]} The severity of fluorosis depends upon the drinking water, daily intake, duration of exposure and climatic condition.^[13] The results showed no correlation between age and occurrence of DF which is similar to the study done by Choubisa et al^[14] who found no correlation between age and occurrence of DF. Since in this study all age groups showed almost equal predilection.

In this study, DF was found to be significantly more in males (96%) as compared to females 77.3%. A similar finding was made by Kotecha et al.^[15] The higher prevalence of DF in male children in present study may be associated with greater physical activity that would have increased the consumption of drinking water. A similar findings was made by Mann in his study.^[16]

Dental fluorosis develops only when one is exposed to high fluoride level during 0 – 6 years of age when dentition develops. Nearly all children (100%) who lived in high fluoride area in first five years showed the presence of DF.

This is similar to the study done by Dhard and Batnagar H.^[17] This is in accordance with the fact that most permanent teeth including permanent incisors and first molar undergo formation within the first 5 years of life.

Dental fluorosis was found mostly in children who consumed bore well water (93%) from pressure pump source and 100% from hand pump source. This is similar to another study done in Tamil Nadu.^[18]

One of the reason for uncommon fluorosis in tropics is the temperature.^[19] People in tropical region drink mixed water, hence more fluoride intake.^[20]

Though well waters have less fluoride content, people feel that the ground water from wells is bacteriologically safe. But it is often not suitable because of presence of excess of naturally occurring chemicals such as fluoride whereas surface water and water from traditionally dug wells have less fluoride content but can be contaminated by faecal matter.

The main content of fluoride in ground water is the fluoride-bearing rocks, rock bearing minerals that contribute to toxicity of domestic water. Also, the content in ground water is a mixture of many factors such as availability and solubility of fluoride minerals, velocity of flowing water, pH and temperature concentration of calcium bicarbonate ions in water. WHO in 2008 has set a range of allowable concentration for fluorides in drinking water, for a region depending on the climatic condition because the amount of water consumed and consequently the amount of fluorides ingested is being primarily influenced by air temperature.

In this study, ion-selective electrodes are used for estimation of fluoride content of drinking water for the reason that it is an automatic analysing system and can be used for estimation of both ionic and non-ionic forms of fluorides in contrast to other methods which cannot distinguish between organic and inorganic fluorides. Also it has tremendous tolerances for extraneous ions like sulphates and phosphates and does calibration to give final results in parts/million and more accurate than other methods.^[21]

In ground water, the main source of drinking water, the fluoride content in this village ranged from 2 - 6.1 mg/dL, depending on the hydrogeological conditions of the most important aquifer system constituted by unconsolidated and semi-solidated formation and weathered and fractured crystalline rocks.^[9]

Fluorides can be beneficial in preventing dental caries at water concentration 1 mg/dL, but it has also been shown to cause dental mottling and adverse effects in bones including increased risk of fracture at concentration in excess of 1.5 mg/dL with the risk gradually increasing with total intake of fluorides.^[22-24]

Apart from these, there are reports that excess consumption causes hip fracture, leads to still births and detrimental neurological effects.^[25]

Sadly, the harmful effects of fluorides not only just alter the aesthetic appearance of teeth but also affect the other body organs. There are reports of neurological manifestation of exposure of fluoride in humans causing headache, insomnia and lethargy.^[26]

In aborted human fetuses collected from endemic fluorosis area, it was found that accumulation of fluorides in brain tissue causes disruption of certain neurotransmitters and receptors in nerve cells and also increased numerical density of volume of nerves and undifferentiated neuroblasts.^[25-27]

There is also evidence of increased activity of alkaline phosphates in femur and kidney and there is reduction in number of mitochondria-rough endoplasmic reticulum and free ribosomes in neurons of cerebral cortex.^[28]

The incidence of DF among children who did not consume milk (96%) was higher than those who consumed milk 78%. However, in the present study no significant correlation was found between DF and consumption of milk. In fact, nutrition has a role in early calcifying of teeth.^[30] Powdered milk^[29] has much more fluoride than natural milk.^[19-32] Osuji demonstrated that longterm use of powdered milk (13 months or more) increases fluorine rate.^[33]

The rate and extent of fluoride absorption from the gastrointestinal tract are reduced by ingestion of food rich in calcium such as milk.^[34] In rats a diet rich in calcium increases the faecal fluoride excretion.^[35]

Dental fluorosis was found to occur more in children who consumed black tea (98%). A sustained amount of fluoride is released during tea infusion and nearly all the fluorides released are absorbed by consumer. Water brewed with tea leaves increases its fluoride content by 3-4 times.^[36]

Cooking in aluminium vessels using fluoridated water results in formation of aluminium fluoride complex that get absorbed rapidly from intestine resulting in fluoride toxicity.^[37] In this study, there is a positive correlation between DF and use of aluminium vessels for cooking. Inappropriate use of tooth paste in children also increases fluorosis.^[38-39]

There is no positive correlation between DF and use of tobacco, betel leaves and areca nuts, since the subjects participating in the study are children, who do not show the presence of such pernicious habits.^[36]

Limitation of the Study

Due to the short duration of study, convenience sampling technique was followed. Thus, sampling size was also calculated by convenience. The results of the study cannot be

generalised due to the potential bias resulting from the sampling technique and sample size estimation.

CONCLUSION

In accordance with the geological mapping done by Joshua Amarnath et al, children belonging to Avarankattur Village in Pappireddipatti showed a significantly high prevalence of DF, whereas the fluoride content ranged between 2 mg/dL to 6.1 mg/dL. The prevalence of DF was significantly high in males and directly proportional to the fluoride content of drinking water and duration of residence, and the first five years in that village. There was positive correlation between DF and children consuming bore well water, black tea and usage of aluminium vessels for cooking.

This study is aimed at creating an awareness of fluoride toxicity and educate the people.

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