International Journal of Zoology and Applied Biosciences
Volume 1, Issue 5, pp: 226-230, 2016
Research Article
ISSN: 2455-9571
http://www.ijzab.com

PREVALENCE OF DENTAL FLUOROSIS IN ASSOCIATION WITH HIGH LEVELS OF FLUORIDE CONTENT IN DRINKING WATER IN NAGAPATTINAM AND CUDDALORE DISTRICTS OF TAMIL NADU, INDIA

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Article History: Received 10th October 2016; Accepted 25th October 2016; Published 31st October 2016

ABSTRACT

Fluorosis resulting from high fluoride concentration in drinking water is a major public health problem in India. This study was carried out to measure and compare the prevalence of dental fluorosis in primary school children in selected areas of Nagapattinam and Cuddalore districts of Tamil Nadu, India. A cross-sectional study was carried out among 1327 native primary school students (752 boys and 575 girls), aged 5-10 years belonging to different communities. Data was collected by using a questionnaire followed by an intraoral examination to ascertain fluorosis and its grades of severity using Dean's index. In Nagapattinam district, 61.4 % of school children using ground water as the source of drinking water showed the prevalence of dental fluorosis whereas, in Cuddalore district, 62.0 % of school children were affected with fluorosis. Among the municipal water users, 59.4 % of school children were affected with dental fluorosis in Nagapattinam district while it was nearly 57.7 % in Cuddalore district. The severity of dental fluorosis among the school children with the source of drinking water was found to be not significant thereby showing a strong association of dental fluorosis with the fluoride content of water rather than its sources. Similarly, the number of children affected with dental fluorosis increased with an increase in the age-groups of children. However, gender wise comparison of prevalence of dental fluorosis showed no statistical difference between boys and girls but showed identical prevalence and severity of dental fluorosis in both the sexes. The drinking water samples from the selected areas were collected and the fluoride level was estimated using Alizarin visual method.

Keywords: Alizarin visual method, Intraoral, Dean's index, Dental fluorosis.

INTRODUCTION

Fluoride is an essential micronutrient for the health of an individual by playing a critical role in the calcification of bones and teeth. While its deficiency leads to dental caries on one hand; its excess consumption through water, food, drugs, inhalation of air contaminated with fluorine and dentifrices lead to dental and skeletal fluorosis. The main dietary source of fluoride is drinking water. Optimal carioprotective fluoride content in drinking water is approximately 1 mg/l in temperate climate. In tropical countries where intake of water is more, the desirable fluoride content of drinking water may be 0.5 mg/l. World Health Organization (WHO) has set the upper limit of fluoride concentration in drinking water at 1.5 mg/l (WHO, 2004). The Bureau of Indian Standards, has therefore, laid down Indian standards as 1.0 mg/l as maximum permissible limit of fluoride with further remarks as "lesser the better" (Government of India report, 1993). The WHO in Oral Health Report (2003) has stated fluoride as most effective agent in dental caries prevention but the fluoridation of water to prevent caries is always at the expense of a certain degree of dental fluorosis.

Nearly 12 million of the 85 million tons of fluoride deposits in the earth's crust are found in India (Teotia and Teotia, 1994), suggesting that as the most possible reason for endemicity of fluorosis in 20 states of India. The highest rates of endemicity have been reported from Andhra Pradesh, Haryana, Karnataka, Punjab, Rajasthan and Tamil Nadu. The most common cause of fluorosis in India is fluoride laden water derived from bore wells dug (Chaubisa *et al.*, 1995) deep into earth.

Endemic fluorosis resulting from high fluoride concentration in groundwater is a public health problem in India. Dental fluorosis is the most sensitive sign of prolonged high fluoride exposure (WHO, 1994). Monitoring of the fluoride levels in drinking water is required to tackle and mitigate the problem of fluorosis in

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such areas. Most of the rural areas are devoid of piped water supply and as a result, people depend on ground water for drinking purposes so the study area is ideal for assessing the prevalence and severity of dental fluorosis in association with water sources. Very few studies have been conducted in this area hence this study was undertaken with the objectives to study the prevalence of dental fluorosis and its severity among primary school children in the Nagapattinam and Cuddalore districts of Tamil Nadu and to examine the associations of the condition with potential risk factors.

METHODOLOGY

Sampling Procedure

Drinking water samples were collected from various sources in the selected areas of the Cuddalore and Nagapattinam districts for estimation of fluoride by Alizarin Visual method at the Amphigene laboratories, Thanjavur. The selected areas viz. Pinnalur, Karaimedu, Maruvai and Manjalkollai in Cuddalore district and Vadakarai, Arangangkudi, Sembanarkoil and Mannampandal in Nagapattinam district were divided into groups on the basis of the source of drinking water and the varying fluoride concentration in drinking water.

A cross-sectional survey of school children in the age group of 5-10 years (classes 1 to 5) of 12 primary schools in the two districts was conducted. Children selected were permanent residents of the selected areas (since birth). Children in this age group were selected because they represent a population at risk for dental fluorosis; as the period of calcification of teeth from infancy to 6 years of age constitutes the vulnerable period for the onset of the condition. The examiner underwent training in physical characteristics of fluorosis from the data gathered in a literature review, photographs found in books and from databases of pictures on the Internet. She received practical training from a senior academic clinician also. The study was conducted during the months of November, 2011 to March, 2012.

Questionnaire

The data were collected and recorded, based on a structured close ended pre-tested questionnaire to obtain information on the potential risk factors like socioeconomic status, occupation and level of education of the parents, the source of drinking water, amount of water consumed and use of fluoride-containing toothpaste by the students. Those suffering from any systemic illness, uncooperative were excluded from the study. The children not attending the school were also not included for the sampling.

Oral examination

The examination for dental fluorosis was carried out by adopting the methodology given by WHO Oral Health Survey Basic Methods (1999**)**. The survey included intraoral assessment of all teeth using the Dean's Fluorosis Index (1942), the most universally accepted classification system. An individual's fluorosis score is based on the most severe form of fluorosis found on two or more teeth and was assigned one of the six diagnostic codes: Normal, Questionable, Very Mild, Mild, Moderate and Severe.

Statistical analysis

Data were analyzed using SPSS 11.5 version. Chi square test was used for the comparison of prevalence of fluorosis and various levels of fluoride concentration in drinking water. The prevalence of dental fluorosis was estimated by taking all cases of dental fluorosis as the numerator and the total child population evaluated in the age group of 5-10 years as the denominator. A Community Fluorosis Index was computed by summating the scores of individual grades and dividing the sum by the total sample size. A community fluorosis index was greater than 0.4 has been used to identify areas where fluorosis is a public health problem. The association of dental fluorosis with selected risk factors was studied using Chi-square ($p<0.05$).

RESULTS

Study sample

The study sample comprised 1327 school children (752 boys and 575 girls) aged between 5-10 yrs. The mean age of the population under study was 7.5 years. Out of the total study population, 364 boys & 232 girls were examined in Cuddalore district and 388 boys and 343 girls were examined in Nagapattinam district. There were 175 (13.2%) subjects of 5 yrs, 265 (20%) subjects of 6 yrs, 236 (17.7%) subjects of 7 yrs, 205 (15.4%) subjects of 8 yrs, 197 (14.8%) subjects of 9 yrs and 187 (14.1%) subjects of 10 yrs age in the study population covering both the districts. Ground water and municipal water were the major source of drinking water in the areas under study. Most of the children consumed fish in their diet and used toothpaste for cleaning their teeth.

Prevalence of Dental fluorosis and associated risk factor

The overall prevalence of dental fluorosis in school children of study sample was 60.4% and the community fluorosis index was calculated as 0.69 in Nagapattinam and 59.8% and 0.54 in Cuddalore district respectively. Table-1 shows prevalence of dental fluorosis among the school children according to the source of drinking water in the study area. In Nagapattinam district, 61.4 % of school children using ground water as the source of drinking water showed the prevalence of dental fluorosis whereas in Cuddalore district, 62.0 % of school children were affected with fluorosis. Among the municipal water users, 59.4 % of school children were affected with dental fluorosis in Nagapattinam district while it was nearly 57.7 % in Cuddalore district.

When the severity of dental fluorosis in the school children was associated with the source of drinking water (Table 2), the difference was found to be not significant

($p>0.05$). The prevalence of dental fluorosis was irrespective of source of drinking water.

An association between age and the prevalence of dental fluorosis was also observed, showing increase in prevalence with an increase in the age of children in both the districts (Fig. 1). However, gender wise comparison of prevalence of dental fluorosis showed no statistical difference between boys and girls and showed identical prevalence and severity of dental fluorosis (Table - 3).

Analysis of Water Samples

All the selected areas were found to have above the optimum level of fluoride concentration i.e above the maximum allowable concentration of 4 mg/l. The prevalence of dental fluorosis showed positive correlation with the concentration of fluoride in drinking water. It was found that the number of children affected with dental fluorosis increased with the increase in level of fluoride content in drinking water.

Table 1. Prevalence of dental fluorosis among the school children according to the sourceof drinking water in the study area.

Source of drinking water	Nagapattinam			Cuddalore		
	No. of children examined	No. of children with dental fluorosis	Prevalence of dental fluorosis (%)	No. of children examined	No. of children with dental fluorosis	Prevalence of dental fluorosis (%)
Ground water	145	89	61.4	248	143	62.0
Municipal water	589	350	59.4	345	214	57.7

Table 2. Severity of dental fluorosis among the school children with the source of drinking water in the study area.

District	Source of drinking water	Fluorosis score							Chi Square value	P value
		0	1	2	3	4	5	Total		
Nagapattinam	Groundwater	56	8	46	17	18	1	146	5.579	0.233
	Municipal water	239	15	204	76	54	0	588		
Cuddalore	Groundwater	98	22	54	44	28	2	248	4.996	0.288
	Municipal water	134	28	100	52	31	0	345		

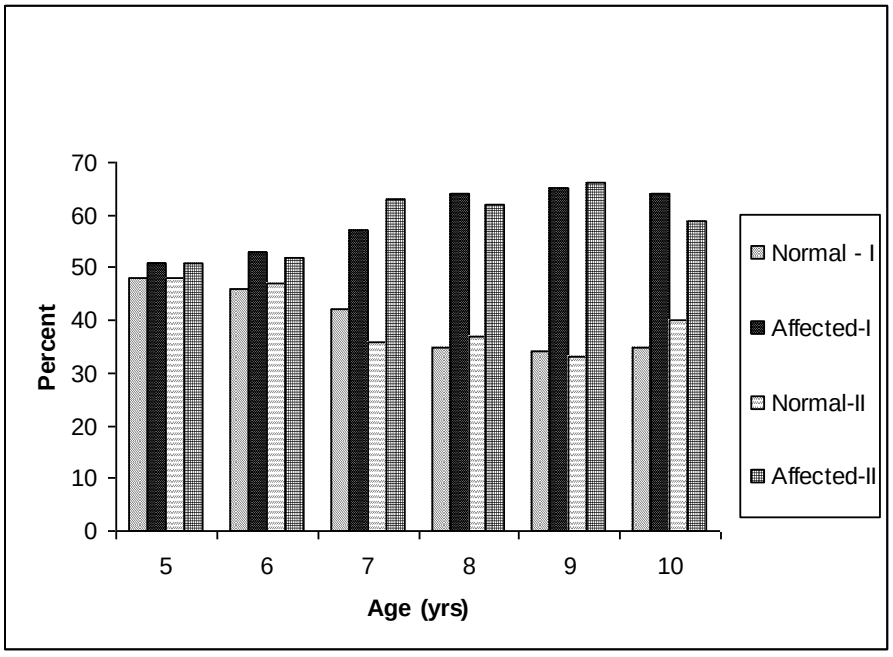

Figure 1. Prevalence of dental fluorosis among children of different age groups in Nagapattinam and Cuddalore Districts.

Table 3. Age cohort and sex-wise distribution of dental fluorosis in the study sample.

Age in years	Nagapattinam				Cuddalore			
	Male	%	Female	%	Male	%	Female	%
5	37	11.5	50	14.8	45	16.3	43	13.2
6	61	19.0	65	19.2	49	17.7	45	13.7
7	83	25.9	64	18.9	43	15.5	46	14.1
8	52	16.2	64	18.9	44	15.9	45	13.7
9	36	11.2	49	14.5	59	21.3	53	16.2
10	51	15.9	45	13.3	36	13.0	55	16.8
Total	320		337		276		327	

DISCUSSION

Dental fluorosis is a condition where excessive fluoride can cause yellowing of teeth, white spots, and pitting or mottling of enamel. Consequently, the teeth may become unsightly. At drinking water concentration between 0.9 – 1.2 mg/l, fluoride may give rise to mild dental fluorosis. Values of 1.5 – 2.0 mg/l of fluoride in drinking water gives rise to higher chances of dental fluorosis and while values exceeding 2 mg/l may have very high chances of dental and skeletal fluorosis (WHO, 1994). Similarly, the children residing in study area with very high level of fluoride concentration in drinking water had more dental fluorosis (66%) when compared to children residing in areas with comparatively less level of fluoride concentration in drinking water (50 %) corresponding with the finding of National Oral Health Survey and Fluoride Mapping (2002), Akpata *et al.,* (l997), Budipramana *et al.,* (2002) and Neurath Canton (2005). This might be due to the availability of fluoride to those children from drinking water and other sources of fluoride which exceeds the tolerance dose of fluoride against dental fluorosis.

In the present study, it was observed that dental fluorosis existed in very mild to moderate fluorosis form irrespective of the source of drinking water. The mean fluoride content of the drinking water sources of both Nagapattinam and Cuddalore districts was higher than the permissible level of 1 ppm according to WHO (1984). The condition is more prevalent in rural areas where drinking water is derived from shallow wells or hand pumps

The percent distribution of dental fluorosis among children aged between 5 – 10 yrs in Nagapattinam district was found out, it was observed that out of 731 subjects, nearly 44% were found to be normal with fluorosis score of 0, about 8% were with score of 1 and came under the questionable category, 35% were with the score of 2 belonging to the category of very mild, 11% belonged to the category of mild with the score of 3, only 1% belonging to the category of moderate and severe with the dental fluorosis score of 4 and 5 respectively. Similarly, the percent distribution of dental fluorosis among the children aged between 5-10 yrs in Cuddalore district showed that out of 596 subjects, 36%, 8%, 23%, 24%, 8% and 1% belonged fluorosis score of 0, 1, 2, 3, 4 and 5 respectively.

An increase in the prevalence of dental fluorosis with increase in age was observed consistent with the findings of Larsen *et al.,* (1987), National Oral Health Survey and Fluoride Mapping (2002), Akpata *et al.,* (l997). This pattern might be due to increased exposure to other sources of fluoride, such as fluoride tooth paste and other fluoride prophylactic measures, consuming more of fluoridated water. However, gender wise comparison of prevalence of dental fluorosis showed no statistical difference between male and female.

CONCLUSIONS

The present study gives us an insight into the problem of dental fluorosis among primary school children in rural areas of Nagapattinam and Cuddalore districts, where fluorosis is a public health problem. The CFI value and the fluoride level of water warrant the urgent need to provide defluoridated water to the affected area and also to educate the people to use safe sources of water for drinking.

ACKNOWLEDGEMENT

Authors are thankful to the Head of the Department of A.V.C. College (Autonomous) for the facilities provided to carry out the work.

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