Prevalence of dental fluorosis among primary school children in association with different water fluoride levels in Mysore district, Karnataka

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ABSTRACT

Background: Fluoride intake at optimal level decreases the incidence of dental caries. However, excessive intake, especially during developmental stages can cause adverse effects such as dental and skeletal fluorosis.

Aim: To assess the prevalence and severity of dental fluorosis in primary school children born and raised in three villages of Mysore District. The three selected villages have different water fluoride concentrations.

Materials and Methods: Three villages namely, Nerale (water fluoride 2.0 ppm), Belavadi (1.2 ppm) and Naganahally (0.4 ppm) were selected for the study. Then, a total of 405 children, 10–12-year-old (204 [50.4%] males and 201 [49.60%] females) were selected from three schools of the villages. Dean’s fluorosis index recommended by World Health Organization was used to evaluate fluorosis among the study population.

Results: The overall prevalence of dental fluorosis was found to be 41.73%. An increase in the community fluorosis index (CFI) was higher among those living in high water fluoride area.

Conclusion: A significantly positive correlation was found between CFI and water fluoride concentration in drinking water.

Key words: Dental fluorosis, drinking water, fluoride, primary school children

Fluoride is a double-edged sword. Fluoride intake at optimal level decreases the incidence of dental caries and is also necessary for maintaining the integrity of oral tissues. But at the same time when consumed in excess amount during developmental stages can cause adverse effects such as dental and skeletal fluorosis. Dental fluorosis is a disturbance in tooth formation caused by excessive intake of fluoride during the formative period of the dentition. The degree of severity of the clinical manifestations of this form of chronic fluoride intoxication depends on the amount, form and frequency of fluoride ingestion, the duration of exposure, the age of the person, the bioavailability of the fluoride compound and possibly other yet unknown factors.

In India, provision of safe drinking water is a constitutional mandate. Thirty percent of urban and 90% of rural population is dependent on untreated water source, of which 80% is ground water. By early 2004, the rural drinking water supply program in India was estimated to have 3.7 million hand pumps dependent on ground water. While this has lowered the incidence of waterborne diseases, it has led to the emergence of other problems such as depletion of drinking water sources due to excessive withdrawal by irrigation wells and contamination by fluorides and arsenic. The principal source of these fluoride contaminants is from the soil.

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World Health Organization (WHO) has set the upper limit of fluoride concentration in drinking water at 1.5 mg/L. However, in 1984 WHO suggested that in areas with a warm climate the optimal fluoride concentration in drinking water should remain below 1 mg/L while in cooler climates, it could go up to 1.2 mg/L. Therefore, the Bureau of Indian Standards has laid down Indian standards as 1.0 mg/L as the maximum permissible limit of water fluoride concentration with further remarks as "lesser the better." In the early 1930s, fluorosis was reported only in four states of India; however, in 2007, it has spread to over 20 states including Karnataka and 66.62 million people are at risk, indicating that endemic fluorosis has emerged as one of the most alarming health problems of the country. According to Sachetana Drinking Water Project; Karnataka district in Karnataka state is considered to be the naturally fluoridated area. So far, no data are available on the prevalence and severity of dental fluorosis among schoolchildren of Mysore district. Thus, the aim of this study was to estimate the prevalence of dental fluorosis in relation with different fluoride levels in drinking water among primary school children of 10–12 years age in Mysore district, Karnataka.

MATERIALS AND METHODS

This study was conducted among 10–12-year-old- primary school children of Mysore district, Karnataka, India during October 2012 to March 2013. Ethical approval was granted from the Institutional Ethical Committee of JSS Dental College and Hospital, Mysore.

The fluoride levels in different places of Mysore district was obtained from Rajiv Gandhi National Rural Drinking Water Program. Based on this report, three villages were randomly selected namely Nerale which belonged to high fluoride area (>1.5 ppm), Belavadi which belonged to optimum fluoride area (0.5–1.5 ppm) and Nagannahalli which belonged to low fluoride area (<0.5 ppm). The list of primary schools in Mysore district was obtained from the Deputy Director of Public Instructions Office, Mysore and from each village one school was selected for the study purpose. Each school was considered as a cluster and all school children in the age group of 10–12 years who fulfilled the eligibility criteria were included in the study. School-going children aged 10–12 years who were permanent residents of that particular region and who were using the same source of drinking water from birth were included in the study. Children who were not the permanent residents of that particular area and with a change of source of drinking water, those with orthodontic brackets, dentofacial deformities or any syndromes or uncooperative, medically and physically compromised patients were excluded from the study.

After conducting a pilot study in Mysore city, the sample size was estimated at 390, with 130 children from each village. A total of 405 children participated in this study with 135 children from each village. The pilot study children were not included in the main study. After obtaining permission from school authorities, written informed consent was obtained from parents of children who participated in this study. In addition, the children were provided with information about the study, and verbal assent was obtained. Personal data including demographic information, permanent residential address and drinking water source were recorded in a preformed performa. Assessment of dental fluorosis was done using Dean’s fluorosis index. The recording was made on the basis of the two teeth that were most affected. If the two teeth were not equally affected, the score for the less affected tooth was recorded. Community fluorosis index (CFI) was recorded to identify whether dental fluorosis has been a common public health problem in that area. CFI was computed by summing up the scores of individual grades of dental fluorosis as described by Dean and dividing the sum by the total sample size. The public health significance of CFI values is as below:

| CFI range value | Public health significance |
|----------------|---------------------------|
| 0.0-0.4        | Negative                  |
| 0.4-0.6        | Borderline                |
| 0.6-1.0        | Slight                    |
| 1.0-2.0        | Medium                    |
| 2.0-3.0        | Marked                    |
| 3.0-4.0        | Very marked               |

The clinical examination was carried out by a trained examiner (i.e., investigator himself) under the adequate natural light in school premises. Prior to conducting the study, the investigator was trained in the Department of Public Health Dentistry, JSS Dental College and Hospital, Mysore on twenty subjects under the supervision of an expert. For determination of intra-examiner variability, 20 children were examined twice using diagnostic criteria on successive days, and the results were compared to know the diagnostic variability. The kappa coefficient value for intra-examiner reliability was 0.843. These values reflected a high degree of conformity in observations. Statistical analysis was performed using Statistical Package of Social Science (version 17; Chicago Inc., IL, USA). Descriptive statistics were used to describe the prevalence and severity of dental fluorosis. Spearman’s rank correlation coefficient test was used to measure the correlation between water fluoride level and CFI.

RESULTS

Out of the total sample, 204 (50.4%) were males and 201 (49.60%) were females. In the age of 10 years, there were 77 (37.75%) males and 76 (37.81%) females, in 11 years,
there were 72 (35.30%) males and 69 (34.33%) females and in 12 years, there were 55 (26.96%) males and 56 (27.86%) females [Table 1]. The overall prevalence of dental fluorosis was 41.72%. The prevalence was 10.37% in Naganahally (0.4 ppm), 27.40% in Belavadi (1.2 ppm) and 87.40% in Nerale (2.0 ppm). The difference was statistically significant (P=0.03) [Table 2]. An increase in the CFI with corresponding increase in water fluoride content, 0.14 at 0.4 ppm to 2.03 at 2.0 ppm was found with the mean CFI value of 0.86 (1.02). Thus, a significantly positive correlation (P=0.04) was found between CFI and fluoride concentration in drinking water. Regression analyses showed significantly higher CFI by increased fluoride concentration in drinking water [Table 3].

**DISCUSSION**

This study was a cross-sectional study to estimate the prevalence of dental fluorosis among primary school children in villages of Mysore district with different water fluoride levels. The recognition of the protective role of fluoride in drinking water against dental caries is considered as one of the major public health advances of this century. It is also recognized, that fluoride levels in excess of those that provide most of the protection against dental caries can lead to dental mottling. It is a paradox that mottled enamel (dental fluorosis) was associated with the presence of fluoride in drinking water long before its relationship with lower caries prevalence was noted.

The consumption of water by children in Naganahally village with an average water fluoride concentration of 0.4 ppm resulted in dental fluorosis among 10.3% of the children examined. Previous studies in communities with similar water fluoride concentration in the water, have reported fluorosis prevalence of 2.8–8.8%. Our findings showed that the prevalence and severity of dental fluorosis were greater among children with high water fluoride content. As a probable result of the “halo effect,” we found that more than 20% of children living in Belavadi village with standard water fluoride level were affected by dental fluorosis. This was in accordance with WHO guidelines explaining that at an optimal fluoride level (1 ppm), about 20% of the population demonstrates fluorosis.

In this study, there was an increase in the percentage of children affected with dental fluorosis with an increase in fluoride level in drinking water which was in close agreement with other studies. In our study, an increase in the CFI with corresponding increase in water fluoride content was found. These findings were supported by studies carried out by Chandrashekar and Anuradha and Budipramana et al. The allowable concentration of fluoride in drinking water for a region depends on its climatic conditions because the amount of water consumed and consequently, the amount of fluoride ingested being influenced primarily by the air temperature. The fluoride-related problems are closely associated with climate. In hot tropical part of the world, people consumed more water and consequently, the risk of fluoride accumulation increases. The relatively higher daily temperature of Mysore district necessitates increased consumption of water per day. This leads to an increased ingestion of fluoride which in turn results in higher prevalence of dental fluorosis. The findings in this study are supported by the studies conducted by Khan et al. in Pakistan and Menon and Indushekar in Dharwad.

This study was conducted in three groups of children aged 10–12 years who were raised continuously since birth in a different area, each of which had constant levels of fluoride in the drinking water. In most cases, not only had the

| Area (ppm)  | Sex | Age  | Total |
|------------|-----|------|-------|
| Nerale (2.0) | Male | 32 | 25 | 13 | 70 |
| Belavadi (1.2) | Female | 30 | 22 | 13 | 65 |
| Female | 13 | 25 | 20 | 58 |
| Female | 30 | 29 | 18 | 77 |
| Naganahally (0.40) | Male | 32 | 22 | 22 | 76 |
| Female | 16 | 18 | 25 | 59 |

**Table 2: Prevalence of dental fluorosis at varying levels of fluoride concentration in drinking water**

| Fluoride concentration (ppm) | Normal 0 | Questionable 0.5 | Very Mild 1 | Mild 2 | Moderate 3 | Severe 4 | Number of children with fluorosis (%) |
|-----------------------------|----------|------------------|-------------|-------|------------|---------|------------------------------------|
| 0.4                         | 121 (89.6) | 3 (2.2) | 7 (5.1) | 3 (2.2) | 0 | 1 (0.74) | 14 (10.3) |
| 1.2                         | 98 (72.6) | 10 (7.4) | 14 (10.4) | 5 (3.7) | 7 (5.1) | 1 (0.74) | 37 (27.4) |
| 2.0                         | 17 (12.6) | 18 (13.3) | 24 (17.8) | 25 (18.5) | 13 (9.6) | 38 (28.1) | 118 (87.4) |

**Table 3: Relation between community fluorosis index and water fluoride level**

| Fluoride concentration in drinking water (ppm) | CFI | Means SD | Fluoride concentration of drinking water | CFI | Correlation coefficient | Regression coefficient |
|-----------------------------------------------|-----|----------|----------------------------------------|-----|------------------------|-----------------------|
| 0.4                                           | 0.14 | 1.2 (0.8) | 0.86 (1.02) | 0.92 | 0.84 |
| 1.2                                           | 0.4  |            |                                        |     |                        |                       |
| 2.0                                           | 2.03 |            |                                        |     |                        |                       |

CFI=Community fluorosis index, SD=Standard deviation
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children lived in a specific area since birth but so had their parents. Furthermore, the study population was virgin in this study as there was no exposure to clinical application of fluoride or rinses and the use of fluoridated toothpaste was limited because of economic factor. The use of water from unknown water sources is always an obstacle when people in less remote areas are surveyed. However, in our study, the drinking water sources were boreholes and had been in use for many years. If any seasonal variation in the fluoride levels of the drinking water could have occurred, it would have been for the whole population of all the three villages.

This study reports dental fluorosis in the mixed dentition on examining primary school children. However, reporting fluorosis in mixed dentition is not very straight forward. Data about dental fluorosis on permanent dentition (i.e., high school children) is more appropriate. However, information furnished in the present study can be utilized as preliminary data. On considering the fact that Mysore district has more than 150 schools, the 3 schools that were surveyed represent only a very small fraction. A large scale study would have been more appropriate.

CONCLUSION

Our findings showed that the risk of dental fluorosis was significantly higher in the areas showing more fluoride content in drinking water. This study can act as a pointer to public health physicians, dentists, administrators, planners, and water supply authorities. The information furnished can be utilized as preliminary data, and a well-designed epidemiological investigation can be undertaken at village level and district level to confirm and assess dental fluorosis and to evaluate the risk factors associated with the condition in Mysore district. It is recommended to reduce the fluoride content of drinking water in the high fluoride area by making either alternative water source available or providing water with reduced fluoride content.

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Conflicts of interest

There are no conflicts of interest.

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