Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Disease

journal homepage:www.elsevier.com/locate/apjtd

Document heading doi: 10.1016/S2222-1808(12)60101-7

Prevalence and severity of dental fluorosis and genu valgum among school children in rural field practice area of a medical college

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ARTICLE INFO

Article history:
Received 13 August 2012
Received in revised form 19 August 2012
Accepted 8 December 2012
Available online 28 December 2012

Keywords:
Dental fluorosis
Genu valgum
Prevalence
School children
Rural Karnataka

ABSTRACT

Objective: To assess the prevalence of dental fluorosis and genu valgum among school children in the above mentioned area. **Methods:** A Cross sectional study was conducted on school children of 1st to 7th standard in the rural field practice area of a medical college. Children were examined for dental fluorosis and genu valgum. Drinking water samples were also tested for fluoride levels. Proportion of children with dental fluorosis and genu valgum were calculated by severity, age and sex. Statistical significance was analyzed by using Chisquare test or Mc Nemar test. **Results:** Of the 1544 children examined 42.1% and 8.4% had dental fluorosis and genu valgum respectively. Prevalence of very mild dental fluorosis and moderate grade genu valgum were high compared to other categories. Prevalence rates increased with the age ($P<0.05$) and was more among girls (45.2%) as compared to boys (39.1%) ($P<0.05$). Of the 26 water samples analysed, 18 samples (69.2%) revealed the fluoride content above the permissible limit. **Conclusions:** Findings of the present study reveal a high prevalence of dental fluorosis and genu valgum amongst school children and high fluoride level in the water. Further studies are needed to evaluate the other risk factors and reasons for gender differences.

1. Introduction

Fluorosis is a condition caused by an element known as fluorine. It is thirteenth most abundant element available in the earth's crust. Globally, fluorosis is endemic in at least 25 countries. The total number of people affected across the globe is not known, but a conservative estimate would number in the tens of millions. India lies in a geographical fluoride belt, which extends from Turkey up to China and Japan through Iraq, Iran and Afghanistan[1]. Consequently, fluorosis is an endemic condition prevalent in 19 Indian states and union territories including the state of Karnataka. It has been estimated that 66 million people in India are at risk of developing fluorosis, including 6 million children below the age of 14, where as 25 million people are already affected by fluorosis[2]. Kolar district is one of the endemic districts for fluorosis in the state of Karnataka[3]. The data on prevalence and severity of fluorosis are scanty in the rural health training centre of Kaiwara (which earlier was part of Kolar district), of the Department of Community Medicine of M.S.Ramaiah Medical College, Bangalore. The present study was carried out with the objective of assessing the prevalence and severity of dental fluorosis and genu valgum among the school children in Kaiwara Primary Health Center administrative area.

2. Materials and methods

This cross sectional study was undertaken between the months of June to December in the year 2009 among primary school children studying in 1st to 7th standard in the rural areas of Kaiwara hobli, Chikkaballapur district,

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Foundation Project: Supported by Karnataka State Council for Science and Technology (No. 32S-1102).

Karnataka. Kaiwara is a small township situated about 75 km from Bangalore city. The Kaiwara Primary Health Center caters to a population of approximately 33 336 people living in 36 surrounding villages. Before the start of the survey, permission was sought from the appropriate district authorities explaining the objectives of the study.

2.1. Study population

The Inclusion criteria consisted of all primary school children from 1st standard to 7th standard present on the day of the survey.

2.1.1. Exclusion criteria

Children having local deposits on their teeth like debris were excluded from the study. Children having orthopedic deformities of the lower limb, which interfere with measurement of genu valgum, were also excluded.

2.2. Sample size estimation

The pilot study carried out by the investigator revealed that the prevalence of dental fluorosis to be 20%. The sample size for the present study was determined based on the above prevalence rate with a absolute precision of ±2 and at 95% confidence level. The required sample size for the study was worked out to be 1 537 children.

2.3. Sampling method

Sampling frame consisted of all the list of all primary schools located in Kaiwara hobli. School was taken as the primary sampling unit of the study. By adopting simple random sampling, 24 schools were randomly selected from a total of 40 schools to meet the above sample size. All the children present in the 24 schools were enlisted for the study.

2.4. Instrument for the study

Predesigned and pretested semi structured questionnaire was employed for collecting data. The questionnaire consisted of identification particulars and items such as sociodemographic particulars, findings of clinical examination relating to dental fluorosis and genu valgum. Socio-demographic details of children were obtained from school records with the help of teachers. Dental examination was carried out in daylight with the help of self-illuminated hand held magnifying lens by the first investigator who had undergone training from the dental department staff. Dean's index was used to grade the severity of dental fluorosis[4]. Genu valgum was measured with the help of a divider and a plastic scale. The degree of genu valgum was measured by the distance between the medial malleoli at the ankle when the child stands or lies down with the knees touching each other and accordingly it was graded as Mild (<5 cm), Moderate (5-10 cm) and Severe (> 10cm)[5]. Operationally, those with moderate and severe degree of genu valgum were considered as having genu vlagum. Fluoride content of water samples (n=30) from all the studied villages was estimated at Public Health Institute, Bangalore, using colorimetric method.

2.5. Statistical analysis

Prevalence of dental fluorosis and genu valgum was estimated along with 95% confidence interval. Chi-square test of significance was used to test for the statistical association of flurosis between age and gender. Mc Nemar test was used to test for the association between dental fluorosis and genu valgum. All the analysis was carried out using SPSS -18.0 version.

Table 1
Age and sex wise prevalence rate of dental fluorosis.

Age (in years)	Boys[1]		Girls[2]		Total[3]	
	Examined	Affected	Examined	Affected	Examined	Affected
6-7	210 (26.8%)	37 (17.6%)	183 (24.0%)	27 (14.8%)	393 (25.4%)	64 (16.3%)
8-9	231 (29.5%)	86 (37.2%)	230 (30.3%)	119 (51.7%)	461 (29.9%)	205 (44.5%)
10-11	223 (28.5%)	120 (53.8%)	226 (29.7%)	131 (58.0%)	449 (29.1%)	251 (55.9%)
12-13	119 (15.2%)	63 (52.9%)	122 (16.0%)	67 (54.9%)	241 (15.6%)	130 (53.9%)
Total	783 (100.0%)	306 (39.1%)	761 (100.0%)	344 (45.2%)	1 544 (100.0%)	650 (42.1%)

[1] X^2=70.889, P<0.001; [2] X^2=91.971, P<0.001; [3] X^2= 1.57, df=3, P<0.05.

Table 2
Age and sex wise prevalence rate of genu valgum.

Age (in years)	Boys[1]		Girls[2]		Total[3]	
	Examined	Affected	Examined	Affected	Examined	Affected
6-7	210 (26.8%)	15 (7.1%)	183 (24.0%)	8 (4.4%)	393 (25.5%)	23 (5.9%)
8-9	231 (29.5%)	8 (3.5%)	230 (30.3%)	23 (10.0%)	461 (29.8%)	31 (6.7%)
10-11	223 (28.5%)	16 (7.2%)	226 (29.7%)	28 (12.4%)	449 (29.1%)	44 (9.8%)
12-13	119 (15.2%)	14 (11.8%)	122 (16.0%)	18 (14.8%)	241 (15.6%)	32 (13.3%)
Total	783 (100.0%)	53 (6.8%)	761 (100.0%)	77 (10.1%)	1 544 (100.0%)	130 (8.4%)

[1] X^2=8.811, P=0.03; [2] X^2=10.813, P=0.01 ; [3] X^2=13.5 , P<0.05.

3. Results

A total of 1 544 children were studied from the 24 selected schools which consisted of 783 boys and 761 girls respectively prevalence of dental fluorosis (Table 1). The overall prevalence of dental fluorosis in the present study was 42.1% (95% CI: 39.6% to 44.6%). It was observed that the prevalence of dental fluorosis was slightly higher in girls (45.2%) compared to boys (39.1%) which was found to be statistically significant (P<0.05). The prevalence of was also found to be increasing with increasing age except for 12-13 years old which was almost similar to 10-11 years old. This difference in prevalence of dental fluorosis across different age groups was found to be statistically significant (P<0.05). Prevalence rate of dental fluorosis in the age group of 6-7 years old was 17.6% and 14.8% in boys and girls respectively. With increasing age prevalence also increased, both in boys and girls, with maximum prevalence seen in the age group of 10-11 years old (boys 53.8% 7 girls 58.0%). This increase in prevalence with increasing age was found to be statistically significant (P<0.001) in both sexes. However, there was a slight decrease in prevalence rate in 12-13 years old age group in both sexes.

Table 2 showed the prevalence of genu valgum. Overall prevalence of genu valgum was 8.4% (with 95% CI of 7% to 9.8%). It was observed that 77 (10.1%) girls and 53 (6.8%) boys were suffering from genu valgum. This difference in prevalence of genu valgum between boys and girls was found to be statistically significant (P<0.05). Thirty-two (13.3%) children affected with genu valgum were in the age group of 12-13 years old and the least prevalence was seen in the age group of 6-7 years old where 23 (5.9%) children were affected. Prevalence of genu vlagum among boys in the age group of 12-13 years old was 11.8% and the lowest was in the age group of 8-9 years old (3.5%). This difference in prevalence across different age group was found to be statistically significant (P<0.05). Prevalence rate of genu valgum among girls showed an increasing trend with

Table 3
Age and sex wise distribution of severity of dental fluorosis.

	Age (in years)	Normal	Questionable	very mild	mild	moderate	severe	Total
Severity of dental fluorosis among males in different age groups*	6-7	166(79.0%)	7(3.3%)	29(13.8%)	8(3.8%)	0(.0%)	0(.0%)	210(26.8%)
	8-9	134(58.0%)	10(4.3%)	56(24.2%)	24(10.4%)	6(2.6%)	1(.4%)	231(29.5%)
	10-11	92(41.3%)	11(4.9%)	69(30.9%)	30(13.5%)	17(7.6%)	4(1.8%)	223(28.5%)
	12-13	46(38.7%)	10(8.4%)	40(33.6%)	13(10.9%)	7(5.9%)	3(2.5%)	119(15.2%)
	Total	438(55.9%)	38(4.9%)	194(24.8%)	75(9.6%)	30(3.8%)	8(1.0%)	783(100.0%)
Severity of dental fluorosis among females in different age groups#	6-7	149(81.4%)	7(3.8%)	26(14.2%)	1(0.5%)	0(0%)	0(0%)	183(24.0%)
	8-9	99(43.0%)	12(5.2%)	81(35.2%)	34(14.8%)	2(0.9%)	2(0.9%)	230(30.2%)
	10-11	90(39.8%)	5(2.2%)	70(31.0%)	39(17.3%)	15(6.6%)	7(3.1%)	226(29.7%)
	12-13	47(38.5%)	8(6.6%)	36(29.5%)	13(10.7%)	13(10.7%)	5(4.1%)	122(16.1%)
	Total	385(50.6%)	32(4.2%)	213(28.0%)	114(11.4%)	30(3.9%)	14(1.8%)	761(100.0%)
Severity of dental fluorosis in study population in different age groups@	6 - 7	315(80.2%)	14(3.6%)	55(14.0%)	9(2.3%)	0(0%)	0(0%)	393(25.5%)
	8 - 9	233(50.5%)	22(4.8%)	137(29.7%)	58(12.6%)	8(1.7%)	3(0.7%)	461(29.9%)
	10 - 11	182(40.5%)	16(3.6%)	139(31.0%)	69(15.4%)	32(7.1%)	11(2.4%)	449(29.1%)
	12 - 13	93(38.6%)	18(7.5%)	76(31.5%)	26(10.8%)	20(8.3%)	8(3.3%)	241(15.6%)
	Total	823(53.3%)	70(4.5%)	407(26.4%)	162(10.5%)	60(3.9%)	22(1.4%)	1544(100.0%)

* X^2=93.45, P<0.001; # X^2=1.36, P<0.001; @ X^2=2.13, P<0.001.

Table 4
Age and sex wise distribution of severity of genu valgum.

	Age (in years)	Normal	Mild	Moderate	Total
Severity of genu valgum among males in different age groups*	6-7	35(16.7%)	160(76.2%)	15(7.1%)	210(26.8%)
	8-9	69(29.9%)	154(66.7%)	8(3.5%)	231(29.5%)
	10-11	87(39.0%)	120(53.8%)	16(7.2%)	223(28.5%)
	12-13	38(31.9%)	67(56.3%)	14(11.8%)	119(15.2%)
	Total	229(29.2%)	501(64.0%)	53(6.8%)	783(100.0%)
Severity of genu valgum among females in different age groups#	6-7	27(14.8%)	148(80.9%)	8(4.4%)	183(24.0%)
	8-9	56(24.4%)	151(65.7%)	23(10.0%)	230(30.2%)
	10-11	47(20.8%)	151(66.8%)	28(12.4%)	226(29.7%)
	12-13	34(27.9%)	70(57.4%)	18(14.8%)	122(16.0%)
	Total	164(21.6%)	520(68.3%)	77(10.1%)	761(100.0%)
Severity of genu valgum among study population in different age groups@	6-7	62(15.8%)	308(78.4%)	23(5.9%)	393(25.5%)
	8-9	125(27.1%)	305(66.2%)	31(6.7%)	461(29.9%)
	10-11	134(29.8%)	271(60.4%)	44(9.8%)	449(29.1%)
	12-13	72(29.9%)	137(56.8%)	32(13.3%)	241(15.6%)
	Total	393(25.5%)	1021(66.1%)	130(8.4%)	1544(100.0%)

* X^2=37.02, P<0.001; # X^2=23.47, P=0.001; @ X^2=46.94, P<0.001.

increasing age with prevalence of 4.4% and 14.8% in 6–7 and 12–13 year old age group respectively. This difference was found to be statistically significant (P<0.05).

Table 3 showed the severity of dental fluorosis. It was observed that 407 (26.4%) children were having very mild dental fluorosis, 162 (10.5%) children were having mild dental fluorosis and 22 children (1.4%) were suffering from severe dental fluorosis. The prevalence of very mild grade dental fluorosis was 24.8% and 28.0% in boys and girls respectively. Similarly prevalence of severe type of dental fluorosis was 1.0% and 1.8% in boys and girls respectively and this difference in severity of dental fluorosis between both sexes was not found to be statistically significant (P=0.219). However the severity of dental fluorosis increased with increasing age in both boys and girls and this difference was found to be statistically significant (P<0.05).

Table 4 showed the severity of genu valgum. It was observed that 1 021 (66.1%) children were suffering from mild genu valgum and 130 (8.4%) children were suffering from moderate genu valgum. There were no children with severe degree genu valgum. The prevalence of moderate grade genu valgum was 6.8% and 10.1% in boys and girls respectively, and this difference in severity of genu valgum between both sexes was found to be statistically significant (P<0.001). It was also found that severity of dental fluorosis increased with increasing age in both sexes and this difference was found to be statistically significant (P<0.05).

It was observed that 66 (10.2%) children with dental fluorosis have genu valgum and 64 (7.2%) children without dental fluorosis have genu valgum in Table 5. This difference in prevalence of genu valgum among those with and without dental fluorosis was found to be statistically significant (P<0.05).

Table 5
Association between dental fluorosis and genu valgum.

Dental fluorosis	Genu valgum (%)		Total
	Present	Absent	
Present	66 (10.2)	584 (89.8)	650
Absent	64 (7.2)	830 (92.8)	894
Total	130 (8.4)	1 414 (91.6)	1 544

X^2=4.37, P<0.05.

Table 6
Fluoride levels in the drinking water sources of the study villages.

Concentration of fluoride in water (mg/L)	No of drinking water sources in 20 villages (n=26)
≤1.0	8 (30.7%)
1.1–1.9	13 (50.0%)
≥2.0	5 (19.3%)

It was observed that, of all the drinking water sources in 20 villages in which study was carried, 13 (50%) had fluoride levels in above the permissible limit (permissible limit is 1.0 mg/L and 5 had more than 2.0 mg/L (19.3%) (Table 6). Almost 70% of water sources were unfit for human consumption.

4. Discussion

In the present study the prevalence of dental fluorosis was 42.1%, though the water fluoride level is marginally raised above the permissible limit. This estimate is near to findings (31.4%) in rural primary school children of Chidambaram Taluk, Tamilnadu[1] and very close to findings (36.36%) in school children of rural areas of Udaipur, Rajasthan[6].

There was a higher prevalence among girls compared to boys which was statistically significant. The possible reason for this could be due to poor nutritional status amongst girls. However, further studies are needed to be carried out to confirm the findings. This finding is in accordance with the study done by Gopalakrishnan et al in Alapuzza district of Kerala[7]. However, study done by Saravanan *et al*[1] in Cuddalore district of Tamil Nadu showed the prevalence in girls to be 29.3% and 33.7% in boys which was not shown to be statistically significant. In the study by Kadir *et al*[8] covering 2 400, 14–year–old Yemeni adolescents, found that fluorosis was prevalent in 30.8% of all subjects examined. Slightly more males (32.3%) than females (29.3%) were observed to have varying degrees of fluorosis. Fluoride concentration in natural drinking water in the study locations was found to be between 0.5–3.8 mg/kg.

An increasing trend in prevalence rate was observed with increasing age except for the last age group which was almost similar to that of 10 to 11 years old. This is in accordance with study done by Saravanan *et al*[1] and Dharv *et al*[6]. This suggests that prevalence rate increases with increase in duration of exposure to fluoride. In a study conducted by Srivastava *et al*[9], in Uttarpradesh state of India covering a population of 5 024, 43% had fluorosis (dental and skeletal). The prevalence of dental and skeletal fluorosis was 28.6% and 14.2% respectively. Dental fluorosis was highest in 13–15 years old age group with boys more commonly affected than girls. Fluorosis increases from 5–15 years of age, highest in 13–15 years of age, as water (and hence fluoride) consumption increases in growing age and also because amelogenesis and enamel maturation is also taking place, thus making the enamel more susceptible[9].

It was also observed that 407 (26.4%) children were having very mild dental fluorosis, 162 (10.5%) children were having mild dental fluorosis and 22 children (1.4%) were suffering from severe dental fluorosis. A study done by Dhar et al in rural areas of Udaipur district of Rajasthan showed 18.9% of children examined were having questionable dental fluorosis, 10.7% were having moderate dental fluorosis and only 0.19% of children were having severe dental fluorosis[6]. Possible reason for high prevalence rate of very mild fluorosis is due to the fact that the fluoride concentration in water in the study area were marginally elevated above the permissible limit and the highest concentration observed was 2.5 mg/kg.

Prevalence of genu valgum in the present study was 8.4%

which is very close to the findings (11.0%) of study done by Arjunan *et al*[10] in Kaiwara village. A study done by National Institute of Nutrition in Nawada district of Bihar showed no perceivable difference in genu valgum among males and females[11]. Another study done by Chakma *et al*[12] in Mandla district of Madhya Pradesh showed that genu valgum is more among males compared to females. Our study findings are not in conformity with the above two studies, the possible reason could be difference in the nutritional status of children in two studies. The present study reported the prevalence to be highest in the age group of 12-13 years which can be explained by the fact that prevalence increases with increase in duration of exposure. However study done by NIN in Nawada district of Bihar state reported the prevalence to be predominant in the age group of 1-5 years.

This study also shows a significant association between dental fluorosis and genu valgum which can be explained by the fact that both dental fluorosis and genu valgum are different manifestations of the condition called fluorosis which in turn is caused due to the exposure to increased levels of fluoride.

The Ministry of Health and Family Welfare, Government of India, has prescribed 1.0 and 2.0 mg/L as permissive and excessive limits for fluoride in drinking water, respectively[13]. More than half of the drinking water source, in the study area, had fluoride concentration above permissible limit and of these three villages had excessive fluoride concentration in drinking water.

Water borne fluorosis is endemic in study area with prevalence of dental fluorosis and genu valgum increasing with increase in age and also showing higher prevalence among girls. Further epidemiological studies are needed to evaluate the risk factors for fluorosis and also to identify the reasons for gender differences and finally develop an epidemiologically sound preventive programme specific to the local needs.

Conflict of interest

We declare that we have no conflict of interest.

Acknowledgments

We are deeply indebted and grateful to the school teachers and students who were part of this study. Interest on fluorosis in us is because of inspiration we got from Dr. N Kochupillai, former professor of Endocrinology, AIIMS and former Research Director of MSRMC & MSRMH. We sincerely thank sir for rousing that interest in us. We immensely thank Sri B R Prabhakara, Chief Executive - Gokula Education Foundation, Dr. S Kumar, President Medical Education, Gokula Education Foundation and Dr. Saraswati G Rao, Principal and Dean- MS Ramaiah Medical College for their support. We are also greatful to all faculties from Department of Community medicine, MS Ramaiah Medical College, Yogi Narayana Ashrama, Kaiwara and Medical officers and other Staffs of Kaiwara Primary Health Cente, kaiwara for their invaluable support. We specially thank Karnataka State Council for Science and Technology for their financial support (Grant No. 32S-1102).

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