INTERNATIONAL JOURNAL OF MEDICAL AND APPLIED SCIENCES
Earthjournals Publisher
E-ISSN:2320-3137
www.earthjournals.org

RESEARCH ARTICLE

FLUORIDE ESTIMATION IN DRINKING WATER AND ITS CORRELATION WITH SEVERITY OF DENTAL FLUOROSIS AMONG 12 -15 YEAR SCHOOL CHILDREN OF 3 DISTRICTS OF CHHATTISGARH

Pagaria S, Lodha R, Dubey A, Avinash A, Baranwal R, Mujoo S

1. Pagaria S*, Department of pedodontics and preventive dentistry Rungta College of Dental Sciences and Research, Kohka, Kurud, Bhilai (C.G.)
2. Lodha R. Private practiotioner, India
3. Dubey A, Associate professor, Department of pediatric dentistry, College of Dentistry, Jazan University, Saudi Arabia
4. Avinash A, Reader, Department of pedodontics and preventive dentistry, Rungta College of Dental Sciences and Research, Kohka, Kurud, Bhilai (C.G.)
5. Baranwal R, Department of pedodontics and preventive dentistry, Rungta College of Dental Sciences and Research, Kohka, Kurud, Bhilai (C.G.)
6. Mujoo S, Assistant Professor (Oral Medicine & Radiology), College of Dentistry, Jazan University, Jazan, Saudi Arabia.

Corresponding Author: Dr. Pagaria S, Department of pedodontics and preventive dentistry, Rungta College of Dental Sciences and Research, Kohka, Kurud, Bhilai (C.G.)

ABSTRACT:
Introduction : The purpose of study was to evaluate the fluoride level in drinking water and to determine its clinical correlation with fluorosis in three districts of Chhattisgarh. **Materials and methods :**A cross sectional study was conducted in 1200 school going children aged 12-15 years in 3 districts of Chhattisgarh (Durg,Raipur and Rajnandgaon).Water samples were collected and analyzed in order to confirm the fluoride levels. The districts were stratified based on the concentration of fluoride in drinking water as above optimal, optimal and suboptimal.The Clinical assessment was carried out using a questionnaire consisted of information in 2 parts: The first part consisted of information on demographic data, oral hygiene habits, source of drinking water in the questionnaire; The second part consisted of a table for recording fluorosis using Dean's index. **Result**s : Among all the districts studied prevalence of fluorosis in Durg was highest (18.75%) and the level of fluoride in water was found to be most inappropriate for oral health. **Conclusion :**This study has ascertained the cause-and-effect relationship between concentration of fluoride in drinking water and dental fluorosis**.**
Key words : Dental fluorosis, Dean's index, prevalence, water fluoride.

INTRODUCTION

Drinking water fluoridation has been gradually carried out at mass level as part of health promotion in the last few decades.In India, adeveloping countrydental fluorosis exists as an endemic disease especially in regions where adequate resources of dental treatment are not available,there is lack of public health awareness, motivation and controlled water fluoridation.These are risk factors which predispose the people living in such areas to dental disease and fluorosis [1].Classic studies conducted by Dean established the qualitative relationship between fluoride content in drinking water and the occurrence of dental

fluorosis. Optimal fluoride uptake is sufficient to confer caries protection on an individual. However when excessive fluoride is ingested during tooth development it causes dental fluorosis which is a mineralization disorder of teeth.

In 2002-2003National Oral Health Survey and Fluoride Mapping, a national level epidemiological study was carried out in which mapping of fluoride level was made a part of the survey. Findings revealed that the prevalence of dental fluorosis was 10.2 % among 12 year old and 9.9 % among 15 year old children[2].

Endemic fluorosis is an extensively researched health problem in India. Presently 17 out of 29 states in India,constituting a total of 60-70 million people, mostly belonging to rural areashave been identified as endemic [3]. In Chhattisgarh approximately 10-40 % districts are affected with dental fluorosis as demonstrated by studies but the exact figures are still awaited. Meanwhile sporadic studies conducted in various parts of country reveal a prevalence of dental fluorosis as anywhere between 13-97% [4].The fluoride concentration in groundwater of India varies considerably from 0.12 to 24.17 ppm [5].

Owing to the paucity of research on the topic of content of fluoride in drinking water and its relationship with severity of dental fluorosis in Chhattisgarh state,no studies providing estimation of fluoride level and its clinical correlation with dental fluorosis have been conducted. Therefore the objective of survey was to evaluate the fluoride level in drinking water and to determine its clinical correlation with fluorosis in three districts of Chhattisgarh. Identification of endemic areas could lead to adoption of remedial measures to prevent the problem of fluoride toxicity.

MATERIALS AND METHODS

I. Study design

A cross sectional study was conducted to estimate the level of fluoride in drinking water and to assess the prevalence of dental fluorosis among 12- to 15-year-old school children in 3 districts of Chhattisgarh.

II. Sampling technique

A Multistage sampling technique was used (Flowchart 1).

IIIA. Fluoride estimation

a. Source of water samples

For fluoride estimation, all the administrative blocks of Durg, Raipur, Rajnandgaon were included. Four villages were randomly selectedfrom each administrative block and water samples were collected.

b. Collection and analysis of sample

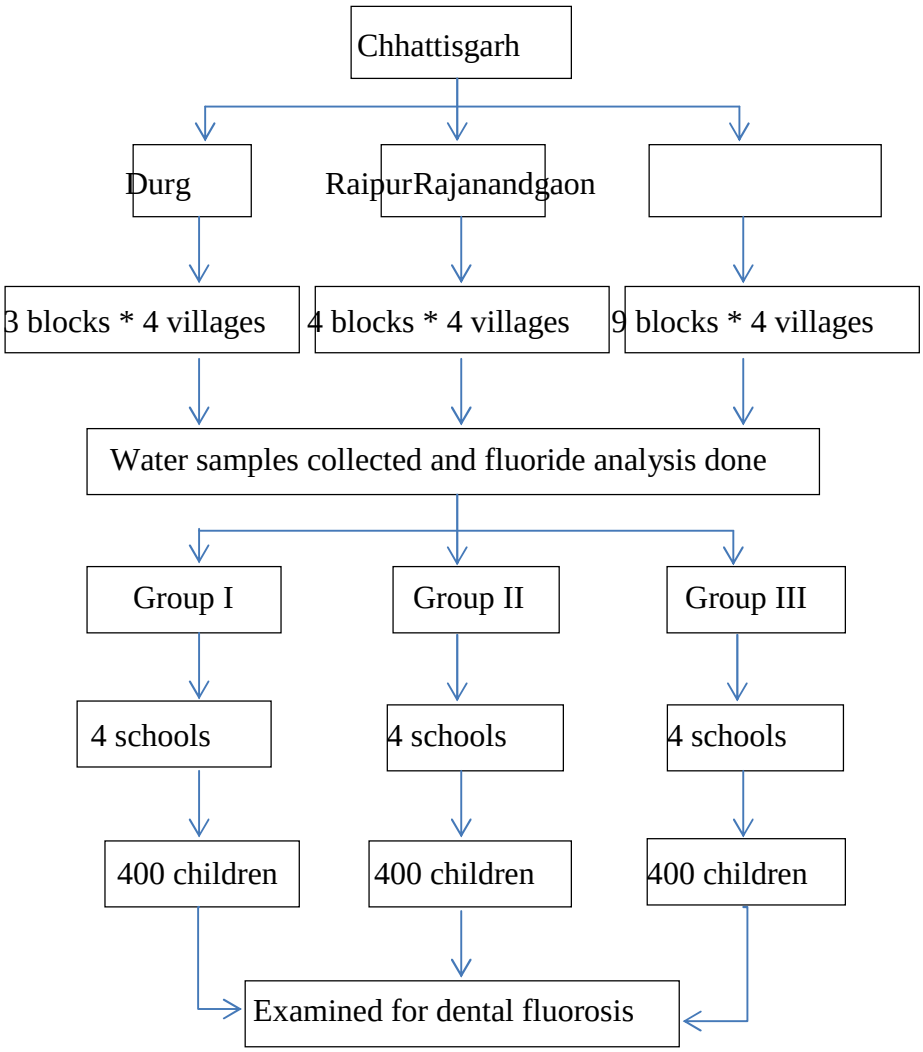
Collection of water samples was done based on the methodology followed in National Oral Health Survey and Fluoride Mapping 2002-2003[2].The water Samples were collected in good quality half litre sterilized polyethylene bottles without addition of any preservative and were identified with labels indicating the location of the collection site and date. The samples were stored at room temperature till the analysis [6]. The fluoride content in drinking water was analyzed using an ion selective electrode method (Orion 940) in order to confirm the fluoride levels in the water samples beforecommencement of clinical examination (Table 1).

III B. Dental fluorosis assessment

a.Ethical clearance and informed consent

Before starting the study, ethical clearance was obtained from the Ethical Committee of Rungta College of Dental Sciences and Research, Bhilai. Informed consent was obtained from the respective school headmasters.

Flowchart 1 : Study Design



b.Selection of sample for dental fluorosis

4 schools were randomly selected from each of the 3 districts. A total of 400 children from 4 schools of each district were selected in this manner constituting a sample size of 1200.To determine the feasibility a pilot study was carried out on 50 school children after random selection. Practicability of Dean's index was assessed and prevalence of fluorosis was found to be 12%.

c.Inclusion and Exclusion criteria

School children aged 12-15 years who were lifelong residents of that particular region and who were using the same source of drinking water from birth to 10 years of age were included.

Children who had migrated from some other place or who were not permanent residents of that particular area and had a change of source of drinking water were not included. Children with orthodontic brackets and children with severe extrinsic stains on their teeth were excluded.

d.Method of calibration of examiner

All examinations were carried out by a single examiner. Calibration of the examiner was done before the study was conducted and during the study by conducting duplicate examination of 5% (1 in 20) of the total population; intra-examiner agreement was assessed with Kappa statistics for dental fluorosis with Kappa levels above 75%.

e.Clinical assessment

Data was collected through individual interview followed by clinical examination. Children were examined in broad daylight in the school premises on predecided dates. Children were seated on an ordinary chair in an upright position[7]. The questionnaire consisted of information in 2 parts: The first part consisted of information on demographic data, oral hygiene habits, source of drinking water in the questionnaire; The second part consisted of a table for recording fluorosis using Dean's index[8]. Intraoral examinations weremade using a mouth mirror and explorer.

STATISTICAL ANALYSIS

Data were computerized and analyzed using the statistical package for social sciences (SPSS version 13.0).Non parametric tests were applied as the data were in scores, Kruskal-Wallis test were used for multiple group comparisons; and Mann-Whitney U test, for group wise comparison.P value < 0.05 was considered statistically significant.

RESULTS

Water samples from three representative areas were analysed and following groups were made.

I. Durg – Above optimal Fluoride levels (4.19 ppm)
II. Raipur – Optimal Fluoride levels (1.22 ppm)
III. Rajnandgaon – Suboptimal Fluoride levels (0.60 ppm)

Majority of the subjects enrolled in the study were females. Out of a total of 1200 respondents enrolled, 662 (55.16%) were females and 538 (44.83%) were males (Table 2).Graph 1 shows comparison of percentage of fluorosis present between both the groups,Statistically a significant difference among the groups was noted ($p<0.05$*).Table 3depicts number of children according to age. Children with age 12 years were 326 (27.16), with age 13 years were 382 (31.83), age 14 years 266 (22.16) and 15 years 226 (18.83). On comparing statistically between the 4 groups, no significant difference was observed ($p>0.05$, Graph 2).

Blockwise distribution reveals that maximum number of affected children 21 (22.6%) and 21 (22.3%) were from school ofDhamdha andDurg respectively and both of these blocks belong to Durg district while 4 (5.97%) children were affected in Dongargaon which was the least affected out of 12 block examined in the study. This table also describes fluoride level and number of children examined in each block with maximum fluoride concentration being 4.68 ppm in Gadadih and Bharar belonging to Durg only(Table 4).

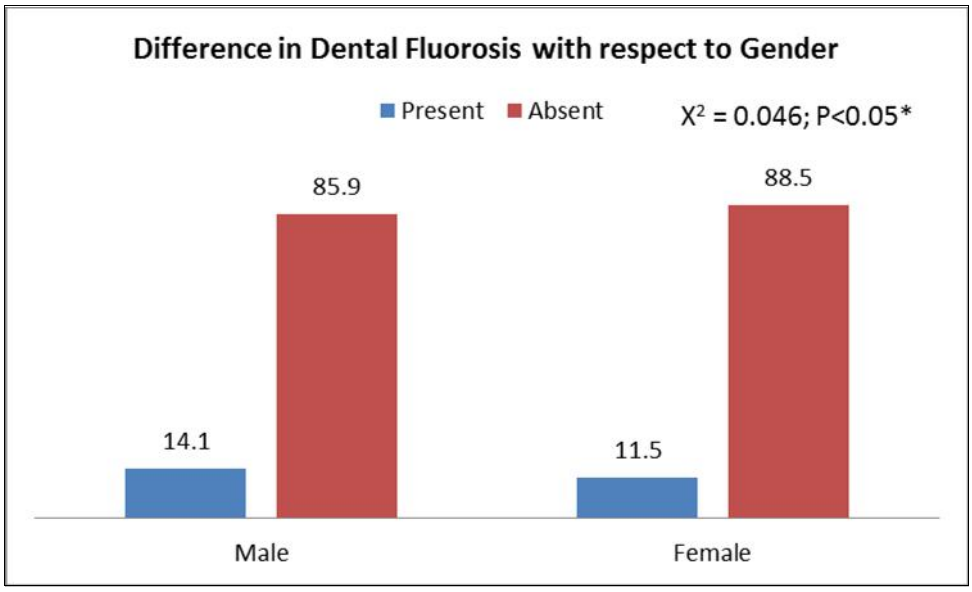
Out of 3 groups, Group I, Durg showed the maximum prevalence of fluorosis with 75 (18.75 %) children affected which is highest among all the groupswith corresponding highest community fluorosis index score of 0.37. Group IIIRajnandgaon had lowest prevalence of fluorosis with 31 (7.75%) children affected.(Table 5).

Table 6 illustrates Block wise Pearson correlation and regression analysis between CFI and fluoride concentration in drinking water which was statistically found to be highly significant ($p<0.001$*). Similarly group wise Pearson correlation and regression analysis between CFI

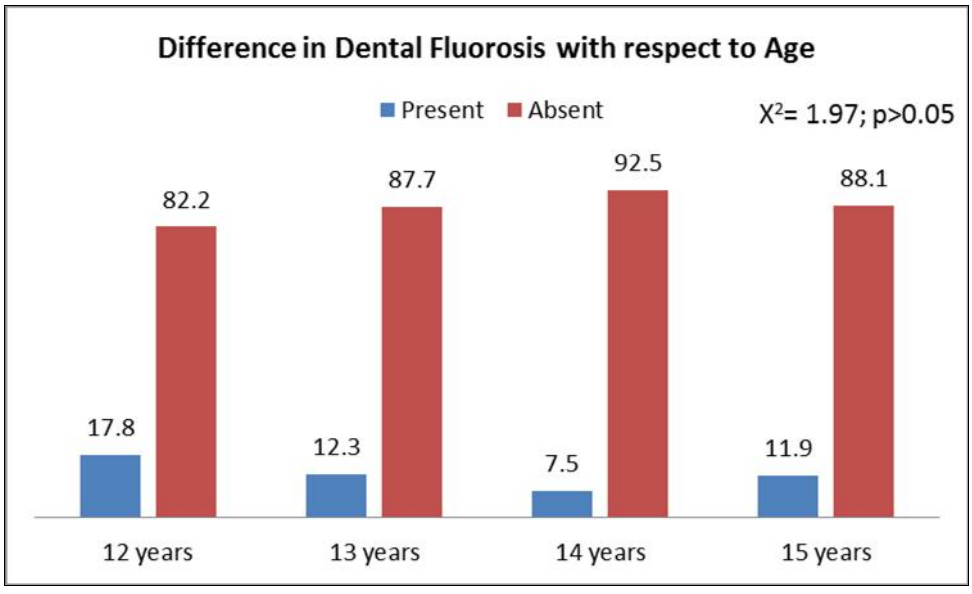
and fluoride concentration in drinking water statistically found to be significant ($p<0.025$*). Therefore it can be concluded that there exists a direct positive relationship between the two. (Table 7)

Kruskal-Wallis test was applied which showed a very strong statistical (P value = 0.000*)difference between the groups followed by Mann Whitney U-test showing strong correlation between Group I and III (Table 8).

Graph 1 : Difference in Dental Fluorosis with respect to gender



Graph 2: Difference in Dental Fluorosis with respect to age



INTERNATIONAL JOURNAL OF MEDICAL AND APPLIED SCIENCES
Earthjournals Publisher
E-ISSN:2320-3137
www.earthjournals.org

Table 1 Fluoride estimation of water samples

Group	Block	Fluoride concentration	Source of drinking water	Average fluoride level of district
Durg	Patan	4.68 ppm	Borewell	4.19 ppm
	Dhamdha	3.69 ppm	Borewell	
	Durg	4.2 ppm	Borewell	
Raipur	Tilda	1.15 ppm	Borewell	1.22 ppm
	Dharsiwa	1.22 ppm	Borewell	
	Aarang	1.3 ppm	Borewell	
	Abhanpur	1.2 ppm	Borewell	
Rajnandgaon	Rajnandgaon	0.50 ppm	Borewell	0.60 ppm
	Dongargarh	0.62 ppm	Borewell	
	Dongargaon	0.62 ppm	Borewell	
	Khairagarh	0.50 ppm	Borewell	
	Churia	0.42 ppm	Borewell	
	Chuikhadan	0.80 ppm	Borewell	
	Chowki	0.50 ppm	Borewell	
	Manpur	0.70 ppm	Borewell	
	Mohala	0.60 ppm	Borewell	

Table 2 Distribution of sample according to gender

Group	**Block**	**No. of children examined by sex**			
		Male (%)	**Total no. of Male in District**	**Female (%)**	**Total no. of Female in District**
Durg	Patan	98 (46 %)		115 (54 %)	
	Dhamdha	23 (24.7 %)	154	70 (75.3 %)	246
	Durg	33 (35.1 %)		61 (64.9 %)	
Raipur	Tilda	88 (97.8 %)		2 (2.2 %)	
	Dharsiwa	35 (31 %)	222	78 (69 %)	178
	Aarang	51 (52 %)		47 (48 %)	
	Abhanpur	48 (48.5 %)		51 (51.5 %)	
Rajnandgaon	Tumdibod	30 (30 %)		70 (70 %)	
	Dongargarh	23 (28.4 %)	162	58 (71.6 %)	238
	Dongargaon	39 (58.2 %)		28 (41.8 %)	
	Khairagarh	70 (46.1 %)		82 (53.9 %)	
Total			538 (44.83%)		662 (55.16%)

χ^2=0.046; p<0.05*

INTERNATIONAL JOURNAL OF MEDICAL AND APPLIED SCIENCES
Earthjournals Publisher
E-ISSN:2320-3137
www.earthjournals.org

Table 3Distribution of sample according to age

Group	Block	No. of children examined by age group				
		12years (%)	**13 years (%)**	**14 years (%)**	**15 years (%)**	**Total**
Durg	Patan	89 (41.78%)	60 (28.2%)	39 (18.3%)	25 (11.73%)	213
	Dhamdha	24 (25.8%)	6 (6.5%)	25 (26.9%)	38 (40.9%)	93
	Durg	37 (39.4%)	38 (40.4%)	5 (5.3%)	14 (14.9%)	94
Raipur	Tilda	7 (7.8%)	43 (47.8%)	24 (26.7%)	16 (17.8%)	90
	Dharsiwa	32 (28.3%)	40 (35.4%)	26 (23%)	15 (13.27%)	113
	Aarang	24 (24.5%)	37 (37.8%)	27 (27.6%)	10 (10.2%)	98
	Abhanpur	42 (42.4%)	13 (13.1%)	22 (22.2%)	22 (22.2%)	99
Rajnandgaon	Tumdibod	8 (8%)	37 (37%)	40 (40%)	15 (15%)	100
	Dongargarh	24 (29.6%)	19 (23.5%)	13 (16%)	25 (30.9%)	81
	Dongargaon	2 (3%)	46 (68.7%)	13 (19.4%)	6 (8.95%)	67
	Khairagarh	37 (24.3%)	43 (28.3%)	32 (21.1%)	40 (26.3%)	152
Total		326 (27.16%)	382 (31.83%)	266 (22.16%)	226 (18.83%)	1200 (100%)

Table 4 District, Block and schools with corresponding percentage of Dental Fluorosis

S.No.	District	Block	Schools	Fluoride level in drinking water (ppm)	No. of Indivisuals examined	No. of Children affected (%)
1	Durg	**Dhamdha**	**Dhamdha**	**4.2**	**93**	**21 (22.6%)**
2		**Durg**	**Junwani**	**3.69**	**94**	**21 (22.3%)**
3		Patan	Gadadih	4.68	68	17 (25%)
4		Patan	Bharar	4.68	145	16 (11.03%)
5	Raipur	Aarang	Borid	1.3	98	14 (14.28%)
6		Abhanpur	Sarona	1.2	99	8 (8.08%)
7		Tilda	Tilda	1.15	90	11 (12.22%)
8		Dharsiwa	Dharsiwa	1.22	113	13 (11.5%)
9	Rajnandgaon	Rajnandgaon	Tumdibod	0.68	100	5 (5%)
10		Dongargarh	Dongargarh	0.62	81	9 (11.11%)
11		Dongargaon	Dongargaon	0.60	67	4 (5.97%)
12		Khairagarh	Khairagarh	0.50	152	13 (8.55%)

Table 5 Group wise distribution of samples, individuals affected and Community Fluorosis Index

Group	No. of individuals examined	No. of affected (%)	Community Fluorosis index (CFI)
I	400	75 (18.75%)	0.37
II	400	46 (11.5%)	0.11
III	400	31 (7.75%)	0.07

Table 6 Pearson Correlation Coefficient & Linear Regression Analysis between CFI and Fluoride Concentration in Drinking water (Block wise)

Fluoride Concentration in drinking water (in ppm)	CFI	Mean ± SD of Fluoride Concentration in Drinking Water	Mean ± SD of CFI	Correlation Coefficient "R"	Regression Coefficient "b"	Significance (p value)
4.2	0.42	1.80 ± 1.57	0.17 ± 0.14	0.946	0.082	<0.001* (HS)
3.69	0.37					
4.68	0.32					
1.3	0.16					
1.2	0.09					
1.15	0.11					
1.22	0.08					
0.68	0.06					
0.62	0.11					
0.6	0.03					
0.5	0.08					

Table 7 Pearson Correlation Coefficient & Linear Regression Analysis between CFI and Fluoride Concentration in Drinking water (Group wise)

Fluoride Concentration in drinking water (in ppm)	CFI	Mean ± SD of Fluoride Concentration in Drinking Water	Mean ± SD of CFI	Correlation Coefficient "R"	Regression Coefficient "b"	Significance (p value)
4.19	0.37	2 ± 1.92	0.18 ± 0.16	0.999	0.085	0.025*
1.22	0.11					(S)
0.6	0.07					

Table 8 Comparison of prevalence and Severity of Dental Fluorosis between areas with different fluoride levels in drinking water

Group	Fluoride Level	No of cases	Range of DFI	Kruskal Wallis Test (p value)
I	>3 ppm	400	0-4	$X^{2=}$ 23.121
II	0.7-3 ppm	400	0-2	P=0.000*
III	<0.7 ppm	400	0-2	(HS)

Groups Groups I & III 0.000* (HS), Groups I & II 0.006*, Group II & III 0.057,

Inter group comparisons (Mann Whitney U test)

DISCUSSION

The severity and distribution of fluoride is directly proportional to the fluoride concentration, duration of exposure to fluoride, stage of tooth maturation and individual susceptibility. It is considered to be the first sign of systemic toxicity. Dental fluorosis is a preventable condition. Therefore it is significant from a clinical, public health, and research point of view. It has wide ranging implications in the community for its cosmetic, environmental, and caries-preventive effects.

Occurrence of fluoride in drinking water has been widely reported in literature from various studies conducted in several states of India including Punjab, Tamil Nadu, Uttar Pradesh etc [9], but Chhattisgarh still needs to be explored. Therefore it was necessary to carry out a survey in Chhattisgarh, in order to determine the current prevalence of dental fluorosis and

also to determine the relationship existing between the level of fluoride in drinking water and severity of dental fluorosis.

Most of the children residing in different areas of Chhattisgarh belong to lower socioeconomic class. Opinion is divided regarding the importance of association between socioeconomic status and the level of severity of fluorosis. However in our study social class differentiation was not deliberate owing to its predominantly rural population

Literature on fluorosisprevalence also reports that dental fluorosis is more in males than in females. Chandra et al [10]conducted a study to find the relationship between caries and fluorosis in Lucknow in the age group of 7-14 years. Their findings revealed that the average percentage of males affected with fluorosis was more as compared to females. The results were partly explained by the fact that males are more active physically, do hard work and perspire more because of which they consume large amounts of water as compared to females. Dental fluorosis affects the teeth at the time of calcification (Before 10 years of age). Since the calcification of most of the permanent teeth except third molars is complete by 10 years of age, the duration of and exposure after this age will not have much influence [11].

The age group of 12 to 15 years was selected in the study as this age group fallsin the index age group category, specified for basic oral health surveys. 12 years age group is also the global monitoring age for comparing dental disease status between the nations and beyond the age of 15 years a reliable sample from the school system cannot be drawn. Moreover, dental fluorosis is more common in permanent dentition than in deciduous dentition, and all the permanent teeth have erupted by 14 years except third molars [11].

In the present study for determination of dental fluorosis prevalence and to classify the degrees of fluorosisDean's Fluorosis Index modified (1942) was selected. This index has been chosen because it is universally accepted for epidemiological studies of dental fluorosis and is the one still recommended by WHO in its basic survey manual [7]. It has also been found to be sensitive to both qualitative and quantitative assessments. Cleaning and drying of teeth makes the appearance of fluorosis, moreconspicuous thus making diagnosis easier in questionable cases [12].Some practical difficulties were encountered in differentiating between early surface demineralization due to incipient carious lesion and questionable form of fluorosis. Therefore, only those subjects in whom we could clearly distinguish between dental fluorosis and incipient caries were reported in the present study. Irregularly shaped flecks within the enamel rather than on the surface, and which were not distributed symmetrically on both the sides of the dental arch were excluded as being idiopathic non-fluoride enamel opacities [13].

Russell's criteria was used for the differential diagnosis of non fluoride opaque lesions and lesions due to mild fluorosis [14]. Clinically, fluoride opacities are white non discrete and affect homologous teeth. These may varyfrom white striations to extensive involvement of lusterless enamel; post-eruptive staining or pitting of enamel may occur. The clinical manifestationin dental fluorosis may thus range from delicate accentuation of perikymata pattern to confluent pitting or disfiguration along with loss of external part of enamel [15].

In the present study average fluoride level in the above optimally fluoridated area was found to be 4.19 ppm and the prevalence of fluorosis was 18.75%. Maximum affected blocks also belonged to above optimally fluoridated areas. Out of 12 schools selectedGadadih (25%), Dhamdha (22.6%) and Junwani (22.3%) had a fluoride concentration of 4.68, 4.2 and 3.68 ppm respectively.Least fluorosis was observed in Dongargarhwhich had fluorosis prevalence of 5.97 %.Dongargarh is a low fluoride area with its water fluoride concentration being 0.60 ppm. This can be explainedon the basis of high concentration of fluoride in former regions

and also the fact that the fluoride in drinking water is the single largest contributor to daily fluoride intake.The relation is strongly dose dependent and numerous studies have repeatedly confirmed the Cause- -and-effect relationship between fluoride and dental fluorosis [15].It is also noteworthy to mention that moderate and severe form of fluorosis was noted only in area where fluoride concentration was above optimal.

It was observed that as the fluoride concentration increased from 0.60 ppm to 4.19 ppm, there was a corresponding significant increase in the severity of dental fluorosis. This finding is in accordance to the findings reported by number of investigators viz. Forsman, Riordan PJ, Ng'anga' PM, Awadia AK, Budipramana, Hamdan M, Ruan JP, America P Pontigo-Loyola, Marya CM, Shanthi M[16-25].

In the present study the highest prevalence of dental fluorosis was observed in Durg district which was 18.75%Durg is hence an above optimal fluoride area.On the other handa study conducted by Dahiya et alin another above optimal fluoride area showed a prevalence of 92.73% in the village of JuaiKalan, Bhiwani district, Haryana [26].Similarly a 100% prevalence of dental fluorosis inNalgonda district was noted in a study coded by KM Sudhir et al[27].Nalgonda has been identified as endemic fluoride belt on the basis of exhaustive studies.However for direct comparison in state of Chhattisgarh not much information is available for fluorosis since this area remains largely unexplored. Isolated study conducted ina village of Durg district demonstrated a prevalence of 8.2% which was lesser than noted in our study [28].

On comparison of the above results it was clearly demonstrated that there exists a direct positive linear relationship between fluoride level in drinking water and prevalence of dental fluorosis. The positive correlation between fluoride concentration and CFI (community fluorosis index) score, was in agreement with the results of studies by Ruan JP et al, Acharya and Kumar [22,29]. These findings were also consistent with the findings of the studies by Sharma et al in Haryana, India and Ekanayake et al in Sri Lanka [30].Budipramana et al [20], Chandrashekhar and Anuradha[31], Naidu GM [9] and Shanthi M [25]also recorded similar findings.

Thus, the factors believed to be responsible for aggravation of fluorosis, apart from fluoride content of drinking water are, amount of water consumption, mean temperature of the area, amount of fluoride present on surface of enamel, fluoride content of diet etc. Therefore, in order to find out in detail the exact causes of enamel fluorosis, all the above factors must be considered. However covering all the above factors was beyond the scope and purview of the study, hence these factors were not included [24].

As mentioned previously the fluoride from drinking water was the single largest contributor to daily fluoride intake. Contribution of dietary fluoride would have been difficult to assess as information bias could be incorporated. It is expected that the effect of other factors would not have been considerable so as to cause a significant difference to overall prevalence of fluorosisas children residing in rural areas are much less exposed to fluoride dentifrices, mouth rinses and at the same time possess less dental awareness.

Although the data in the study are cross sectional and reasonably representative of rural population they at best provide an insight into concentration of fluoride in drinking water and prevalence of dental fluorosis in these districts. Population based surveys with a large sample size and a public health orientation, which cover all the district of Chhattisgarh state are required for a clear picture to emerge.

CONCLUSION

This study has ascertained the **cause-and-effect relationship** between concentration of fluoride in drinking water and dental fluorosis. Of all the districts studied prevalence of fluorosis in Durg was highest and the level of fluoride in water was found to be most inappropriate for oral health. It requires consistent efforts and coordination of public health planners, administrators and authorities to make it suitable for public health consumption. Defloridation of water should be prioritized before distribution to reduce the negative sequelae associated with dental fluorosis. Prospective studies should accommodate the multifactorial nature of dental fluorosis and should incorporate extraneous factors responsible for its prevalence.

REFERENCES

1. Kulkarni SS, Deshpande SD. Caries prevalence and treatment need in 11-15 years old children of Belgaum city. J indian Soc Pedod Prev Dent.2002; 20 (1): 12-15.
2. Bali RK, Mathur VB, Talwar PP, Chanana HB. National oral health survey and Fluoride Mapping 2002-2003 India, 1st ed. New Delhi: Dental Council of India and Ministry of Health and Family Welfare, Government of India; 2004.
3.Chandrashekar J, Thankappan KR, Sundaram KR.Severe dental fluorosis and jowar consumption in Karnataka, India. Community Dent Oral Epidemiol. 2010 Dec;38(6):559-67.
4.Susheela AK. Fluorosis: Indian scenario : A treatise on Fluorosis. New Delhi : Fluorosis Research and Rural Development Foundation 2001.
5. Kumar, S, Gopal K. A review on fluorosis and its preventive strategies. Indian Journal of Environmental Protection 2000; 20 : 430–440.
6.Sarvaiya BU, Bhayya D, Arora R, Mehta DN. Prevalence of dental fluorosis in relation with different fluoride levels in drinking water among school going children in Sarada tehsil of Udaipur district, Rajasthan. J Indian Soc Pedod Prev Dent. 2012;30(4):317-22.
7.WHO. World Health Organisation: Oral health Surveys: basic methods, ed 4. Geneva:World Health Organisation ,1997.
8. Dean HT, Arnold FA, Evolve E. Fluoride and dental Health. American Assoc of adv of science 1942;57:23-31.
9. Naidu GM, Rahamthullah SA, Kopuri RK, Kumar YA, Suman SV, Balaga RN. Prevalence and self perception of Dental Fluorosis among 15 year old school children in Prakasham district of south India. J Int Oral Health 2013; 5(6):67-71.
10. Chandra S,Chawla TN, Malik. Relationship of mottling with caries in lucknow school going children. J Ind dent asso. 1976; 479-483.
11. Chandrashekhar, Cheluvaiah M, Namile D. Prevalence of dental caries and dental fluorosis among 12 and 15 years old school children in relation to fluoride concentration in drinking water in an endemic fluoride belt of Andhra Pradesh. Ind J pub Health 2012;56(2):122-8.
12. Rozier RG. Epidemiologic indices for measuring the clinical manifestations of dental fluorosis: Overview and critique. Adv Dent Res 1994;8:39-55
13.Clark DC.Trends in prevalence of dental fluorosis in North America. Community Dent Oral Epidemiol. 1994 Jun;22(3):148-52.
14. Russell AL. The Differential Diagnosis of Fluoride and Nonfluoride Enamel Opacities, J PublHlth Dent 1961; 21:143-146.Cutress TW, Suckling GW.Differential diagnosis of dental fluorosis. J Dent Res 1990; 69(Spec Issue): 714–720.
15. Cutress TW, Suckling GW. Differential diagnosis of dental fluorosis. J Dent Res 1990; 69(Spec Issue): 714–720.
16. Forsman B. Dental fluorosis and caries in high-fluoride districts in Sweden. Community Dent Oral Epidemiol. 1974;2(3):132-48.
17. Riordan PJ, Banks JA. Dental Fluorosis and Fluoride Exposure in Western Australia. J Dent Res 1991; 70:(7) : 1022-1028.
18. Ng'ang'a PM, Valderhaug J; Prevalence and severity of dental fluorosis in primary School children in Nairobi, Kenya. Community Dent Oral Epidemiology 1993; 21; 15-8.

19. Awadia AK, Birkeland JM, Haugejorden O, Bjorvatn K. An attempt to explain why Tanzanian children drinking water containing 0.2 or 3.6 mg fluoride per liter exhibit a similar level of dental fluorosis. Clin Oral Invest 2000;4:238–244.
20. Budipramana ES, Hapsoro A, Irmawati ES, Kuntari S. Dental fluorosis and caries prevalence in the fluorosis endemic area of Asembagus, Indonesia.International Journal of Paediatric Dentistry 2002; **12:** 415–422.
21. Hamdan M.The prevalence and severity of dental fluorosis among 12-year-old schoolchildren in Jordan.Int J Paed Dent2003; **13:** 85–92.
22. Ruan JP, Yang ZQ, Wang ZL, Astrom AN, Bardsen A, Bjorvatn K. Dental fluorosis and dental caries in permanent teeth: rural schoolchildren in high-fluoride areas in the Shaanxi province, China. ActaOdontol Scand. 2005;63(5):258-65.
23. América P. Pontigo-Loyola, Arturo Islas-Márquez, Juan P. Loyola-Rodríguez, Gerardo Maupome, Lourdes Marquez-Corona, Carlo E. Medina-Solis.Dental Fluorosis in 12- and 15-Year-Olds at High Altitudes in Above-Optimal Fluoridated Communities in Mexico. Journal of public health dent 2008; 68(3):163-6.
24. Marya CM, Ashokkumar BR, Dhingra S, Dahiya V, Gupta A.Exposure to High-Fluoride Drinking Water and Risk of Dental Caries and Dental Fluorosis in Haryana, India.Asia Pac J Public Health. 2012 Oct 15;26(3):295-303.
25. Shanthi M, Reddy BV, Venkataramana V, Gowrisankar S, Reddy BV, Chennupati S. Relationship between drinking water fluoride levels, dental fluorosis, dental caries and associated risk factors in 9-12 year old school children of NelakondapallyMandal of Khammam district, Andhra Pradesh, India: A cross-sectionalsurvey. J Int Oral Health 2014;6(3):106-10.
26. Dahiya S, Kaur A, Jain N. Prevalence of fluorosis among school children in rural area, district Bhiwani: A case study. Indian J Environ Health 2000;42:192-5.
27. Sudhir KM, Prashant GM, Subba Reddy VV, Mohandas, U, Chandu GN. Prevalence and severity of dental fluorosis among 13-15 year old school children known for endemic fluorosis: Nalgonda district of Andhra Pradesh. J indsocpedo preventive dent 2009 ;27(4) :190-196.
28. Pandey A.Prevalence of fluorosis in an endemic village in central India. Trop doct 2010; 40: 217–219.
29. Acharya S. Dental Caries, its surface susceptibility and dental fluorosis in South India. *Int Dent J*.2005;55:359-364.
30.Ekanayake L, van der Hoek W. Dental caries and developmental defects of enamel in relation to fluoride levels in drinking water in an arid area of Sri Lanka. Caries Res. 2002;36(6):398-404.
31. Chandrashekhar J, Anuradha K. Prevalence of dental fluorosis in rural areas of Davengere, India. *Int Dent J.* 2004;54:235-239.