

PREVALENCE AND CAUSATIVE FACTORS OF DENTAL FLUOROSIS IN KERALA

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ABSTRACT: Excessive consumption of fluoride leads to toxic manifestations in man, collectively referred to as Fluorosis. Latest estimates suggest that around 200 million people from among 25 nations the world over, are under the dreadful fate of Fluorosis. In India, 20 states are under fluoride attack. **OBJECTIVES:** To study the prevalence and causative factors of dental fluorosis among children in the age group of 10-15 years in Kerala. **METHODOLOGY:** Two endemic districts and two neighboring non endemic districts were selected for this study. Sample size of 980 was calculated and adequate sample was selected from the school going children. A pretested modified questionnaire was used to collect the data. The fluorosis status was assessed by dental specialists. The information regarding the fluoride content of the water was also obtained. The data was entered and analyzed. The prevalence of fluorosis was calculated in percentages. **RESULTS:** The prevalence of dental fluorosis in the endemic districts of Alappuzha and Palakkad were 37.4% and 39.2% respectively. The prevalence in the neighboring non endemic districts of Kollam and Thrissur were 4.4 % and 2.2% respectively. The community fluorosis index was 0.61 in Alappuzha and 0.63 in Palakkad. The prevalence was higher among boys than among girls. **CONCLUSION:** Dental fluorosis is a public health problem in the districts of Alappuzha and Palakkad in Kerala, India. The main causative risk factor is the increased fluoride content of drinking water. Immediate measures should be taken to de-fluoridate the water to the optimum level of fluoride in order to solve this public health problem. **KEYWORDS:** Dental fluorosis, water fluoride, Dean's index and community fluorosis index.

INTRODUCTION: Fluoride is one of the critical elements that can cause significant health effects in people through the drinking water¹. Credible evidences from scientific literature substantiate beneficial as well as detrimental effects of fluoride on human health with only a narrow margin of safety². Researchers have found that the fluoride content in the drinking water below 1 parts per million is beneficial in the prevention of dental caries, but excessive exposure can have adverse health effects.

These range from mild dental fluorosis to crippling skeletal fluorosis. The most recent announcement that more than 200 million people around the globe are at risk of Fluorosis, indeed raises global alarm and anguish.³ The intensity of natural fluoride in ground water ranges from 0.5 to 48 parts per million (ppm) or even more. Presence of even low levels of fluoride in ground water turns disastrous when coupled with malnutrition; especially for children in rural and semi urban areas of the country and that about 66 million people in India are at risk of fluorosis amounting to one third of global population.⁴

Since fluoride in drinking water does not change its color, smell or taste; normally there is no way to detect it unless tested. The victims of fluorosis are often helpless and continue to suffer

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without their disease being diagnosed.⁴ As we are living in the decade of Water for Life (2005-2015) as proclaimed by United Nations, it is worth mentioning that for the millions of people in the rural areas of endemic fluorosis, the right to safe water remains a promise unfulfilled.

So the studies on the prevalence of dental fluorosis are extremely significant the world over, and are more pertinent in the Indian context. The paucity of epidemiological studies on fluorosis in Kerala and the gravity of the problem have paved way for the conceptualization of this study. Thus the aims and objectives of the this study was to find out the prevalence and causative factors of dental fluorosis among children in the age group of 10-15 years in Kerala.

SUBJECTS AND METHODS: A cross sectional survey was conducted among school going children of 10 -15years in endemic districts of Alappuzha and Palakkad and two neighboring non endemic districts- Kollam and Thrissur respectively. Children in this age group are considered to be at risk for dental fluorosis. With 5% alpha error and the reported prevalence rate of 36% in a previous study in Ambalappuzha taluk of Alappuzha⁵ with an acceptable error of + 3% in the estimate, minimum sample size estimated was 980, which was rounded to 1000 in a district.

With the permission of Director of Public Instruction of Kerala, the lists of schools having standards of 5 to 10 in the four districts were prepared. The total divisions in the above schools in each Taluk were numbered separately. Twenty divisions from each Taluk were selected using random number table. All the students in these divisions were included to attain the sample size. A total of 1344 children from Alappuzha, 1324 children from Palakkad, 1181 from Kollam and 1067 children from Thrissur were included in the study.

A questionnaire was prepared keeping in view the objectives of the study including questions on socio-economic status, source of drinking water, amount of water consumed, brick-tea consumption, use of fluoride- containing tooth paste by the students. These factors were identified as potential risk factors for dental fluorosis in previous studies.⁶⁻⁸

The questionnaire was pilot tested on 50 children and necessary modifications were made. An educational session on oral hygiene and dental fluorosis was conducted for the whole students in each class using audiovisual aids to motivate the students and staff to recognize the importance of dental health. Following the session, details were collected by the investigator.

Research and Institutional Ethical Committee approval was obtained prior to the study. Informed consent was taken from school authorities and parents of the children.

Dental Examination: The dental examination of each student was carried out by the dental experts in the common hall of the school or in the concerned classroom in bright daylight using sterile dental probe. The absence or presence and severity of dental fluorosis were recorded, along with any other dental conditions observed. Dean's index was used to determine the grade of dental fluorosis⁹, which is as shown below.

Criteria	Description of enamel
Normal	Smooth, glossy, pale creamy-white translucent surface
Questionable	Very few white flecks or white spots
Grade I (very mild)	Occasional white flecking over the tooth surface mainly on the incisor tips and cusp tips.

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Grade II (Mild)	White opaque areas involving less than 25% of the tooth surface
Grade III (Moderate)	White opaque areas involving more than 25% and less than 50% of the tooth surface.
Grade IV (Severe)	All tooth surfaces affected, discrete or confluent pitting, wide-spread brown stains, teeth often appear corroded.

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 10-15 years as the denominator. A Community Fluorosis Index was computed by summing the scores of individual grades (as described by Dean) and dividing the sum by the total sample size.

A Community Fluorosis Index of greater than 0.4 has been used to identify areas where fluorosis is a public health problem.¹⁰

The fluoride content of drinking water in each area has been obtained, as estimated by the Department of Ground water and Kerala Water Authority. These departments conduct routine water analysis by taking water samples from different places in the Municipal and Panchayath areas.

The data collected was entered in to MS Excel and analyzed using SPSS version 15. The frequencies and percentages were calculated; the association of dental fluorosis with select individual risk factors was studied using Chi square test and p value less than .05 were considered for statistical significance.

Inter observer variability: The students of two divisions in a school in Alappuzha were selected to determine the inter observer variability. 85 students from the above classes were screened for dental fluorosis by another specialist. The inter observer agreement was 97.6% (Kappa=0.90).

RESULTS:

Districts	Dental fluorosis		No. of Children examined
	Present	Absent	
Alappuzha	502 (37.4%)	842 (62.6%)	1344
Kollam	52 (4.4%)	1129 (95.6%)	1181
Palakkad	518 (39.2%)	805 (60.8%)	1323
Thrissur	24 (2.2%)	1043 (97.8%)	1067
Total	1096 (22.3%)	3819 (77.7%)	4915

Table 1: District wise distribution of children with dental fluorosis

Prevalence of dental fluorosis was 37.4% and 39.2% in Alappuzha and Palakkad respectively. The non- endemic neighboring districts of Kollam and Thrissur were having 4.4% and 2.2% respectively.

District		Male			Female			Overall prevalence	p value
		With fluorosis	Without fluorosis	Total	With Fluorosis No, %	Without fluorosis	Total		
Alappuzha	1344	325 (39.4)	500 (60.6)	825	177 (34.1)	342 (65.9)	519	37.4	.056
Kollam	1181	35 (5.5)	599 (94.5)	634	17 (3.1%)	530 (96.9)	547	4.4	.047

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Palakkad	1324	300 (37.2)	507 (62.8)	807	218 (42.2)	298 (57.8)	516	39.2	.073
Thrissur	1067	14 (2.7)	511 (97.3)	525	10 (1.8)	532 (98.2)	542	2.2	.413

Table 2: Gender wise distribution of children with dental fluorosis

The prevalence of dental fluorosis was 39.4% and 34.1% respectively among males and females in Alappuzha. In Palakkad it was 37.2% and 42.2% respectively among males and females.

District	Total No: of Children	Rural			Urban			Overall prevalence	p value
		With fluorosis	Without fluorosis	Total	With fluorosis	Without fluorosis	Total		
Alappuzha	1344	304 (30.3)	700 (69.7)	1004	198 (58.2)	142 (41.8)	340	37.4	.000
Kollam	1181	48 (5.2)	878 (94.8)	926	4 (1.6)	251 (98.4)	255	4.4	.009
Palakkad	1323	479 (44.0)	610 (56.0)	1089	195 (83.3)	39 (16.7)	234	39.2	.000
Thrissur	1067	13 (2)	629 (98)	642	11 (2.6)	414 (97.4)	425	2.2	.536

Table 3: Urban-Rural difference in the prevalence of dental fluorosis

The prevalence was 30.3% and 58.2% respectively in the rural and urban areas in Alappuzha. It was 44.0% and 83.3% respectively in the rural and urban areas in Palakkad.

District		Alappuzha	Kollam	Palakkad	Thrissur
Total No: of Children		1344	1181	1324	1067
10-11 years	With fluorosis	30 (25.2%)	5 (5.1%)	39 (41.9%)	1 (11.1%)
	Without fluorosis	89(74.8%)	93(94.9%)	54(58.1%)	8(88.9%)
	Total	119	98	93	9
12-13 years	With fluorosis	203(36.8%)	25(5.4%)	193(38.6%)	9(3%)
	Without fluorosis	349(63.2%)	435(94.6%)	307(61.4%)	228(97%)
	Total	552	460	500	297
14-15 years	With fluorosis	254(41.2%)	22(3.7%)	370(60%)	13(1.9%)
	Without fluorosis	363(58.8%)	569(96.3%)	247(40%)	687(98.1%)
	Total	617	591	617	700
>15 years	With fluorosis	15(26.8%)	0(0%)	39(34.5%)	1(1.6%)
	Without fluorosis	41(73.2%)	32(100%)	74(65.5%)	60(98.4%)
	Total	56	32	113	61
Overall prevalence		37.4%	4.4%	39.2%	2.2%
P value		.003	.334	.662	.201

Table 4: Age wise distribution of dental fluorosis among children

The overall prevalence of dental fluorosis was 25.2% in the age group of 10-11 years, 36.8% in the age group of 12-13 years, 41.2% in 14-15 years and 26.8% in children above 15 years in Alappuzha. In Palakkad the prevalence was observed to be 41.9%, 38.6%, 60%, and 34.5% respectively in the age group of 10-11 years, 12-13 years, 14-15 years and above 15 years.

District		Alappuzha	Kollam	Palakkad	Thrissur
Total No. of children		1344	1181	1324	1067
2-3 glasses	With Fluorosis	71(33.6%)	5(3.0%)	141(41.3%)	3(1.8%)
	Without Fluorosis	140(66.4%)	163(97.0%)	200(58.7%)	166(98.2%)
Total		211	168	341	542
4-6 glasses	With Fluorosis	217(35.4%)	30(5.0%)	230(35%)	10(1.8%)
	Without Fluorosis	396(64.6%)	573(95%)	427(65%)	532(98.2%)
Total		613	603	657	542
>7 glasses	With Fluorosis	214(41.2%)	17(4.1%)	147(45.2%)	11(3.1%)
	Without Fluorosis	360(58.8%)	393(95.9%)	178(54.8%)	345(96.9%)
Total		520	410	325	356
p value		0.066	0.510	0.005	0.423

Table 5: Prevalence of dental fluorosis and quantity of water consumed

The prevalence of dental fluorosis was 33.6% among children who consumed 2-3 glasses of water, 35.4% among those who consumed 4-6 glasses and 41.2% among children consumed 7 or more glasses of water.

DISCUSSION: The prevalence of dental fluorosis among school going children in the age group of 10-15 years in the endemic districts of Kerala was 38.3% and in the non-endemic districts was 3.3% combined with Community Fluorosis Index of 0.61 and 0.63 suggests that dental fluorosis is a major public health problem in these districts. In this study the prevalence of dental fluorosis was higher among boys than among girls in Alappuzha though there was no statistical significance ($p=0.056$). In Palakkad the prevalence was more among girls than boys, with no statistical significance ($p=0.073$). Thus there was no significant difference between boys and girls in the prevalence of dental fluorosis in the present study.

There was step wise increase in dental fluorosis according to the quantity of water consumed in Alappuzha, but it was not statistically significant. This is due to the reason that those who consume more water get more fluoride. In a cross-sectional study conducted by Sudhir et al¹² among 1000 school children in the age group of 13-15 years in Nalgonda district of Andhra Pradesh found that the prevalence and severity of dental fluorosis increased with the increased fluoride level in drinking water. The recommended level of fluoride in drinking water is 0.5 to 0.8 mg/L.¹¹

In a study conducted by P.V. Kotacha et al. in Vadodara district in Gujarat, India, the prevalence was reported to be 59.31% in areas where the water fluoride level was high and problem of dental fluorosis increased with passage of time, suggesting that the fluoride content in the water has perhaps increased over time.¹³ This had been found in other studies also. In a study conducted in 1998 by Gopalakrishnan et al.⁵ in Alappuzha the prevalence was 35.6% and in the present study it was found to be 37.4%.

In another study conducted by Sarvaiya et al¹⁴ in Sarada Tahsil of Udaipur district in Rajasthan there was a prevalence of 69.84% and increased Community Fluorosis Index with higher water fluoride content.

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The prevalence was significantly higher in the urban areas in both endemic districts ($p < 0.001$) and non-endemic districts ($p < 0.05$) which was consistent with another study conducted in Tamil Nadu.¹¹ In the rural areas in Alappuzha and Palakkad most of the people depend on well water for drinking purpose, which is surface water with less fluoride content. The consumption of ground water supplied through pipe in Alappuzha and Palakkad with high fluoride level may be attributing to the higher prevalence of dental fluorosis in urban areas.

A similar study conducted by Saravanan et al. in Chidambaram Taluk, Cudalore district, Tamil Nadu in India had a prevalence of 31.4% among the students in the age group of 5-12 years. Gender difference was not statistically significant. The Community Fluorosis Index was 0.43 and 0.54. Dental fluorosis increased with age.¹⁵

CONCLUSION AND RECOMMENDATIONS: Dental fluorosis is endemic in the districts of Alappuzha and Palakkad in Kerala. The prevalence of 37.4% and 39.2% dental fluorosis respectively in Alappuzha and Palakkad combined with Community Fluorosis Index of 0.61 and 0.63 suggests that dental fluorosis is a major public health problem in these districts.

Increased fluoride level in drinking water was found to be a risk factor for the development of dental fluorosis in Alappuzha and Palakkad. Water has to be defluoridated to the optimum level in the public water supply system to prevent fluorosis. Kerala is a state blessed with rain for almost six months, which can be harvested for drinking purpose.

Rain water contains no fluoride and thus the total average fluoride intake can be reduced if it is utilized. Community education along with support from local self-Government agencies has to be provided for utilization of rain water. People should be educated not to use fluoride tinted tooth paste in the fluorosis endemic areas.

REFERENCES:

1. Fawell J, Bailey K, Chilton J, Dahi E, Fewtrell L, Magara Y, editors. Fluoride in drinking water. World Health Organization. London: IWA Publishing; 2006.
2. Ayoob S, Gupta AK. Fluoride in Drinking Water: A Review on the Status and Stress Effects. *Crit Rev Environ Sci Technol.* 2006; 36(6): 433-87.
3. Taiyuan Declaration on Water Quality and Arsenic Mitigation. Taiyuan, China. 2004. Available from: http://www.unicef.org/china/media_1163.html
4. Susheela AK. A treatise on Fluorosis. 2nd Ed. New Delhi: Fluorosis Research and Rural Development Foundation; 2003.
5. Gopalakrishnan P, Vasana RS, Sarma PS, Thankappan KR. Prevalence of dental fluorosis and associated risk factors among school children in Alappuzha district, Kerala. *Nat Med J Ind.* 1999; 12(3): 99-103.
6. Chatterjea MN, Rana S. Textbook of Medical Biochemistry. New Delhi: Jaypee Brothers Medical Publishers, 1993.
7. Cao J, Bai X, Zhao Y, Zhou D, Fang S, Jia M, Wu J. The relationship of fluorosis and brick-tea drinking in Chinese Tibetans. *Environment Health Prospect* 1996; 104: 1340-3.
8. Mella S, Molina X, Atalah E. Prevalence of endemic dental fluorosis and its relation with fluoride content of public drinking water. *Rev Med Chil* 1994; 122: 1263-70.

ORIGINAL ARTICLE

9. Rozier RG. Epidemiological indices for measuring the clinical manifestations of dental fluorosis; Overview and critique. *Adv Dent Res.* 1994; B (1): 39-55.
10. Das PK. Commutation of a Community Index of Dental fluorosis. *Indian J Public Health* 1997; 41: 86-9.
11. Jolly SS, Singh ID, Prasad S, Sharma R, Singh BM, Mathur OC. An epidemiological study of endemic fluorosis in Punjab. *Indian J Med Res.* 1969 Jul; 57 (7): 1333-46.
12. Sudhir K M, Prashant G M, Subba Reddy V V, Mohandas U, Chandu G N. Prevalence and severity of dental fluorosis among 13- to 15-year-old school children of an area known for endemic fluorosis: Nalgonda district of Andhra Pradesh. *J Indian Soc Pedod Prev Dent* 2009; 27: 190-6.
13. P V Kotecha, S V Patel, K D Bhalani, D Shah, V S Shah, K G Mehta. Prevalence of dental fluorosis & dental caries in association with high level of drinking water fluoride content in a district of Gujarat, India. *Indian J Med Res* 135, June 2012, pp 873-877.
14. Sarvaiya B U, Bhayya D, Arora R, Mehta D N. 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* [serial online] 2012 [cited 2014 Jul 3]; 30: 317-22. Available from: <http://www.jisppd.com/text.asp?2012/30/4/317/108929>.
15. S. Saravanan, C Kalyani, MP Vijayarani, P Jayakodi, Ajiw Felix, S Nagarajan, P Arumozhi, V Krishnan. Prevalence of dental fluorosis among primary school children in rural areas of Chidambaram taluk, Cuddalore district, Tamil Nadu, India. *Indian J Community Med* 2008; 33:146-50.

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