Type of Manuscript: ***Original Research***

Prevalence of Fluorosis among Patients Visiting a Private College and Hospital in Chennai, India

Neha Sharma M[1], Pratibha Ramani[2], L. Leelavathi[3]

[1]Research Associate, Department of Oral Pathology, *[2]Professor, Department of Oral Pathology, [3]Senior Lecturer, Department of Public Health Dentistry, Saveetha Dental College & Hospitals, Saveetha University, Saveetha Institute of Medical and Technical Sciences, Chennai*

Abstract

Dental fluorosis is a tooth malformation caused by the intake of excess fluoride from various sources, such as water, food, and air, during tooth development and mineralization. The regional concentration of fluoride and extensive application of fluoride to prevent dental caries have resulted in the high incidence of this malformation. Though many institutional studies on fluoride concentration and its adverse effects have been conducted , the result is highly scattered and needs to be systematically summarized for better utilization. Hence the aim of this study was to assess the prevalence of fluorosis and its severity among the patients visiting a private teaching hospital in a non fluorosis endemic area in Chennai. It is a retrospective cross sectional study was carried out and the case records of patients having fluorosis was collected by reviewing patient records and analyzing the data of 86000 patients from June 2019- April 2020. Patients screened for Dean's Fluorosis index were selected. The data was collected and subjected to statistical analysis and correlation using the SPSS software. The results showed that fluorosis was found to be more prevalent in males (71.5%) than females (28.5%) , it was also found that 37.5 % of the patients had mild fluorosis. It was observed that patients presented with mild fluorosis especially in the upper arch in our hospital.

Keywords: *Correlation; Fluorosis; Gender; Severity; Teeth*

Introduction

Dental fluorosis is a fluoride-induced condition, which leads to specific interruption in tooth formation, mineralisation and an aesthetic condition, in which enamel formation is altered and hypo mineralized [1]. The regional concentration of fluoride and extensive application of fluoride to prevent dental caries have resulted in the high incidence of this malformation. Calcium, phosphate, and fluoride ions play an important role in the battle between demineralization and remineralization processes and accordingly modify the susceptibility of tooth to caries progression [2]. Carbonate apatite is also the material found in calcifications in the vascular walls [3]. The clinical appearance of dental fluorosis is distinguished by lustreless opaque white patches within the enamel which can become striated, mottled and/or pitted [4]. The diagnosis of these lesions is based on clinical history[5]. The incidence of dental fluorosis reaches 80–90% in some high-fluoride areas [6]. The Bureau of Indian Standards (BIS) has set the standards for fluoride levels in drinking water with maximum desirable limit as 1.0 mg/L and permissible limit in the absence of alternate source as 1.5 mg/L [7]. Fluorosis has its impact on 21 states of India [8]. India is situated within the geographical fluoride belt and in locations where fluoride content is high in rocks or soil, leaching of fluoride occurs, causing excess fluoride level in groundwater. However, the extent of fluoride in water

Corresponding Author
Pratibha Ramani
Professor, Head of the Department,
Department of Oral Pathology, Saveetha Dental College & Hospitals, Saveetha University, Saveetha Institute of Medical and Technical Science,
Chennai-600077,
E-mail ID:pratibaramani@saveetha.com
Phone: +91 9841414603

also depends on the natural solubility, presence of other minerals, the acidity of the soil and amount of water present, which explains high fluoride content in the groundwater [9]. In a study done in the Madurai district of Tamil Nadu, India showed that due to high concentration of fluoride in groundwater , dental fluorosis was a major problem among people residing in that area [10]. About 20 out of 35 states and union territories of India were identified as endemic for fluorosis and about 66 million people in these regions are at risk of fluoride contamination [11].

It is known that fluoride content in drinking water is the primary cause of fluorosis [12]. Clinically ,it is very important to understand varying factors which may alter the course of any condition [13]. It is suggested that other factors like altitude of residence, climate, dietary habits, tea consumption, nutritional status of the child, duration of breastfeeding, infant formulae and use of fluoridated toothpaste have an influence on the prevalence and severity of dental fluorosis [14,15]. A study done in the central plateau district of Nigeria showed that the prevalence of fluorosis was significantly higher in the high altitude parts of the district than the low altitude parts [16]. Yet another study indicated that toothpaste , if swallowed by young children , is a risk factor but this risk is under the parent's control: less toothpaste can be used and low fluoride toothpaste can be introduced [17]. Whole saliva is mainly composed of fluid produced by major and minor salivary glands[18]. A previous study suggests that a combination of fluoride excess and calcium deficiency may lead to the development of a mixed picture of osteosclerosis and osteopenia [17,19]. Despite diagnostic and therapeutic advances over the decades, the disease remains a challenge for medical and dental professionals [20].

It is important to educate the community on dangers of using water with excess fluoride and other associated risk factors of fluorosis to ensure good health [21]. Patients from different backgrounds and localities come to dental clinics seeking for treatments but they might have other underlying conditions like fluorosis which show evident changes in the tooth structure. Thus the treatment plan should change accordingly in order to treat the main complaint along with other conditions like fluorosis.

Hence the aim of this study was to assess the prevalence of fluorosis and its severity among the patients visiting a private teaching hospital in a non fluorosis endemic area in Chennai.

Materialsand Methods

Study Setting

This is a retrospective study regarding patients with fluorosis who have visited Saveetha Dental College and Hospitals in between June 2019- April 2020. The approval for this study setting was obtained from the Institution Ethics Board. The sample size of n= 488 patients in which sampling bias was minimized with the verification of photographs. The main purpose of photography in dentistry is the registration of clinical information in the oral cavity [22] The study was reviewed by two reviewers and it was cross verified. All patients data diagnosed with fluorosis were included for the data analysis. Cases with Incomplete record entry in the system were excluded from the study.

Data Collection

The case records of patients having fluorosis was collected by reviewing patient records and analyzing the data of 86000 patients. The data of these patients was collected and tabulated. It included parameters – Patients ID, Age , Gender, Teeth and severity of fluorosis. Age was categorized into 14-18 years, 36-55 years and patients more than 55 years. Severity of fluorosis was grouped into questionable, very mild, mild, moderate and severe fluorosis.

Statistical Analysis

All the parameters were tabulated and assessed for statistical significance using the SPSS software [23]. Percentage , mean, standard deviation, frequency of parameters were employed in the analysis. Chi square test was used to detect the significance between age, gender, severity of fluorosis and teeth involving fluorosi. P value less than 0.05 was considered to be statistically significant.

Results and Discussion

The results of this study show that among the total participants, 71.5% of them were males whereas 28.5% of them females [Figure 1]. It was observed that 63%

of p
and
fluor
seve
the p
were
betw
to be

lower arch,
d with mild
sis, 9% had
ts , 82% of
the patients
Correlation
5 was found

outp
the p
Blue
and
insti

visiting the
s represents
d the colour
were males
visiting the

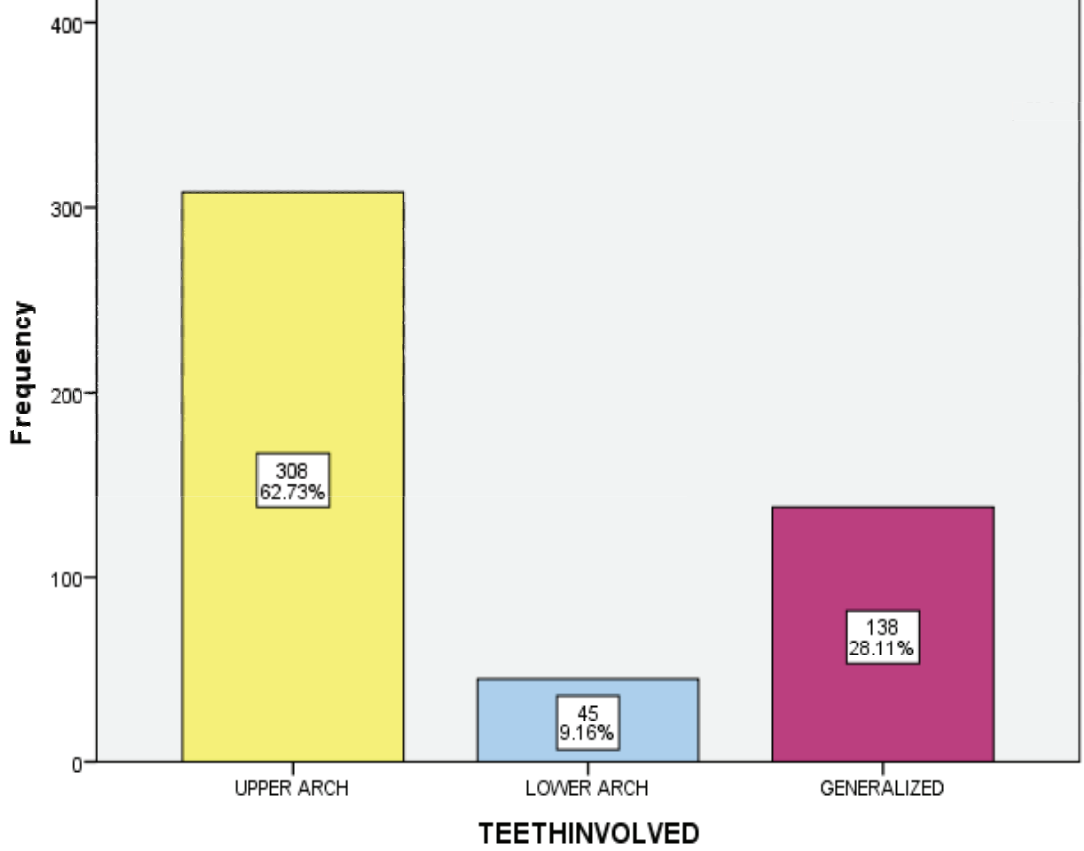

Figure 2: Bar graph depicting the teeth involved in fluorosis among patients visiting the outpatient department at a private dental hospital. X axis represents the teeth involved in fluorosis and Y axis represents the frequency of patients having fluorosis. The colour Yellow denotes upper arch, Blue denotes lower arch and the colour Magenta denotes generalized fluorosis. The graph shows that among the patients having fluorosis, 62.7% of them had fluorosis in the upper arch, 28% had generalized fluorosis and 9.2% of them had fluorosis involving the lower arch indicating that fluorosis was most commonly seen in the upper arch among the patients visiting the institution.

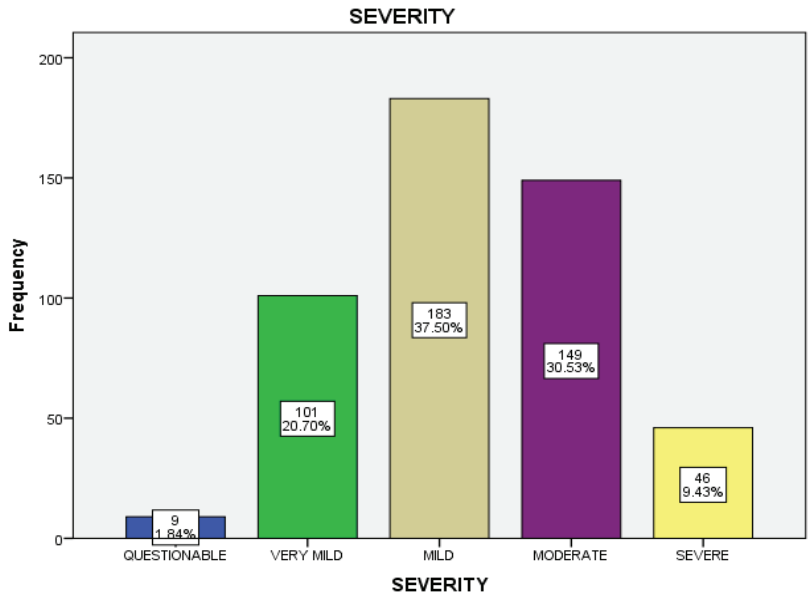

Figure 3: Bar graph depicting the severity of fluorosis among patients visiting the outpatient department at a private dental hospital. X axis represents the severity of fluorosis and Y axis represents the frequency of patients

having fluorosis. Blue colour denotes questionable fluorosis, green denotes very mild fluorosis, beige denotes mild fluorosis, purple denotes moderate fluorosis and yellow denotes severe fluorosis. The graph shows that among the patients having fluorosis, 37.5% of them had mild fluorosis, 30.5% had moderate fluorosis, 20.7% had very mild fluorosis, 9.4% had severe fluorosis and 1.8% of them had questionable fluorosis indicating that mild fluorosis was most commonly seen among the patients visiting the institution.

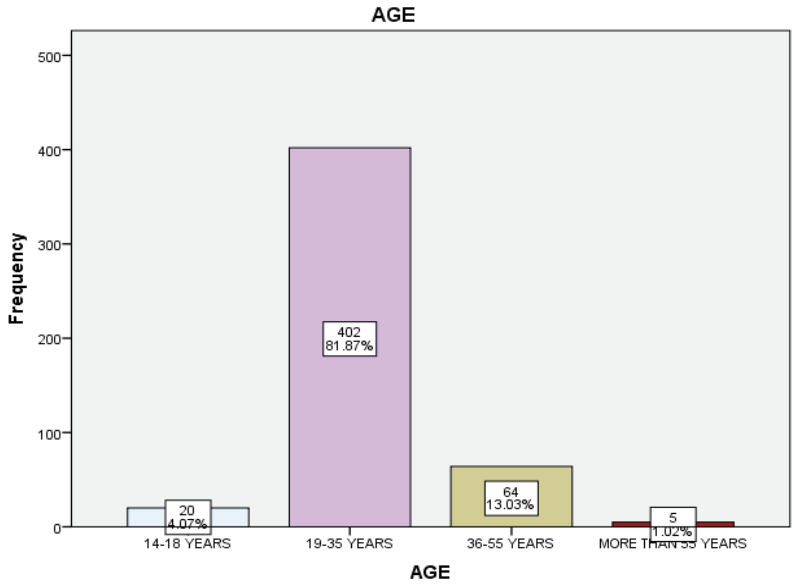

Figure 4: Bar graph depicting the prevalence of fluorosis between different age groups of patients visiting the outpatient department at a private dental hospital. X axis represents the Age of the patients and Y axis represents the frequency of patients having fluorosis. The colour blue denotes 14-18 years, purple denotes 19-35 years, brown denotes 36-55 years and red denotes more than 55 years. The graph shows that among the patients having fluorosis, 81.8% of them were between 19-35 years, 13% belonged to the age group 36-55 years, 4% were between 14-18 years and 1% of them were more than 55 years old indicating that fluorosis most commonly occurred in the age group 19-35 years among the patients visiting the private institution.

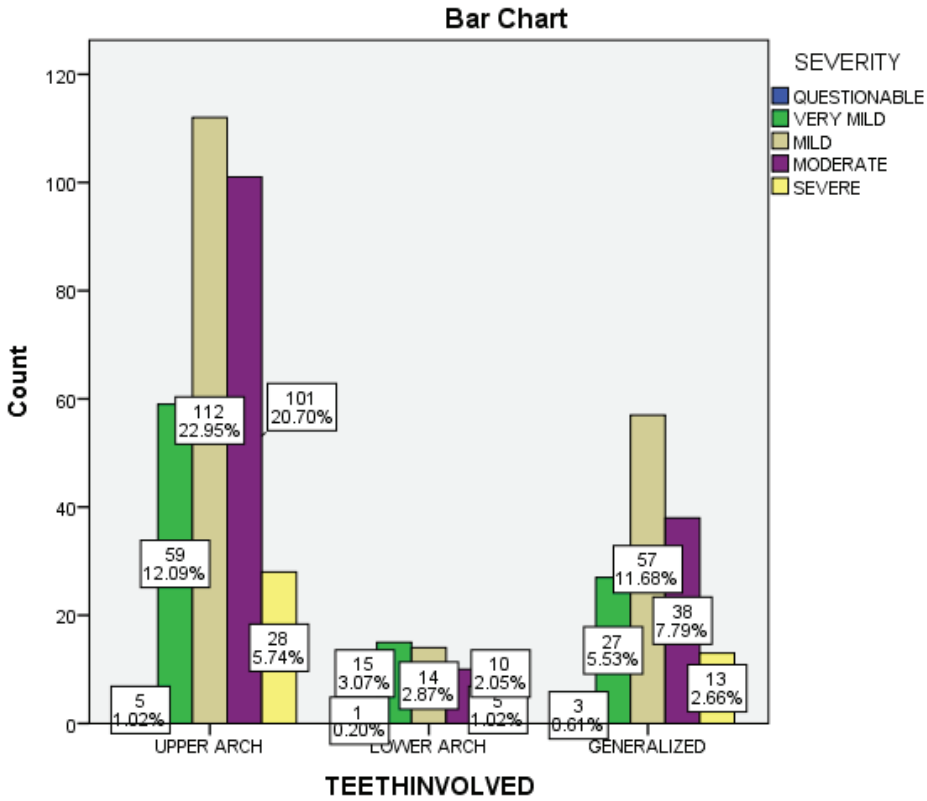

Figure 5: Bar graph depicting the correlation and association between severity of fluorosis and teeth involved in fluorosis among outpatients visiting a private dental hospital. X axis represents the teeth involved in fluorosis and Y axis represents the severity of the fluorosis. The above graph shows that 63% of the patients presented with fluorosis of upper arch out of which a maximum of 23% of them had mild fluorosis. However the severity of fluorosis and teeth involved was not statistically significant. Pearson Chi-Square analysis done p-0.502 and hence, it is not significant.

Dental fluorosis is a condition of enamel hypo-mineralization caused due to the effects of excessive fluoride on ameloblasts during enamel formation [24,25] . Dental fluorosis in teeth exhibits the first sign of fluoride toxicity in the form of "mottled enamel" [26]. The main cause is the water containing excess fluoride content especially ground water of particular communities [27]. Dental fluorosis has several stages. Initially, the teeth become chalky and opaque as an outcome of subsurface hypomineralization. As dental fluorosis progresses, the teeth lose enamel and increasingly develop pits and grooves [28]. If the condition is mild the enamel has opaque white areas covering 50% of the tooth surface [29]. There is a propensity for affecting the entire body leading to skeletal fluorosis and may cause debilitating disabilities compromising the quality of life [30]. Dental fluorosis is more common in permanent dentition than in deciduous dentition [31]. The excessive fluoride intake must occur during the period of tooth formation, since the fluoride appears to affect the activity of ameloblasts [32]. In our study, severity of fluorosis was calculated using Dean's fluorosis index. The success of any treatment for fluorosed teeth depends on the severity of the fluorosis [33,34]. According to Dean's index, Questionable fluorosis includes occasional white fleckings and sightings of enamel, Mild fluorosis includes white opaque areas involving more of the tooth surface, Moderate and severe fluorosis includes pitting and brownish staining of tooth surface [35]. In Spite of these obstacles, several groups have successfully gleaned important insights from the focused comparison of disparate microarray results [36] . Many laboratory, clinical and dental public health researchers after more than 70 years of research have concluded that fluoride is a double–edged weapon,

where its deficiency increases the risk for dental caries and excess consumption increases the risk for dental fluorosis [37]. Despite diagnostic and therapeutic advances over the decades, this condition remains a challenge for medical and dental professionals [38] . It is known that a concentration of 1 parts per million (ppm) of fluoride in water offered significant protection against dental caries [39]. The decline in dental caries prevalence and incidence in developed countries over the last two decades is considered to be largely due to the widespread use of fluoride [40]. The fluoride produces a dose-dependent effect on the dentition [41].

In this present study, it is seen that more males presented with fluorosis with a percentage of 71.5% whereas females were only 28.5%. This is in concordance with a study done among the school children of Nalgonda district in Andhra Pradesh [42]. Previous studies done by Molina *et al* and Sabokseir *et al* showed similar results stating that around 53% of the participants who had fluorosis were males and the remaining were females [43,44]. Firempong *et al* in their study stated that 54.5% of the people diagnosed with fluorosis were males and only 45.5% were females [45]. However Idon *et al* and Molina *et al* in their study reported a contradictory result showing that the prevalence of fluorosis is more common among the females [46,47]. The probable reasons for prevalence in males could be that their daily work schedule ,access and lifestyle which may prevent them from utilising the different preventive strategies enforced in their localities .A study done in the Prakasam district of Tamil Nadu shows that the prevalence of dental fluorosis was 82.04% and compared to urban areas, the prevalence of dental fluorosis was higher in rural areas [48]. Another study done in the Cuddalore District of Tamil Nadu revealed that only one-third of children had experienced dental fluorosis of 31.4% [49]. This might be because in an endemic fluorosis area, a great amount of fluoride is incorporated into food materials and ingested into the body.

Our study also revealed that most of the participants presented with mild fluorosis (37.5%). This is in concordance with previous studies performed by Damelash *et al* and Khan *et al* which revealed that there was a high prevalence of mild fluorosis [50,51] . Another study showed similar results stating that the majority of the participants presented with mild fluorosis [52].This solely depends on the concentration of fluoride in the ground water of the locality and in the diet consumed by the participants. The severity of fluorosis could depend on the difference in exposure to fluoride or on the individual characteristics of the participants.

In our study, a major proportion (63%) of the participants presented with fluorosis in the upper arch. This is in concordance with a similar study done in North-Western Villages of Makoo which reveals that maxillary teeth were more affected by fluorosis [53]. Other studies done by Mehta D et al and Lasrsen et al show similar results stating that there is more than 50% risk for maxillary teeth especially central incisors and first premolars to get affected by fluorosis [54,55]. In another study by Larsen et al, it is stated that the prevalence of fluorosis is least in lower incisors and increases in the upper molars, incisors and canines [56]. This is because fluorosis affects teeth like maxillary incisors, canines and first molars which mineralize last. Hence maxillary teeth are more affected than mandibular teeth. Although Chi square test did not reveal any significance between the teeth involved and severity of fluorosis (p value 0.5>0.05).

In our present study, about 82% of the sample size presenting with fluorosis were in the 19- 35 years age group. This is in concordance with a study done by Akinkugbe *et al* that shows similar results stating that the majority of the patients having fluorosis were between 18-45 years [57]. However Szpunar et al in his study shows contradictory results stating that prevalence of fluorosis increased in the age group 8-10 years. [58]. This is because, at early ages there is little control of expectoration of the residues of the toothpaste during brushing and this leads to the ingestion of toothpaste in children. Hence children are more commonly affected by fluorosis.

Thus fluorosis can be prevented by having an adequate knowledge of the fluoride sources, knowing how to manage this issue and therefore, avoid overexposure [59]. Providing decreased fluoride content water to the community can be useful in the management of this condition as a whole [60].

The study was geographically limited and predominantly consisted of the South Indian population. Data which were unclear were excluded thereby

reducing the sample size. Within the limit of the study , it was found that 488 cases of fluorosis reported to the private dental college and hospital and showed a male predilection majorly affecting age groups of 19 to 35 years. To ascertain the results of this study and to increase the level of significance, the sample size and the geographic area of coverage should be extended to at least most parts of South India. Thus the study helps in gaining knowledge about the prevalence of fluorosis which will help in taking up further interventions like setting up of community defluoridation units and improving the awareness about the current scenario.

Conclusion

Although dental fluorosis is an irreversible condition of the enamel of teeth, it can be prevented if the level of fluoride in water is optimum. Regular water testing, routine medical check-up camps, and continued health awareness program would definitely benefit the community residing in fluoride endemic areas.

Acknowledgements

The authors would like to acknowledge the help and support rendered by the Department of Oral Pathology and Information Technology of Saveetha Dental College and Hospitals and the management for their constant assistance with the research.

Conflict of Interest: None to declare

Ethical Clearance: It is taken from "Saveetha Institute Human Ethical Committee" (Ethical Approval Number- SDC/SIHEC/2020/DIASDATA/0619-0320)

References

1. Rahila C, Narayanan MBA, Kumar SGR, Selvamary AL, Sujatha A, Kirubaharan JJ. Association of COL1A2 (PvuII) gene polymorphism with risk and severity of dental fluorosis--A case control study. The Saudi Dental Journal 2019;31:463–8.
2. Sandhya A, Vishnu Priya V, Gayathri R. Estimation of salivary total protein and calcium in patients with dental fluorosis. Drug Invention Today. 2018 Jun 1;10(6).
3. Swathy S, Gheena S, Varsha SL. Prevalence of pulp stones in patients with history of cardiac diseases. Research Journal of Pharmacy and Technology 2015;8:1625.
4. Manthra Prathoshni SM, Vishnu Priya V, Sohara Parveen N. Awareness of Dental Fluorosis among Children – A Survey. Journal of Pharmaceutical Sciences and Research. 2017 Apr 1;9(4):459.
5. Sherlin H, Ramani P, Premkumar P, Kumar A, Natesan A. Expression of CD 68, CD 45 and human leukocyte antigen-DR in central and peripheral giant cell granuloma, giant cell tumor of long bones, and tuberculous granuloma: An immunohistochemical study. Indian Journal of Dental Research 2015;26:295.
6. Min J, Yu P, Xu Z, Li Z, Zhang Q, Yu H, et al. Investigation on the Gradient Nanomechanical Behavior of Dental Fluorosis Enamel. Nanoscale Research Letters 2018;13.
7. Jayaraj G, Sherlin H, Ramani P, Premkumar P, Anuja N. Cytomegalovirus and Mucoepidermoid carcinoma: A possible causal relationship? A pilot study. Journal of Oral and Maxillofacial Pathology 2015;19:319.
8. Anil NS, Shruthi MN. A comparative study of dental fluorosis and non-skeletal manifestations of fluorosis in areas with different water fluoride concentrations in rural Kolar. Journal of Family Medicine and Primary Care 2018;7:1222.
9. Verma A, Shetty BK, Guddattu V, Chourasia MK, Pundir P. High prevalence of dental fluorosis among adolescents is a growing concern: a school based cross-sectional study from Southern India. Environ Health Prev Med 2017;22:17.
10. Kumar RP, Pradeep Kumar R, Vijayalakshmi B. Assessment of Fluoride Concentration in Ground Water in Madurai District, Tamil Nadu, India. Research Journal of Pharmacy and Technology 2017;10:309.
11. Majumdar K. Health impact of supplying safe drinking water containing fluoride below permissible level on fluorosis patients in a fluoride-endemic rural area of West Bengal. Indian Journal of Public Health 2011;55:303.
12. Jangid K, Alexander A, Jayakumar N, Varghese S, Ramani P. Ankyloglossia with cleft lip: A rare case report. Journal of Indian Society of Periodontology 2015;19:690.

13. Gupta V, Ramani P. Histologic and immunohistochemical evaluation of mirror image biopsies in oral squamous cell carcinoma. J Oral Biol Craniofac Res 2016;6:194–7.

14. Mahantesha T, Dixit UB, Nayakar RP, Ashwin D, Kamavaram Ellore VP. Prevalence of Dental Fluorosis and associated Risk Factors in Bagalkot District, Karnataka, India. International Journal of Clinical Pediatric Dentistry 2016;9:256–63.

15. Sivaramakrishnan SM, Ramani P. Study on the Prevalence of Eruption Status of Third Molars in South Indian Population. Biology and Medicine 2015;07.

16. Akosu TJ, Zoakah AI. Risk factors associated with dental fluorosis in Central Plateau State, Nigeria. Community Dentistry and Oral Epidemiology 2008;36:144–8.

17. Riordan PJ. Dental fluorosis, dental caries and fluoride exposure among 7-year-olds. Caries Res 1993;27:71–7.

18. Shree KH, Hema Shree K, Ramani P, Herald Sherlin, Sukumaran G, Jeyaraj G, et al. Saliva as a Diagnostic Tool in Oral Squamous Cell Carcinoma – a Systematic Review with Meta Analysis. Pathology & Oncology Research 2019;25:447–53.

19. Mithal A, Trivedi N, Gupta SK, Kumar S, Gupta RK. Radiological spectrum of endemic fluorosis: relationship with calcium intake. Skeletal Radiology 1993;22.

20. Sridharan G, Ramani P, Patankar S. Serum metabolomics in oral leukoplakia and oral squamous cell carcinoma. Journal of Cancer Research and Therapeutics 2017;0:0.

21. Rustagi N, Rathore A, Meena J, Chugh A, Pal R. Neglected health literacy undermining fluorosis control efforts: A pilot study among schoolchildren in an endemic village of rural Rajasthan, India. Journal of Family Medicine and Primary Care 2017;6:533.

22. Hannah R, Ramani P, Herald. J. Sherlin, Ranjith G, Ramasubramanian A, Jayaraj G, et al. Awareness about the use, Ethics and Scope of Dental Photography among Undergraduate Dental Students Dentist Behind the lens. Research Journal of Pharmacy and Technology 2018;11:1012.

23. Jayaraj G, Sherlin HJ, Ramani P, Premkumar P, Natesan A. Stromal myofibroblasts in oral squamous cell carcinoma and potentially malignant disorders. Indian Journal of Cancer 2015;52:87.

24. Kumar N, Gauba K, Goyal A, Kapur A. Comparative evaluation of three different recording criteria of dental fluorosis in a known endemic fluoride area of Haryana. Indian Journal of Medical Research 2018;147:567.

25. Gheena S, Ezhilarasan D. Syringic acid triggers reactive oxygen species–mediated cytotoxicity in HepG2 cells. Human & Experimental Toxicology 2019;38:694–702.

26. Shah MS, Vishnupriya V, Gayathri R. Awareness about Fluorosis-A Survey. Res J Pharm Biol Chem Sci 2016;8:530.

27. Pratha AA, Ashwatha Pratha A, Gheena S. Patterns and Distribution of Dental Caries and Dental Fluorosis in School Children of Sivakasi. Indian Journal of Public Health Research & Development 2019;10:85.

28. Rango T, Kravchenko J, Atlaw B, McCornick PG, Jeuland M, Merola B, et al. Groundwater quality and its health impact: An assessment of dental fluorosis in rural inhabitants of the Main Ethiopian Rift. Environment International 2012;43:37–47.

29. Benly P. Effect of Fluorosis on Enamel. Research Journal of Pharmacy and Technology 2014;7:362–4.

30. Viveka TS, Shyamsundar V, Krishnamurthy A, Ramani P, Ramshankar V. p53 Expression Helps Identify High Risk Oral Tongue Premalignant Lesions and Correlates with Patterns of Invasive Tumour Front and Tumour Depth in Oral Tongue Squamous Cell Carcinoma Cases. Asian Pacific Journal of Cancer Prevention 2016;17:189–95.

31. Shekar C, 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. Indian Journal of Public Health 2012;56:122.

32. Ganesh C, Ganasundram N, Maragathavalli G, Maheswar TNU. Prevalence of Dental Caries in Different Grades of Dental Fluorosis in Salem

and Dharmapuri Districts Aged 15 to 17 Years. Journal of Indian Academy of Oral Medicine and Radiology 2013;25:251.

33. Jain AR. Evaluation of esthetic rehabilitation of teeth with severe fluorosis using direct and indirect laminate veneer: A case report. Biol Med 2016;8:2.
34. Jayaraj G, Ramani P, Herald J. Sherlin, Premkumar P, Anuja N. Inter-observer agreement in grading oral epithelial dysplasia – A systematic review. Journal of Oral and Maxillofacial Surgery, Medicine, and Pathology 2015;27:112–6.
35. Sherwood IA. Fluorosis varied treatment options. J Conserv Dent 2010;13:47–53.
36. Thangaraj SV, Shyamsundar V, Krishnamurthy A, Ramani P, Ganesan K, Muthuswami M, et al. Molecular Portrait of Oral Tongue Squamous Cell Carcinoma Shown by Integrative Meta-Analysis of Expression Profiles with Validations. PLoS One 2016;11:e0156582.
37. Sukhabogi JR, Parthasarathi P, Anjum S, Shekar BRC, Padma CM, Rani AS. Dental fluorosis and dental caries prevalence among 12 and 15-year-old school children in Nalgonda District, Andhra Pradesh, India. Annals of Medical and Health Sciences Research 2014;4:245.
38. Sridharan G, Ramani P, Patankar S, Vijayaraghavan R. Evaluation of salivary metabolomics in oral leukoplakia and oral squamous cell carcinoma. Journal of Oral Pathology & Medicine 2019;48:299–306.
39. Rajarajan G, Kumar RP, Priyadorshini SP. A review on the ethics of artificial water fluoridation. Drug Invention Today 2019;11.
40. Shilpa R. Fluorosis and its relation to Dental Caries. Res J Pharm Biol Chem Sci 2017;9:1237.
41. Nathasha A, Sivakumar P, Dhanalakshmi V, Ganapathy D. Dental fluorosis and the prevalence of dental caries in children age on 6–16 in Malaysia Drug Invention Today. 2019 Sep 15;11(9).
42. Chandu GN, Sudhir KM, Prashant GM, Reddy VVS, Mohandas U. 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. Journal of Indian Society of Pedodontics and Preventive Dentistry 2009;27:190.
43. Molina-Frechero N, Gaona E, Angulo M, Pérez LS, González RG, Rascón MN, et al. Fluoride Exposure Effects and Dental Fluorosis in Children in Mexico City. Medical Science Monitor 2015;21:3664–70.
44. Sabokseir A, Golkari A, Sheiham A. Distinguishing between enamel fluorosis and other enamel defects in permanent teeth of children. PeerJ 2016;4:e1745.
45. Firempong C, Nsiah K, Awunyo-Vitor D, Dongsogo J. Soluble fluoride levels in drinking water-a major risk factor of dental fluorosis among children in Bongo community of Ghana. Ghana Med J 2013;47:16–23.
46. Idon PI, Enabulele JE. Prevalence, severity, and request for treatment of dental fluorosis among adults in an endemic region of Northern Nigeria. European Journal of Dentistry 2018;12:184–90.
47. Molina-Frechero N, Nevarez-Rascón M, Nevarez-Rascón A, González-González R, Irigoyen-Camacho M, Sánchez-Pérez L, et al. Impact of Dental Fluorosis, Socioeconomic Status and Self-Perception in Adolescents Exposed to a High Level of Fluoride in Water. International Journal of Environmental Research and Public Health 2017;14:73.
48. Naidu GM, Rahamthullah SAKU, Kopuri RKC, Kumar YA, Suman SV, Balaga RN. Prevalence and self perception of Dental Fluorosis among 15 year old school children in Prakasam district of south India. J Int Oral Health 2013;5:67–71.
49. Saravanan S, Kalyani C, Vijayarani MP, Jayakodi P, Felix AJW, Nagarajan S, et al. Prevalence of dental fluorosis among primary school children in rural areas of Chidambaram taluk, Cuddalore district, Tamil Nadu, India. Indian Journal of Community Medicine 2008;33:146.
50. Demelash H, Beyene A, Abebe Z, Melese A. Fluoride concentration in ground water and prevalence of dental fluorosis in Ethiopian Rift Valley: systematic review and meta-analysis. BMC Public Health 2019;19.
51. Khan S, Moheet I, Farooq I, Farooqi F, ArRejaie A, Al Abbad MH, et al. Prevalence of dental fluorosis in school going children of Dammam, Saudi Arabia. Journal of Dental and Allied Sciences 2015;4:69.

52. Kebede A, Retta N, Abuye C, Whiting S, Kassaw M, Zeru T, et al. Dietary Fluoride Intake and Associated Skeletal and Dental Fluorosis in School Age Children in Rural Ethiopian Rift Valley. International Journal of Environmental Research and Public Health 2016;13:756.

53. Aminabadi N, Taghizdeh Gangi A, Balayi E, Sadighi M. Prevalence of Fluorosis in 5-12 Year-old Children in the North-Western Villages of Makoo in 2004. J Dent Res Dent Clin Dent Prospects 2007;1:33–41.

54. Mehta D, Shah J. Reversal of dental fluorosis: A clinical study. Journal of Natural Science, Biology and Medicine 2013;4:138.

55. Larsen MJ, Richards A, Fejerskov O. Development of Dental Fluorosis according to Age at Start of Fluoride Administration. Caries Research 1985;19:519–27.

56. Larsen MJ, Kirkegaard E, Poulsen S. Patterns of Dental Fluorosis in a European Country in Relation to the Fluoride Concentration of Drinking Water. Journal of Dental Research 1987;66:10–2.

57. Akinkugbe A, Iafolla T, Chattopadhyay A, Garcia I, Adams A, Kingman A. The role of partial recording protocols in reporting prevalence and severity of dental fluorosis. Community Dentistry and Oral Epidemiology 2014;42:563–71.

58. Szpunar SM, Burt BA. Dental Caries, Fluorosis, and Fluoride Exposure in Michigan Schoolchildren. Journal of Dental Research 1988;67:802–6.

59. Ilankizhai RJ. Dental Fluorosis and Its Management-A Review. Research Journal of Pharmacy and Technology 2016;9:967–71.

60. Pratiti Datta, Pratyay Pratim Datta. Prevalence , etiology and clinical features of skeletal fluorosis: A critical review. Innovare Journal of Medical Science. 2013;1(2):5-6.