Original Research Article

Assessment of knowledge, attitude, and practice of fluorosis among Indian dentists: a cross-sectional questionnaire-based study

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ABSTRACT

Background: Dental fluorosis is a significant public health problem in India as drinking water with high fluoride is widespread throughout the country. Although dentists are key players in the prevention and management of the condition, little is known about their knowledge, attitudes and practices (KAP) related to fluorosis.
Methods: A cross-sectional study on an Indian dentist population was conducted. A 13-question survey was completed by participants in January 2023 - April 2023 using simple random sampling. The questionnaire included some demographic data and information on the source of knowledge and risk factors of fluorosis, related diseases, proper diagnostic measures and treatment and the point of view concerning prophylaxis. Data analysis was done using SPSS Version 23.
Results: Nearly half were aware of drinking water as a key source of fluoride, however all had gaps in knowledge regarding additional sources and adequate level of fluoride. Most of dentists wanted bleaching and veneers; preferences varied while attitudes towards prevention were positive, the study found a gap in applying sections of the essential knowledge and identified that competence in fluorosis management should be improved with educational interventions.
Conclusions: Knowledge and practices regarding fluorosis are variable among Indian dentists, with significant gaps in understanding of this condition and its diagnosis. There is a need for educational programs, interdisciplinary work and public awareness in these areas to improve management of fluorosis and oral health. Integration of the subject of fluorosis in the undergraduate courses are recommended to fill the gaps of knowledge and competence in health professionals.

Keywords: Dental fluorosis, Fluoride exposure, Preventive measures, Diagnostic techniques, Treatment modalities

INTRODUCTION

Fluorosis, a preventable yet highly prevalent endemic disease across the world, continues to pose significant challenges to public health, particularly in regions with elevated fluoride levels in drinking water. In India, the battle against fluorosis, especially dental fluorosis, persists, necessitating a thorough understanding and proactive approach from healthcare professionals, particularly dentists. Given their proximity to cases of fluorosis in daily practice and their role in preventive measures, dentists play a pivotal role in combating this crippling disorder. Fluorosis arises due to chronic exposure to high levels of fluoride during tooth development, leading to a range of dental and skeletal abnormalities. Dental fluorosis, characterized by enamel discoloration, surface irregularities, and pitting, often manifests during childhood, impacting oral health and

overall well-being. While fluoride is essential for dental health at optimal levels, excessive intake, primarily from drinking water, can result in fluorosis.[1,2]

The geographical distribution of fluorosis is closely linked to fluoride belts, encompassing areas affected by excessive fluoride concentration in water sources. India, among other countries, grapples with this issue, with approximately 62 million individuals suffering from fluorosis, a substantial portion being children due to high fluoride levels in drinking water. The prevalence of fluorosis is influenced by natural factors such as soil composition, hydrogeology, and climate, with India harboring a significant portion of the world's fluoride reserves.[3] Recognizing the gravity of the situation, the Indian government has launched initiatives like the National Program for Prevention and Control of Fluorosis under the National Health Mission. Additionally, dental education curriculum integration and awareness campaigns aim to equip healthcare professionals, including dentists, with the necessary knowledge and skills to tackle fluorosis effectively.[4]

Inspired by previous studies, this questionnaire-based research aims to evaluate the knowledge, attitudes, and practices of Indian dentists regarding fluorosis, with a specific focus on dental fluorosis. Through a comprehensive questionnaire, this study endeavors to assess dentists' understanding of the pathology of fluorosis and its etiology, diagnostic, treatment, and preventive measures. The findings of this study are expected to shed light on existing gaps in dentists' knowledge and practices related to fluorosis, thereby guiding future interventions and educational initiatives aimed at improving fluorosis management in India.[5]

Moreover, recent advancements in diagnostic techniques and treatment modalities, such as digital imaging technologies for early detection of fluorosis and minimally invasive cosmetic procedures for its management, have revolutionized the approach towards fluorosis in dental practice. These developments underscore the importance of continuous education and training for dentists to stay updated with the latest evidence-based practices in fluorosis management. Furthermore, community engagement and collaboration between healthcare providers, policymakers, and local communities are essential for implementing preventive measures and ensuring access to safe drinking water in fluorosis-affected regions. By addressing the multifaceted challenges posed by fluorosis, India can make significant strides towards mitigating its burden on public health and improving the quality of life for affected individuals.[6]

In summary, understanding the knowledge, attitudes, and practices of dentists regarding fluorosis is crucial for effective prevention, diagnosis, and management of this pervasive condition. By leveraging insights from this study and fostering interdisciplinary collaboration, India can take proactive steps towards achieving fluorosis-free communities and ensuring oral health equity for all its citizens.

Objective

The objective of this research was to assess the knowledge, attitudes, practices (KAP) of Indian dentists on fluorosis management, especially dental fluorosis. The results of this knowledge, attitude, and practice survey underscore the need for well-planned education and training programs, as well as continuing dental education programs on fluorosis management for the Indian dental practitioners.

METHODS

The methodology employed in this study aimed to comprehensively assess the knowledge, attitudes, and practices of dental professionals regarding the management of fluorosis, with a particular focus on dental fluorosis, in India.

Study design

This study adopted a cross-sectional survey design to gather data from dental professionals across various regions in India. The survey questionnaire was designed to collect information on participants' demographic characteristics, including gender, age, educational qualifications, professional experience, and clinical practice settings. By incorporating a diverse range of demographic variables, the study aimed to capture a holistic understanding of the dental workforce's perspectives on fluorosis management.

Inclusion criteria

The study population included postgraduate students, general dentists, and specialist dentists practicing in both government dental institutions and private clinics. Dental professionals with less than five years of work experience were included to capture insights from early-career practitioners, while those with more than fifteen years of experience provided perspectives from seasoned professionals.

Exclusion criteria

Undergraduate dental students were excluded from the survey population to focus specifically on practicing dental professionals with clinical experience in fluorosis management.

Informed consent was obtained from all participants before their participation in the study, ensuring confidentiality, voluntary participation, and the right to withdraw from the study at any time without repercussions. Additionally, measures were implemented to safeguard participants' privacy and anonymity throughout the research process, including the

anonymization of data and the secure storage of electronic records.

Questionnaire development

A pretested questionnaire comprising 13 closed-ended questions was developed to evaluate participants' knowledge, attitudes, and practices related to fluorosis management. The questionnaire underwent a rigorous validation process to ensure its reliability and validity. Expert opinions from dental public health specialists, epidemiologists, and experienced dental practitioners were sought to refine the questionnaire items and ensure their alignment with the study objectives. Additionally, a pilot test involving a small sample of dental professionals was conducted to assess the questionnaire's clarity, comprehensibility, and appropriateness before its full-scale implementation.

Data collection

The questionnaire was distributed to dental professionals through both physical copies and an online Google Form platform. A total of 200 dental professionals were selected as participants using a simple random sampling method. The sample size was determined based on the population size of registered dental practitioners in India and the desired level of confidence and precision. The data collection period spanned from January 2023 to April 2023 to ensure adequate representation and response rate. To maximize participation and data quality, reminders and follow-up communications were sent to non-respondents at regular intervals throughout the data collection phase. Out of 200 selected participants we got response from 165 dentists.

Statistical analysis

Upon completion of the data collection phase, all responses were coded and entered into the Statistical Package for the Social Sciences (SPSS) software Version 23 for analysis. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were utilised to summarize participants' demographic characteristics and responses to the questionnaire items. Inferential statistical analyses, such as Chi-square tests was also applied.

RESULTS

The study aimed to evaluate the knowledge, attitudes, and practices (KAP) regarding the management of fluorosis among dental students. The findings of the study, along with a critical discussion, are presented below.

Demographic characteristics

Most of the respondents 107 (64.8%) were male and 58 (35.2%) were female dentists. Additionally, 86 (52.1%) of the participants held Master of Dental Surgery (MDS)

degrees, 77 (46.7%) were BDS graduate and only 2 (1.2%) out of 165 responders held PhD degree. Among 165 responders, 88 (53.3%) has less than 5 years of clinical practice experience, 47 (28.5%) dentists have 5-10 years of experience, 12 (7.3%) has 10-15 years of experience, and 18 (10.9%) have more than 15 years of experience. A majority 93 (56.4%) dentists are practicing in urban areas, 9 (5.5%) are at semi urban areas, only 2 (1.2%) in village and 61 (37%) work at an institution.

Knowledge of fluorosis sources and risk factors

Participants demonstrated varying levels of knowledge regarding the sources and risk factors associated with fluorosis. While a majority 82 (49.7%) identified drinking water as a major source of fluoride exposure, toothpaste and dental fluoride application are selected by only 1 (0.6%) dentist for each option, and 20 (12.1%) dentists went for more than one options including diet source. 61 (37%) all of the given options, Among the dietary sources which has risk of developing fluorosis, 37 (22.4%) responders chose black tea/ coffee, 26 (15.8%) selected black salt, 8 (4.8%) chose grapes and raisins, only 1 (0.6%) selected boiled spinach, 9 (5.5%) dentists chose more than one options, 59 (35.8%) selected all of the options and 25 (15.2%) dentists chose none of the above option. 98 (59.4%) dentists believes that optimum level of fluoride in drinking water should be 1 ppm, 27 (16.4%) selected 1-2 ppm, 38 (23%) selected less than 1 ppm option and only 2 (1.2%) don't know the answer. 113 (68.5%) dentists are aware of all the three types of fluorosis (dental, skeletal, non-skeletal). However, 23 (13.9%) selected only dental fluorosis, 15 (9.1%) only chose skeletal fluorosis and 14 (8.5%) such dentists chose both dental and skeletal fluorosis. Figure 1 shows the respondent's knowledge regarding the source. Similarly, awareness of dietary sources with the greatest risk of developing fluorosis varied among respondents (Figure 2), with notable knowledge gaps observed for certain food items.
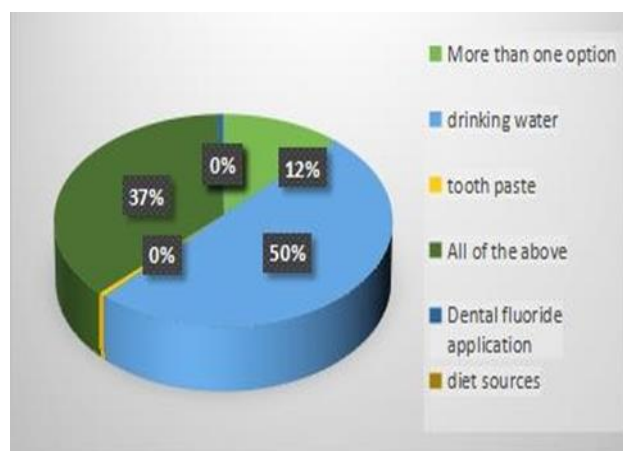

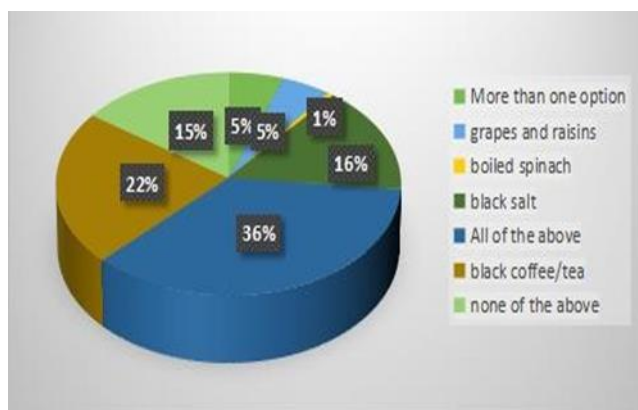**Figure 1: Respondent's knowledge regarding source of fluorosis.**

Figure 2: Respondent's knowledge regarding of dietary sources having the greatest risk of developing fluorosis.

Knowledge of diseases associated with high fluoride concentration

Participants' awareness of diseases associated with high fluoride concentration in the body was assessed. Among the respondents, 113 (68.48%) dentists demonstrated knowledge of all three types of fluorosis: dental, skeletal, and non-skeletal. Furthermore, 23 (13.93%) participants correctly identified dental fluorosis only, while 15 (9.09%) participants selected skeletal fluorosis exclusively.

Interestingly, 14 (8.48%) respondents recognized both dental and skeletal fluorosis, indicating a comprehensive understanding of the spectrum of fluorosis-related conditions among dentists.

Materials for estimating fluoride levels

Participants' knowledge of materials used for estimating fluoride levels in samples was evaluated the majority of respondents, comprising 116 (70.3%) dentists, correctly identified drinking water as a material for estimating fluoride levels. However, urine and blood samples, which are alternative indicators of fluoride exposure, were selected by 78 (47.27%) and 79 (47.87%) dentists respectively. This suggests a potential gap in awareness regarding alternative methods for assessing fluoride levels beyond drinking water analysis among dentists.

Analytical techniques for determining fluoride level

Participants' familiarity with analytical techniques used to determine fluoride levels in samples was investigated. While an ion-selective electrode was recognized by 65 (39.39%) respondents as a method for fluoride analysis, only a small number of participants, 3 (1.81%) MDS and 1 (0.6%) BDS graduates, identified colorimetry and gas chromatography as analytical techniques. Notably, a significant portion of respondents, totalling 92 (55.75%) individuals, correctly identified all three methods,

indicating a comprehensive understanding of fluoride analysis techniques among a majority of dentists.

Attitudes towards prevention and control measures

The study revealed generally positive attitudes towards preventive measures and control strategies for fluorosis. The vast majority 132 (80%) and 155 (93.5%) of respondents acknowledged the importance of national programs for fluorosis prevention and expressed willingness to collect and save data on fluorosis cases in their day-to-day practice respectively. Additionally, most participants 155 (93.5%) indicated their readiness to refer patients with advanced dental fluorosis to other specialists, underscoring a collaborative approach to patient care. Moreover, a high proportion 157 (95.2%) of participants reported informing patients about dental fluorosis when encountered during clinical consultations, highlighting the role of dental professionals in patient education and awareness. Only a small number 8 (4.8%) of dentists are not doing it.

Diagnostic skills and treatment preferences

Participants demonstrated varying levels of proficiency in diagnosing dental fluorosis and selecting appropriate treatment options. While a majority 117 (70.9%) dentists employed multiple diagnostic methods to confirm a diagnosis, 21 (12.75%) relied solely on clinical examination, and 26 (15.8%) dentists uses clinical examination and history taking but not laboratory diagnosis.

Treatment preferences varied, with bleaching 21 (24.41%) and veneers 27 (31.39%) being the most commonly selected options. However, there was also interest in alternative treatments such as full ceramic crowns 06 (6.97%) and micro/macro abrasion 07 (8.13%) methods, 23 (26.74%) dentists chose more than one option. Represents the treatment preference of the respondents.

Despite the respondents' overall positive attitudes towards fluorosis prevention and control, certain knowledge gaps and inconsistencies in diagnostic skills and treatment preferences were evident. These findings highlight the need for targeted educational interventions aimed at enhancing dental students' competency in fluorosis management. Strategies such as incorporating fluorosis-related topics into the dental curriculum, providing hands-on training in diagnostic techniques and treatment modalities, and promoting interdisciplinary collaboration with other healthcare professionals could contribute to more effective fluorosis management practices among future dental practitioners.

The study provides valuable insights into the KAP regarding fluorosis management among dental students. Addressing the identified knowledge gaps and promoting evidence-based practices in fluorosis prevention and

treatment are essential steps towards improving oral health outcomes in fluorosis-endemic regions. Future research and educational initiatives should focus on empowering dental students with the necessary skills and knowledge to effectively address the challenges posed by fluorosis in clinical practice.
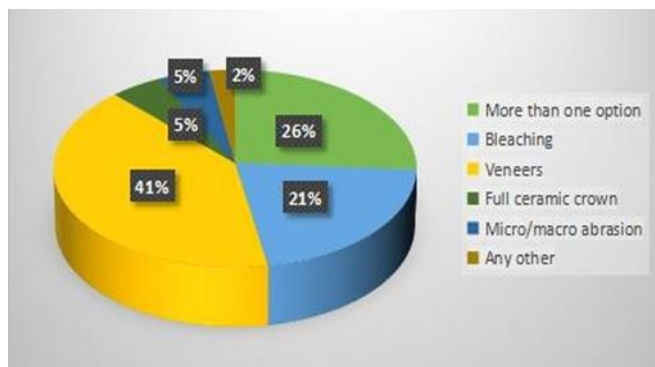

Figure 3: Respondent's preference on treatment options.

Chi-square test

The findings of the study pertaining to the risk assessment of fluorosis development in dietary sources, the determination of the most common sources for fluoride by dentists, and the preferences for mild to moderate dental fluorosis treatment among dental professionals are presented. Table 1 displays the outcomes of the chi-square test, indicating a statistically significant relationship ($\chi2=24.524$, $p<0.05$) between dietary sources and the risk of fluorosis development. Similarly, Table 2 demonstrates the significance ($\chi2=34.358$, $p<0.05$) of the association between identified fluoride sources and their prevalence as determined by dental experts. Furthermore, Table 3 showcases the treatment preferences for mild to moderate dental fluorosis among dentists, with a statistically significant chi-square value of 11.79 and a p-value less than 0.05. These findings underscore the importance of understanding the varying degrees of risk associated with different dietary sources of fluoride and highlight the consensus among dentists regarding fluoride sources and treatment modalities for dental fluorosis.

Table 1: Risk assessment of fluorosis development in dietary sources.

Dietary sources	MDS (%)	BDS (%)	PhD (%)	Total
More than one option	09 (10.46)	0	0	9
Grapes and raisins	03 (3.48)	04 (5.19)	01 (50)	8
Boiled spinach	0	01 (1.29)	0	1
Black salt	12 (13.95)	13 (16.88)	01 (50)	26
Black coffee/tea	23 (26.74)	14 (18.18)	0	37
All of the options	26 (30.23)	33 (42.85)	0	59
None of the options	13 (15.11)	12 (15.58)	0	25
Total (N)	86 (52.12)	77 (46.66)	2 (1.21)	165
Chi-square (X^2)	24.524	P value	<0.05	

Table 2: Most common sources for fluoride determined by dentists.

Sources	MDS (%)	BDS (%)	PhD (%)	Total
More than one option	17 (19.76)	01 (1.29)	02 (100)	20
Drinking water	46 (53.48)	36 (46.75)	0	82
Toothpaste	0	01 (1.29)	0	1
Dental fluoride	0	01 (1.29)	0	1
All of the above options	23 (26.74)	38 (49.35)	0	61
Diet sources	0	0	0	0
Industrial sources	0	0	0	0
Total (N)	86 (52.21)	77 (46.66)	02 (1.21)	165
Chi-square (X^2)	34.358	P value	<0.05	

Table 3: Mild to moderate dental fluorosis treatment preferences among dentists.

Treatment preferences	MDS (%)	BDS (%)	PhD (%)	Total
Bleaching	21 (24.41)	12 (15.58)	02 (100)	35
Veneers	27 (31.39)	40 (51.94)	0	67
Full ceramic	06 (6.97)	02 (2.59)	0	8
Micro/macro abrasion	07 (8.13)	01 (1.29)	0	8

Continued.

Treatment preferences	MDS (%)	BDS (%)	PhD (%)	Total
More than one option	23 (26.74)	20 (25.97)	0	43
Any other	02 (2.32)	02 (2.59)	0	4
Total (N)	86 (52.12)	77 (46.66)	02 (1.21)	165
Chi-square (X^2)	11.79	P value	<0.05	

DISCUSSION

Knowledge of fluorosis sources and risk factors

Nearly half of the respondents had identified drinking water as an important source of fluoride exposure in the study. These finding parallels what is reported in the existing literature that drinking water is the main source of fluoride in endemic areas.[7] However, there were knowledge gaps identified related to other sources including dietary intake and dental products. The latter is also confirmed by similar gaps that have been identified in previous studies which in turn confirms a sustained state of limited fluoride knowledge among healthcare practitioners in relation to the different sources of fluoride.[8] This is especially worrisome as toothpaste use is ubiquitous and can contribute to fluoride intake.[9] yet only 1% of dentists identified toothpaste as a source during free- text responses.

More experienced dentists must be aware of the range of other reported sources of fluoride exposure, e.g.: consumption of tea and certain food products shown to contain fluoride in a number of studies like the ones mentioned.[10] This detailed understanding is essential for optimal patient education and public health approaches. Furthermore, there is regional variation in the content of fluoride in water supplies making the scenario even more challenging which necessitates that dental professionals be experienced and vigilant and have in-depth knowledge about the particular location they are practicing.[11]

Awareness of fluorosis-associated diseases

There was a wide breadth and ease of discussion among most participants regarding dental, skeletal, and non-skeletal fluorosis, indicating a good understanding of fluorosis-related conditions. This is also consistent with previously described studies that healthcare providers had a limited knowledge on the clinical presentations of fluorosis.[12] However, demographics of some Tanzanian communities are representative of fluoride spectrumial fluorosis which its etiology and pathology can be understood thorough a better educational course since the understanding was varied among surveyed study participants.[13]

Dentists are less aware of non-skeletal features of fluorosis, despite the fact that fluoride effects on the brain and gut have been known for over a century.[14] and that researchers have been unable to separate skeletal from non-skeletal effects of fluoride.[15] This information gap might cause underdiagnosis or misdiagnosis of fluorosis cases presenting with these symptoms. Better training modules covering all presentations of fluorosis and their systemic consequences are required to facilitate better diagnosis and improve treatment outcomes.[16]

Diagnostic skills and treatment preferences

Participants had a range of diagnostic abilities, with many relying purely on clinical examination. This heavy reliance on traditional diagnostic procedures compared to more modern techniques is not only characteristic of the research.[17] but of the current prediagnosis practices among physicians gating high-level exposure and treatment by a dermatologist. There is poor awareness of analytical techniques such as ion-selective electrodes, colorimetry, and gas chromatography in the study area among the general public and respondents that might be associated with subjectivity or misinterpretation of results which shows the need to sensitize the people for the training on modern diagnostic methodologies for the better detection and assessment of fluorosis.[18]

Isotopic material of the basic summary of features of the bone provides a specialized diagnostic tool for one of the most secure changes at bone at until and the as a recommended in the aids recent summary on addition to some cancer adults, are removed and the text relatively innocuous evidence is incumbent only if such signals include been marshalled adequately in the bone fluorides involvement diagnosis have been slow features to develop, despite on the effect of dental imaging and so-called biochemical markers in blood and urine, were useful closer for the progression of fluorosis.[19] Including these techniques into the regular practice of dentistry might improve the diagnostic competency of practicing dentists. Standard diagnostic protocols and guidelines should be introduced to develop uniform practices for the diagnosis process with in-depth consideration of the standards.[20]

There is a documented magnitude in the efficacy and patient satisfaction of the different treatment modalities. In a systematic review concluded that micro abrasion combined with bleaching gave a moderate level of evidence that was efficacious for mild to moderate fluorosis cases.[21] Resin infiltration has been introduced as an alternative minimally invasive approach providing encouraging results as reported.[22] This emphasizes the need to deliver a variety of treatment options in order to meet the different needs and wishes of patients most effectively.

Attitudes towards prevention and control measures

A relatively high level of positive attitudes toward prevention practices and control measures of fluorosis was observed in this study. Assistance sought from dental practitioners to collect data on fluorosis and to save records, refer patients to specialists, and inform patients about dental fluorosis suggest that dentists appeared to manage dental fluorosis actively. This echoes the findings of other studies that dentists have a positive attitude about prevention and control measures, and can act as health educators and community health workers in the control of a pandemic.[23]

Dentists' proactive intent is key to successful public health campaigns for toothpaste-related fluorosis prevention and management. Acting as a community educator in preventive measures helps in the form of example advocacy for use of low-fluoride toothpaste, and safe water consumption practices among others. In addition, cooperation with public health officials is needed to create and deliver education and public awareness programs.[24]

Implications for education and practice

Identified knowledge gaps and variations in diagnostic process and treatment preferences demonstrate an immediate need for focused educational intervention. Key strategies to increase the competence of dental professionals in the management of fluorosis are: integration of fluorosis- related topics into the dental curriculum, practice in diagnostic techniques, and interaction with other health care providers in a team setting. The maintenance of continuous professional development opportunities and public awareness campaigns are also critical to ensure practicing dentists remain up to date on best practice and to educate communities in the dangers and prevention of fluorosis.[25]

Taking steps to address these key areas would constitute significant progress in reducing the burden and impact of fluorosis in India and subsequently enhancing quality of life of individuals affected. Accomplishing these goals will require extensive educational programs that are augmented by the right policy changes, and by new money for public health efforts. In addition, developing a learning culture for dentists would also lead to the continuation of further effective measures in the management and prevention of fluorosis.[26]

While efforts were made to ensure a representative sample of dental professionals, the study's findings may be subject to selection bias due to the voluntary nature of participation. Additionally, the reliance on self-reported data may introduce response bias and affect the accuracy of the findings. Moreover, the study's cross-sectional design precludes the establishment of causal relationships between variables, limiting the ability to infer causality from observed associations.

Overall, the methodology employed in this study aimed to provide valuable insights into the knowledge, attitudes, and practices of dental professionals regarding fluorosis management in India, thereby contributing to the development of evidence-based interventions, educational initiatives, and policy recommendations in this critical area of oral health research.

CONCLUSION

Indian dentists have several strong areas and others needing improvement on knowledge, attitudes, and practices (KAP) regarding fluorosis management. Participants displayed a range of understanding and engagement with respect to concepts related to fluorosis and knowledge deficits and variation in diagnostic skills and treatment preferences were apparent. Despite overall favourable attitudes toward fluorosis prevention and control, more focused educational intervention to improve dental professionals' competence in fluorosis management is urgently needed. Inclusion of fluorosis in the dental curriculum and a practical session for diagnosis and treatment could provide a better resolution. Maintaining interdisciplinary collaboration with other healthcare providers, policy makers and local community will help in establishing effective preventive measures and safe drinking water supply at a place affected with fluorosis. For practicing dentists, CYS professional development opportunities are paramount to keep them aware of best evidence-based practices in managing fluorosis. Public awareness campaigns are also needed in order to inform communities about the origins, risks, and prevention of fluorosis, so people are better equipped to protect their oral health. This study contributes to the field by highlighting crucial disparities recognized in dental education and practice and proposing pragmatic interventions to improve the management of fluorosis, thereby potentially ameliorating the oral health situation in fluorosis affected areas. If these recommendations are met and a synchronised approach to combat fluorosis is encouraged, then India can bring a substantial substantive difference in the public health burden of fluorosis and the quality of life for affected individuals. Further research should be targeted at enhancing the competence amongst the dental professionals that are in a better position to address the clinical manifest of fluorosis.

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