

# Knowledge Attitude and Practices Regarding Dental Fluorosis among Saudi Subpopulations: A Questionnaire-based Study

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Received on: 02 May 2024; Accepted on: 01 June 2024; Published on: 05 August 2024

## ABSTRACT

**Aim:** This study aims to examine the awareness, attitudes, and perceptions towards dental fluorosis in Hail, Saudi Arabia.

**Materials and methods:** It was an epidemiological study with a descriptive cross-sectional design. Participants meeting the inclusion criteria were recruited from Hail, Saudi Arabia, through a convenient non-probability sampling strategy. The study planned to recruit at least 400 participants. However, ( $n = 419$ ) was obtained during the 2 months of data collection. Data for the present study was collected using a validated questionnaire via Google form by disseminating it to the targeted population using non-probability snowball sampling through various social media platforms. The questionnaire comprised three parts including demographics (6 questions), a knowledge-related section comprised of (6 questions), and attitude relation portion (14 questions).

**Results:** The majority of participants ( $n = 369$ , 88.1%) were willing to undergo treatment for dental improvement. Additionally, most respondents ( $n = 389$ , 92.8%) advocated for government participation in preventive programs and emphasized the importance of raising public awareness. Furthermore, a significant proportion ( $n = 401$ , 95.7%) expressed interest in launching mass public health campaigns to prevent dental fluorosis. Females showed significantly higher awareness levels.

**Conclusion:** The study highlights significant sociodemographic influences on awareness and attitudes towards dental fluorosis. While age, nationality, and income showed no impact, gender and education were significant factors. Despite gaps in knowledge, there was strong support for preventive measures. Esthetic concerns were evident, with high rates of dental consultations and recognition of social stigma. Targeted interventions are needed to address knowledge gaps and promote preventive measures, considering sociodemographic differences and broader social implications.

**Clinical significance:** The findings could be the cornerstone for promoting preventive measures and improving consultation behaviors, ultimately enhancing the overall management and prevention of dental fluorosis in the community.

**Keywords:** Attitude, Awareness, Dental fluorosis, Hail, Knowledge, Saudi Arabia.

*The Journal of Contemporary Dental Practice* (2024): 10.5005/jp-journals-10024-3691

## INTRODUCTION

Dental fluorosis is decreased in mineral contents or hypoplasia and defects in tooth formation of teeth as a result of long-term fluoride exposure during tooth formation, which can lead to discoloration or mottling of the teeth. Dental fluorosis appears as dull, opaque white spots on the enamel, which can progress to develop pits, stripes, or mottling.<sup>1</sup> The opaque portions could get yellow or dark brown stains. In more extreme situations, wider areas of enamel hypoplasia and many pits may emerge, resulting in the loss of the tooth's typical morphology.<sup>2</sup> Fluoride is essential for bone and tooth formation, as well as overall health maintenance. Due to its ability to prevent caries, fluoride is crucial in preventive dentistry. Water naturally contains fluoride, which is a crucial trace component that the body needs.<sup>3</sup> However, excessive use of fluoride beyond recommended levels can lead to toxicity. Excessive fluoride consumption significantly increases the risk of developing dental fluorosis.<sup>4</sup>

The World Health Organization (WHO) establishes 1.5 mg fluoride (F)/L as the recommended maximum concentration in drinking water to prevent dental fluorosis and other health issues. However, local guidelines may set a lower limit, particularly in areas where the overall fluoride intake might exceed 6 mg F/day due to additional sources such as fluoridated dental products, dietary supplements, or naturally fluoridated water. In fluoridated areas,

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**How to cite this article:** Siddiqui AA, Alanazi YA, Almagdawy EA, *et al.* Knowledge Attitude and Practices Regarding Dental Fluorosis among Saudi Subpopulations: A Questionnaire-based Study. *J Contemp Dent Pract* 2024;25(5):405-410.

**Source of support:** Nil

**Conflict of interest:** None

where fluoride is added to the water supply, the concentration is typically maintained around 0.7-1.2 mg/L, which is considered optimal for preventing dental caries while minimizing the risk of dental fluorosis. In non-fluoridated areas, residents may rely on fluoride supplements or other sources to achieve adequate fluoride intake for dental health. It is crucial to balance fluoride intake from all

sources to adhere to the safe limits established by both international and local guidelines, ensuring effective prevention of dental caries without increasing the risk of dental fluorosis.<sup>5</sup> Water fluoridation was introduced in the United States of America (USA) to reduce the prevalence of dental cavities. Even though the objective was met, it was noted that dental fluorosis severity had risen.<sup>6</sup> A meta-analysis conducted in 2020 on the prevalence of dental fluorosis in Saudi Arabia revealed that the country's total prevalence was 46.52%, with the Hail region having the highest incidence of the condition.<sup>7</sup>

Fluoride's negative charge attracts calcium's positive charge, leading to their interaction. Fluoride exposure can cause dental fluorosis, tooth mottling, skeleton fluorosis, and bone deformation in both adults and children since calcium is abundant in teeth and bones.<sup>8-11</sup> Dental fluorosis can be caused by consuming more fluoride than is advised, particularly during the critical period of tooth development, which spans from birth to 8 years of age. Additional usage of fluoride-containing agents such as fluoridated mouthwash, dentifrice, chewing gum, and other products can contribute to excessive fluoride intake during this time, increasing the risk of dental fluorosis. These should be taken very seriously as the main factors that could increase the chance of developing dental fluorosis.<sup>12</sup> The primary concern with dental fluorosis is changes in the appearance of permanent teeth, which typically affect children aged 20–30 months with high fluoride exposure levels. It is also crucial to remember that children are not at risk for fluoride overexposure after the age of approximately 8 years, with the highest risk occurring between 1 and 4 years old.<sup>11,13,14</sup> Fluoride is naturally present in water sources, and its concentration can vary significantly depending on geological factors. In some regions, such as certain parts of Africa, Asia, and the Middle East, natural fluoride levels in groundwater exceed recommended limits, leading to a higher prevalence of dental fluorosis. Saudi Arabia, particularly the Hail region, is known for its unique geological formations that contribute to varying fluoride levels in the water supply.<sup>15</sup> It is critical to determine the level of awareness of the community towards dental fluorosis. So that the preventive measures can be more effective and targeted toward the specific needs of the community. To the best of our knowledge, there have been numerous studies focusing on the prevalence, and severity of dental fluorosis in Hail, but no studies have measured awareness levels in Hail or Saudi Arabia (SA), supporting our aim to assess awareness of dental fluorosis in specific subpopulations.

## MATERIALS AND METHODS

This was an epidemiological study with a descriptive cross-sectional design. Participants meeting the inclusion criteria were recruited from Hail, Saudi Arabia, through non-probability snowball sampling. Ethical approval was applied and approved through the scientific research committee at the Deanship of Research, University of Ha'il, and was granted with approval number H-2024-073 on March 3, 2024. Data for the present study was collected from March 5 to May 5, 2024. The study planned to recruit at least 400 participants. However,  $n = 419$  was obtained during the 2 months of data collection. Participants provided informed consent to participate in the study after reading an information sheet that contained the aims of the study, methodology, and a description of the potential risks. The current study used already existing validated and reliable questionnaires.<sup>11</sup> Prior permission to use the existing questionnaire utilized by Pahuja and Nagar in 2019 was requested and obtained from the corresponding author through email.<sup>11</sup> The questionnaire

comprised three parts: demographics, knowledge regarding fluorosis, and attitude-related questions. Specifically, the demographic section was comprised of six questions (age, nationality, region of residence, gender, level of education, and monthly income level), similarly, six questions to assess knowledge about dental fluorosis (availability of treatment, causes of fluorosis, and sources of information about the ill-effects of excessive fluoride), one question to evaluate practice (consultation with a dentist regarding the appearance of teeth), and thirteen questions to understand attitudes towards dental fluorosis and its prevention (willingness to get treatment, opinions on government actions, perception of teeth appearance, feelings of embarrassment, concern about appearance, impact on smiling, and impact on social gatherings). The questionnaire was administered in English, to ensure credibility. Participants responded by selecting appropriate options in the Google form. Data from the completed questionnaires were automatically compiled in a Google sheets. Incomplete questionnaires and those with multiple answers for a single question were excluded from the analysis to maintain data integrity. Although the present study employed non-probability sampling, still participants were recruited from healthcare setups, community centers, and online platforms to reflect the population of the entire region.

The study included participants who met specific criteria to ensure the validity and relevance of the research. Eligible participants were required to be over 16 years of age, as this ensures they are legally capable of providing informed consent and are generally considered capable of making independent decisions. Additionally, participants had to reside in Hail, Saudi Arabia, or belong to Hail but live in other regions of Saudi Arabia. This was done to ensure that the study population is relevant to the local context, allowing for accurate regional analysis. Furthermore, participants needed to be mentally and physically fit. Mental fitness means having no diagnosed mental health disorders that could impair judgment or cognitive function, while physical fitness implies the absence of physical disabilities that could hinder active participation in the study. The exclusion criteria were equally specific. Individuals under 16 years of age were excluded based on ethical considerations and legal constraints regarding minors' ability to provide informed consent independently. Those not belonging to the Hail region were excluded to maintain the study's geographical relevance and avoid confounding factors from different regions. Lastly, individuals with mental or physical impairments were excluded to ensure all participants could fully understand the study details and participate without additional risks or the need for special accommodations, ensuring the integrity and feasibility of the study.

The present study employed the Statistical Package for Social Sciences (SPSS) software version 21 for Windows to analyze the data. Data was displayed as  $n$  (%) and as figures. For inferential statistics, the Pearson Chi-square test was used. The  $p$ -value  $< 0.05$  was considered statistically significant.

## RESULTS

The majority ( $n = 410$ , 97.9%) of the respondents were over 18 years old. Similarly, the majority of participants ( $n = 410$ , 97.9%) were Saudi citizens; the others ( $n = 9$ , 2.1%) were non-Saudi. In terms of geography, the largest number of the participants were from Hail ( $n = 264$ , 63%), followed by Riyadh ( $n = 35$ , 8.4%), Makkah/Jeddah ( $n = 6$ , 1.4%), AlQaseem ( $n = 15$ , 3.6%), and other regions ( $n = 99$ , 23.6%). Among gender, the male participants were ( $n = 226$ , 53.9%),

whereas the female participants were ( $n = 193, 46.1\%$ ). Academically, a substantial number of participants had university-level education ( $n = 288, 68.7\%$ ), followed by high school degrees ( $n = 68, 16.2\%$ ), diplomas ( $n = 55, 13.1\%$ ), secondary schooling ( $n = 5, 1.2\%$ ), and primary schooling of ( $n = 3, 0.7\%$ ). Financially, most participants reported income below 2000 SAR ( $n = 132, 31.5$ ), followed by

participants ( $n = 112, 26.7\%$ ) with income between 2,000 and 5,000 SAR, individuals having income above 10,000 SAR were ( $n = 91, 21.7$ ) and the least number of participants ( $n = 84, 20\%$ ) reported having income between 5,000 and 10,000 SAR (Table 1).

The results showcased the significant relationship between certain sociodemographic variables and the perception of dental fluorosis. With no significant impacts of age and nationality, questions regarding the knowledge of dental fluorosis indicated that the awareness level was the same across all age-groups and nationalities (Table 2).

Likewise, the region did not show much impact on knowledge of fluorosis-related questions, indicating the same level of awareness irrespective of place. However, "gender" showed a highly significant relation to Q1 and Q2 of knowledge-related questions ( $p = 0.002$ ) and ( $p = 0.017$ ), respectively, which shows, that awareness level was different among males and females in the study population. Concerning educational level as well, a significant relation was observed ( $p = 0.031$ ) with Q1, indicating that people with more education demonstrated more consideration towards dental fluorosis compared to those with less education (Table 2).

However, income level did not seem to influence the knowledge-related questions regarding dental fluorosis, indicating that level of income did not affect the level of awareness. Therefore, this showed that knowledge and awareness of dental fluorosis are not determined by the level of income.

Age and region of residence had no significant associations with attitude-related questions about dental fluorosis, and no differences across different demographic groups were observed. Gender, however, showed a significant relationship with the participant's attitudes towards dental fluorosis for Q2 ( $p = 0.024$ ), which demonstrates gender-related variation among attitudes towards fluorosis prevention (Table 2).

Results demonstrated a significant relationship between nationality and Q2–Q4 of questions about participants' attitudes, which might be explained by different regional perceptions towards fluorosis prevention and the local government involvement in the fluorosis prevention process. With regards to knowledge, the results demonstrated that one-half of the respondents ( $n = 218, 48\%$ ) knew that there are treatments applied to dental problems related to dental fluorosis, but on the other hand, only ( $n = 163, 38.9\%$ ) knew the harmful effects of excessive water fluoride on the human body, total of ( $n = 125, 29.8\%$ ) received information reading ill effects from

**Table 1:** Demographic data

Variable	N (%)
Age-group	
>18 years	410 (97.9%)
<18 years of age	9 (2.1%)
Nationality	
Saudi	410 (97.9%)
Non-Saudi	9 (2.1%)
Region	
Hail	264 (63%)
Riyadh	35 (8.4%)
Makkah/Jeddah	6 (1.4%)
AlQaseem	15 (3.6%)
Others	99 (23.6%)
Gender	
Male	226 (53.9%)
Female	193 (46.1%)
Level of education	
Primary school	3 (0.7%)
Secondary school	5 (1.2%)
High school	68 (16.2%)
Diploma	55 (13.1%)
University degree	288 (68.7%)
Income	
Below 2,000 SAR	132 (31.5%)
2,001–5,000 SAR	112 (26.7%)
5,001–10,000 SAR	84 (20%)
Above 10,000 SAR	91 (21.7%)

**Table 2:** Relationship of knowledge of dental fluorosis with sociodemographic variables

No.	Knowledge questions	Age-group	Nationality	Region	Gender	Level of education	Income
1.	Do you know that treatment is available for such teeth?	0.070	0.256	0.339	0.002	0.031*	0.429
2.	Have you received information about the ill effects of excessive fluoride in water?	0.729	0.084	0.551	0.017*	0.464	0.457
3.	Have you received information about the ill effects of excessive fluoride in water from a dentist?	0.333	0.215	0.077	0.343	0.078	0.981
4.	Have you received information about the ill effects of excessive fluoride in water from the government?	0.110	0.103	0.212	0.869	0.308	0.469
5.	Have you received information about the ill effects of excessive fluoride in water from teachers?	0.956	0.956	0.551	0.712	0.447	0.494

\*p-value obtained from  $\chi^2$  test. \*Statistically significant

**Table 3:** Relationship of attitude of dental fluorosis with sociodemographic variables

No.	Attitude questions	Age-group	Nationality	Region	Gender	Level of education	Income
1.	Are you willing to get treatment done for the appearance of your teeth?	0.939	0.293	0.678	0.993	0.278	0.404
2.	Do you want the government to take any steps for the prevention of dental fluorosis?	0.388	0.021*	0.552	0.024*	0.330	0.314
3.	The government should step up de fluoridation plant for the prevention of dental fluorosis.	0.400	0.076	0.339	0.284	0.731	0.372
4.	The government should make policies for the prevention of dental fluorosis.	0.521	0.007	0.535	0.112	0.932	0.437
5.	The government should launch a mass public health campaign for the prevention of dental fluorosis.	0.521	0.308	0.482	0.268	0.918	0.085

\*Statistically significant of  $p \leq 0.05$

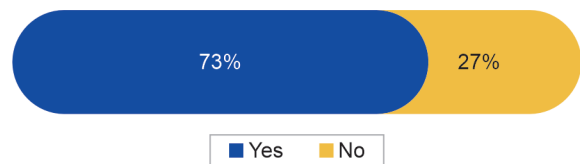
**Table 4:** Knowledge and attitude towards dental fluorosis

Knowledge and attitude related questions	Yes N (%)	No N (%)
<i>Knowledge questions</i>		
Do you know that treatment is available for such teeth?	201 (48.0%)	218 (52.0%)
Have you received information about the ill-effects of excessive fluoride in water?	163 (38.9%)	256 (61.1%)
Have you received information about the ill-effects of excessive fluoride in water from a dentist?	125 (29.8%)	294 (70.2%)
Have you received information about the ill-effects of excessive fluoride in water from the government?	94 (22.4%)	325 (77.6%)
Have you received information about ill-effects of excessive fluoride in water from teachers?	90 (21.5%)	329 (78.5%)
<i>Attitude questions</i>		
Are you willing to get treatment done for the appearance of your teeth?	369 (88.1%)	50 (11.9%)
Do you want the government to take any steps for the prevention of dental fluorosis?	397 (94.7%)	22 (5.3%)
The government should step up defluoridation plants for the prevention of dental fluorosis.	389 (92.8%)	30 (7.2%)
The government should make policies for the prevention of dental fluorosis.	401 (95.7%)	18 (4.3%)
The government should launch a mass public health campaign for the prevention of dental fluorosis.	401 (95.7%)	18 (4.3%)

excessive fluoride from dentists however, ( $n = 94, 22.4\%$ ) received this information while ( $n = 90, 21.5\%$ ) mentioned that they received information from teachers. Awareness campaigns from dentists, government agencies, and teachers were less effective (Table 3).

The participants were supportive of the measures to prevent dental fluorosis. The majority of the respondents ( $n = 369, 88.1\%$ ) have been willing to go through treatment to improve their dental appearance, and the majority of the respondents ( $n = 389, 92.8\%$ ) also demanded government participation in preventive programs. Most of the participants ( $n = 401, 92.8\%$ ) also emphasized raising public awareness and demanded practical steps from the government to initiate interventions like the advancement of defluorination plants and other policies for fluoride prevention (Table 4). Not only that, the latest survey revealed that a large majority of people  $n = 401 (95.7\%)$  wanted to introduce a mass public health campaign to prevent dental fluorosis. The results demonstrated participants' esthetic concerns resulting from fluorosis, as the majority (73%) of the participants consulted dentists for treatment (Fig. 1).

About half (42.2%) of the respondents affirmed that the main cause of dental fluorosis is bad oral hygiene. Notably, people's understanding of fluorosis covered not only issues of appearance but also the stigma related to socializing and smiling confidently (Fig. 2).

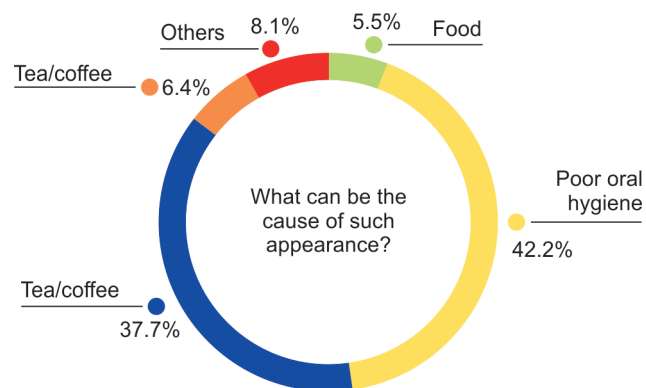


**Fig. 1:** Have you ever consulted any dentist regarding the appearance of your teeth

## DISCUSSION

The study findings provide in-depth information into the level of knowledge, attitude, and perceptions about dental fluorosis among the public. Certain socio-demographic factors (age, region, gender, education level, and income) were examined regarding dental fluorosis awareness and knowledge. Even though most of the sociodemographic factors did not have a significant relationship with the awareness level of dental fluorosis, associations were observed between gender and certain knowledge-related questions. The results are in line with the findings in another study conducted by Tahoori et al. in 2022 in Chennai, India, which stated that awareness levels had constant variations depending on gender, with women revealing a higher level of awareness.<sup>15</sup> The findings of a similar study conducted by Aldaigy et al. in 2019 in Riyadh, Saudi Arabia,





**Fig. 2:** Perceived causes of dental fluorosis

are in line with the current study, which stated that women tend to have more awareness and are more conscious about oral and esthetic procedures.<sup>16</sup> Another study conducted by Alhoberia et al. in 2015 in Hail, Saudi Arabia, highlighted the very high prevalence of dental fluorosis among the general population. The study also highlighted gender-related differences and emphasized the importance of gender-sensitive interventions in public health campaigns targeting dental fluorosis prevention.<sup>17</sup>

Moreover, the results revealed varied attitudes and behaviors of respondents toward dental fluorosis prevention. The difference in respondents' opinions according to age-group and place of residence was not significant. However, gender influenced certain knowledge- and attitude-related questions. The female respondents had more positive attitudes towards the involvement of the government in the prevention of fluorosis. This reflects the significance of integrating gender perspectives into public health projects whose primary aim is to heighten the public's awareness of preventive measures for dental fluorosis. A literature review conducted by Siddiqui et al., in 2017 on Saudi population the review concluded variations in dental fluorosis across different regions and in gender and recommended further conclusive studies among different subpopulations so that fluorosis preventive measure strategies can be formulated.<sup>18</sup> Moreover, the study discovered that residence was the only demographic factor that had a significant association with certain attitude-related questions (Q2 and Q4). The results showed that individuals from different regions of the KSA have varying attitudes regarding fluoride prevention. Additionally, the study explored perceptions and consultation behaviors concerning fluorosis. The majority of respondents visited the dentist after having tooth issues, which provided evidence of professional advice being a preferred source of guidance for dental fluorosis. Siddiqui et al., in their book chapter on oral health in Saudi Arabia in 2021, concluded that the majority of the population seeks professional dental care due to esthetic and other issues related to teeth.<sup>19</sup>

On the one hand, misconceptions were also reported concerning the reasons for dental fluorosis, as the majority of the respondents believe that poor oral hygiene is the main cause of dental fluorosis. The insights from the study indicate the need for educational programs to both clarify the misconceptions concerning dental fluorosis and promote factual knowledge among the public.

From the aspect of public health interventions, the study pointed out the emphasis on targeted approaches like educational campaigns that aim at raising awareness and creating a positive attitude about possible ways and methods of preventing dental fluorosis. The government should play a crucial role in this concern through diverse public health campaigns and policy formulation. These activities provide opportunities for the community to get involved in preventive measures. The collaborative actions between health professionals, policymakers, and community stakeholders are therefore crucial for the success of these initiatives, and health outcomes can be greatly enhanced.

Despite providing valuable insights, the study has its limitations. The data may reflect response bias among respondents. Furthermore, the research was done in a specific geographic region, which may limit the generalizability of the findings to other communities.

To broaden the scope of future research, the effects of targeted interventions, like specific educational campaigns for targeted audiences, could be studied in terms of correcting misconceptions regarding dental fluorosis. Longitudinal studies can further evaluate the lasting benefits of the public health programs and the new oral-care policies on preventive behaviors and health-related general outcomes. Moreover, qualitative studies could reveal the socio-cultural determinants of the public's attitudes towards dental fluorosis and, hence, aid in the creation of tailored programs.

## CONCLUSION

In conclusion, the study underscores the importance of understanding awareness, attitudes, and perceptions of dental fluorosis in the community. Despite variations across sociodemographic factors, there exists a considerable need for targeted public health interventions to improve awareness, correct misconceptions, and promote positive attitudes toward dental fluorosis prevention. By addressing these challenges through collaborative efforts between healthcare professionals, policymakers, and community stakeholders, we can work towards enhancing preventive measures and ultimately improving oral health outcomes for all individuals.

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