

Assessment Of Dental Fluorosis Among Patients At A Northern India District Hospital: A Cross-Sectional Study

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Abstract

Background: Dental fluorosis, a condition caused by excessive fluoride intake during tooth development, is a significant public health concern in regions with high fluoride levels in drinking water. This study aims to assess the prevalence and severity of dental fluorosis among patients at a district hospital in northern India and examine its association with oral hygiene and periodontal disease.

Methods: This cross-sectional study was conducted at the Department of Dentistry, Autonomous State Medical College, Fatehpur, India, over twelve months from June 2022 to June 2023. A convenience sample of 1,879 adult patients aged 18 years and above was recruited. Data were collected using a standardized questionnaire, clinical examinations for dental fluorosis severity using the Thylstrup and Fejerskov Index (TFI), oral hygiene assessment using the Simplified Oral Hygiene Index (SOHI), and periodontal disease diagnosis based on bleeding on probing and probing depth. Statistical analyses were performed using chi-square tests and Spearman correlation coefficients.

Results: The study found that 58.4% of participants exhibited dental fluorosis, with 27.4% having mild and 19.5% having moderate fluorosis. Poor oral hygiene was observed in 14.4% of participants, and 23.8% had periodontitis. Significant associations were found between dental fluorosis severity and oral hygiene status ($p < 0.01$), as well as between dental fluorosis severity and periodontitis ($p < 0.05$). A moderate positive correlation was identified between dental fluorosis and SOHI ($r = 0.34$, $p < 0.01$), and between SOHI and periodontitis ($r = 0.41$, $p < 0.01$).

Conclusion: The study underscores the high prevalence of dental fluorosis in northern India and its association with poor oral hygiene and periodontal disease. These findings highlight the need for comprehensive public health strategies to mitigate fluoride exposure and improve oral health practices among the affected population. Further research with larger, geographically diverse samples and longitudinal studies is recommended to better understand the long-term impacts of dental fluorosis on oral health.

Keywords Dental fluorosis, Oral hygiene, Periodontal disease, Prevalence, India, Public health

Introduction

Dental fluorosis presented a significant public health concern, affecting millions globally [Thylstrup et al., 1987]. This developmental defect of tooth enamel resulted from excessive fluoride intake during the crucial stages of tooth formation [Fejerskov and Young, 2008]. While fluoride offered a well-established benefit in preventing dental caries by strengthening tooth enamel [Ekstrand et al., 2017], exceeding the recommended intake levels led to a spectrum of visible changes in the enamel [Ahuja et al., 2010]. These changes ranged from mild white flecking to severe pitting and discoloration, impacting the aesthetics and potentially the function of the teeth [Susheela et al., 2005].

The severity of dental fluorosis depended on several factors, including the duration, level, and timing of fluoride exposure during childhood [Ekvall et al., 2000]. During tooth development, which primarily occurred between the ages of 6 months and 8 years for permanent teeth, excessive fluoride intake disrupted the enamel mineralization process [Den Besten et al., 2012]. This disruption led to the formation of hypomineralized enamel, which was weaker and more susceptible to aesthetic defects and potential functional issues [Xing Liang et al.201].

India faced a unique challenge regarding dental fluorosis due to natural variations in fluoride levels within its historical groundwater sources [Karthikeyan et al., 2018]. Northern regions of the country were particularly susceptible due to the presence of naturally occurring fluoride-rich soil and rock formations [Meenakshi et al., 2006]. This geological composition likely led to elevated fluoride concentrations in drinking water, a primary source of fluoride intake, increasing the risk of dental fluorosis development in these populations [Choubisa, 2010].

This study aimed to contribute valuable information to our understanding of dental fluorosis in a specific Northern Indian population. We investigated the prevalence of dental fluorosis among adult patients who sought dental care at a district hospital. Additionally, we explored the potential association between the severity of dental fluorosis, oral hygiene status, and the prevalence of periodontal disease within this patient group.

Materials and Methods

Study Design and Setting

This cross-sectional study was conducted at the Department of Dentistry, Autonomous State Medical College, Fatehpur, India. The study spanned one year from June 2022 to June 2023.

Sample Size and Selection

A convenience sample of 1,879 adult patients aged 18 years and above, who sought dental care at the department, were recruited for the study.

Inclusion Criteria

- Age 18 years and above
- Willingness to participate and provide informed consent

Exclusion Criteria

- Pregnant or lactating women
- Patients with a history of systemic conditions affecting oral health (e.g., uncontrolled diabetes mellitus)
- Patients with prior dental fluorosis treatment

Data Collection

- **Questionnaire:** A standardized questionnaire was administered to gather demographic information (age, gender, residence) and medical history.
- **Dental Examinations:** Trained and calibrated dentists conducted visual examinations to assess dental fluorosis severity using the Thylstrup and Fejerskov Index (TFI). The TFI categorizes fluorosis based on the degree of enamel involvement, ranging from no visible changes (score 0) to severe pitting and discoloration (score 4).
- **Oral Hygiene Status:** Evaluated using the Simplified Oral Hygiene Index (SOHI), which assesses plaque accumulation on tooth surfaces.
- **Periodontal Disease Diagnosis:** Conducted through clinical examination based on bleeding on probing (presence of bleeding upon gentle probing of the gums) and probing depth (distance between the gum and the tooth bone).

Data Management and Analysis

Data were anonymized and entered into a password-protected database. Statistical analysis was performed using IBM SPSS version 20. Descriptive statistics summarized demographic characteristics, prevalence of dental fluorosis with different severity levels, oral hygiene status, and periodontal disease prevalence. Chi-square tests analyzed the association between dental fluorosis severity, oral hygiene status, and periodontal disease. The Spearman correlation coefficient assessed correlations between these variables. The level of statistical significance was set at $p < 0.05$.

Results

Table 1 presents the demographic details of the 1,879 participants. The age distribution shows that the largest group is between 31-40 years (27.3%), followed closely by those aged 18-30 years (25.9%). The smallest age group is those aged 61 and above, comprising 8.7% of the sample. Gender distribution indicates a higher number of male participants (54.5%) compared to females (45.5%). Additionally, a slight majority of participants reside in urban areas (54.3%), with the remaining 45.7% living in rural areas.

Table 1: Demographic Characteristics of the Study Population

Demographic Variable	Number of Participants (n=1879)	Percentage (%)
Age (years)		
18-30	487	25.9
31-40	512	27.3
41-50	401	21.3

51-60	315	16.8
61 and above	164	8.7
Gender		
Male	1023	54.5
Female	856	45.5
Residence		
Urban	1021	54.3
Rural	858	45.7

Table 2 details the prevalence and severity of dental fluorosis among the participants using the Thylstrup and Fejerskov Index (TFI). A significant portion of the population, 41.6%, exhibited no signs of fluorosis (TFI score 0). Mild fluorosis (TFI score 1) was observed in 27.4% of participants, while moderate fluorosis (TFI score 2) affected 19.5%. Moderate to severe fluorosis (TFI score 3) was seen in 8.4%, and severe fluorosis (TFI score 4) was present in 3.1% of the participants.

Table 2: Prevalence and Severity of Dental Fluorosis

TFI Score	Number of Participants (n=1879)	Percentage (%)
0 (No fluorosis)	782	41.6
1 (Mild)	514	27.4
2 (Moderate)	367	19.5
3 (Moderate-Severe)	157	8.4
4 (Severe)	59	3.1

Table 3 outlines the oral hygiene status of the study participants, assessed using the Simplified Oral Hygiene Index (SOHI). The data reveals that 36.3% of the participants maintained good oral hygiene (SOHI score 0-1). A fair oral hygiene status (SOHI score 1.1-3) was observed in 49.3% of the participants, while 14.4% had poor oral hygiene (SOHI score 3.1-6).

Table 3: Oral Hygiene Status (SOHI)

SOHI Score	Number of Participants (n=1879)	Percentage (%)
Good (0-1)	683	36.3
Fair (1.1-3)	926	49.3
Poor (3.1-6)	270	14.4

Table 4 provides information on the prevalence of periodontal disease among the participants. According to clinical examination, 39.5% of the participants showed no signs of periodontal disease. Gingivitis, indicated by bleeding on probing, was present in 36.7% of the participants. Periodontitis, defined by probing depths greater than 4mm, affected 23.8% of the study population.

Table 4: Prevalence of Periodontal Disease

Periodontal Condition	Number of Participants (n=1879)	Percentage (%)
No periodontal disease	743	39.5
Gingivitis (bleeding on probing)	689	36.7
Periodontitis (probing depth >4mm)	447	23.8

Table 5 shows the results of chi-square tests analyzing the associations between dental fluorosis severity, oral hygiene status, and periodontal disease. The analysis reveals a significant association between dental fluorosis severity and oral hygiene status (chi-square value 18.64, $p < 0.01$). There is also a significant association between dental fluorosis severity and periodontitis (chi-square value 12.45, $p < 0.05$). Additionally, a significant relationship exists between oral hygiene status and periodontitis (chi-square value 20.32, $p < 0.01$).

Table 5: Association Between Dental Fluorosis Severity, Oral Hygiene Status, and Periodontal Disease

Variable Comparison	Chi-Square Value	p-value
Dental Fluorosis vs. SOHI	18.64	<0.01
Dental Fluorosis vs. Periodontitis	12.45	<0.05
SOHI vs. Periodontitis	20.32	<0.01

Table 6 presents the Spearman correlation coefficients for the relationships between dental fluorosis severity, oral hygiene status, and periodontitis. A moderate positive correlation was found between dental fluorosis and SOHI (correlation coefficient 0.34, $p < 0.01$), indicating that higher fluorosis severity is associated with poorer oral hygiene. There is also a significant positive correlation between dental fluorosis and periodontitis (correlation coefficient 0.28, $p < 0.05$), and a stronger correlation between oral hygiene status and periodontitis (correlation coefficient 0.41, $p < 0.01$), suggesting that poorer oral hygiene is linked to higher prevalence of periodontitis

Table 6: Correlations Between Variables

Variables Compared	Spearman Correlation Coefficient	p-value
Dental Fluorosis and SOHI	0.34	<0.01
Dental Fluorosis and Periodontitis	0.28	<0.05
SOHI and Periodontitis	0.41	<0.01

Discussion

This study investigated the prevalence of dental fluorosis, oral hygiene status, and periodontal disease among adult patients attending a district hospital in Northern India. The findings highlight concerning public health issues and potential interactions between these factors.

Dental Fluorosis Prevalence and Severity

The observed prevalence of dental fluorosis (58.4%) aligns with studies conducted in regions with high fluoride levels in drinking water (Karthikeyan et al., 2018). The dominance of mild to moderate fluorosis (TFI scores 1-2) is consistent with findings by Susheela et al. (2005) in a similar population in India. However, even a small percentage (3.1%) with severe fluorosis (TFI score 4) underscores the urgency for public health interventions to control fluoride exposure, as emphasized by Choubisa (2010).

Several studies support the link between high fluoride levels and fluorosis severity. Aykut et al. (2006) found a significant association between increased water fluoride concentration and higher TFI scores in Turkey (Aykut et al., 2006). Similarly, a meta-analysis by Li et al. (2017) analyzing data from various countries demonstrated a dose-dependent relationship between fluoride intake and dental fluorosis prevalence (Li et al., 2017). Yin et al. (2018) suggest genetic polymorphisms may influence how individuals metabolize fluoride and contribute to fluorosis risk (Yin et al., 2018).

Oral Hygiene and Periodontal Disease

The finding that a significant proportion (63.7%) of participants had fair to poor oral hygiene (SOHI scores 1.1-6) aligns with observations in other studies conducted in India (Ahuja et al., 2010). Poor oral hygiene is a well-established risk factor for periodontal disease, as evidenced by the high prevalence (60.5%) observed in this study. This aligns with findings by Beck et al. (1996) who reported a strong association between poor oral hygiene and periodontitis (Beck et al., 1996). Furthermore, research by Al-Zahrani et al. (2012) suggests that poor oral hygiene can exacerbate inflammatory responses in the gums, leading to faster progression of periodontal disease (Al-Zahrani et al., 2012).

Interactions Between Factors

The significant associations identified between dental fluorosis severity, oral hygiene status, and periodontal disease suggest potential interactions. Participants with higher fluorosis severity tended to have poorer oral hygiene (chi-square value 18.64, $p < 0.01$) and a higher prevalence of periodontitis (chi-square value 12.45, $p < 0.05$). These findings partially support the notion that fluorosis may contribute to oral hygiene challenges and periodontal health, as suggested by Choubisa (2010). However, the moderate positive correlations observed (Spearman correlation coefficient 0.34 for fluorosis and SOHI, 0.28 for fluorosis and periodontitis) indicate a complex relationship requiring further investigation. The stronger correlation between poor oral hygiene and periodontitis (correlation coefficient 0.41) emphasizes the critical role of good oral hygiene practices in preventing gum disease.

Several studies have explored the potential link between fluorosis and periodontal health. While some, like Twetman et al. (1984), found no association between fluorosis and periodontitis (Twetman et al., 1984), others suggest a possible influence. For instance, a study by Wei et al. (2012) in China reported a higher prevalence of periodontitis in individuals with fluorosis (Wei et al., 2012). The mechanisms underlying this potential association are not fully understood. One hypothesis suggests that changes in enamel structure caused by fluorosis may create a more favorable environment for

plaque accumulation and bacterial growth, ultimately contributing to gum inflammation (Lussi & Choubisa, 2006). Further research is needed to elucidate these potential mechanisms and determine if fluorosis severity plays a role.

Public Health Implications:

The study's findings highlight the urgency for multi-pronged public health strategies to address dental fluorosis and its associated oral health problems. These strategies could include:

- Implementing safe drinking water initiatives and public awareness campaigns to reduce fluoride exposure, as emphasized by Meenakshi et al. (2006).
- Enhancing oral hygiene education and promoting regular brushing practices to prevent and control periodontal disease, as recommended by Ekvall et al. (2000).
- Ensuring regular dental check-ups and providing effective treatments to manage fluorosis and its complications.

By addressing these critical issues, we can work towards improving oral health outcomes in this population and similar settings with high fluoride exposure

Limitations

The study's limitations include the use of a convenience sample, which may limit the generalizability of the findings. Additionally, the cross-sectional design prevents the establishment of causal relationships between variables. Future research should consider longitudinal studies to better understand the causal pathways and long-term impacts of dental fluorosis on oral health.

Conclusion

This cross-sectional study examined the occurrence of dental fluorosis and its potential association with oral hygiene and periodontal disease among patients at a district hospital in northern India. The findings provide crucial data for understanding the public health burden of fluorosis and its impact on oral health in this region. To enhance the generalizability of these results, further research with larger, more geographically diverse samples is recommended. Additionally, longitudinal studies could offer valuable insights into the long-term effects of fluorosis on oral health outcomes.

The study highlights the significant prevalence of dental fluorosis among patients in northern India and its association with poor oral hygiene and periodontal disease. Addressing these issues through comprehensive public health strategies is essential to improving the overall oral health of the affected population.

Further Research

This study opens doors for further research in the following areas:

- Investigating the impact of fluorosis severity on oral health-related quality of life.
- Exploring the potential influence of socioeconomic factors and dietary habits on fluorosis prevalence.
- Evaluating the effectiveness of various preventive and management strategies for dental fluorosis in the Northern Indian population.

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