







# Prevalence of Dental Caries and Dental Fluorosis among 7-12-Year-Old School Children in an Indian Subpopulation: A Cross-Sectional Study

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**Academic Editor:** Alessandro Leite Cavalcanti

**Received:** 20 June 2020 / **Review:** 26 August 2020 / **Accepted:** 21 September 2020

**How to cite:** Aggarwal C, Sandhu M, Sachdev V, Dayal G, Prabhu N, Issrani R. Prevalence of dental caries and dental fluorosis among 7-12-year-old school children in an Indian subpopulation: a cross-sectional study. *Pesqui Bras Odontopediatria Clín Integr.* 2021; 21:e0141. <https://doi.org/10.1590/pboci.2021.031>

## ABSTRACT

**Objective:** To assess the prevalence of dental caries and fluorosis among 7-12-year-old school children in Muradnagar, India. An additional objective was to determine the relationship between dental caries and fluorosis in the studied population. **Material and Methods:** A total of 1500 school children aged between 7 to 12 years, and both genders were randomly selected for the present study. The selected participants were divided into three groups based upon age, viz 7-8 year (group I), 9-10 year (group II) and 11-12 year (group III). Sterile mouth mirrors and explorers were used for the detection of caries. The water samples were collected to assess the fluoride concentration. The data collected were tabulated and statistically analysed using Chi-square, ANOVA, Spearman's correlation and t-test wherever applicable. **Results:** Out of 1500 participants, 54.1% were females and 45.9% were males. The prevalence of dental caries and fluorosis was 89.3% and 93.7%, respectively. The prevalence of caries increased with age ( $p < 0.05$ ) and females showed a higher prevalence in both the dentitions. Most dental fluorosis was 'very mild' (40.1%). Prevalence of dental fluorosis increased with age and males showed more fluorosis than females. A negative relationship was found between dental caries and fluorosis ( $p < 0.05$ ). **Conclusion:** Dental caries and fluorosis are the public health problems in Muradnagar; therefore, preventive programs should be organized to increase awareness among the general people.

**Keywords:** Stomatognathic Diseases; Fluorosis, Dental; Epidemiology.

## Introduction

Despite remarkable achievements in the oral health of populations globally, problems still remain in many communities worldwide, especially among underprivileged groups in many countries. Among the major oral health problems, dental caries is the most common disease [1,2]. Although a declining curve in dental caries among children in highly developed countries is observed that could be related to better oral health behaviors and higher socio-economic status of parents [3], still certain developing countries have reported an increase in dental caries. This is mainly attributed to the economic, political, and social changes in the developing countries that significantly impact diet and nutrition, with a shift from traditional to a more westernized lifestyle leading to increased availability and consumption of refined sugars [4].

Fluoride is considered as a double-edged agent, where its consumption in small quantities (<0.5 mg/l) is found to be beneficial for teeth, whereas ingestion of higher concentrations (>1.5 mg/l) may cause fluorosis [5,6]. Studies have reported that there are four sources that increase the risk for dental fluorosis, viz: fluoridated drinking water, fluoride supplements, fluoride paste and formula prescribed for children [6].

Oral health-related quality of life (OHRQoL) in children is affected by endogenous factors like children's oral health behaviors, children's dental anxiety, dental caries and exogenous factors such as parental socio-economic status, parental oral health behaviors, parental dental anxiety, and non-carious dental problems. This association has been concluded in a recent study where OHRQoL was related to parental socio-economic status, dental anxiety, and oral health behaviors. Additionally, it was found that parental dental anxiety had the strongest direct effect on OHRQoL whereas children's oral health behaviors had the strongest indirect effect [7].

The high prevalence of dental caries and fluorosis in children makes them a focus group of public healthcare due to the negatively affected oral health. This can also lead to social and psychological problems [8]. Hence oral health diseases and disorders can negatively affect a child's life. Therefore, the need to focus on their prevention is a matter of urgency.

India is one of the 23 nations worldwide where major health issues are reported due to excess intake of fluoride. Around 17 states in India are endemic to dental fluorosis. National oral health survey and fluoride mapping in India found the prevalence of dental caries among 12 and 15-year-old children to be 53.8% and 63.1%, respectively [9].

To the best of the authors' knowledge, no epidemiological study has been conducted in Muradnagar on dental fluorosis; therefore, an attempt was made in the present study to further enhance the knowledge on dental caries and fluorosis in school children in Muradnagar area of Ghaziabad district. The aim was to assess the prevalence of dental caries and fluorosis among 7-12-year-old school children in Muradnagar, India. An additional purpose was to determine the relationship between dental caries and fluorosis in the studied population.

## Material and Methods

### Study Design

This cross-sectional study was conducted among 7-12-year-old school children in Muradnagar, India, from May 2014 to March 2015. Ethical clearance was received from the Institutional Review Board and all the procedures in this study were in compliance with the Helsinki Declaration (Protocol No. ITSCDSR/IIEC/2012-15/PEDO/01). The parents/guardian signed the informed consent form containing information about the details of the study.

### Sample Population, Size and Characteristics

Sample size estimation was determined based on the results of a pilot study that was conducted on a convenience sample (n=100) of school children, which showed a prevalence of dental caries to be 60%. Based on this, the desired sample size was estimated to be 1474 with an absolute precision of 5% and a 95% confidence interval. So a total of 1500 participants were enrolled for this study.

Lists of all schools were obtained from the District Educational Office of Ghaziabad district. A total of 1500 participants were randomly selected from the list obtained. The selected schools were listed, and permission to conduct the study in these schools was obtained from the school principals, who were requested to get the parents/guardians' consent. Prior information was provided for school principals and students about the date and time of the data collection. The inclusion criteria considered were: 1) all 7-12 years old children present on the day of clinical examination; 2) children with at least more than 50% of the crown erupted and no fillings on surfaces to be recorded; 3) children who consumed the same source of drinking water from birth to the day of examination; and 4) parents/ guardians who consented for the study. Children with orthodontic brackets or crowns were excluded from the study.

According to age, the selected participants were grouped as follows: Group I: Participants aged between 7-8 years; Group II: Participants aged between 9-10 years, and Group III: Participants aged between 11-12 years. Information was collected via a predesigned structured questionnaire, which included demographic variables such as name, age, gender, date of birth, school address, and drinking water source.

### Clinical Examination

A single trained and calibrated investigator carried out a comprehensive clinical examination throughout the study. The students were examined at the school premises during the normal working hours of school. Children were comfortably made to sit in an upright position on an ordinary chair towards natural light source in their classroom and oral examination was conducted using sterile mouth mirrors and explorers. Dental fluorosis was recorded based on standard codes and criteria of modified Dean's fluorosis index [10] and the caries status (dmft and DMFT) was recorded based on WHO Oral Health Assessment Form [11].

### Sources of Drinking Water

A common public drinking water supply system was available in the villages. In this system, water was pumped from the bore well into a storage tank, whereas taps were provided near the tanks. Other sources of water in other villages were municipal taps, deep bore and underground water.

### Fluoride Estimation in Drinking Water

500 ml plastic bottles that were doubly rinsed with distilled water were used for collecting the water samples from the different villages. They were coded and sent to the laboratory for fluoride estimation on the same day, where the test was done by Ion Electrode Method.

### Statistical Analysis

The recorded data were analyzed using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) version 13.0. Descriptive statistics were used to summarize the data regarding demographic characteristics. The influence of demographic characteristics on caries and fluorosis was tested using Chi-square test, independent sample t-test and One-Way ANOVA wherever applicable. Spearman rank correlation was applied to analyze the relationship between decayed teeth and dental fluorosis. The level of statistical significance was set at  $p < 0.05$ .

## Results

Out of 1500 school children, 54.1% were females and 45.9% were males. Females were 16.7%, 30.0%, 53.2% and males were 19.8%, 44.0% and 36.2% in group I (7-8 years), group II (9-10 years), and group III (11-12 years), respectively (Table 1).

**Table 1. Distribution of studied population by age and gender.**

| Age Groups  | Male       | Female     | Total        | p-value |
|-------------|------------|------------|--------------|---------|
|             | N (%)      | N (%)      | N (%)        |         |
| 7-8 Years   | 136 (19.8) | 136 (16.8) | 272 (18.1)   | <0.001* |
| 9-10 Years  | 303 (44.0) | 244 (30.0) | 547 (36.5)   |         |
| 11-12 Years | 249 (36.2) | 432 (53.2) | 681 (45.4)   |         |
| Total       | 688 (45.9) | 812 (54.1) | 1500 (100.0) |         |

The prevalence of subjects (7-12 years) with caries experience was 89.3%. Chi-square test for age-wise comparison of dental caries revealed a significant ( $p < 0.05$ ) increase in the prevalence of caries (combined for primary and permanent dentition) with the advancement of age as the prevalence of caries in group I was 79.0%, in group II was 91.3% and in group III was 91.5%.

Gender wise comparison in the prevalence and pattern of distribution of caries showed higher dmft/DMFT scores in females along with the higher prevalence of dental caries for both primary (63.8% vs. 55.2%) and permanent (82.3% vs. 81.8%) dentitions as compared to the males. The 'decayed teeth' component almost fully contributed to the dmft, with virtually no 'missing' or 'filled teeth'. Out of 812 females, 730 females had decayed teeth in which a maximum number of females (233 - 28.7%) had two decayed teeth, followed by 120 (14.8%) females who had four numbers of decayed teeth and only 2 (0.2%) females had eight numbers of decayed teeth. Similarly, out of 688 males, 609 males had decayed teeth in which a number of males (190 - 27.6%) had two decayed teeth followed by 114 (16.6%) males who had one number of decayed teeth and only 1 (0.1%) male had maximum eight number of decayed teeth. Table 2 and 3 show the gender-wise distribution of dmft/DMFT values for primary and permanent dentitions, respectively.

**Table 2. Gender wise distribution of dmft scores in primary dentition.**

| Gender | dmft Score |            |            |            |            |            | dmft<br>Mean ± SD | p-value |
|--------|------------|------------|------------|------------|------------|------------|-------------------|---------|
|        | 0<br>N (%) | 1<br>N (%) | 2<br>N (%) | 3<br>N (%) | 4<br>N (%) | 5<br>N (%) |                   |         |
| Female | 294 (36.2) | 208 (25.6) | 210 (25.9) | 81 (10.0)  | 18 (2.2)   | 1 (0.1)    | 1.17 ± 1.10       | 0.03*   |
| Male   | 308 (44.8) | 144 (20.9) | 142 (20.6) | 81 (11.8)  | 13 (1.9)   | 0 (0.0)    | 1.05 ± 1.13       |         |
| Total  | 602 (40.1) | 352 (23.5) | 352 (23.5) | 162 (10.8) | 31 (2.1)   | 1 (0.1)    |                   |         |

The prevalence of dental fluorosis was found to be 93.7%. Most of the school children had 'very mild' fluorosis for all three age groups. These findings were statistically insignificant ( $p > 0.05$ ). There were no marked gender-related differentials and both the genders had a high prevalence of 'very mild' fluorosis, whereas the 'severe' fluorosis was observed only in a negligible proportion. These findings were statistically insignificant ( $p > 0.05$ ). On applying the One-Way ANOVA test for the dependency of water source with fluorosis index, a statistically insignificant finding was noted as no marked difference was noted in fluorosis index between the deep bore underground water and tap water. Table 4 shows the studied population's distribution according to modified Dean's fluorosis index and different variables.

**Table 3. Gender wise distribution of DMFT scores in permanent dentition.**

| Gender | DMFT Score |            |            |            |           |          |         |         |         | DMFT Mean ± SD | p-value |
|--------|------------|------------|------------|------------|-----------|----------|---------|---------|---------|----------------|---------|
|        | 0          | 1          | 2          | 3          | 4         | 5        | 6       | 7       | 8       |                |         |
|        | N (%)      | N (%)      | N (%)      | N (%)      | N (%)     | N (%)    | N (%)   | N (%)   | N (%)   |                |         |
| Female | 144 (17.7) | 136 (16.8) | 288 (35.6) | 153 (18.9) | 69 (8.5)  | 13 (1.6) | 7 (0.9) | 0 (0)   | 2 (0.2) | 1.94 ± 1.32    | 0.07    |
| Male   | 129 (18.8) | 158 (23.0) | 208 (30.2) | 119 (17.3) | 58 (8.4)  | 12 (1.7) | 2 (0.3) | 1 (0.1) | 1 (0.1) | 1.82 ± 1.32    |         |
| Total  | 273 (18.2) | 294 (19.6) | 496 (33.1) | 272 (18.2) | 127 (8.5) | 25 (1.7) | 9 (0.6) | 1 (0.1) | 3 (0.2) |                |         |

**Table 4. Distribution of school children according to age group, gender and source of water regarding modified Dean's fluorosis index.**

| Modified Dean's Fluorosis Index | Age Group          |                     |                      | Gender          |               | Source of Water    |                            |
|---------------------------------|--------------------|---------------------|----------------------|-----------------|---------------|--------------------|----------------------------|
|                                 | 7-8 Years<br>N (%) | 9-10 Years<br>N (%) | 11-12 Years<br>N (%) | Female<br>N (%) | Male<br>N (%) | Tap Water<br>N (%) | Underground Water<br>N (%) |
| Normal                          | 28 (10.3)          | 29 (5.3)            | 37 (5.4)             | 60 (7.4)        | 34 (4.9)      | 48 (7.1)           | 46 (5.6)                   |
| Questionable                    | 81 (29.8)          | 168 (30.7)          | 198 (29.1)           | 232 (28.6)      | 215 (31.2)    | 207 (30.5)         | 240 (29.2)                 |
| Very Mild                       | 114 (41.9)         | 219 (40.0)          | 269 (39.5)           | 327 (40.3)      | 275 (40.0)    | 268 (39.5)         | 334 (40.7)                 |
| Mild                            | 33 (12.1)          | 101 (18.5)          | 138 (20.3)           | 153 (18.8)      | 119 (17.3)    | 122 (18.0)         | 150 (18.3)                 |
| Moderate                        | 11 (4.0)           | 26 (4.8)            | 38 (5.6)             | 34 (4.2)        | 41 (6.0)      | 32 (4.7)           | 43 (5.2)                   |
| Severe                          | 5 (1.8)            | 4 (0.7)             | 1 (0.1)              | 6 (0.7)         | 4 (0.6)       | 2 (0.20)           | 8 (1.0)                    |
| Total                           | 272                | 547                 | 681                  | 812             | 688           | 679                | 821                        |
| Test value (f-ratio)            |                    | 1.05                |                      |                 | 0.09          |                    | 0.12                       |
| p-value                         |                    | 0.4                 |                      |                 | 0.8           |                    | 0.7                        |

**Table 5. Relationship between dental caries and fluorosis.**

| Modified Dean's Fluorosis Index | Decayed Teeth |            |            |            |            |            |           |          |         | Total<br>N (%) |
|---------------------------------|---------------|------------|------------|------------|------------|------------|-----------|----------|---------|----------------|
|                                 | 0             | 1          | 2          | 3          | 4          | 5          | 6         | 7        | 8       |                |
|                                 | N (%)         | N (%)      | N (%)      | N (%)      | N (%)      | N (%)      | N (%)     | N (%)    | N (%)   |                |
| Normal                          | 10 (10.6)     | 3 (3.2)    | 12 (12.8)  | 22 (23.4)  | 15 (16)    | 15 (16)    | 13 (13.8) | 4 (4.3)  | 0 (0.0) | 94 (6.3)       |
| Questionable                    | 51 (11.4)     | 84 (18.8)  | 87 (19.5)  | 58 (13.0)  | 65 (14.5)  | 61 (13.6)  | 33 (7.4)  | 8 (1.8)  | 0 (0.0) | 447 (29.8)     |
| Very Mild                       | 66 (11.0)     | 86 (14.3)  | 200 (33.2) | 87 (14.5)  | 68 (11.3)  | 58 (9.6)   | 29 (4.8)  | 6 (1.0)  | 2 (0.3) | 602 (40.1)     |
| Mild                            | 22 (8.1)      | 27 (9.9)   | 91 (33.5)  | 51 (18.8)  | 48 (17.6)  | 27 (9.9)   | 3 (1.1)   | 3 (1.1)  | 0 (0.0) | 272 (18.1)     |
| Moderate                        | 11 (14.7)     | 12 (16)    | 29 (38.7)  | 8 (10.7)   | 9 (12.0)   | 2 (2.7)    | 0 (0.0)   | 3 (4.0)  | 1 (1.3) | 75 (5.0)       |
| Severe                          | 1 (10.0)      | 1 (10.0)   | 4 (40.0)   | 0 (0.0)    | 2 (20.0)   | 0 (0.0)    | 2 (20.0)  | 0 (0.0)  | 0 (0.0) | 10 (0.7)       |
| Total                           | 161 (10.7)    | 213 (14.2) | 423 (28.2) | 226 (15.1) | 207 (13.8) | 163 (10.9) | 80 (5.3)  | 24 (1.6) | 3 (0.2) | 1500 (100.0)   |

The prevalence of fluorosis decreased as the number of decayed teeth increased and Spearman's correlation coefficient ( $r_s = -0.089$ ) for the relationship between decayed teeth and fluorosis index was found to be statistically significant ( $p < 0.05$ ), as shown in Table 5.

## Discussion

Many studies [4,5,12-16] have been done to identify the prevalence of dental caries and fluorosis in different parts of India; however, there has been relatively very few data reported in the literature related to the prevalence of dental caries and fluorosis among children in Muradnagar, so the present study was conducted in school children of 7-12 years. The school children were chosen because of the ease of accessibility and adequate representation of the target population.

In this study, the prevalence of dental caries was 89.3%, increasing with advancing age. Similarly, findings were noticed among 8-13 years old school children where the overall deft/DMFT score increased as the age of the children increased [17]. Also, previous studies revealed similar results [5,18]. The longer exposure of teeth to deleterious oral environment and the disease's irreversible nature may explain the higher prevalence of caries among 12 years group compared to 7 years group.

In this study, it was observed that deft/DMFT scores were more in females in both permanent and primary dentition as compared to their counterparts. This finding is consistent with the study conducted by Sukhabogi et al. [5] and Singh and Singh [19]. Earlier eruptions of teeth, snacking during food preparation, hormonal influences, and amelogenin contribution to caries susceptibility are the few known factors for the higher caries prevalence among females [20].

The prevalence of fluorosis in this study was 93.7%, which was much higher than a study done in Kaiwara Village [21] and Barabanki [22], i.e., 24.0% and 33.37% respectively in northern India. In other studies done in southern India, the prevalence of dental fluorosis was seen as in Kerala [9] (35.6%); Tamil Nadu [20] (31.4%), Davangere [23] (44.6%), Raichur [24] (32.6%), Tamil Nadu [25] (19.2%), Kolar [26] (31.1%); and Khammam District [27] (74.9%). The higher prevalence of fluorosis in Muradnagar raises a concern about public health. In the current study, 'very mild fluorosis' was the most common type of fluorosis, whereas 'severe' fluorosis was the least and these findings are in accordance with other studies [17,26,28].

The current study showed a positive correlation between the age and severity of fluorosis. A similar finding was documented by Kola et al. [4]; Saravanan et al. [20]; Veeresh et al. [23]; Mane et al. [24]; Punitha et al. [27]; Dahiya et al. [29] and Kiran and Vijaya [30]. One possible explanation for lower prevalence in the younger age groups is that the teeth' mineralization in primary dentition occurs in the intra-uterine phase. During this phase, only placental barrier exists prevent the transfer of fluoride to the developing primary teeth. Hence, fluorosis is less prevalent in primary dentition [4].

Moreover, the duration of exposure to fluoride of the enamel during the formation of primary teeth is shorter [26]. Other reasons are the thinner enamel of primary teeth compared to permanent teeth [31] and the rapid fluoride absorption in growing fetus, making it less available for primary teeth [32]. Conversely, the increased physical activity, the greater body size and weight and the type of food consumed may lead to higher water intake and a higher prevalence in older age groups [29].

In the present study, no significant difference in dental fluorosis was noted among genders, which coincides with the findings reported among rural school children in Tamil Nadu [20], Karnataka [24], and Haryana [29]. The reason may be that the males are majority times involved in outer physical activities, which leads to higher water intake, thus a higher prevalence in males. However, in the study done in Kerala [9], the prevalence of fluorosis was more in girls than in boys.









In this study, different concentrations of fluoride were noted in the water obtained from different water sources located closely in the same village. Similar observations were reported by Gopalakrishnan et al. [9] and El-Nadeef et al. [33], where deeper layers of water in bore wells had more fluoride content than superficial layers, and it was also proved in this study. In this study, a higher number of children (54.7%) drank water from deep bore underground water and (45.3%) from tap water. Further most common fluorosis observed was 'very mild' for both the deep bore underground and the tap water. This result was inconsistent with Shanthi et al. [27], who found that the number of children with fluorosis was highest in children who consume water from bore wells.

Furthermore, in the current study, it was found that as fluorosis increased, the number of decayed teeth decreased and the linear correlation between decayed teeth and fluorosis index was statistically significant. This finding is in accordance with the studies conducted by Kola et al. [4]; Tuli et al. [17] and Shanthi et al. [27], whereas a study done by Wondwossen et al. [34] found that dental caries increased with dental fluorosis in both 'moderate' and 'high' fluoride area. Many authors explained the possible reasons for this phenomenon. According to Subbareddy et al. [35], the altered morphology of the fluorotic teeth facilitates plaque accumulation and food lodgement, leading to initiation of dental caries. Once initial caries occurred in the severely fluorotic tooth, it progresses very fast, leading to total destruction of the tooth structure. On the other hand, Kotecha et al. [12] and Ramesh et al. [36] found no significant relationship between dental caries and fluorosis. Thus, the relation between fluoride concentrations in drinking water with dental caries is inconsistent.

## Conclusion

The 'very mild' form of dental fluorosis is prevalent in Muradnagar and dental caries is negatively related to dental fluorosis, as noted in the current study. Since children and adolescents were most commonly affected by dental caries and fluorosis; therefore, continuous update of the prevalence of caries and fluorosis is required, and oral health preventive programs need to be focused on them. Additional epidemiological surveys in other areas of Muradnagar are recommended to further enhance the knowledge on the prevalence and correlation of dental caries and fluorosis.

## Authors' Contributions

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All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.

## Financial Support

None.

## Conflict of Interest

The authors declare no conflicts of interest.

## Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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