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# Prevalence of Dental Fluorosis Among Basic School Children Aged (8-14) Years in Sulaymaniyah City

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## Abstract

**Background and objectives:** Fluoride is supported by much scientific evidence for its carious preventing effect. It has an important role in public health, but an excess amount of fluoride results in a condition called fluorosis. This study aimed to determine the prevalence of fluorosis among basic schoolchildren aged eight to fourteen years old in the Sulaymaniyah City/ Kurdistan region of Iraq and find relations of fluorosis with age, sex, and other demographic variables.

**Methods**: in a cross-sectional study design, among 174203, 798 basic schoolchildren were chosen by multistage sampling method in Sulaimaniyah city in October and November 2022 and examined by modified Dean's fluorosis index to assess fluorosis status. A form was also provided to be filled out and signed by the parents, which contained informed consent, demographical background, and information about the study.

**Results**: Of 798 candidates examined, 389 (48.7%) were male and 408 (51.1%) females. The prevalence of fluorosis among participants was 18.54%, and the majority of cases were questionable 69 (47.58%) and very mild fluorosis 69 (47.58%), the rest were mild fluorosis 10 (6.89%), moderate fluorosis 1 (0.68%), and no severe fluorosis. There was a significant difference in fluorosis status between ages ($p<0.001$), but other demographic data have no statistically significant effect on fluorosis status, except for education of the mother p value<0.0001.

**Conclusions:** Dental fluorosis is a public health concern in Sulaymaniyah City, the cause appears to be dietary sources other than drinking water which we recommend to be further investigated before any fluoridation programs.

**Keywords:** Dental public health, Enamel fluorosis, Fluoride, Water fluoridation

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## Introduction

Fluorine ranks as the 13th most abundant element in Earth's crust, making it highly prevalent. It is exceptionally reactive and readily soluble in water, forming fluoride ions.[1] Fluoride, known for its caries-preventing effect, has been extensively studied and supported by scientific evidence. Its introduction into dentistry represents a significant milestone in public health. However, excessive fluoride ingestion can lead to a condition known as fluorosis.[2] Galen's early observations in 131-201 AD marked the first descriptions of fluorosis and dental caries.[3] However, modern understanding of these conditions traces back to Dr. Frederick McKay in 1901. While investigating the "Colorado stain" in Colorado Springs, he identified the condition as mottled enamel. His collaboration with Dr. GV Black led to the publication of the first article on the subject. Dr. OE Martin was among the first to link water supply to enamel defects. Chemist Mr. HV Churchill subsequently discovered elevated fluoride levels in the drinking water of areas with endemic fluorosis. Following these discoveries, Trendley H. Dean conducted a comprehensive investigation into fluorosis across the United States, establishing a direct link between fluoride concentration in drinking water and the severity of enamel fluorosis. Dean also developed Dean's Index, a classification system for dental fluorosis severity.[4,5] Dental fluorosis, also known as enamel fluorosis or mottled enamel, is a condition that affects the teeth, particularly in children under the age of eight. It is caused by the ingestion of excessive amounts of fluoride during the period when the permanent teeth are still developing. Fluoride interferes with the normal maturation and calcification of the enamel, leading to hypo mineralization and discoloration of the enamel surface. Because the maturation of permanent teeth typically completes around the age of eight, only children under this age are at risk of developing fluorosis.[6] Dental fluorosis in primary dentition is often overlooked in the literature due to its milder nature and lower prevalence. This is attributed to the placental barrier that limits fluoride exposure to developing teeth and the shorter duration of tooth formation in primary dentition.[7] The World Health Organization (WHO) recommends a guideline value of around 1.5 mg/liter of fluoride in drinking water. For caries prevention, WHO suggests artificially fluoridating water at levels between 0.5-1.0 mg/liter, fluoride concentrations above this range may lead to dental fluorosis; while drinking water is a major source of fluoride intake, it is not the sole source. Many foods and drinks also contain significant amounts of fluoride. In recent years, there has been an observed increase in fluoride intake by children from various sources, including food, drinks, and toothpaste.[8,9,10] Excessive fluoride intake can lead to various health issues beyond enamel fluorosis. Acute fluoride toxicity, while rare, can be fatal. Chronic fluoride toxicity may result in skeletal fluorosis, as well as thyroid or kidney diseases. These risks highlight the importance of monitoring fluoride levels in water and dental products.[11] Fluorosis at the individual level can lead to aesthetic concerns. Severe cases may require restoration or veneers, while smaller spots can be treated with micro abrasion or bleaching, with the latter being more effective. More recently, resin infiltration has emerged as a highly effective treatment option for fluorosis.[12] Studying fluorosis at the community level is crucial for understanding its prevalence. By analyzing fluoride levels in drinking water and other sources, we can gain valuable insights for planning purposes. This research aims to address the existing gap in the literature,


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particularly the lack of data on fluorosis in Sulaymaniyah City.

## Patients and methods

This is a cross-sectional design that was employed to determine the prevalence of fluorosis in Sulaymaniyah City during October and November 2022. A modified Dean's index was utilized to assess the fluorosis condition, categorizing it into six grades (0: no fluorosis, 0.5: questionable fluorosis, 1: very mild fluorosis, 2: mild fluorosis, 3: moderate fluorosis, 4: severe fluorosis). Examination inside the school premises was conducted using disposable instruments such as mirrors, masks, and gloves.[13] Ages eight to fourteen were selected for fluorosis assessment because this age group makes it easier to detect and less likely to have restorations. Inclusion criteria required children to be born and reside within the city to ensure exposure to fluoride from drinking water and other sources. Additionally, participants must have at least the upper incisors erupted and not received any anterior restoration. The general education directorate in the Sulaymaniyah governorate divided the city center into two education directorates, east and west. For the study year 2022, there were 174,203 students in the basic stage, ranging from first grade (six years old) to ninth grade (14 years old). Ten schools were selected for the study, with four public schools and one private school randomly chosen from each directorate. This information was gathered after an interview with the general director of education of the Sulaymaniyah governorate and then with the head of the statistics department and media & relations department on October 6$^{th,}$ 2022. After that, the random numbers that represent target schools were obtained by the "randomizer" Android application. According to the Epi Info application, the estimated sample size for this population would be 766 participants. The settings were as follows: Expected frequency for the condition: 50%, confidence level: 95%, acceptable margin of error: 5%, cluster: 1, Design effect: 2. An informed consent form was prepared in Kurdish, clearly stating the purpose of the research, inclusion criteria, and voluntarism. Two days before the examination, the form was provided to the school principal and distributed to students from stage three to stage nine. It was required to be signed by one of the parents. Additionally, a phone number was provided on the form to address any questions or notes from the parents. The study proposal, with the attached informed consent form, was presented to the Kurdistan Higher Council of Medical Specialties KHCMS research ethics committee. It has been accepted with the formal letter dated and numbered (July 18th, 2022- 1283). Cohen's kappa statistics were employed to determine intra-examiner and inter-examiner reliability, resulting in values of 0.9 and 0.8, respectively. Data analysis was conducted using IBM SPSS Statistics version 25. Besides descriptive statistics, the chi-square test was used to find the relationship between the degree of fluorosis and the obtained variables, a p value of 0.05 or less was considered statistically significant, and the confidence interval was set at 0.05.

## Results

Of the 798 eligible candidates examined, 389 (48.7%) were male and 408 (51.1%) were female. Fluorosis was detected in 145 (18.54%) candidates, with 71 males and 74 females affected as shown in Figure (1). However, the difference in fluorosis prevalence between the sexes was not statistically significant (P=0.34), Among participants who had fluorosis, 65 (44.82%) had questionable fluorosis, 69 (47.58%) had very mild fluorosis, 10 (6.89%) had mild fluorosis, and only one participant (0.68%) presented with moderate fluorosis, Figure (2).


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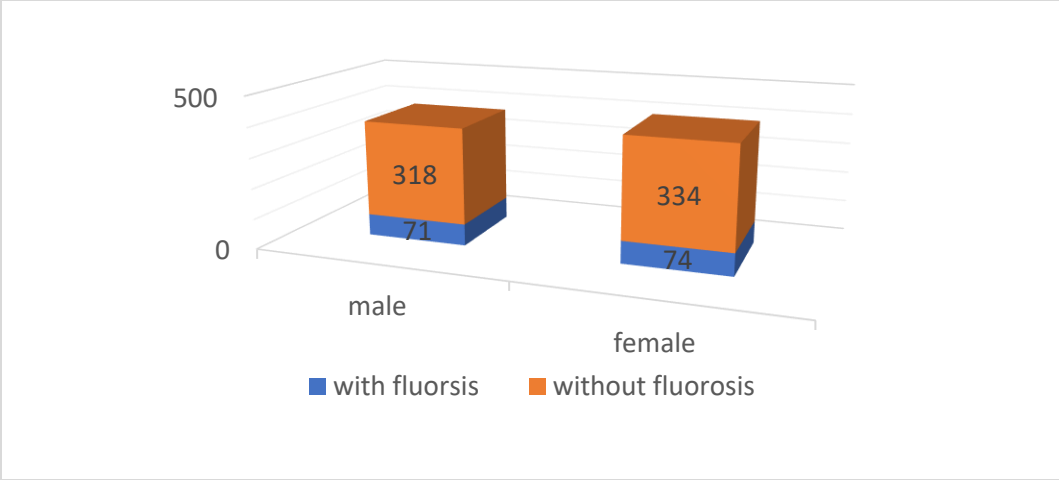


**Figure (1)**: Fluorosis distribution between sexes

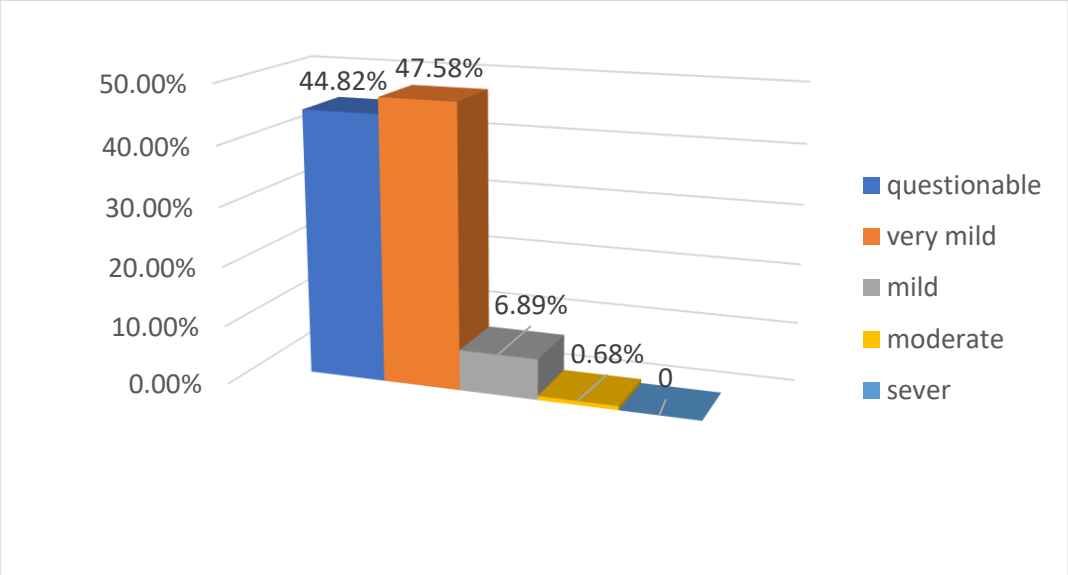


**Figure (2):** Severity of fluorosis among participants who had enamel fluorosis

There was a clear difference in fluorosis status between ages as Table (1) shows, which was statistically significant when analyzed using the chi-square test. Fluorosis status increased with age both in prevalence and severity ($p<0.001$). Moreover, when the fluorosis status was tested with chi-square against other variables, including parents' education and occupation, type and location of the schools, and family income, the results showed that there is no association between the fluorosis status of the children and the mentioned variables except for the occupation of the mother, in which Pearson chi-square scored p value<0.0001. Table (2) shows the statistical significance of the relationship between the fluorosis status and the demographical variables in the Pearson chi-square test.


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**Table (1):** Distribution of fluorosis status across the ages

| | | Fluorosis status | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | No fluorosis | Questionable fluorosis | Very mild fluorosis | Mild fluorosis | Moderate fluorosis | |
| Age | 8 | 45 | 2 | 3 | 1 | 0 | 49 |
| | 9 | 96 | 12 | 4 | 0 | 0 | 111 |
| | 10 | 97 | 8 | 13 | 2 | 0 | 120 |
| | 11 | 93 | 5 | 11 | 1 | 0 | 109 |
| | 12 | 81 | 9 | 17 | 1 | 0 | 108 |
| | 13 | 108 | 16 | 16 | 2 | 0 | 141 |
| | 14 | 133 | 13 | 5 | 3 | 1 | 155 |
| Total | | 653 | 65 | 69 | 10 | 1 | 798 |

**Table (2):** the relation between fluorosis status and demographical variables.

| Relation of the demographical variables with the fluorosis status | p value |
|---|---|
| Education of the mother | 0.57 |
| Education of the father | 0.99 |
| Occupation of the mother | 0.0001 |
| Occupation of the father | 0.90 |
| Economic status of the family | 0.24 |
| Type of the school | 0.91 |
| Location of the school | 0.54 |

## Discussion

The main purpose of this study was to discover the prevalence of dental fluorosis in the Sulaymaniyah City/ Kurdistan region of Iraq, assess the distribution of fluorosis between ages and sexes, and detect the influence of the family's economic status, education, and occupation on the situation. This study is limited to recording findings among individuals only and neglects the distribution of fluorosis among teeth to focus on the public health impact of this condition. Currently, there is no available data regarding fluorosis status in Sulaymaniyah. In Iraq, when fluorosis is discussed, the main focus and concern is on Sinjar province, where the water concentration of fluoride is (2.05-2.22 ppm), and fluorosis prevalence reaches 97.3%.[6] Difference in fluorosis status among individuals of Sinjar and Talkaif provinces is due to the difference in fluoride concentration in the water source of the two cities.[6] Chandrashekar established a direct correlation between fluorosis and fluoride concentration in drinking water and considers 0.74 ppm or above fluoride concentration to be a considerable risk of dental fluorosis.[14] But, Hong et al. established a relationship between total fluoride intake and the development of fluorosis, this is especially true for children under three. [15] To another extent, Newbrun emphasizes that the only way to calculate total fluoride intake accurately is to calculate all daily foods and beverages besides other sources. He thinks this method may not apply to public health investigations. Still, he does not answer the question of variation in fluorosis degree among individuals or at which level of fluoride intake the fluorosis begins.[16] However, in this study, we depend on two previous investigations to assess fluoride concentration in water. Khursheed in 2015 calculated the fluoride concentration range in


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groundwater all over Sulaymaniyah governorate at (0- 0.157 mg/L), and the mean was (0.055 mg/L).[17] While water from three different projects supplying tap water for the city is estimated to have a fluoride concentration of (0- 0.61 mg/L), and the mean fluoride concentration for the three projects was between (0.2- 0.21 ppm) which changes from area to area and across seasons.[18] The 18.54% fluorosis level in a community like Sulaymaniyah, with below normal fluoride levels in drinking water and which doesn't have any fluoridation scheme, seems a little bit high. There are some reasons for this; first of all, the hot weather in summer makes people, especially children, drink more water, whether from bottled or tap water, increasing total fluoride intake.[19] Another reason is that the extra fluoride comes from sources other than drinking water, like toothpaste, as explained by Brut.[10] In this matter, the tea-drinking habit of Iraqi people which is the most drunk beverage after water, brewed black tea has around 3.5 ppm of fluoride or even more.[20,21] One more reason is the use of amoxicillin during the tooth formation period, which was demonstrated in a prospective study that significantly increases the risk of fluorosis in individuals and it's known that amoxicillin is widely used to treat various infections in children.[22] Finally, another possible explanation could be the misdiagnosis of fluorosis. Other enamel conditions, like molar-incisor hypoplasia, are sometimes misdiagnosed as fluorosis, leading to increased fluorosis count.[13] Dental fluorosis may be attributed to other dietary sources of fluoride than drinking, but establishing a correlation between the fluorosis status and other non-dietary variables is difficult because fluoride is the only variable known to have a causative relationship with dental fluorosis.[23,24] However, Kumar et al. discovered that children from families of middle and low socioeconomic status will suffer more from dental fluorosis, the link we failed to establish in our study.[25] Still, there was a strong statistically significant difference in the occupation of the mothers of children with fluorosis. This fact reflects the same findings of the previously mentioned paper, which related lower education levels of mothers with more fluorosis prevalence. This theory may be taken contrary to the idea that high socioeconomic families buy more fluoridated toothpaste for their children and the result will be more fluorosis incidence.[26] In our study population, the fluorosis status increased both in prevalence and severity with age, but sex doesn't have any significant influence on dental fluorosis like some other previous investigations performed in Iraq.[6] However, plenty of research concluded that sex and other demographical variables also influence the prevalence of dental fluorosis.[26 - 28] Furthermore, Pramanik discovered that when the fluoride level in the water, dietary source of fluoride, and socioeconomic factors are equal, the genetic factor may play a role in the expression of fluorosis among individuals.[29]

## Conclusions

Dental fluorosis is a neglected public health concern in Sulaymaniyah City, this study emphasizes the need for further investigations to understand the sources of fluoride, recommends careful planning before any fluoridation program like water fluoridation, and investigations into local dietary habits for prevention and management of dental fluorosis.

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## Conflict of interest

The authors declare that there is no conflict of interest regarding this article.

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