

Association of Calcium and Vitamin D Supplementation with Dental Fluorosis among Adults in Peshawar, Pakistan

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ABSTRACT

Objective: To evaluate the association between calcium and vitamin D supplementation and the prevalence of dental fluorosis among adults in Peshawar, Pakistan.

Methodology: This cross-sectional study was conducted over two months in Peshawar, Pakistan. Based on its prevalence in the area, a total of 370 participants, recruited from Hayatabad Medical Complex, Peshawar, were evaluated. Detailed history was taken from them according to a preformed history Performa. Participants were examined to check the presence of dental fluorosis. Subsequently, they were divided into two equal groups: Group A (calcium and vitamin D supplement user), and Group B, (not taking any calcium and vitamin D supplements). Data collected was analyzed by IBM SPSS Statistics software, version 22.

Results: Out of the total 370 patients, 195 (52.7%) indicated signs of fluorosis which included white opaque spots, yellow to brown discoloration, and chalky enamel appearance. 65 patients in group A and 130 patients in group B were found to be exhibiting dental fluorosis. The association between supplement use and fluorosis prevalence was statistically significant ($p < 0.001$). A relative risk reduction of 50% was observed among supplement users compared to non-users.

Conclusion: The findings indicate a significant association between calcium and vitamin D supplementation and a lower prevalence of dental fluorosis in adults. However, the cross-sectional design of the study limits us in establishing the causal relationships. Further longitudinal or interventional studies are recommended to explore this association in greater depth.

Keywords: Adults, Calcium, Cross-sectional studies, Dental fluorosis, Vitamin D

Authors' Contribution:

^{1,2}Conception; Literature research; manuscript design and drafting; ^{3,4}Critical analysis and manuscript review; ^{5,6}Data analysis; Manuscript Editing.

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Introduction

Fluoride is an essential trace element that is found in many minerals. Foods such as cheese, seafood, milk or salt contain sufficient amounts of fluoride.¹ Absorption of fluoride occurs in gastrointestinal tract through simple diffusion. Presence of calcium, however, decreases its overall absorption.² Through extensive research it was found that the permissible level of fluoride in the body is 1.5 ppm.³

Water fluoridation is the safest and the most effective method to maintain fluoride level in the body. In Pakistan, optimum level of fluoride in water was found to be 0.35 ppm.⁴ It's benefit in remineralization of weakened enamel by decreasing its critical PH, is well known.⁵ During the phase of tooth development, ameloblasts become very sensitive to fluoride. It is also used as a prophylactic agent to prevent caries. Among various methods of

prophylaxis, topically applied fluoride is the most common. It includes fluoride varnishes, which are the concentrated topical fluoride with a resin base, fluoride containing toothpastes, fluoride gels, fluoride containing mouthwash, fissure sealants etc.⁶ However, fluoride induced toxicity is globally prevailing problem that affects millions of people.⁷ The discovery of fluorosis, or fluoride induced toxicity began in 1901, when a young dentist named Frederick McKay embarked upon his own dental practice in Colorado Springs. During this period, he noticed that the natives had grotesque brown stains on their teeth. In 1909, a dental researcher, Dr. G.V Black came to Colorado Springs to investigate about the unusual appearance of teeth. These were soon coined as Colorado brown stains.⁸ The Colorado Springs Dental Society also found out that about 90% of the native residents, including children as well, had these stains. Then, Dr. H. Trendley Dean from National Institute of Health (NIH) started to investigate fluorosis and its prevalence. He discovered that fluoride levels of 1.0 ppm in water does not have any harmful effect on teeth, however, fluoride levels more than these could potentially cause toxicity called fluorosis. It results in the formation of porosities and irregularities in the enamel subsurface.⁹ The prevalence of dental fluorosis in Peshawar, Pakistan was found to be 40.4% (females =39.14%, and males =42.1%), which mainly depends upon the environmental factors associated with the patient such as water containing fluoride, fluoride supplements and intake of food containing increased amount of fluoride.¹⁰ The aim of the study was to evaluate the association between calcium and vitamin D supplementation and the prevalence of dental fluorosis among adults in Peshawar, Pakistan.

Methodology

This cross-sectional study was carried out in a two months' period in Peshawar, Pakistan. Based on the prevalence of dental fluorosis in the area, a total of

370 participants were evaluated after obtaining an informed consent from. Consecutive convenient sampling was employed where each patient coming to the OPD of Hayatabad Medical Complex, Peshawar, who also met the inclusion criteria, were recruited in the study. The Inclusion criteria encompassed all adult patients (≥ 18 years), regardless of their gender, who self-reported to consume municipal tap water as their primary drinking source, and who were not taking any fluoride supplements or consuming commercially fluoridated bottled water. While participants were selected on the basis of their use of municipal tap water, direct measurements of fluoride levels in the local water supply could not be done, which is acknowledged as a limitation of this study. Moreover, patients suffering from any systemic disease were excluded after informed consent, detailed history was taken, including demographic data, medical history (such as systemic diseases, or current medications), past dental history, and history of present illness. Information regarding the intake of calcium and Vitamin D rich food, as well as the use of dietary supplements was also inquired about. For patients using supplements, data on product name, frequency, and duration of intake was also recorded.

Participants were clinically examined by using a mouth mirror to check the presence or absence of dental fluorosis, by using Dean's Fluorosis Index. For analysis, fluorosis was simply dichotomized as 'present vs absent'.

Subsequently, they were divided into two equal groups:

- Group A: Included patients who were taking calcium and vitamin D supplements, at least 3 times per week, consistently for past 3 months. (n=185)
- Group B: Included patients not taking any calcium and vitamin D supplements. (n=185)

Supplement use was self-reported on the basis of their history.

Data collected were entered and analyzed by using IBM SPSS Statistics, version 22. We computed descriptive statistics for age and sex distribution of participants. Prevalence of dental fluorosis was compared between groups using Pearson's chi-square test. P value < 0.05 was considered statistically significant.

Ethical clearance was obtained from Khyber Medical University, having number: KMU/IPDM/IEC/202535 Dated 10-01-2025.

Results

A descriptive analysis showed that group A included 87 males and 98 females, whereas group B included 92 males and 93 females. The mean age of the participants in group A was 36.5 years, while that in group B was 38.2 years.

Categories	Males	Females	Total participants (n=370)	Mean age in Years
Group A	87	98	185	36.5
Group B	92	93	185	38.2

	Fluorosis present n (%)	Fluorosis absent n (%)	Total
Group A (with supplements)	65 (35.1)	120 (64.9)	185
Group B (without supplements)	130 (70.3)	55 (29.7)	185
Total	195 (52.7)	175 (47.3)	370

Moreover, out of the total 370 patients, 52.7% indicated signs of fluorosis which included white opaque spots, yellow to brown discoloration, and

chalky enamel appearance. 65 patients in group A (having supplements), and 130 patients in group B (without supplements) were found to be exhibiting dental fluorosis. A chi square test was also performed to find the association between the two groups and fluorosis. (Table: I). Moreover, a relative risk reduction was also calculated between the two groups, which was found to be 50%. This implies that there is 50% lesser risk of developing dental fluorosis in Group A taking calcium and vitamin D supplements as compared to the Group B taking no such supplements.

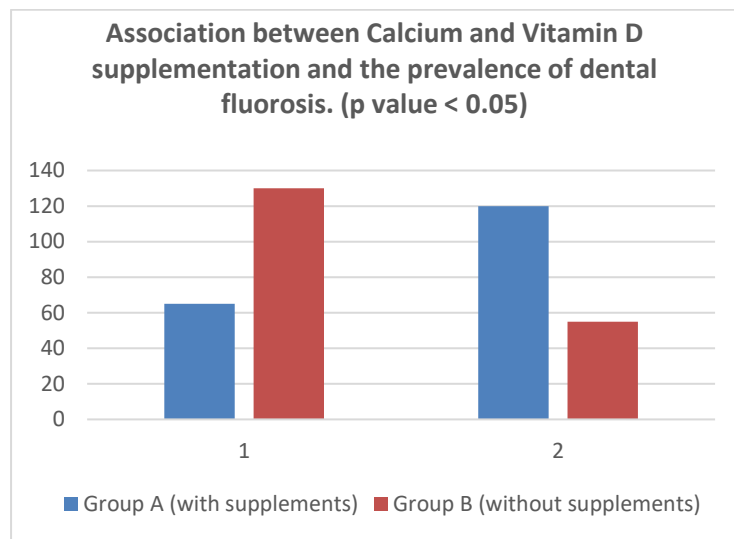


Figure 1: find association between calcium and vitamin D supplementation and the prevalence of dental fluorosis. (p value < 0.05)

Discussion

Fluorosis is a global concern that affect teeth and the skeletal system of an individual. The repercussion of fluoride on enamel formation is dental fluorosis and these effects are cumulative and it depends upon the total fluoride intake from all its resources.¹⁰ In 2025, an Indian study reported that people consuming water that had higher fluoride content were found to have increased calcium levels in 24-

hour urine.¹¹ Another study by Arpan Dey Bhowmik where he performed experiments on Swiss albino mice to assess the alleviation of fluorosis because of calcium and vitamin D supplementation, claims that the mice receiving 2.5-g calcium kg⁻¹ diet and 1000 IU vitamin D kg⁻¹ diet for 4 months had reduced fluoride deposition into the bodies.³

This research aligns with our study as well. Yet, in 2020, a nutrition expert conducted a series of experiments on Wistar rats to check if Calcium and fluoride free water mitigates the skeletal fluorosis. It was, indeed, found that calcium supplements and fluoride free water upregulated the formation of osteocalcin, osteonectin and osteopontin genes that ultimately meant the resolution of skeletal fluorosis.¹² Moreover, an American study by Fiona J. reported an association between secondary hyperparathyroidism and skeletal fluorosis. It was observed that in patients suffering from secondary hyperparathyroidism, the calcium level in the body was fairly low, whereas the fluoride levels were found to be very high in the blood samples. These findings suggest that excess fluoride exposure, combined with calcium deficiency, may possibly contribute to the development and worsening of skeletal fluorosis.¹³

Thus, the findings of these studies are consistent with our research, indicating that calcium and vitamin D play a protective role in reducing the severity of fluorosis. Hence, it is required to regularly monitor the serum concentrations of calcium and vitamin D.¹⁴

Furthermore, several dietary components could also possibly alter the fluoride concentrations in the cells including tamarind seed coat in order to protect lung cells from fluoride toxicity.¹⁵

Conclusion

It is concluded that calcium and vitamin D supplementation was significantly associated with lower prevalence of dental fluorosis, which is a very

serious public health problem that prevails globally. However, due to the cross-sectional nature of the study, these results should be interpreted cautiously as associative rather than causal.

Strengths and Limitations: Strengths include examination of a relatively large outpatient sample and consideration of nutritional supplementation. Limitations include the cross-sectional design of the study, reliance on self-reported supplement use and water source, lack of fluoride quantification and unmeasured confounding (e.g., diet, renal status, socioeconomic factors).

Implications and Future Research: If the observed association is confirmed in prospective studies, public health messaging around adequate calcium and vitamin D intake in fluoride-endemic regions could be considered as an adjunct preventive strategy. Longitudinal cohort studies measuring fluoride concentrations in water, serum, and urine, combined with dietary assessment, are needed to clarify causal pathways. Randomized supplementation trials in high-risk populations may also be informative.

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