

Association of Salivary Vitamin D and Vitamin C Levels with Dental Caries in Children: A Cross-sectional Study

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ABSTRACT

Aim: Dental caries is a prevalent chronic disease affecting children worldwide. This study aimed to investigate the association between dental caries and salivary levels of vitamin D and vitamin C in children.

Materials and methods: This cross-sectional research was conducted at RAK College of Medical Sciences, RAK Medical and Health Sciences University, Ras Al Khaimah, United Arab Emirates, in children between the ages of 4 and 12 years, with a sample of 60 children divided into study and control groups based on the presence or absence of dental caries. Saliva samples were collected, and levels of vitamin D and vitamin C were measured using enzyme-linked immunosorbent assay (ELISA). Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 29.

Results: The results showed that children without dental caries had higher salivary vitamin D and vitamin C levels compared to those with caries.

Conclusion: These findings highlight the potential role of these vitamins in preventing dental caries in children and support the need for public health initiatives promoting optimal oral health through appropriate dietary habits and sun exposure.

Clinical significance: The clinical significance of the study lies in its potential to inform preventive strategies and improve oral health outcomes in children. By recognizing the association between salivary vitamin levels and dental caries, healthcare professionals can take proactive steps to promote better oral health and overall well-being in children worldwide.

Keywords: Children, Dental caries, Saliva, Vitamin D and vitamin C.

International Journal of Clinical Pediatric Dentistry (2024): 10.5005/jp-journals-10005-2902

INTRODUCTION

Dental caries, also referred to as tooth decay or cavities, is a widespread chronic disease affecting children across the globe.^{1,2} This condition arises from the interplay of dental plaque, dietary carbohydrates, and the oral environment. Its consequences can be painful and discomforting, significantly impacting a child's overall well-being and quality of life. With the World Health Organization reporting that tooth or dental decay impacts 60–90% of school-aged children worldwide, it remains a substantial public health concern, especially considering the vulnerability of children due to their developing dentition and behaviors that promote dental plaque buildup and sugar exposure.^{3–5} Over time, researchers and healthcare professionals have focused on various factors contributing to dental caries in children, with two essential vitamins—vitamin D and vitamin C—gaining particular attention for their potential roles in preventing or exacerbating the condition. Vitamin D plays a crucial role in promoting proper tooth development and mineralization, aiding in the absorption of calcium and phosphate necessary for strong tooth enamel formation. Insufficient vitamin D levels can weaken tooth structure, increasing susceptibility to dental caries.⁶ Additionally, vitamin D possesses immunomodulatory properties that reduce inflammation and enhance the body's defense against oral pathogens, further contributing to dental caries prevention.^{7–14} Another vital vitamin, vitamin C or ascorbic acid, acts as a potent antioxidant and is pivotal in maintaining healthy gum tissues.¹⁵ It facilitates collagen synthesis, essential for gum tissue integrity and repair, providing a protective barrier against oral bacteria and preventing their penetration into underlying tooth structures.¹⁶ Inadequate vitamin C intake can lead to gum disease and gingival inflammation, potentially raising the risk of dental caries. Furthermore, vitamin C deficiency

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How to cite this article: Padmanabhan V, Islam MS, Goud M, *et al.* Association of Salivary Vitamin D and Vitamin C Levels with Dental Caries in Children: A Cross-sectional Study. *Int J Clin Pediatr Dent* 2024;17(7):773–776.

Source of support: Nil

Conflict of interest: Dr Vivek Padmanabhan is associated as the International Editorial and Advisory Board member of this journal and this manuscript was subjected to this journal's standard review procedures, with this peer review handled independently of this editorial board member and his research group.

compromises the body's ability to combat oral infections, making children more vulnerable to the development and progression of dental caries.^{16,17} The importance of saliva as a diagnostic resource in healthcare is being more widely recognized due to its easy, noninvasive collection and diverse components. This makes it ideal for evaluating biomarkers associated with numerous health conditions. Salivary diagnostics present opportunities for early disease detection, monitoring disease progression, and personalized treatment plans, significantly transforming healthcare practices.¹⁸ An interesting aspect is the potential synergistic relationship between vitamins D and C in protecting against dental caries. Vitamin D enhances the absorption of dietary vitamin C, supporting the optimal functioning of the immune system and

promoting healthy gum tissues.^{19,20} The combined impact of these factors might result in an oral environment that is less favorable for the proliferation and activity of bacteria that cause cavities. Considering the widespread issue of dental caries in children, it is crucial to understand the connection between vitamins D and C and tooth decay. This knowledge is essential for devising preventive measures and encouraging excellent oral health.²⁰ Emphasizing the role of these vitamins in maintaining healthy teeth and gums allows healthcare professionals to significantly aid in reducing the prevalence of dental caries and enhancing the overall health of children globally. This research aimed to explore the relationship between salivary levels of vitamins D and C in children with and without dental caries. The null hypothesis posited that no connection exists between the salivary concentrations of vitamins D and C and the presence or absence of dental caries in children.

MATERIALS AND METHODS

This research was carried out at RAK College of Dental Sciences (RAKCODS), part of RAK Medical and Health Sciences University (RAKMHSU) in Ras Al Khaimah, United Arab Emirates. The objective was to examine the correlation between dental caries and salivary concentrations of vitamins D and C in children, comparing those with dental caries to those without. The research received approval from the review boards of both the university and the Ministry of Health (proposal/approval number: RAKMHSU-REC-017-2021/22-UG-D, MOHAP/REC/2021/57-2021-UG-D). The study was conducted from January 2022 until March 2023. Children aged 4–12 visiting the RAKCODS pediatric clinics for dental treatment were enlisted for the study with parental consent and child assent. Participants were categorized into two groups based on the presence or absence of dental caries. The study group included 30 children, each with at least five active carious lesions, deliberately chosen to provide a consistent and uniform sample for reliable results. Additionally, a control group of 30 children without any dental caries was included. Appointments for the children were arranged during the standard operating hours of the pediatric dentistry clinic (3:30–6:30 PM) and they were instructed not to eat or drink for at least 2 hours before their visit. To ensure consistency, they were also instructed to rinse their mouths before saliva collection. The coinvestigators received comprehensive training for data recording, dental examinations, and saliva sample collection to minimize bias. With assent and consent from both children and their parents or guardians, unstimulated saliva samples were obtained using the Coachman’s position. During the saliva collection process, participants were instructed to tilt their heads forward slightly, relax, and let saliva flow naturally into a graduated tube over a period of 5 minutes. Following collection, the saliva samples were promptly stored at 4°C in an icebox and transported to the laboratory within 20 minutes. There, they were analyzed using an enzyme-linked immunosorbent assay (ELISA) kit to determine levels of vitamin D and vitamin C.^{19,20} The data-gathering process involved collecting socio-demographic information and details about oral hygiene practices. Dental examinations were conducted prior to any dental procedures. By adhering to these procedures and precautions, the research team aimed to achieve precise and reliable data for the study.

Statistical Analysis

Statistical Package for the Social Sciences (SPSS) version 29 (IBM Corp., 2022) was used to evaluate the data obtained and compare mean salivary vitamin D and vitamin C levels between the control and

study groups. The Mann–Whitney *U* test, a nonparametric statistical test, evaluated differences in their distributions, given the absence of normality assumptions. A *p*-value < 0.05 signified statistically significant differences, implying nonrandom relationships. The statistical analysis sought to understand potential differences in salivary levels of vitamin D and vitamin C between the two groups.

RESULTS

In this study, the researchers aimed to evaluate a cohort of 60 children receiving treatment at pediatric dental clinics. The sample comprised an equal distribution of genders, with 30 girls and 30 boys. Table 1 and Figure 1 examine the average levels of salivary vitamin D in children with active dental caries (study group) vs those without any dental caries (control group). The mean salivary vitamin D level was 13.18 ng/mL in the study group and 18.08 ng/mL in the control group. A reported *p*-value of < 0.0001 (*p* < 0.0001) indicates a statistically significant difference in salivary vitamin D levels between the two groups. Table 2 and Figure 2 compare the average salivary vitamin C levels between children with active

Table 1: Comparison of mean salivary vitamin D levels between study and control group

Group	<i>n</i>	Mean	SD	<i>p</i> -value
Study	30	13.18	3.48	<0.0001
Control	30	18.08	4.87	

The mean salivary vitamin D levels of study group (13.18 ng/mL) are significantly less than those of control group (18.08 ng/mL) and the results are statistically significant (*p*-value < 0.0001)

Table 2: Comparison of mean salivary vitamin C levels between study and control group

Group	<i>n</i>	Mean	SD	<i>p</i> -value
Study	30	0.70	0.16	<0.0001
Control	30	1.23	0.24	

The mean salivary vitamin C levels of study group (0.70 µm/L) are significantly less than those of control group (1.23 µm/L) and the results are statistically significant (*p*-value < 0.0001)

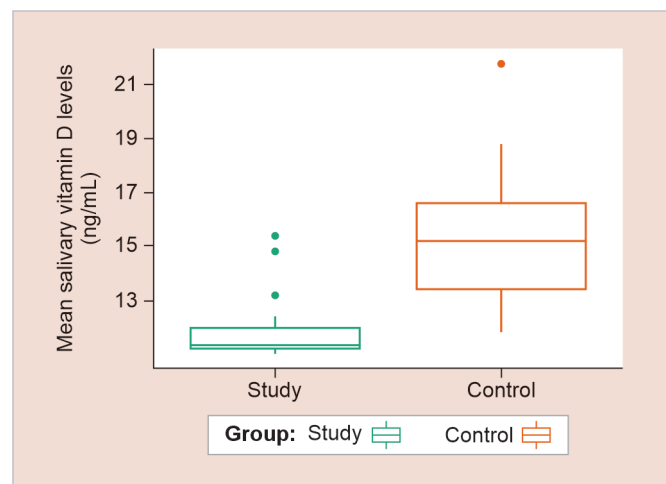


Fig. 1: Box and whisker plot showing the minimum, lower quartile, median, upper quartile, maximum, and outlier values for both the control and experimental groups. This plot demonstrates higher vitamin D values in the control group compared with the study group

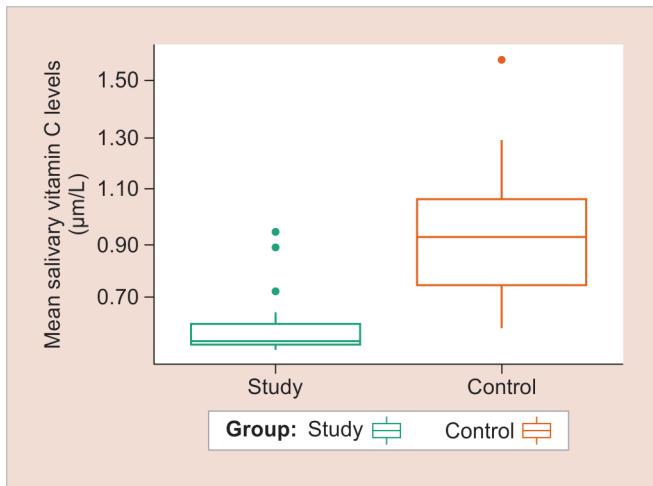


Fig. 2: Box and whisker plot showing the distributions of vitamin C in the control and study groups, which are found to be skewed, indicating a deviation from the normality assumption. A nonparametric test was used to compare the control and experimental groups

dental caries (study group) and those without any dental caries (control group). The mean salivary vitamin C levels were 1.23 µm/L in the control group and 0.70 µm/L in the study group. A reported p -value of <0.0001 ($p < 0.0001$) indicates a statistically significant difference in mean salivary vitamin C levels between the two groups. Overall, the findings of this study suggest a statistically significant relationship between average salivary levels of vitamin D and vitamin C and dental caries, indicating that lower average salivary levels of vitamin D and vitamin C are linked to active caries.

DISCUSSION

The main goal of this study was to investigate the correlation between levels of vitamin D and vitamin C in saliva among children with and without dental caries. The study involved a cohort of 60 children, equally distributed by gender, who were examined. Vitamin D plays a crucial role in facilitating calcium absorption for the development of strong teeth and bones, as well as reducing inflammation and boosting immunity against oral infections.²¹ Similarly, vitamin C acts as a potent antioxidant, supporting gum health and preventing gum disease.^{15,22} By examining the relationship of these essential vitamins, this study explores the influence of vitamin D levels in saliva on oral health among children with and without dental caries. The research revealed that salivary vitamin D levels were significantly higher in children without dental caries compared to those with dental caries (Table 1 and Fig. 1). The findings of this study align with findings from other studies of a similar nature,^{11–13,23} which have revealed that children without dental caries often exhibit elevated salivary vitamin D concentrations compared to those with dental caries. Vitamin D is crucial for maintaining calcium balance and is essential for dental health.^{8,11} It supports the development and maintenance of robust dental structures, while also modulating the immune response and enhancing antimicrobial properties within the oral cavity.¹⁴ A study conducted earlier reported that children with diminished salivary vitamin D levels were at a heightened risk of developing dental caries compared to those with higher levels.⁶ Moreover, reduced vitamin D levels have been linked to increased oral inflammation, potentially contributing to the progression of

dental caries. Scientific investigations have indicated that vitamin D deficiency might compromise the body's immune response, leading to decreased effectiveness in combating oral infections and subsequent dental caries.^{23,24} The results of this study highlight vitamin D's significance in dental health, suggesting that deficiencies could raise the risk of dental caries by compromising immune responses and increasing oral inflammation. However, it's important to recognize that several factors, including exposure to sunlight, dietary intake, and supplementation, can impact vitamin D levels. Therefore, additional investigation is needed to elucidate the exact mechanisms underlying the link between salivary vitamin D levels and dental caries in children. In comparing salivary vitamin C levels between children with and without dental caries, those without dental caries exhibited significantly higher levels of salivary vitamin C than their counterparts with dental caries, highlighting a statistically significant finding (Table 2 and Fig. 2). Studies in the past have shown similar results, suggesting that children with dental caries tend to exhibit decreased values of vitamin C in saliva compared to those without dental caries.^{15,16,21} Vitamin C, or ascorbic acid, is a powerful antioxidant essential for supporting oral health. It helps protect oral tissues from oxidative damage and promotes collagen synthesis, which is crucial for healthy gums and connective tissues in the oral cavity. Vitamin C also supports the immune system, assisting in the defense against oral infections.^{17,18,20} Research indicates that children affected by dental caries exhibit notably lower levels of salivary vitamin C compared to those without cavities. This observation suggests that decreased vitamin C levels could potentially elevate the risk of dental caries.^{18,19} Furthermore, low levels of vitamin C in the oral cavity can compromise the body's ability to combat oral pathogens and contribute to the progression of dental caries.^{23–25} A study highlighted the antimicrobial properties of vitamin C, emphasizing its role in protecting against oral infections and supporting overall oral health.²⁵ It is essential to consider various factors that may influence salivary vitamin C levels, such as dietary habits, overall health, and lifestyle choices. More research is required to clarify the exact mechanisms connecting salivary vitamin C levels and dental caries in children. This study, exploring the correlation between salivary levels of vitamins D and C and their relationship to dental caries, has provided valuable insights into oral health. Nevertheless, it is important to recognize inherent limitations within the research. Firstly, the study's cross-sectional design captures data at a specific moment, making it challenging to establish causality. Longitudinal studies would be more suitable for a comprehensive understanding of the cause-and-effect relationship over time. Secondly, the modest sample size of 60 children might restrict the applicability of the findings to a broader population. A more extensive and diverse sample would provide stronger evidence regarding the correlation between salivary vitamins and dental caries across a wider demographic. Additionally, there might be other factors influencing this association, such as dietary habits, oral hygiene practices, and socioeconomic status, which were not adequately controlled for in the study. The use of salivary levels alone may not fully reflect the overall vitamin status in the body; systemic levels and dietary intake should be considered for a more comprehensive assessment. Other relevant factors that could influence salivary vitamin levels, such as sun exposure, use of supplements, or underlying medical conditions affecting vitamin metabolism, were not taken into account. Despite these limitations, the study's preliminary evidence on the correlation between salivary levels of vitamins D and C and dental caries in children is

significant. Further research, encompassing larger, more diverse samples and accounting for confounding factors, is necessary to draw more robust conclusions in this area of investigation. Based on their findings, the authors of this study aim to advocate for public health initiatives that encourage healthy dietary habits, adequate sun exposure, and potential vitamin supplementation to enhance oral health and reduce the likelihood of dental caries in children.

CONCLUSION

In conclusion, the study findings revealed that children without dental caries exhibited elevated levels of salivary vitamins D and C compared to their counterparts with dental caries. These findings indicate a possible association between elevated levels of salivary vitamins D and C and a decreased risk of dental caries in children.

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