Effect of Serum Vitamin D Level on Oral Health Status of Children

Maknunnahar[1], Md. Shakhawat Hossain[2], SM Rowshan Alam[3], Md. Mahfuj-Ul-Anwar[4], Mohammad Sayeem Rahman Bhuiyan[5], Sharker Md. Numan[6], Mohammad Shoaib Chowdhury MS[7]

1. Clinical Researcher
   Rangpur Asthma COPD Center
   Rangpur, Bangladesh
2. Assistant Professor
   Department of Gastroenterology
   Rangpur Medical College, Rangpur
3. Assistant Professor
   Department of Community Medicine and Public Health
   Rangpur medical College, Rangpur
4. Assistant Professor
   Department of Medicine
   Rangpur Medical College, Rangpur
5. Assistant Professor
   Department of Oral and Maxillofacial Surgery
   Bangladesh Medical University, Dhaka
6. Professor (Medical Science)
   School of Science and Technology
   Bangladesh Open University, Gazipur, Bangladesh
7. Associate Professor
   Department of Gastroenterology
   Bangladesh Medical University, Dhaka

Correspondence to:
Maknunnahar
Clinical Researcher
Rangpur Asthma COPD Center
Rangpur, Bangladesh
Email: drauna89@gmail.com

Submission Date : 07 Dec 2024
Accepted Date : 15 Jan 2025
Published Date : 30 March 2025
DOI: https://doi.org/10.3329/jrpmc.v10i1.81562

Abstract

Background:
Vitamin D, also known as the "sunshine vitamin," plays a vital role in human health by regulating calcium and phosphorus levels, which are essential for bone and teeth mineralization. Vitamin D deficiency has been linked to significant oral health issues, including defective tooth mineralization, periodontitis, and gingival inflammation.

Objective:
To investigate the relationship between serum vitamin D levels and oral health status in children aged 6-12 years.

Methods:
The case-control study included 30 children with poor oral health (cases) and 30 children with good oral health (controls), matched by age and gender. Serum vitamin D levels were measured using a Cobas e 411 analyzer, and oral health status was assessed using the Decayed, Missing, and Filled Teeth/Surface (DMFT/S) index.Statistical analysis included descriptive analysis, independent t-tests, multiple linear regression andPearson correlation.

Results:
Vitamin D was significantly low in children with dental caries (Mean±SD 17.12±6.87 versus 37.30±5.32, p<0.0001). Vitamin D level was significantly associated with higher DMF score (p=0.006), whereas tooth brushing was significantly associated with lower DMF score (p=0.039). Regarding the DMF scores in the study groups with different levels of vitamin D, there was a significant difference in DMF scores between the groups (p=0.025). The highest mean DMF score was found in children with deficient levels (6.14±2.68), while the lowest value was found in children with sufficient levels of vitamin D (4.15±2.38).

Conclusions:
Vitamin D deficiency appears to be significantly associated with poor oral health, including a higher prevalence of dental caries. Adequate vitamin D levels through diet, supplementation, and sun exposure may play a critical role in maintaining optimal oral health.

Keywords: Children, Oral health, Vitamin D, DMF score

Citation: Maknunnahar, Hossain MS, Alam SMR, Anwar MMU, Bhuiyan MSR, Numan SM, Chowdhury MS. Effect of Serum Vitamin D Level on Oral Health Status of Children.J Rang Med Col.2025 Mar;10(1):45-50. doi: https://doi.org/10.3329/jrpmc.v10i1.81562

Introduction:

Vitamin D is a fat-soluble vitamin in the body, also known as the "sunshine vitamin," plays a vital role in human body. It is essential for maintaining normal growth by regulating calcium and phosphorus levels, also influence the mineralization of bones and similar tissues, such as teeth.[1,2] The most significant form of vitamin D in the body is 25-hydroxyvitamin D [25-(OH) D], which is produced in the liver and then further hydroxylated into 1,25-dihydroxy-vitamin D [1,25-(OH) 2D] in kidneys. 1,25-(OH) 2D is the key to the absorption of dietary calcium from the intestinal tract and essential in the formation and development of bones and teeth.[3] There are two primary sources of vitamin D in human body: endogenous vitamin D3 produced by skin exposure to ultraviolet B radiation of sunlight, and exogenous vitamin D3 from diet.[4] Despite geographical and

seasonal variations, up to 90% of the vitamin D in the human body is generated through endogenous metabolism. Vitamin D plays an important role in oral health, and a deficiency in this vitamin has been related to significant impact on oral and dental health.[5] It is essential in maintaining bone mass and mineral metabolism. Both good overall health and oral health require a healthy and well-balanced diet.[6] Phosphorus, magnesium, and calcium absorption from the digestive tract requires vitamin D for healthy tooth development and bone mineralization. Various mechanisms have been proposed to explain the function of vitamin D in reducing caries risk, including the regulation of parathyroid hormone, serum phosphate, and calcium.[7,8]

The DMF index score indicates a total caries experience of an individual and it gives equal weight to decayed, missing because of caries, filled tooth, or tooth surface. The DMFS index stands for "Decayed, Missing, and Filled Surfaces" and is a dental measurement used to assess the extent of dental caries by counting the number of decayed, missing (due to caries), and filled surfaces on a person's teeth, providing a more detailed picture of caries experience compared to simply counting affected teeth (DMFT) which only considers the number of teeth involved.[9,10]

Methods:

This case control study was held on Rangpur city under supervision of Rangpur Asthma COPD center over a period of 6 months from January 2023 to July 2023 with aimedat detecting the consequences of vitamin D deficiency on oral health status among school children.A total of 60 children aged 6-12 years with (case=30) or without (control=30) dental caries, diagnosed at a dental health campin two primary school of Rangpur City, who could provide informed consent through their guardians were included. Children with systemic diseases (e.g., diabetes, cardiovascular disease) or was on medications that may affect oral health, who took anti-inflammatory or antibiotic drugs in the last month or wearing dental prosthesis or orthodontic appliances or taking vitamin D supplements in the two months prior to data collection were excluded from the study. A structured questionnaire was used to collect demographic information, dietary habits, outdoor activities, and oral hygiene practices from parents. An intraoral examination of dental caries status was performed under natural daylight to assess caries status using surface Decayed Surface, Missing Surface, and Filled Surface and Decayed, Missing, and Filled Surface (DS, MS, FS, and DMFS) following a systemic approach as recommended by WHO (2013).[10] Blood samples were collected during dental camp and vitamin D concentration was measured at a single laboratory in Rangpur city using Cobas e 411 analyzer and special kit (Elecsys Vitamin D total, Germany). Children with serum vitamin D concentrations less than 30 ng/mL were considered as vitamin D deficiency and children with serum vitamin D concentrations of 30 ng/mL or more wereleveled sufficient.Informed written consent was taken from guardian and school authorities mentioning study theme before data collection.Descriptive analysis was performed to calculate the frequency, percentage, mean, and standard deviation.The independent t-test was used to compare serum vitamin D levels between cases and controls. Multiple linear regression was used to study the effect of different variables on caries.Pearson correlation was used to determine the linear correlation between quantitative variables.

Results:

A total of 60 children were enrolled in this study to assess the relationship between serum vitamin D levels and caries experience in children. Case group included children total 30 children of 6 to 10 years having dental caries and control group comprises 30 age matched children without caries. Both groups were evaluated for serum vitamin D level. Both the groups were male predominant.Vitamin D was significantly low in children with dental caries (p<0.0001) (Table-I).

Table-I: Distribution of participants according to Age and Sex with vitamin D level

Variable	Case (n=30)	Control (n=30)	p-value
Age			
6-9 years	10	10	
>9-12 years	20	20	
Sex			
Male	16	18	
Female	14	12	
Vitamin D level			
Sufficient no. (%)	7(23.3)	21(70)	
Deficient no. (%)	23(76.4)	9(30)	
Mean±SD	17.12±6.87	37.30±5.32	<0.0001

Results showed the descriptive statistics and statistical difference of dental caries experience by surface decayed Surface (DS), missing Surface (MS), and filled Surface (FS) and decayed, missing, and filled surface (DMFS) among control and study groups, as presented in Table-II. Findings demonstrated that DMFS and its components were higher in the study group than in the control group, except in FS. FS was greater in the control group with a significant difference for FS and highly significant for DS. At the same time, it was not significant for MS and DMFS.

Table-II: Dental caries index (DS, MS, FS, and DMFS) (mean±SD) and statistical differences in the control and study groups

Variable	Control (n=30) Mean±SD	Case (n=30) Mean±SD	t-test	p-value
DS	4.950±2.861	8.875±3.902	2.711	0.005**
MS	1.310±2.928	1.489±3.876	0.269	0.716
FS	3.125±2.991	1.928±2.581	2.198	0.038*
DMFS	8.910±4.798	10.299±6.871	1.967	0.198

DS=Decayed Surface, MS=Missing Surface, FS=Filled Surface, DMFS=Decayed, Missing, and Filled Surface.
*Significant at $p<0.05$; **Highly significant at $p<0.01$.

Out of the indicator variables, only Vitamin D level and tooth brushing were found to significantly contribute to the caries ($p < 0.05$). Vitamin D level was significantly associated with higher DMF score (p=0.006), whereas tooth brushing was significantly associated with lower DMF score (p=0.039) (Table-III). Regarding the DMF scores in the study groups with different levels of vitamin D, there was a significant difference in DMF scores between the groups (p=0.025). The highest mean DMF score was found in children with deficient levels (6.14±2.68), while the lowest value was found in children with sufficient levels of vitamin D (4.15±2.38). Scores in children with a deficient level were significantly higher than those with sufficient level ($p < 0.006$) (Table-III).

Table-III: Associations and Correlations of Dental Caries Experience with Caries Indicators Among the Study Groups

Parameter	DMF score (Mean±SD)	Test Statistic	p-value
Age (6-9 years)	4.15±1.98	-0.41	0.361
Age (>9-12 years)	5.89±2.04		
Sex (Male)	5.91±2.65	-0.22	0.811
Sex (Female)	5.56±2.12		
Fluoride Drops/Tablets (No)	5.16±2.85	-0.41	0.533
Fluoride Drops/Tablets (Yes)	6.23±0.56		
Dental Visits (No)	5.19±3.15	0.26	0.675
Dental Visits (Yes)	5.32±2.49		
Outside Play (No)	4.62±2.23	-2.29	0.023*
Outside Play (Yes)	6.22±3.16		
Mother's Vitamin D Intake During Pregnancy (No)	5.49±2.89	-0.58	0.548
Mother's Vitamin D Intake During Pregnancy (Yes)	5.98±2.33		
Vitamin D Level (Sufficient)	4.15±2.38	2.65	0.006*
Vitamin D Level (Insufficient)	6.14±2.68		
Teeth Brushing (No)	6.11±2.69	2.11	0.039*
Teeth Brushing (Yes)	4.43±2.68		
Snacking (No)	5.51±3.10	-0.10	0.920
Snacking (Yes)	5.25±2.49		
Parental Educational Level (Low)	5.59±3.20	0.43	0.594
Parental Educational Level (High)	5.65±2.19		

DMF score =Decayed, Missing, and Filled score,
* Significant at $p \leq 0.05$

A multiple linear regression model was run to predict caries level (DMF score) from vitamin D as well as from other factors. There was linear relation assessed by partial regression plots and a plot of studentized residuals against the predicted values. The overall result related to variables of caries was statistically significant (p=0.003) and predicted 23.8% (adjusted R) of the variability in dental caries (DMF) score (Table-IV).

Table-IV: Multiple linear regression model showing the relation between dental caries experience and socio-demographic, clinical, and behavioral factors

Parameter	Coefficient	Confidence Interval (SE)	t-value	p-value
Intercept	-1.72	-6.59 to 3.28(2.48)	-0.7	0.479
Age	1.98	0.71 to 3.11(0.61)	3.1	0.002*
Sex (Female)1	-1.12	-2.64 to 0.55(0.79)	-1.3	0.210
Fluoride Drops/Tablets (Yes)[2]	2.19	-1.15 to 5.57(1.6)	1.69	0.205
Dental Visit (Yes)[2]	-1.32	-3.12 to 0.22(0.81)	-1.72	0.078
Outside Play (Yes)[2]	1.19	-0.33 to 2.87(0.79)	1.45	0.112
Mother's Vitamin D Intake During Pregnancy (Yes)[2]	0.69	-1.21 to 2.34(0.78)	0.69	0.510
Vitamin D (Deficient)[3]	1.34	-0.28 to 1.56(0.76)	1.12	0.035*
Brushing (Yes)[2]	-1.78	-2.11 to -0.30(0.79)	-2.21	0.019*
Snacking (Yes)[2]	-1.21	-3.98 to 2.13(1.5)	-0.68	0.443
Parental Educational Level (High)[4]	0.56	-1.12 to 2.54(0.67)	0.5	0.454

*Significant at $p < 0.05$[1]; Reference category "Male"[2]; Reference category "No"[3]; Reference category "Sufficient"[4]; Reference category "Low"

Discussion:

Vitamin D levels are negatively associated with dental caries. Literature searched has shown that there are studies showing a strong association of low vitamin D levels and dental caries severity, while some studies have not shown any correlation. Elevated serum vitamin D level was associated with better dental health parameters.[11] Schroth et al[12] analyzed the relation between vitamin D status and dental caries and found that there exists an association between caries and lower serum vitamin D.Our study found a significant difference in mean (±SD) of serum 25(OH) vitamin D levels between the case (17.12±6.87) and control groups (37.30±5.32, <0.0001). A previous study found a significant difference in mean serum 25(OH) vitamin D levels between the case (12.19±4.37 ng/mL) and control group (20.11±4.12 ng/mL, p-value <0.0001) with a significant inverse correlation between vitamin D levels and severe early childhood caries (SECC), as shown in a simple linear regression(p-value <0.0001).[13] In this study, the effect of different variables on dental caries revealed a positive correlation between vitamin D status and dental caries experience. Our study results revealed that lowest DMF scores were present in children with"Sufficient level" of vitamin D, while the highest values were found in those with "Deficient level". This finding is consistent with studies conducted by Ahmed et al 2023 in Basra, who reported significantly higher 25(OH)D levels among caries-free preschool children.[14] Our findings are deferred with some other studies elsewhere.[15-18] Kuhnisch et al also observed a correlation between increased serum 25(OH)D levels and decrease in dental caries incidence.[11] Additionally, it was observed that children playing outside had significantly higher DMF scores, possibly due to increased consumption of candies and snacks during playtime.One meta-analysis showed that children with vitamin D deficiency had a 22% higher risk of dental caries than those with normal vitamin D levels, with a relative risk (RR) of 1.22 and a 95% confidence interval (CI) of 1.18 to 1.25.[6] The study included cross-sectional, cohort, and case-control studies, showing a consistent association between low vitamin D levels and increased dental caries risk which is very much related to our present study. Another review study discussed how vitamin D deficiency is associated with various oral health disorders, including defective tooth mineralization, periodontitis, gingival inflammation, and certain oral cancers.[19] Additionally, another RCT showed a strong association between vitamin D3 levels with socioeconomic and lifestyle variables, while pregnant ladieswith vitamin D supplements have less incidence of enamel abnormalities.[20] These results align with Kьhnisch et al's[11] findings of a positive correlation between increased blood 25(OH)D concentration at early age and a decreased likelihood of dental caries. It emphasized the importance of maintaining adequate vitamin D levels for good oral health not only in childhood but also in older adults. These studies highlighted the critical role of vitamin D in maintaining oral health and preventing dental caries.

Conclusion:

Vitamin D deficiency appears to be significantly associated with poor oral health, including a higher prevalence of dental caries and altered salivary parameters. Adequate vitamin D levels through diet, supplementation, and sun exposure may play a critical role in maintaining optimal oral health.

References:

1. Borel P, Caillaud D, Cano NJ. Vitamin D bioavailability: state of the art. Crit Rev Food Sci Nutr. 2015;55(9):1193-205. doi: 10.1080/ 10408398.2012.688897
2. Holick MF. Sunlight and vitamin D for bone health and prevention of autoimmune diseases, cancers, and cardiovascular disease. Am J Clin Nutr. 2004 Dec;80(6 Suppl): 1678S-88S. doi: 10.1093/ajcn/ 80.6.1678S.
3. Hollis BW, Wagner CL, Drezner MK, Binkley NC. Circulating vitamin D3 and 25-hydroxyvitamin D in humans: An important tool to define adequate nutritional vitamin D status. J Steroid Biochem Mol Biol. 2007 Mar;103(3-5):631-4. doi: 10.1016/j. jsbmb. 2006.12.066.
4. Macdonald HM. Contributions of sunlight and diet to vitamin D status. Calcif Tissue Int. 2013 Feb;92(2):163-76. doi: 10.1007/s 00223-012-9634-1.
5. Grant WB. Vitamin D, periodontal disease, tooth loss, and cancer risk. Lancet Oncol. 2008 Jul;9(7):612-3. doi: 10.1016/S 1470-2045(08)70164-5.
6. Li Z, Wei X, Shao Z, Liu H, Bai S. Correlation between vitamin D levels in serum and the risk of dental caries in children: a systematic review and meta-analysis. BMC Oral Health. 2023 Oct 19;23(1):768. doi: 10.1186/s 12903-023-03422-z.
7. Mahmood MK, Tassery H, Tardivo D, Lan R. Association between Vitamin D Levels and Dental Caries: A Systematic Review and Dose-Response Meta-Analysis of Cross-Sectional Studies. Appl Sci. 2023;13(17): 9883. doi:10.3390/app13179883
8. Braegger C, Campoy C, Colomb V, Decsi T, Domellof M, FewtrellM, etal; ESPGHAN Committee on Nutrition. Vitamin D in the healthy European paediatric population. J Pediatr Gastroenterol Nutr. 2013 Jun;56(6): 692-701. doi: 10.1097/MPG. 0b013e 318 28f3c05.
9. Klein H, Palmer CE, Knutson JW. Studies on dental caries. Public Health Rep. 1938;53: 751–765.
10. Broadbent JM, Thomson WM. For debate: problems with the DMF index pertinent to dental caries data analysis. Community Dent Oral Epidemiol. 2005 Dec;33(6):400-9. doi: 10.1111/j.1600-0528.2005.00259.x.
11. Kuhnisch J, Thiering E, Kratzsch J, Heinrich Weltzien R, Hickel R, Heinrich J. GINIplus study group; LISAplus study group. Elevated serum 25(OH)-vitamin D levels are negatively correlated with molar-incisor hypomineralization. J Dent Res. 2015 Feb; 94(2):381–387. doi: 10.1177/ 002203451 4561657.
12. Schroth RJ, Rabbani R, Loewen G, Moffatt ME. Vitamin D and Dental Caries in Children. J Dent Res. 2016 Feb;95(2):173-9. doi: 10.1177/0022034515616335.
13. Chhonkar A, Gupta A, Arya V. Comparison of Vitamin D Level of Children with Severe Early Childhood Caries and Children with No Caries. Int J Clin Pediatr Dent. 2018 May-Jun; 11(3):199-204. doi: 10.5005/jp- journals-10005-1511.
14. Ahmed HA, Ahmed GS, Maktoof ZA. Association of vitamin D and dental caries in children in Basra. Int J Pharm Res. Oct-Dec 2020;12(4):3861–3866.doi:10.31838/ijpr/202 0.12.04.528.
15. Williams TL, Boyle J, Mittermuller BA, Carrico C, Schroth RJ. Association between Vitamin D and Dental Caries in a Sample of Canadian and American Preschool-Aged Children. Nutrients. 2021 Dec 14;13(12):4465. doi: 10.3390/nu13124465.
16. Chen Z, Lv X, Hu W, Qian X, Wu T, Zhu Y. Vitamin D Status and Its Influence on the Health of Preschool Children in Hangzhou. Front Public Health. 2021 May 17;9: 675403. doi: 10.3389/fpubh.2021.675403.
17. Schroth RJ, Christensen J, Morris M, Gregory P, Mittermuller BA, Rockman-Greenberg C. The Influence of Prenatal Vitamin D Supplementation on Dental Caries in Infants. J Can Dent Assoc. 2020 Nov;86:k13.
18. El Shiekh MA, Hanafy RMH. Relationship between vitamin D status and caries experience in a group of Egyptian children: a cross-sectional study. BMC Oral Health. 2023 Jun 9;23(1):374. doi: 10.1186/s12903-023-03065-0.
19. Botelho J, Machado V, Proenэa L, Delgado AS,

Mendes JJ. Vitamin D Deficiency and Oral Health: A Comprehensive Review. Nutrients. 2020 May 19;12(5):1471. doi: 10.3390/nu 12051471.

20. Nɯrrisgaard PE, Haubek D, Kьhnisch J, Chawes BL, Stokholm J, Bɯnnelykke K, et al. Association of High-Dose Vitamin D Supplementation During Pregnancy With the Risk of Enamel Defects in Offspring: A 6-Year Follow-up of a Randomized Clinical Trial. JAMA Pediatr. 2019 Oct 1;173(10):924-930. doi: 10.1001/jamapediatrics.2019.2545.