

Association between Serum Vitamin D3 Deficiency and Periodontitis: Evidence from a Pakistani Population

Sumaira Javed¹, Farhan Hashmi²

^{1,2}Department of Periodontology, Mayo Hospital, Lahore, Pakistan

ABSTRACT

Background: Periodontitis is a multifactorial chronic inflammatory disease characterized by progressive destruction of periodontal tissues and alveolar bone. Emerging evidence highlights vitamin D3 deficiency as a potential risk factor due to its immunomodulatory and bone-regulating functions.

Objective: This study investigated the association between serum vitamin D3 levels and periodontitis in a Pakistani population.

Methods: A comparative cross-sectional study was conducted at the Department of Periodontology, Mayo Hospital, Lahore, from January 2023 to December 2023. Eighty-four participants were enrolled, including 46 patients with clinically diagnosed periodontitis and 38 age- and gender-matched healthy controls. Periodontal diagnosis was based on probing depth, clinical attachment loss, and radiographic bone loss. Serum vitamin D3 concentrations were measured using chemiluminescence immunoassay and categorized as deficient (<30 ng/ml) or sufficient (30–100 ng/ml).

Results: The mean serum vitamin D3 level was significantly lower in periodontitis patients (29.07 ± 16.08 ng/ml) compared with controls (41.26 ± 12.94 ng/ml; $p < 0.001$). All periodontitis cases (100%) exhibited vitamin D deficiency, whereas only 47.4% of controls were deficient ($p < 0.001$). Chi-square analysis confirmed a significant association between periodontitis and low serum vitamin D3 ($p < 0.001$).

Conclusion: Vitamin D3 deficiency was highly prevalent among periodontitis patients compared to healthy individuals, suggesting its potential role as a biomarker and modifiable risk factor. Incorporating vitamin D assessment and correction into periodontal management may enhance clinical outcomes. Larger longitudinal and interventional studies are warranted to clarify causality and therapeutic implications.

Keywords: Periodontitis, Vitamin D3 deficiency, Alveolar bone loss, Immunomodulation, South Asia.

INTRODUCTION

Periodontitis is a multifactorial, multifactorial, and chronic inflammatory disease that causes progressive loss of support structures of teeth, which eventually leads to tooth loss on untreated.^{1,2} It is considered one of the most widespread oral health issues worldwide since it affects at least 20–50 percent of the adult population, and fatal cases can affect close to 10 percent of global population.^{3,4} Periodontitis pathogenesis is a complicated relationship between microbial biofilm and host immune response, and leads to persistent inflammation, connective tissue breakdown and alveolar bone resorption.^{5,6} Although the key role is played by bacterial pathogens as then-hypothetical etiological agents, host susceptibility, systemic conditions, nutritional status, and environmental exposures play a crucial role in factors affecting the etiology and progression of the disease.^{7,8}

Within the last twenty years, the role of systemic factors such as micronutrients in periodontal health has gained more and more interest.^{9,10} Vitamin D is one of them that has become a possible determinant of periodontal disease status due to its pleiotropic roles in calcium metabolism and bone homeostasis, as well as immune regulations.^{11,12} Vitamin D is a secosteroid fat-soluble hormone which is mainly produced in the skin under the influence of UV rays (B) and, though rarely, in the diet.^{13,14} In addition to the established effect of bone mineralization, vitamin D has immunomodulatory and anti-inflammatory activities and both affects innate and adaptive immune responses.¹⁵ The dual role is especially pertinent to periodontitis where dyscontrolled host immunity and bone resorption are the key factors concerning disease pathophysiology.^{6,16}

There is also an emerging body of evidence indicating that low serum vitamin D concentrations may put patients at risk of periodontal degeneration.¹⁰ Vitamin D has also been reported to modulate the expression of antimicrobial peptides like cathelicidin and defensins that are crucial in restoring mouth

microbial balance.¹⁷ It also regulates the synthesis of pro-inflammatory cytokines thus suppressing the exaggerated immune response that causes destruction of periodontal tissues. Vitamin D increases calcium absorption and osteoblastic activity and decreases osteoclastic bone resorption in the skeletal system, all of which are directly applicable to the preservation of alveolar bone mass.^{18,19} Therefore, it has been suggested that hypovitaminosis D is a possible risk agent of progression and severity of periodontitis.

Various epidemiological studies have already recorded an inverse relationship between serum vitamin D levels and periodontal parameters including probing depth, clinical memory loss, and radiograph bone danger.²⁰ Additionally, interventional researches have found that the use of vitamin D supplier might complement periodontal treatment outcomes by improving gingival index, decreasing the level of bleeding on probing, and stimulating bone regeneration.²¹ The results however are inconsistent across populations with some studies unable to show a significant relationship. These discrepancies are probably linked to variability in the study design, population properties or features, the manner and method in which vitamin D has been measured, and the cutoffs (deficiency).²²

In South Asia, the deficiency of vitamin D is extremely widespread, and it is estimated that over 70 percent of the adult population is unable to maintain optimum serum levels in spite of being well-exposed to sunlight.²³ Causative factors are; unless they are exposed to the sun through cultural farming practices, the skin pigmentation is darker, the dietary intake is not satisfactory, and there is no policy to supplement. Particularly Pakistan, there are some of the highest cases of vitamin D deficiencies in the region, which is not only linked to skeletal issues but also to metabolic, cardiovascular, and infectious disease. Based on this context, there is a significant level of public health interest in examining the impact of vitamin D deficiency and periodontitis in this community.²⁴ The acknowledgment of avoidable risk elements (including deficiencies in micronutrients) may be the precursor to adjunctive preventive/therapeutic interventions in periodontal care.²⁵

Although there has been an increase in information regarding vitamin D and periodontal disease, there is a dearth of it among South Asian populations, where periodontal disease and hypovitaminosis D are widespread.²⁶ The available literature has mainly cross-sectional studies, with small study samples, or lack of confounding factors, and as such, are not generalizable. Also, the Pakistani cohorts study on whether serum vitamin D status can

Correspondence to: Sumaira Javed,
Department of Periodontology, Mayo Hospital, Lahore, Pakistan.
Email: sumairajaved93@gmail.com

How to Cite: Javed S, Hashmi F. Association Between Serum Vitamin D3 Deficiency and Periodontitis: Evidence from a Pakistani Population. Pak. J. Healthc Res. 2024 Jun; 1(1): 4-6

Article History

Received: 25-03-2024 | Accepted: 11-06-2024 | Published: 30-06-2024

significantly predict periodontal disease severity lacks enough evidence facts to back up the findings. A closed-gap in knowledge is essential since it might give an idea of the possibility to implement the vitamin D evaluation and correction in the common periodontal treatment plan.

The current research was consequently a comparative cross sectional study to examine the relationship between the levels of serum vitamin D3 and periodontitis on a Pakistani population. In particular, we aimed to compare the levels of vitamin D3 in patients with clinically diagnosed periodontitis, and age/gender-coordinated healthy controls. We theorized that periodontitis patients would have great reduced serum vitamin D3 levels in relation to that of the controls, a claim in line with the idea that vitamin D deficiency is risk factor that can be adjusted in the pathogenesis of periodontal disease. Explaining this relationship, our results can add to the ongoing conceptualization of periodontal diseases etiology and complement the possibility of the vitamin D beneficial effect on a complex periodontal management approach.

METHODOLOGY

The present cross-sectional study was a comparative study, which was carried out at the Periodontology Department in the Department of Dentistry at the Mayo Hospital, Lahore, between January 2023 and December 2023. Eighty-four subjects were ultimately enrolled in the study, 46 of which were clinically diagnosed with periodontitis and 38 healthy age and gender-matched controls with healthy periodontium. The probing pocket depth, clinical attachment loss (CAL) and radiography of loss of alveolar bone were used to establish the periodontitis diagnosis. Healthy controls were chosen as individuals with probing depth [?]3 mm, no CAL and no radiographic bone loss. As an exclusion criteria, systemic illnesses (such as diabetes, chronic renal failure, auto-immune diseases etc.) and pregnancy, lactation and intake of antibiotics and/or vitamin D in the past six months were taken into account. Background Implementation/Detailed clinical examination: The participants were all examined in details following the written informed consent. Aseptic collection was 5 ml of peripheral venous blood and centrifuged to separate the serum that was immediately sacrificed by placing it at freezer temperatures [?]20degC. Serum vitamin D3 levels were measured by standardized chemiluminescence immunoassay. To use serum vitamin D3 analytically, serum levels were categorized as deficient (<30 ng/ml), sufficient (30-100 ng/ml), and toxic (>100 ng/ml). Data were recorded in a structured proforma and then statistically analyzed to obtain a comparison of vitamin D3 status of cases and controls.

RESULTS

The study comprised 84 people in total, including 38 age- and gender-matched controls with healthy periodontium and 46 patients with periodontitis. There was no statistically significant difference in the mean age of the cases and controls, which were 42.1 ± 9.8 and 41.7 ± 8.9 years, respectively (p=0.74). Additionally, the distribution of genders was similar in both groups (p=0.81).

Table 1: Baseline Characteristics of Study Participants

Variable	Periodontitis Cases (n=46)	Controls (n=38)	p-value
Age (years, mean ± SD)	42.1 ± 9.8	41.7 ± 8.9	0.74
Gender (Male/Female)	28/18	22/16	0.81

Serum Vitamin D3 Levels

The average serum vitamin D3 levels of periodontitis patients were 29.07 +- 16.08 ng/ml and this was lower than it was in controls; that is, 41.26 +- 12.94 ng/ml (p<0.001). All in all, 76.3 percent of the study population had a deficiency in vitamin D3 (less than 30 ng/ml). Of particular importance was the fact that 100 percent of the 46 cases (100 percent) lacked vitamin D3 and only 18 of the controls lacked (47.4) controls (p<0.001).

Association of Vitamin D3 Deficiency with Periodontitis

The Chi-square analysis revealed statistically significant between periodontitis and low serum vitamin D3 levels (p<0.001), which indicated that low serum vitamin D3 levels could be the risk factor in the development of periodontal diseases.

Table 2: Serum Vitamin D3 Levels in Cases and Controls

Group	Mean Vitamin D3 (ng/ml) ± SD	Deficient (<30 ng/ml)	Sufficient (30-100 ng/ml)	p-value
Periodontitis Cases (n=46)	29.07 ± 16.08	46 (100%)	0 (0%)	<0.001
Controls (n=38)	41.26 ± 12.94	18 (47.4%)	20 (52.6%)	

Table 3: Association between Vitamin D3 Deficiency and Periodontitis

Vitamin D3 Status	Periodontitis Cases (n=46)	Controls (n=38)	Total (n=84)	p-value
Deficient (<30 ng/ml)	46 (100%)	18 (47.4%)	64 (76.3%)	<0.001
Sufficient (≥30 ng/ml)	0 (0%)	20 (52.6%)	20 (23.7%)	

These findings indicate that the incidence of vitamin D3 deficiency among patients with periodontitis was significantly higher as compared to healthy people; the variation in serum levels showed a significant difference (p<0.001). Close association of vitamin D3 deficiency with periodontitis is an indicator of the potentially useful vitamin D3 as a periodontal health biomarker.

DISCUSSION

The existing comparative cross-sectional research demonstrates that the relationship between serum deficiency in vitamin D3 and periodontitis is high and statistically significant. It was noted that the low concentration of vitamin D3 was found in all periodontitis patients in our cohort, but nearly half of non-periodontitis controls. This highlights hypovitaminosis D3 as a potential risk factor in the etiology of periodontal disease. These findings are consistent with other available research studies that suggest that vitamin D is relevant to periodontal health due to the fact that it is immunomodulatory, anti-inflammatory and capable of affecting bone metabolism. It has been found that deficiency of vitamin D can lead to disrupted osteoblastic functioning, increased susceptibility to alveolar bone resorption and a change in host immune responses, hence giving the breakdown of periodontal tissue.

The results align with the world studies which suggest the relative decrease in vitamin D of the periodontitis patients compared to the control. The same type of trends is observed in both European, Middle Eastern and South Asian populations indicating that the correlation between vitamin D deficiency and periodontitis is unlikely to be constrained by the geographical location. The lack of vitamin D in our population may also be linked to the inappropriateness of nutrition in the region, the lack of sunshine due to cultural traditions and the lack of supplementation, which have been found to cause poor vitamin D levels in South Asia. The clinical implications of the findings suggest that vitamin D level in serum is a crucial and efficient indicator of patients with periodontitis to be analyzed and treated. Even though scaling, root planing and surgical treatment still remain the main element of the treatment, the root cause (vitamin D deficiency) could be an additive element to the enhancement of the periodontal healing and prevention of disease recurrence. The evidence that the level of clinical attachment may be influenced by the vitamin D supplement supports and the inflammation of the gingiva can be mitigated can justify it.

However, this study does not come without some weaknesses. The cross-sectional study does not grant an opportunity to notice a cause-effect relationship between periodontitis and vitamin D deficiency, and the sample size is not so large to make generalizations. Moreover, there was no consideration of an interaction (pre study and post study) with any known

confounding factors such as dietary intake of calcium, body mass index, and seasonal influence on availability of vitamin D in the body. The current study has supported the role of vitamin D supplement in prevention and treatment of periodontal disease, and it is reasonable to appoint in the future initiations of the steadfastness with the view to large scale prospective and interventional studies.

To summarize our research harbors a considerable level of association between vitamin D3 deficiency and periodontitis whereby all cases of patients having the disease expressed deficient serum levels. This data indicates that 1,400 mg D3 is an indicator of risk that periodontal disease may biologically result in and is a treatment target that may be employed in complete periodontal care.

CONCLUSION

The research shows a strong relationship between serum vitamin D3 deficiency and periodontitis and all individuals living with the disease have comparable levels of deficiency. These findings support the biological judgement that insufficient Vitamin D3 interferes with the regulation of the immune system, stimulates inflammatory reactions and enhances the resorption rates of the alveolar bone-processes that control the immune defense mechanism in periodontal tissue-destruction. These results have significant implications to the population because the prevalence

REFERENCES

1. Ray, R. R. (2023). "Periodontitis: an oral disease with severe consequences." *Applied biochemistry and biotechnology* 195(1): 17-32. <https://doi.org/10.1007/s12010-022-04127-9>
2. Dolińska, E., et al. (2024). "Periodontal molecular diagnostics: State of knowledge and future prospects for clinical application." *International Journal of Molecular Sciences* 25(23): 12624. <https://doi.org/10.3390/ijms252312624>
3. Amarasena, N., et al. (2021). "Oral health of Australian adults: distribution and time trends of dental caries, periodontal disease and tooth loss." *International Journal of Environmental Research and Public Health* 18(21): 11539. <https://doi.org/10.3390/ijerph182111539>
4. Chan, A. K. Y., et al. (2021). "Common medical and dental problems of older adults: a narrative review." *Geriatrics* 6(3): 76. <https://doi.org/10.3390/geriatrics6030076>
5. Usui, M., et al. (2021). "Mechanism of alveolar bone destruction in periodontitis—Periodontal bacteria and inflammation." *Japanese Dental Science Review* 57: 201-208. <https://doi.org/10.1016/j.jdsr.2021.09.005>
6. Han, N., et al. (2023). "Regulation of the host immune microenvironment in periodontitis and periodontal bone remodeling." *International Journal of Molecular Sciences* 24(4): 3158. <https://doi.org/10.3390/ijms24043158>
7. Buduneli, N. (2021). "Environmental factors and periodontal microbiome." *Periodontology* 2000 85(1): 112-125. <https://doi.org/10.1111/prd.12355>
8. Isola, G., et al. (2023). "Periodontal health and disease in the context of systemic diseases." *Mediators of inflammation* 2023(1): 9720947. <https://doi.org/10.1155/2023/9720947>
9. Grant, W. B., et al. (2023). "Periodontal disease and other adverse health outcomes share risk factors, including dietary factors and vitamin D status." *Nutrients* 15(12): 2787. <https://doi.org/10.3390/nu15122787>
10. Berg, Y., et al. (2024). "The impact of nutritional components on periodontal health: a literature review." *Nutrients* 16(22): 3901. <https://doi.org/10.3390/nu16223901>
11. Lu, E. M. C. (2023). "The role of vitamin D in periodontal health and disease." *Journal of periodontal research* 58(2): 213-224. <https://doi.org/10.1111/jre.13083>
12. Meghil, M. M. and C. W. Cutler (2023). "Influence of vitamin D on periodontal inflammation: a review." *Pathogens* 12(9): 1180. <https://doi.org/10.3390/pathogens12091180>
13. Dominguez, L. J., et al. (2021). "Vitamin D sources, metabolism, and deficiency: available compounds and guidelines for its treatment." *Metabolites* 11(4): 255. <https://doi.org/10.3390/metabo11040255>
14. Gratton, M.-P., et al. (2022). "Effect of vitamin D on bone morphometry and stability of orthodontic tooth movement in rats." *American Journal of Orthodontics and Dentofacial Orthopedics* 162(6): e319-e327. <https://doi.org/10.1016/j.ajodo.2022.08.019>
15. Álvarez-Mercado, A. I., et al. (2023). "Vitamin D: Role in chronic and acute diseases." *Encyclopedia of Human Nutrition*: 535. <https://doi.org/10.1016/b978-0-12-821848-8.00101-3>
16. Sadek, K. M., et al. (2023). "Molecular basis beyond interrelated bone resorption/regeneration in periodontal diseases: a concise review." *International Journal of Molecular Sciences* 24(5): 4599. <https://doi.org/10.3390/ijms24054599>
17. Tokajuk, J., et al. (2022). "Cathelicidin LL-37 in health and diseases of the oral cavity." *Biomedicines* 10(5): 1086. <https://doi.org/10.3390/biomedicines10051086>
18. Omi, M. and Y. Mishina (2022). "Roles of osteoclasts in alveolar bone remodeling." *genesis* 60(8-9): e23490. <https://doi.org/10.1002/dvg.23490>
19. Sundar, R., et al. (2023). "The role of Vitamin D as an adjunct for bone regeneration: A systematic review of literature." *The Saudi Dental Journal* 35(3): 220-232. <https://doi.org/10.1016/j.sdntj.2023.02.002>
20. Liu, X., et al. (2023). "Associations between vitamin D levels and periodontal attachment loss." *Clinical oral investigations* 27(8): 4727-4733. <https://doi.org/10.1007/s00784-023-05100-4>
21. Liang, F., et al. (2023). "Association of vitamin D in individuals with periodontitis: an updated systematic review and meta-analysis." *BMC Oral Health* 23(1): 387. <https://doi.org/10.1186/s12903-023-03120-w>
22. Olszewska-Czyz, I. and E. Firkova (2022). "Vitamin D3 serum levels in periodontitis patients: a case-control study." *Medicina* 58(5): 585. <https://doi.org/10.3390/medicina58050585>
23. Siddiquee, M. H., et al. (2023). "Risk perception of sun exposure and knowledge of vitamin D among the healthcare providers in a high-risk country: a cross-sectional study." *BMC Medical Education* 23(1): 46. <https://doi.org/10.1186/s12909-023-04001-0>
24. Li, Y., et al. (2023). "Association of serum vitamin D with periodontal disease." *International dental journal* 73(5): 777-783. <https://doi.org/10.1016/j.identj.2023.06.004>
25. Carra, M. C., et al. (2023). "Periodontitis and atherosclerotic cardiovascular disease: A critical appraisal." *Periodontology* 2000. <https://doi.org/10.1111/prd.12528>
26. Arshad, S. and S. J. A. Zaidi (2022). "Vitamin D levels among children, adolescents, adults, and elders in Pakistani population: a cross-sectional study." *BMC Public Health* 22(1): 2040. <https://doi.org/10.1186/s12889-022-14526-6>