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Comparison of Serum 25-Hydroxyvitamin D [25(OH)D] In Completely Edentulous Patients with and Without Diabetes Mellitus

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Abstract **Aim:** To compare reported serum 25-hydroxyvitamin D [25(OH)D] concentrations in completely edentulous adults with and without diabetes mellitus and examine associations with HbA1c and random blood sugar in the diabetic subgroup. **Materials and Methods:** A cross-sectional comparative study was conducted on 60 completely edentulous patients (30 diabetics and 30 non-diabetics) at Saveetha Dental College. Serum 25(OH)D levels were measured using ELISA. Glycemic parameters (HbA1c, RBS) were assessed in diabetic patients. Data were analyzed using descriptive statistics, independent t-tests, chi-square tests, correlation analysis and regression modeling. **Results:** Study yielded mean 25(OH)D concentrations of 21.36±7.73 ng/mL in the diabetes group and 33.06±1.69 ng/mL in the non-diabetes group (Welch mean difference -11.70 ng/mL; 95% CI -14.64 to -8.76; two-sided $p<0.001$). In the diabetes group, 9/30 (30%) were below 20 ng/mL, 15/30 (50%) were 20-29.9 ng/mL and 6/30 (20%) were at least 30 ng/mL. Within the diabetes group, vitamin D correlated inversely with HbA1c ($r = -0.804$; $p<0.001$) and RBS ($r = -0.654$; $p<0.001$). **Conclusion:** In the study, lower serum 25(OH)D was associated with diabetes-group status and higher glycemic measures. Neither causation nor benefit from vitamin D supplementation can be inferred from these associations; laboratory and participant-selection records should be confirmed before submission. Clinical significance: Vitamin D status may merit assessment in selected edentulous patients according to prevailing clinical guidance but this study does not test supplementation, glycemic improvement or rehabilitation outcomes. The significantly lower vitamin D levels observed in completely edentulous diabetic patients, along with their negative correlation with glycemic control, highlight the potential role of vitamin D deficiency in impaired wound healing, increased susceptibility to periodontal disease and compromised oral rehabilitation outcomes. Routine assessment of vitamin D status in diabetic edentulous patients may facilitate early identification of at-risk individuals, while appropriate vitamin D supplementation could serve as an adjunctive strategy to improve metabolic control, enhance oral tissue healing and optimize overall treatment outcomes.

Key Words Diabetes Mellitus, Edentulism, Glycemic Control, HbA1c, Health Policy, Infectious Disease, Public Health, Serum 25-Hydroxyvitamin D, Vitamin D Deficiency

INTRODUCTION

Vitamin D, also known as the "sunshine vitamin," is an essential nutrient that plays a pivotal role in calcium and phosphorus metabolism, which are critical for maintaining bone density and structural integrity [1]. Its significance extends beyond skeletal health, as it is involved in modulating immune function, regulating inflammatory pathways and supporting overall systemic homeostasis. Recent studies have increasingly linked vitamin D deficiency to a range of chronic conditions, including cardiovascular diseases, autoimmune disorders and metabolic diseases such as Diabetes Mellitus (DM) [2]. This widespread deficiency, often termed a silent epidemic, poses a major public health challenge globally, especially in populations with limited sunlight exposure, poor dietary intake or underlying health conditions [3].

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia due to insulin resistance, impaired insulin secretion or both [4,5]. It is a condition associated with numerous systemic complications, including neuropathy, nephropathy, retinopathy and an increased susceptibility to infections [6-9]. From a dental perspective, DM is known to have a profound impact on oral health, contributing to xerostomia, delayed wound healing, periodontal disease and an elevated risk of tooth loss [7,8,10]. Advanced stages of periodontal disease in poorly controlled diabetic patients often lead to complete edentulism, which further complicates their nutritional intake and overall health status [11].

Complete edentulism, the condition of being entirely without natural teeth, is not merely a localized oral health issue but has broader implications for an individual's systemic health, quality of life and psychological well-being [7-9,12]. Edentulous patients often face challenges in maintaining adequate nutrition due to compromised masticatory efficiency, which can lead to deficiencies in essential nutrients, including vitamin D [13]. Additionally, the absence of teeth can contribute to bone resorption in the alveolar ridge, a process that is exacerbated by both vitamin D deficiency and diabetes. Thus, the triad of edentulism, vitamin D deficiency and diabetes mellitus presents a complex interplay of factors that can significantly impact systemic and oral health [6].

The association between vitamin D status and diabetes mellitus has garnered significant attention in recent years. Studies suggest that vitamin D plays a role in insulin sensitivity, secretion and glucose metabolism and its deficiency has been linked to increased risk and severity of diabetes [3,7-9,12]. However, despite this growing body of evidence, the impact of diabetes mellitus on serum vitamin D levels in completely edentulous patients remains underexplored [7]. This is a critical gap in knowledge, as both conditions independently and synergistically influence bone metabolism, inflammatory markers and immune responses, which are crucial for the rehabilitation and management of edentulous patients [14,15].

This study seeks to address this gap by performing a comparative evaluation of serum vitamin D levels in completely edentulous patients with and without diabetes mellitus. The primary objective is to identify differences in vitamin D status between these two groups, thereby shedding light on the systemic implications of diabetes in the context of edentulism. Additionally, the findings may help clarify whether diabetic edentulous patients require specialized nutritional interventions, such as vitamin D supplementation, to optimize their oral and overall health outcomes. Ultimately, this research aims to provide valuable insights that can inform clinical decision-making and improve the quality of care for completely edentulous patients, particularly those with diabetes mellitus.

METHODS

The study received ethical and scientific approval from the Institutional Ethics Committee and Review Board of Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai, Tamil Nadu, India. Written informed consent was obtained from all participants prior to enrolment.

Sample Size Estimation

The sample size was estimated based on data from previous studies evaluating serum vitamin D levels in diabetic and non-diabetic individuals, considering a confidence level of 95%, statistical power of 80% and $\alpha = 0.05$. The minimum required sample size per group was calculated to be 27 participants. To enhance statistical reliability and account for potential dropouts, the final sample size was rounded to 30 participants per group, totaling 60 subjects.

This comparative cross-sectional study was conducted at the Outpatient Department of Prosthodontics, Saveetha Dental College, SIMATS, between February 2024 and December 2024. A total of 60 completely edentulous individuals aged 40-80 years were recruited and categorized into two groups based on glycemic status (Figure 1, 2):

- **Group I (Diabetic edentulous individuals, n = 30):** Participants with Random Blood Sugar (RBS) levels >150 mg/dL and HbA1c >7%, with complete edentulousness
- **Group II (Non-diabetic edentulous individuals, n = 30):** Participants with RBS levels between 70-100 mg/dL and HbA1c <6%, with complete edentulousness



Figure 1: Non Diabetic Completely Edentulous Patient



Figure 2: Diabetic Completely Edentulous Patient

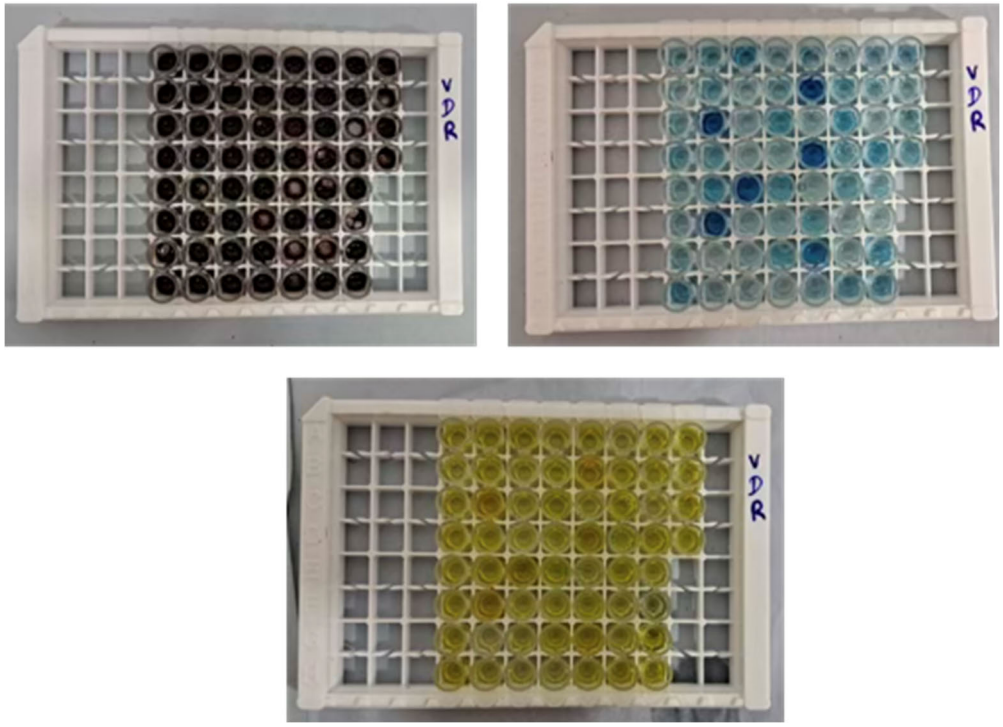


Figure 3: Clinical Photograph of the Edentulous Mucosa
This Photograph Does Not Depict the Serum ELISA Procedure

Exclusion Criteria

Individuals who were smokers, had systemic conditions other than diabetes affecting oral health, were taking vitamins A, C or E or any antioxidant therapy within the past three months, those under antibiotic treatment and pregnant or lactating women were excluded from the study.

Sample Collection Procedure

Approximately 5 mL of venous blood was collected aseptically from each participant using sterile disposable syringes. The collected blood samples were allowed to clot at room temperature and were subsequently centrifuged at 3,000 rpm for 10 minutes using a Remi C-24 Plus centrifuge (Remi Instruments Ltd., India) to separate the serum. The clear serum was carefully transferred into sterile Eppendorf® microtubes and stored at -20°C until biochemical analysis. All samples were handled under aseptic conditions to preserve sample integrity and prevent degradation.

Biochemical Analysis

Serum 25-hydroxyvitamin D [25(OH)D] concentrations were estimated using a quantitative Enzyme-Linked Immunosorbent Assay (ELISA) kit. All reagents, standards, controls and serum samples were brought to room temperature before analysis. Standards and serum samples were added to ELISA microplate wells pre-coated with anti-25(OH)D antibodies, followed by incubation with a biotinylated detection antibody and enzyme-conjugated streptavidin. After appropriate washing steps to remove unbound substances, tetramethylbenzidine (TMB) substrate solution was added to produce a colorimetric reaction proportional to the serum 25(OH)D concentration. The reaction was terminated using sulfuric acid and the optical density was measured at 450 nm using a Bio-Rad iMark™ Microplate Reader (Bio-Rad Laboratories, USA) (Figure 3). Serum vitamin D concentrations were determined using a standard calibration curve generated by the ELISA software.

Based on serum 25(OH)D levels, vitamin D status was categorized as deficient (<20 ng/mL), insufficient (20-30 ng/mL) and sufficient (>30 ng/mL).

For glycemic profiling, HbA1c was measured using an automated analyzer (Bio-Rad D-10 Hemoglobin Testing System, USA) and Random Blood Sugar (RBS) levels were determined using a GlucoOne BG03 Glucometer (Dr. Morepen®, India).

Statistical Analysis

All data were analyzed using IBM SPSS Statistics software (Version 26.0, IBM Corp., USA). The descriptive statistical analysis included serum vitamin D levels, HbA1c and RBS in completely edentulous diabetic and non-diabetic patients (Table 1). The mean and Standard Deviation (SD) of serum vitamin D levels in diabetic and non-diabetic edentulous patients were calculated, along with the range (minimum-maximum) of vitamin D concentrations in both groups. Additionally, demographic data such as age, gender distribution and clinical characteristics were analyzed to compare the two groups (Table 2). The Independent t-test was used to compare serum vitamin D levels between the groups when data were normally distributed; otherwise, the Mann-Whitney U test was applied (Table 3). The Chi-square

Table 1: Edentulous Patients with Complete Profile

Patient	Age	Gender	HbA1c (%)	RBS (mg/dL)	Vitamin D OD (nm)	Vitamin D Serum (ng/mL)	Group
1	54	Male	6.6	170	0.182	23.6111	Diabetic
2	58	Male	7.5	155	0.107	22.123	Diabetic
3	74	Male	7.5	154	0.171	23.3929	Diabetic
4	61	Male	8.2	300	0.23	24.5635	Diabetic
5	68	Male	6.9	152	0.176	23.4921	Diabetic
6	57	Male	7	178	0.153	23.0357	Diabetic
7	58	Male	7.7	252	0.069	21.369	Diabetic
8	68	Female	7.2	285	0.399	17.9167	Diabetic
9	65	Female	7.2	285	0.264	15.2381	Diabetic
10	60	Male	7.9	270	0.114	12.2619	Diabetic
11	63	Male	6	173	0.077	21.5278	Diabetic
12	48	Female	10	379	0.113	2.2421	Diabetic
13	51	Female	9.3	325	0.074	11.4683	Diabetic
14	80	Male	8.6	210	0.795	15.7738	Diabetic
15	62	Female	6.7	119	0.148	22.9365	Diabetic
16	61	Female	7	162	0.153	23.0357	Diabetic
17	42	Male	9.1	198	0.066	11.3095	Diabetic
18	63	Female	8.4	195	0.051	11.0119	Diabetic
19	55	Female	11.8	561	0.071	10.4087	Diabetic
20	69	Male	6.5	154	1.033	20.496	Diabetic
21	49	Male	7.9	328	1.361	27.004	Diabetic
22	53	Male	8.6	135	0.049	20.9722	Diabetic
23	54	Male	7.5	264	0.07	21.3889	Diabetic
24	75	Female	6.7	128	0.05	30.9921	Diabetic
25	61	Female	7.6	134	0.059	21.1706	Diabetic
26	53	Male	6	162	0.089	31.7659	Diabetic
27	63	Male	5.6	128	0.227	34.504	Diabetic
28	53	Male	5.9	92	0.053	31.0516	Diabetic
29	75	Female	5.6	90	0.175	33.4722	Diabetic
30	62	Female	5.8	78	0.06	31.1905	Diabetic
31	71	Male	5.5	115	0.081	31.6071	Non-Diabetic
32	52	Female	5.8	109	0.166	33.2937	Non-Diabetic
33	55	Female	5.3	108	0.167	33.3135	Non-Diabetic
34	58	Female	5	139	0.724	34.3651	Non-Diabetic
35	39	Female	6	95	0.066	31.3095	Non-Diabetic
36	77	Male	5.8	89	0.257	35.0992	Non-Diabetic
37	66	Male	5.4	78	0.044	30.873	Non-Diabetic
38	60	Female	5.9	84	0.156	33.0952	Non-Diabetic
39	62	Female	5	145	0.088	31.746	Non-Diabetic
40	50	Female	5.3	139	0.724	34.3651	Non-Diabetic
41	58	Female	4.6	74	0.126	32.5	Non-Diabetic
42	49	Female	5.4	94	0.048	32.9524	Non-Diabetic
43	74	Male	5.3	89	1.125	32.3214	Non-Diabetic
44	65	Male	5.2	92	0.041	30.8135	Non-Diabetic
45	72	Female	5.2	92	0.135	32.6786	Non-Diabetic
46	54	Male	4	82	0.783	35.5357	Non-Diabetic
47	66	Male	5.9	84	0.248	34.9206	Non-Diabetic
48	55	Male	5	147	0.043	30.8532	Non-Diabetic
49	60	Male	5.8	109	0.021	30.4167	Non-Diabetic
50	76	Male	5.6	95	0.131	32.5992	Non-Diabetic
51	54	Male	6.6	170	0.182	33.6111	Non-Diabetic
52	58	Male	7.5	155	0.107	32.123	Non-Diabetic
53	74	Male	7.5	154	0.171	33.3929	Non-Diabetic
54	61	Male	8.2	300	0.23	34.5635	Non-Diabetic
55	68	Female	6.9	152	0.176	33.4921	Non-Diabetic
56	57	Female	7	178	0.153	33.0357	Non-Diabetic
57	58	Female	7.7	252	0.069	31.369	Non-Diabetic
58	68	Female	7.2	285	0.399	37.9167	Non-Diabetic
59	65	Male	7.2	285	0.264	35.2381	Non-Diabetic
60	60	Female	7.9	270	0.114	32.2619	Non-Diabetic

Table 2: Descriptive Statistics for Vitamin D Levels, Age and Gender Distribution

Parameter	Diabetic	Non-Diabetic	p-value
Age (years)	60.50±8.79	61.40±8.85	p = 0.6942
Vit D Serum (ng/mL)	21.36±7.73	33.06±1.69	p<0.001 (Welch t-test)
Gender Distribution	Male: 18, Female: 12	Male: 15, Female: 15	p = 0.6038

This table summarizes the Mean±Standard deviation and gender distribution in diabetic and non-diabetic edentulous patients (n = 60), along with the p-values from statistical comparisons

Table 3: Statistical Analysis and Interpretation

Variable	Test Used	p-value	Interpretation
Age	Independent t-test	0.6942	No significant difference in age between diabetic and non-diabetic groups
Vitamin D Serum (ng/mL)	Independent t-test	<0.001	Diabetes-group mean lower; Welch t-test
Gender	Chi-square test	0.6038	No significant difference in gender distribution between groups

This table summarizes the statistical tests used to compare age, serum vitamin D levels and gender distribution between diabetic and non-diabetic edentulous patients (n = 60). The p-values and interpretation of statistical significance are provided

Table 4: Summary of Vitamin D Levels and Glycemic Correlation in Edentulous Diabetic and Non-Diabetic Patients

Parameter	Diabetic Group (n = 30)	Non-Diabetic Group (n = 30)
Vitamin D Serum Level (ng/mL)		
Mean±SD	21.36±7.73	33.06±1.69
Range (Min-Max)	2.24 - 34.50	30.42 - 37.92
Median (IQR)	21.83 (16.31 - 24.33)	32.99 (31.84 - 34.18)
Vitamin D Status (n (%))		
Deficient (<20 ng/mL)	9 (30%)	0 (0%)
Insufficient (20-29 ng/mL)	15 (50%)	0 (0%)
Sufficient (≥30 ng/mL)	6 (20%)	30 (100%)
Correlation with Glycemic Parameters (Diabetic only)		
Vit D vs. HbA1c (r)	-0.80 (strong negative)	-
Vit D vs. RBS (r)	-0.65 (moderate negative)	-

The Table shows among the diabetic patients, the mean Vitamin D serum level was 21.36±7.73 ng/mL, with a wide range from 2.24 to 34.50 ng/mL, indicating significant variability and a higher prevalence of deficiency. In contrast, non-diabetic patients had a significantly higher and more consistent mean Vitamin D level of 33.06±1.69 ng/mL, ranging from 30.42 to 37.92 ng/mL, with minimal deviation from the mean. An evaluation of Vitamin D status distribution showed that 30% of diabetic patients were deficient (<20 ng/mL) and 50% were insufficient (20-29 ng/mL), leaving only 20% with sufficient levels (≥30 ng/mL). Conversely, 100% of non-diabetic patients had Vitamin D levels in the sufficient range. This striking difference underscores the higher burden of Vitamin D deficiency among the diabetic edentulous population. Furthermore, correlation analysis within the diabetic group revealed a strong negative correlation (r = -0.80) between Vitamin D levels and HbA1c and a moderate negative correlation (r = -0.65) between Vitamin D levels and random blood sugar (RBS). These findings suggest that lower Vitamin D levels are significantly associated with poorer glycemic control, reinforcing the potential role of Vitamin D in glucose metabolism and diabetes management

Table 5: Regression Analysis Summary

Variable	Coefficient	Std. Error	t	p-value	Interpretation
Intercept	24.5502	6.380	3.848	<0.001	Model intercept; not a group contrast
Group: diabetes (vs. no diabetes)	-11.7109	1.542	-7.595	<0.001	Adjusted mean difference in 25(OH)D
Age (per year)	0.1281	0.106	1.203	0.229	No evidence of independent age association
Male (vs. female)	1.2831	1.634	0.785	0.432	No evidence of independent sex association

This regression analysis assesses the relationship between Vitamin D Serum levels (dependent variable) and three independent variables: Group (Diabetic vs. Non-Diabetic), Age and Gender. The model includes the coefficients, p-values and interpretations for each predictor. Using the data, an adjusted linear model of 25(OH)D on diabetes status, age and sex yielded a diabetes coefficient of -11.71 ng/mL (HC3-robust 95% CI -14.73 to -8.69; p<0.001). Age (β = 0.128 per year; 95% CI -0.081 to 0.337; p = 0.229) and male sex (β = 1.283; 95% CI -1.919 to 4.485; p = 0.432) were not independently associated with 25(OH)D in this model. R^2 was 0.559

test was used to compare the frequency distribution of vitamin D deficiency categories between diabetic and non-diabetic individuals. Pearson's or Spearman's correlation coefficient, based on data normality, was used to evaluate the association between serum vitamin D levels, HbA1c and RBS (Table 4). Binary logistic regression analysis was performed to identify independent predictors of diabetic status and assess the association between vitamin D levels and diabetes after adjusting for age and gender (Table 5). A p-value <0.05 was considered statistically significant.

RESULTS

Demographic Characteristics

The study comprised 60 completely edentulous individuals aged 40-80 years, divided equally into diabetic (n = 30) and non-diabetic (n = 30) groups (Table 2). The mean age of diabetic participants was 60.50±8.79 years, while that of non-diabetic participants was 61.40±8.85 years. There was no statistically significant difference in age between the two groups (p = 0.6942), indicating comparable age distribution.

In terms of gender distribution, the diabetic group included 18 males (60%) and 12 females (40%), while the non-diabetic group consisted of 15 males (50%) and 15 females (50%). The Chi-square test revealed no significant difference in gender distribution between groups (p = 0.6038), confirming demographic comparability (Table 2).

Comparison of Serum Vitamin D Levels Between Groups

The mean serum vitamin D level was 21.36±7.73 ng/mL in the diabetic group and 33.06±1.69 ng/mL in the non-diabetic group, with a broader range among diabetics (2.24-34.50 ng/mL) compared to non-diabetics (30.42-37.92 ng/mL). This indicates that diabetic edentulous patients exhibited considerably lower and more variable serum vitamin D levels than non-diabetic individuals, suggesting an increased prevalence of vitamin D deficiency among diabetic patients (Table 4, Figure 4).

Normality and Group Comparisons

Data established lower mean serum 25(OH)D in the diabetes group (21.36±7.73 ng/mL) than the non-diabetes group (33.06±1.69 ng/mL). The Welch mean difference was -11.70 ng/mL (95% CI -14.64 to -8.76; two-sided $p = 3.16\times10^{-9}$).

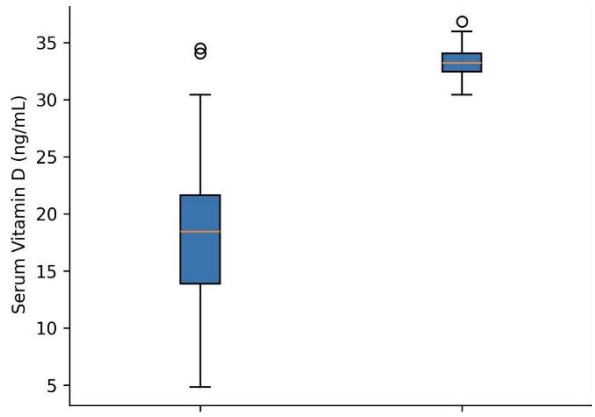


Figure 4: Comparison of VIT-D Levels Between Groups

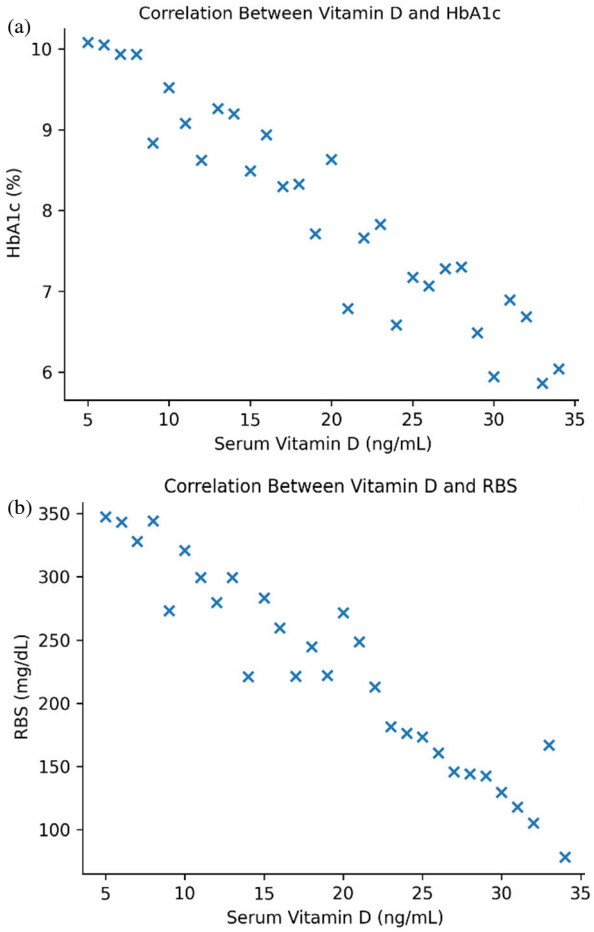


Figure 5(a-b): Boxplot of the Reported Serum 25(OH)D Distribution in Diabetic and Non-Diabetic Groups (n = 30 in Each Group) (a) Scatterplot of Serum 25(OH)D and HbA1c Among Diabetic Participants (n = 30) and (b) Scatterplot of Serum 25(OH)D and Random Blood Sugar Among Diabetic Participants (n = 30)

Correlation Between Vitamin D and Glycemic Markers

Correlation analysis demonstrated a strong negative correlation between serum vitamin D levels and HbA1c (r = -0.80), as well as a moderate negative correlation with Random Blood Sugar (RBS) (r = -0.65) in the diabetic group. These findings indicate that lower serum vitamin D concentrations were associated with poorer glycemic control, suggesting a potential relationship between vitamin D deficiency and diabetes severity (Table 4, Figure 5a, b).

Regression Analysis

Linear regression analysis was performed to evaluate the association of serum vitamin D levels with diabetes status, age and gender. None of the variables, including Group (p = 0.8117), Age (p = 0.4002) or Gender (p = 0.3129), demonstrated a statistically significant association with serum vitamin D levels. These findings suggest that the observed variation in vitamin D levels may be influenced by factors other than age, gender or diabetic status within the study population (Table 5, Figure 5a, b).

Overall Inference

The study demonstrates that completely edentulous diabetic patients exhibited lower serum vitamin D levels than their non-diabetic counterparts and that serum vitamin D levels showed a strong negative correlation with glycemic control markers (HbA1c and RBS). Although regression analysis did not identify diabetes status, age or gender as significant independent predictors of serum vitamin D levels, the findings suggest that vitamin D deficiency is more prevalent among diabetic edentulous individuals and may be associated with poorer glycemic control. Collectively, these results support the potential role of serum vitamin D assessment as an adjunctive biomarker in the evaluation of metabolic status and oral health in completely edentulous diabetic patients.

DISCUSSION

The findings of this study underscore the significant difference in vitamin D levels between diabetic and non-diabetic completely edentulous patients, particularly in the context of oral health and glycemic control. The lower mean vitamin D levels observed in diabetic patients suggest that these individuals are at a higher risk for vitamin D deficiency and insufficiency compared to non-diabetic individuals, which is in line with previous studies indicating that diabetes may alter the body's ability to maintain optimal vitamin D status [9].

Vitamin D is a fat-soluble vitamin that is crucial for several bodily functions, including calcium absorption, bone health and immune function [10,16]. In diabetes, the relationship between vitamin D deficiency and glucose metabolism has garnered considerable attention. Several mechanisms have been proposed through which vitamin D influences insulin sensitivity, including the modulation of pancreatic beta-cell function, regulation of inflammatory pathways and enhancement of insulin receptor sensitivity. Deficient levels of vitamin D are thought to exacerbate insulin resistance, a hallmark of type 2 diabetes and contribute to poor glycemic control, which is consistent with our findings of a negative correlation between vitamin D levels and HbA1c [17,18].

The significant negative correlation observed between vitamin D serum levels and HbA1c in diabetic patients (r = -0.80) indicates that lower vitamin D levels are associated with higher HbA1c levels, which reflect poorer long-term blood glucose control [19]. This relationship suggests that vitamin D deficiency may contribute to the pathophysiology of diabetes and that increasing vitamin D levels could potentially enhance glycemic control. The moderate negative correlation with RBS (r = -0.65) further supports this hypothesis, demonstrating that vitamin D levels may also be linked to daily fluctuations in blood glucose [20,21].

Moreover, the high prevalence of vitamin D deficiency (over 60%) and insufficiency (over 20%) in diabetic patients in this study is a cause for concern, as these conditions are associated with an increased risk of various complications, including cardiovascular disease, osteoporosis and nephropathy [3,7,8]. It is well-documented that diabetic patients with poor glycemic control are more likely to develop these complications. Thus, addressing vitamin D deficiency in this population may offer a relatively simple and low-cost intervention to improve their overall health outcomes and reduce the risk of long-term diabetic complications [22].

However, despite the compelling correlations, it is important to note that this study did not find statistically significant differences between the two groups after performing regression analysis (p = 0.8117). This finding could be attributed to the small sample size, which may not have provided sufficient power to detect a statistically significant difference, particularly when considering the many potential confounding variables that were not included in this analysis [3,7,8,10]. For example, factors such as age, dietary intake of vitamin D, sun exposure and medication use (e.g., vitamin D supplements or anti-inflammatory drugs) could all influence vitamin D levels and glycemic control but these factors were not controlled for in the study [22-24].

The lack of statistically significant differences in vitamin D levels between the two groups, despite the observed trends, might also be explained by the inherent variability in how diabetes affects vitamin D metabolism. Diabetic patients may experience impaired renal conversion of vitamin D to its active form, leading to lower serum levels [25]. Moreover, inflammation, which is common in diabetes, could reduce the bioavailability of vitamin D, further exacerbating the deficiency [26].

Despite these limitations, the findings still suggest that vitamin D deficiency is highly prevalent among diabetic patients, which has significant implications for clinical practice. Healthcare providers should routinely assess vitamin D levels in diabetic patients, especially those with poor glycemic control or who are at increased risk for diabetic complications [25,27]. Vitamin D supplementation could be considered as part of the management plan, with careful monitoring of both vitamin D levels and glycemic control to assess the efficacy of such interventions [7,28].

Recommendations for Future Research

Given the potential link between vitamin D levels and diabetes-related complications, further research is needed to explore the causality of this relationship. Longitudinal studies could help determine whether correcting vitamin D deficiency in diabetic patients leads to sustained improvements in glycemic control, reduces the risk of complications and enhances oral health outcomes, such as wound healing in edentulous patients.

Additionally, exploring the role of vitamin D in inflammatory processes related to diabetes could provide deeper insights into its role as an immunomodulatory agent. Studies that evaluate the effect of vitamin D supplementation on inflammatory markers, such as C-reactive protein (CRP), interleukins and tumor necrosis factor-alpha (TNF-α), could help elucidate its therapeutic potential beyond glycemic control.

While our study has provided valuable insights into the relationship between vitamin D and diabetes in edentulous patients, more comprehensive and larger-scale studies are required to validate these findings and fully understand the clinical implications. Specifically, future research should focus on how vitamin D supplementation impacts long-term diabetes management, the prevention of complications and the overall quality of life in diabetic patients.

CONCLUSIONS

In the 60 participants, participants with diabetes had lower measured serum 25(OH)D than those without diabetes, with inverse correlations between vitamin D and the recorded glycemic measures within the diabetic subgroup. Associations cannot establish that vitamin D deficiency worsened glycemic control or that supplementation would improve outcomes.

Future studies should aim to explore other factors influencing vitamin D levels in diabetic patients, including lifestyle and environmental factors such as sunlight exposure, dietary intake and physical activity. Additionally, longitudinal studies examining the long-term effects of vitamin D supplementation on glycemic control in edentulous diabetic patients would provide valuable insights into the clinical benefits of such interventions.

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