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Original Research Article

Assessment of Vitamin D Level and Risk Factors in A Patient of Diabetes Mellitus: A Retrospective Study

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Abstract:

Background: Vitamin D has attracted growing attention in recent years for its possible role in glucose metabolism, insulin resistance, and chronic inflammatory processes. Hypovitaminosis D is suspected to be a contributing factor in the development and progression of type 2 diabetes mellitus (T2DM), particularly in populations with high cardiometabolic risk.

Objective: To evaluate the correlation between serum vitamin D levels and a spectrum of clinical and lifestyle-related risk factors among adult patients with T2DM.

Methods: A retrospective study was conducted at Department of Respiratory medicine, Sardar Patel Medical College, Bikaner, Rajasthan, India for one year . A total of 240 adult T2DM patients were enrolled. Data were collected on age, gender, BMI, physical activity, diet, sun exposure, duration of diabetes, and glycemic control. Serum 25-hydroxyvitamin D [25(OH)D] was assessed using chemiluminescent immunoassay. Statistical analysis included Pearson's correlation and multivariate regression models to identify independent predictors of low vitamin D.

Results: Among the 240 participants, 63.3% were vitamin D deficient (<20 ng/mL), and only 13.8% had sufficient levels (>30 ng/mL). There was a significant inverse correlation between vitamin D and HbA1c ($r = -0.31$, $p < 0.001$), BMI ($r = -0.27$, $p = 0.003$), and sedentary lifestyle ($p = 0.01$). Poor glycemic control and obesity remained independent predictors in multivariate analysis.

Conclusion: Vitamin D deficiency is widespread among diabetic patients and is significantly associated with obesity, physical inactivity, and poor glycemic control. Timely screening and correction of vitamin D status may support better metabolic management in T2DM.

Keywords: Vitamin D, Type 2 diabetes mellitus, HbA1c, Obesity, Lifestyle, Serum 25(OH)D.

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Introduction

Diabetes mellitus (DM) is one of the most prevalent chronic non-communicable diseases globally, posing significant public health challenges due to its rising incidence and associated complications. Type 2 diabetes mellitus (T2DM), in particular, accounts for more than 90% of all diabetes cases and is characterized by insulin resistance, relative insulin deficiency, and metabolic dysregulation [1]. In India, the prevalence of T2DM has increased markedly due to rapid urbanization, lifestyle changes, and dietary transitions, especially in states like Rajasthan where both urban and rural populations are at risk [2].

Emerging research has highlighted the potential non-skeletal roles of vitamin D, including modulation of insulin sensitivity, pancreatic β-cell function, and inflammation. Vitamin D receptors (VDRs) are present in several tissues, including pancreatic islets, adipose tissue, and muscle, suggesting a regulatory role in glucose metabolism [3]. Hypovitaminosis D has been proposed as a modifiable risk factor that may influence the onset and progression of T2DM and its associated comorbidities, such as hypertension, dyslipidemia, and obesity [4]. However, the direction and magnitude of this association remain variable across different populations due to differences in sun exposure, dietary habits, and genetic predispositions.

India, despite being a tropical country with abundant sunlight, has a surprisingly high prevalence of vitamin D deficiency across all age groups. Several urban and semi-urban studies have reported that over 70–90% of individuals have suboptimal vitamin D levels, largely due to inadequate sun exposure, indoor-based lifestyles, and poor dietary intake of vitamin D-rich foods [5]. Among diabetic patients, this deficiency may further exacerbate insulin resistance, increase inflammatory burden, and worsen glycemic control. Moreover, co-existing factors such as obesity, lack of physical activity, and poor metabolic control may influence both vitamin D status and diabetes severity [6].

Although several international studies have examined this association, there remains limited region-specific evidence from north-western India, particularly Rajasthan. Furthermore, the influence of lifestyle, obesity, comorbidities, and glycemic indices on serum vitamin D levels among diabetic patients in this geographic context has not been adequately evaluated. Understanding this relationship is essential for developing targeted prevention strategies and identifying potentially reversible contributors to poor diabetic outcomes.

Hence, this study was undertaken to assess the correlation between serum vitamin D levels and various risk factors in adult patients with T2DM attending a tertiary care hospital in Bikaner, Rajasthan.

Methodology

A retrospective study was conducted at Department of Respiratory medicine, Sardar Patel Medical College, Bikaner, Rajasthan, India for one year. The primary objective of the study was to determine the association between serum vitamin D levels and selected clinical and lifestyle-related risk factors in adult patients diagnosed with type 2 diabetes mellitus (T2DM).

A total of 240 adult patients (aged 30 to 70 years) with previously diagnosed T2DM were recruited from the outpatient and inpatient departments through consecutive sampling. Patients included in the study were those with a confirmed diagnosis of T2DM for at least one year, irrespective of the treatment regimen. Exclusion criteria included patients with type 1 diabetes mellitus, chronic kidney disease (stage 3 or above), liver disorders, malabsorption syndromes, thyroid disorders, malignancies, those on vitamin D supplementation within the past 6 months, and pregnant or lactating women.

After obtaining informed written consent from each participant, a structured data collection sheet was used to record demographic details (age, gender, residence), clinical history (duration of diabetes, medication use, comorbidities such as hypertension and dyslipidemia), anthropometric measurements (height, weight, BMI), and lifestyle characteristics including physical activity, dietary habits, and sunlight exposure. BMI was categorized as per WHO guidelines, and physical activity was self-reported based on frequency and duration of exercise per week. Glycemic control was evaluated using the most recent HbA1c reports (within the past 3 months), obtained from hospital records or fresh laboratory testing if not available.

A 5 mL venous blood sample was drawn from each participant under aseptic conditions and sent to the central laboratory for analysis. Serum 25-hydroxyvitamin D [25(OH)D] levels were measured using a standardized chemiluminescent immunoassay method (CLIA). The results were classified based on Endocrine Society Clinical Practice Guidelines as follows: deficiency (<20 ng/mL), insufficiency (20–30 ng/mL), and sufficiency (>30 ng/mL). HbA1c was measured using high-performance liquid chromatography (HPLC), and fasting blood sugar (FBS) levels were also recorded.

Data were entered into Microsoft Excel and analyzed using IBM SPSS version 26. Descriptive statistics were used to summarize the baseline characteristics. Continuous variables were presented as mean ± standard deviation (SD), and categorical variables as frequency and percentage. Pearson's correlation coefficient was used to assess the relationship between serum vitamin D levels and continuous variables such as BMI, HbA1c, and FBS. Chi-square test was applied to evaluate associations between categorical variables (e.g., physical activity, sun exposure) and vitamin D status. Variables showing statistical significance ($p < 0.05$) in bivariate analysis were entered into a multiple linear regression model to identify independent predictors of vitamin D deficiency.

Results

A total of 240 adult patients with type 2 diabetes mellitus were enrolled in the study. The mean age of participants was 55.3 ± 9.2 years, with a nearly equal gender distribution. Vitamin D deficiency (<20 ng/mL) was identified in 152 patients (63.3%), insufficiency (20–30 ng/mL) in 55 patients (22.9%), and sufficiency (>30 ng/mL) in only 33 patients (13.8%). The majority of vitamin D deficient individuals had poor glycemic control, higher BMI, and reported low physical activity levels. The tables below present the associations between vitamin D levels and various demographic, clinical, and lifestyle parameters.

Table 1: Distribution of Vitamin D Status among T2DM Patients (n = 240)

Vitamin D Status	Frequency (n)	Percentage (%)
Deficient (<20 ng/mL)	152	63.3%
Insufficient (20–30)	55	22.9%
Sufficient (>30)	33	13.8%

Table 2: Association of Vitamin D Status with Age Categories

Age Group (years)	Deficient (n=152)	Insufficient (n=55)	Sufficient (n=33)	p-value
≤50	66	22	11	0.71
>50	86	33	22	

Table 3: Association of Vitamin D Status with Gender

Gender	Deficient (n=152)	Insufficient (n=55)	Sufficient (n=33)	p-value
Male	81	27	18	0.66
Female	71	28	15	

Table 4: Association of Physical Activity with Vitamin D Levels

Physical Activity	Deficient (n=152)	Insufficient (n=55)	Sufficient (n=33)	p-value
Sedentary lifestyle	98	26	11	0.01
Physically active	54	29	22	

Table 5: Association of BMI with Vitamin D Levels

BMI Category (kg/m²)	Deficient (n=152)	Insufficient (n=55)	Sufficient (n=33)	p-value
<25 (Normal)	26	18	15	0.004
≥25 (Overweight/Obese)	126	37	18	

Table 6: Association of HbA1c Levels with Vitamin D Status

HbA1c Category (%)	Deficient (n=152)	Insufficient (n=55)	Sufficient (n=33)	p-value
≤7% (Controlled)	38	19	18	<0.001
>7% (Uncontrolled)	114	36	15	

Table 7: Correlation of Vitamin D with Continuous Variables

Variable	Correlation Coefficient (r)	p-value
BMI	–0.27	0.003
HbA1c	–0.31	<0.001
Fasting Blood Sugar	–0.23	0.006
Duration of DM	–0.09	0.21

Table 8: Multivariate Regression Predicting Serum Vitamin D Levels

Predictor Variable	β Coefficient	p-value
HbA1c (%)	–0.26	<0.001
BMI (kg/m²)	–0.22	0.002
Physical inactivity	–0.19	0.015
Duration of diabetes	–0.05	0.41

Table 9: Association of Daily Sunlight Exposure with Vitamin D Status

Sun Exposure (minutes/day)	Deficient (n=152)	Insufficient (n=55)	Sufficient (n=33)	p-value
<15 min	104	31	8	0.002
≥15 min	48	24	25	

Table 10: Association of Dietary Intake (Vitamin D-rich Foods) with Vitamin D Status

Diet Type (Self-reported)	Deficient (n=152)	Insufficient (n=55)	Sufficient (n=33)	p-value
Poor intake	116	34	15	0.03
Regular intake	36	21	18	

Table 11: Association of Hypertension with Vitamin D Status

Hypertension Status	Deficient (n=152)	Insufficient (n=55)	Sufficient (n=33)	p-value
Present	93	30	12	0.03
Absent	59	25	21	

Table 12: Association of Insulin Therapy Use with Vitamin D Status

Insulin Use	Deficient (n=152)	Insufficient (n=55)	Sufficient (n=33)	p-value
Yes	65	20	10	0.27
No	87	35	23	

A summary of the above findings demonstrates that the prevalence of vitamin D deficiency among T2DM patients was significantly associated with various modifiable and non-modifiable risk factors. Table 1 identified deficiency in over 63% of cases. No significant difference was observed across age or gender as shown in Tables 2 and 3. However, sedentary lifestyle (Table 4), higher BMI (Table 5), and poor glycemic control (Table 6) were significantly associated with lower vitamin D levels. Correlation analysis (Table 7) and regression analysis (Table 8) reaffirmed these associations. Environmental and lifestyle factors such as inadequate sun exposure (Table 9), poor dietary intake of vitamin D-rich foods (Table 10), and comorbid hypertension (Table 11) were also linked to lower vitamin D status. The use of insulin therapy did not show a statistically significant association (Table 12).

Discussion

The current study confirms a high prevalence of vitamin D deficiency among patients with type 2 diabetes mellitus, with 63.3% of participants falling below 20 ng/mL, consistent with prior research from Indian and South Asian populations where lifestyle and environmental factors often contribute to widespread hypovitaminosis D [6]. This observed deficiency, despite abundant sunlight in Rajasthan, reinforces the paradox of high prevalence in sun-rich regions, likely driven by urbanized indoor lifestyles, poor dietary intake, and inadequate skin exposure [7].

Our findings demonstrated a statistically significant inverse correlation between serum vitamin D levels and glycemic indices such as HbA1c and fasting blood sugar, suggesting that lower vitamin D may impair glycemic control. These results align with biological mechanisms proposed in earlier research, which postulated that vitamin D plays a role in pancreatic β-cell function, insulin receptor sensitivity, and glucose uptake [8]. The negative correlation between BMI and vitamin D levels observed in this study also supports previous evidence suggesting that adiposity leads to sequestration of vitamin D in fat stores, reducing its bioavailability in circulation [9].

The study also highlighted the impact of lifestyle-related variables, such as physical activity and sun exposure. Patients with sedentary behavior and <15 minutes of daily sunlight were more likely to be vitamin D deficient. These associations reinforce the role of behavioral and environmental factors as contributors to deficiency states [10]. Additionally, dietary intake of vitamin D-rich foods showed a modest but statistically significant relationship with serum levels, consistent with the literature emphasizing the role of nutrition in maintaining optimal vitamin D status [11].

Interestingly, hypertension was more prevalent in the vitamin D deficient group, which aligns with previous studies suggesting a possible link between vitamin D deficiency and activation of the renin-angiotensin system, thereby influencing blood pressure regulation [12]. However, no statistically significant association was noted between insulin therapy and vitamin D levels in our cohort, suggesting that treatment modality may not directly affect vitamin D metabolism—a finding consistent with some, but not all, published studies [13].

Although no significant associations were observed between vitamin D levels and age or gender in this study, these variables have shown inconsistent results across different population groups. Some studies have reported lower vitamin D levels in elderly or female patients due to limited mobility and sun avoidance, but these patterns were not reflected in our population, possibly due to the homogeneous exposure patterns seen in the studied region [14].

The strength of this study lies in its adequate sample size, standardized biochemical assessment, and comprehensive evaluation of both metabolic and lifestyle risk factors. However, the cross-sectional nature precludes causal inferences. Longitudinal follow-up studies or interventional trials using vitamin D supplementation would be necessary to validate the observed associations and explore their potential for clinical translation.

In summary, this study reinforces the role of vitamin D deficiency as a common yet modifiable co-factor in diabetes management. Given the strong correlation with poor glycemic control, obesity, and sedentary behavior, regular monitoring and timely correction of vitamin D levels could be integrated into the comprehensive care protocols for patients with T2DM.

Conclusion

This study confirms that vitamin D deficiency is highly prevalent among patients with type 2 diabetes mellitus, with over 60% of participants falling into the deficient category. A significant inverse relationship was observed between serum vitamin D levels and glycemic control, body mass index, and physical inactivity, highlighting the role of modifiable risk factors in determining vitamin D status. Regression analysis further emphasized poor glycemic control and obesity as independent predictors of low vitamin D levels. Additionally, limited daily sun exposure and inadequate dietary intake of vitamin D-rich foods were strongly associated with deficiency, underlining the need for targeted behavioral interventions. The association between hypovitaminosis D and hypertension observed in this study suggests a broader cardiometabolic impact that warrants attention. Although no significant associations were found with age, gender, or insulin therapy, the findings support the inclusion of vitamin D screening as part of routine diabetic management. Addressing lifestyle and environmental contributors to vitamin D deficiency may provide metabolic benefits and help improve long-term glycemic outcomes. Further longitudinal studies and interventional trials are needed to establish causality and assess the impact of supplementation in diverse diabetic populations.

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