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PREVALENCE OF VITAMIN D DEFICIENCY AND ITS ASSOCIATION WITH GLYCEMIC CONTROL IN TYPE 2 DIABETES MELLITUS

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ABSTRACT

Background: Vitamin D deficiency is increasingly recognized as a common comorbidity in patients with Type 2 Diabetes Mellitus (T2DM) and may influence glycemic control through its effects on insulin secretion and insulin sensitivity. The present study aimed to determine the prevalence of vitamin D deficiency and evaluate its association with glycemic control among patients with T2DM.

Methods: This hospital-based cross-sectional observational study included 180 patients with T2DM attending a tertiary care teaching hospital. Demographic and clinical details were recorded, and laboratory investigations including fasting blood sugar (FBS), postprandial blood sugar (PPBS), glycated hemoglobin (HbA1c), and serum 25-hydroxy vitamin D levels were assessed. Vitamin D status was categorized as deficient (<20 ng/mL), insufficient (20–29 ng/mL), and sufficient (≥30 ng/mL). Association between vitamin D levels and glycemic parameters was analyzed statistically.

Results: The mean age of participants was 54.8 ± 10.6 years, and the mean HbA1c was 8.2 ± 1.6%. The mean serum vitamin D level was 19.6 ± 8.4 ng/mL. Vitamin D deficiency was observed in 56.7% patients, while 26.7% had insufficient levels. A significant association was found between vitamin D deficiency and poor glycemic control ($p < 0.001$). Serum vitamin D levels showed a significant negative correlation with HbA1c ($r = -0.48$), fasting blood sugar ($r = -0.39$), and postprandial blood sugar levels ($r = -0.42$).

Conclusion: Vitamin D deficiency is highly prevalent among patients with T2DM and is significantly associated with poor glycemic control. Lower serum vitamin D levels correlate with higher HbA1c and blood glucose levels, suggesting a potential role of vitamin D in glucose metabolism. Routine screening and appropriate management of vitamin D deficiency may help improve metabolic outcomes in diabetic patients.

Keywords: Type 2 Diabetes Mellitus; Vitamin D deficiency; Glycemic control; HbA1c; Hyperglycemia; Insulin resistance.

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INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is one of the most prevalent chronic metabolic disorders worldwide and represents a major public health challenge due to its increasing incidence and associated complications. Persistent hyperglycemia in T2DM results from insulin resistance and impaired insulin secretion, leading to microvascular and macrovascular complications that significantly increase morbidity and mortality. According to the International Diabetes Federation, the global burden of diabetes continues to rise, particularly in developing countries such as India, where rapid urbanization, sedentary lifestyle, and dietary changes contribute substantially to disease prevalence [1].

Vitamin D is traditionally known for its role in calcium homeostasis and bone metabolism; however, recent evidence suggests that it also plays an important role in glucose metabolism and insulin function. Vitamin D receptors are present in pancreatic β-cells and peripheral insulin-sensitive tissues, indicating its potential involvement in insulin secretion and insulin sensitivity. Deficiency of vitamin D has been associated with impaired β-cell function, increased insulin resistance, systemic inflammation, and poor glycemic control in patients with T2DM [2, 3].

Vitamin D deficiency is highly prevalent worldwide and is increasingly recognized as a common comorbidity among individuals with T2DM. Several studies have demonstrated an inverse relationship between serum vitamin D levels and glycated hemoglobin (HbA1c), suggesting that lower vitamin D levels may contribute to poor glycemic control. Moreover, vitamin D deficiency has been linked with an increased risk of diabetic complications including neuropathy, nephropathy, and cardiovascular diseases [4, 5].

India has a paradoxically high prevalence of vitamin D deficiency despite abundant sunlight exposure. Factors such as darker skin pigmentation, limited outdoor activity, inadequate dietary intake, obesity, and sociocultural practices contribute to widespread hypovitaminosis D among the Indian population. In patients with T2DM, the coexistence of vitamin D deficiency may further worsen metabolic control and disease progression [6, 7].

Although several studies have evaluated the relationship between vitamin D status and diabetes, the findings remain inconsistent, and regional data from the Indian population are still limited. Therefore, the present study was undertaken to determine the prevalence of vitamin D deficiency and evaluate its association with glycemic control among patients with Type 2 Diabetes Mellitus.

MATERIALS AND METHODS

Study Design and Setting: This hospital-based cross-sectional observational study was conducted in the Department of General Medicine at a tertiary care teaching Indian hospital over a period of 12 months

Study Population: The study included 180 patients diagnosed with Type 2 Diabetes Mellitus attending the outpatient and inpatient departments of General Medicine**.**

Inclusion Criteria

- Patients aged ≥18 years diagnosed with Type 2 Diabetes Mellitus
- Patients willing to provide written informed consent

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Exclusion Criteria

- Patients with Type 1 Diabetes Mellitus or gestational diabetes
- Patients receiving vitamin D or calcium supplementation within the previous 6 months
- Patients with chronic liver disease, chronic kidney disease, malabsorption syndrome, thyroid or parathyroid disorders
- Patients on steroids, anticonvulsants, or drugs affecting vitamin D metabolism

Data Collection: Detailed demographic and clinical information including age, sex, duration of diabetes, body mass index (BMI), dietary habits, physical activity, and treatment history were recorded using a predesigned proforma. Blood pressure and anthropometric measurements were obtained using standard methods.

Laboratory Investigations: After overnight fasting, venous blood samples were collected for estimation of Fasting Blood Sugar (FBS), Postprandial Blood Sugar (PPBS), Glycated Hemoglobin (HbA1c) and Serum 25-hydroxy vitamin D [25(OH) D]**.** HbA1c was measured using high-performance liquid chromatography (HPLC) method. Serum vitamin D levels were estimated by chemiluminescent immunoassay.

Vitamin D status was categorized as:

- Deficient: <20 ng/mL
- Insufficient: 20–29 ng/mL
- Sufficient: ≥30 ng/mL

Glycemic control was assessed using HbA1c levels. Patients with HbA1c <7% were considered to have good glycemic control, while HbA1c ≥7% indicated poor glycemic control.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 25.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The association between vitamin D levels and glycemic parameters was analyzed using Pearson's correlation coefficient and Chi-square test. A p-value <0.05 was considered statistically significant.

RESULTS

The mean age of the study participants was 54.8 ± 10.6 years, with males constituting 56.7% of the study population. The mean duration of diabetes was 8.1 ± 4.7 years and the average BMI was 27.4 ± 3.9 kg/m². Hypertension was present in 52.2% participants, while 60.0% had a sedentary lifestyle [Table: 1].

Table 1: Socio-demographic and Clinical Characteristics of Study Participants (n=180)

Variable	Frequency (%) / Mean ± SD
Age (years)	54.8 ± 10.6
Male	102 (56.7%)
Female	78 (43.3%)
Duration of diabetes (years)	8.1 ± 4.7

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Variable	Frequency (%) / Mean ± SD
BMI (kg/m²)	27.4 ± 3.9
Hypertension present	94 (52.2%)
Sedentary lifestyle	108 (60.0%)
Vegetarian diet	74 (41.1%)
Mixed diet	106 (58.9%)

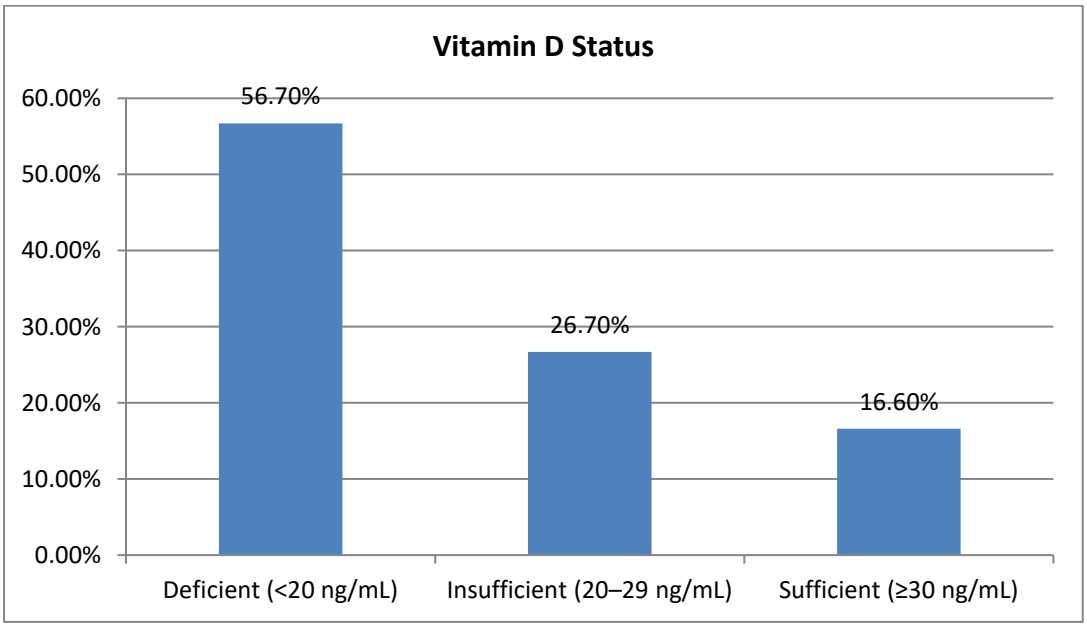
The laboratory findings demonstrated poor glycemic control among study participants, with a mean HbA1c of 8.2 ± 1.6%. Mean fasting and postprandial blood sugar levels were elevated at 162.5 ± 42.8 mg/dL and 246.7 ± 61.4 mg/dL respectively. The mean serum vitamin D level was 19.6 ± 8.4 ng/mL, indicating low vitamin D status in the study population [Table: 2].

Table 2: Laboratory variable among study participants (n = 180)

Variable	Frequency (%) / Mean ± SD
HbA1c (%)	8.2 ± 1.6
Fasting Blood Sugar (mg/dL)	162.5 ± 42.8
Postprandial Blood Sugar (mg/dL)	246.7 ± 61.4
Serum Vitamin D (ng/mL)	19.6 ± 8.4

More than half of the study participants (56.7%) had vitamin D deficiency, while 26.7% had insufficient vitamin D levels and only 16.6% had sufficient vitamin D levels. This finding indicates a high prevalence of hypovitaminosis D among patients with Type 2 Diabetes Mellitus [Graph:1]

Graph 1: Distribution of Vitamin D Status among Study Participants



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A statistically significant association was observed between vitamin D status and glycemic control ($p < 0.001$). Poor glycemic control was most common among patients with vitamin D deficiency, whereas patients with sufficient vitamin D levels showed comparatively better glycemic control [Table: 3].

Table 3: Association between Vitamin D Status and Glycemic Control

Vitamin D Status	Good Glycemic Control (HbA1c <7%)	Poor Glycemic Control (HbA1c ≥7%)	Total	p-value
Deficient	18	84	102	**<0.001**
Insufficient	16	32	48	
Sufficient	18	12	30	
Total	52	128	180	

Serum vitamin D levels showed a significant negative correlation with HbA1c ($r = -0.48$), fasting blood sugar ($r = -0.39$), and postprandial blood sugar ($r = -0.42$), indicating that lower vitamin D levels were associated with poorer glycemic parameters among study participants[Table: 4].

Table 4: Correlation of Serum Vitamin D Levels with Glycemic Parameters

Parameter	Correlation Coefficient (r)	p-value
HbA1c	-0.48	<0.001
Fasting Blood Sugar	-0.39	<0.001
Postprandial Blood Sugar	-0.42	<0.001

DISCUSSION

The present study demonstrated a high prevalence of vitamin D deficiency among patients with Type 2 Diabetes Mellitus (T2DM), with more than half of the participants exhibiting deficient serum vitamin D levels. Additionally, serum vitamin D levels showed a significant inverse association with HbA1c, fasting blood sugar, and postprandial blood sugar, suggesting that lower vitamin D levels are associated with poorer glycemic control. These findings support the growing evidence that vitamin D may play an important role in glucose metabolism and insulin regulation.

In the present study, majority of diabetic patients had vitamin D deficiency, which is comparable to findings reported by Kostoglou-Athanassiou et al., who observed a high prevalence of hypovitaminosis D among patients with T2DM and suggested that vitamin D deficiency may contribute to worsening metabolic parameters.[8] Similarly, Dutta et al. reported a high burden of vitamin D deficiency in Indian diabetic populations and emphasized its association with obesity and insulin resistance.[9] The high prevalence observed in the current study may be

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attributed to reduced outdoor activity, obesity, dietary insufficiency, and chronic inflammatory state commonly seen in diabetic patients.

The mean HbA1c level in the present study was elevated, indicating poor glycemic control among most participants. A statistically significant association was found between vitamin D deficiency and poor glycemic control. Similar observations were reported by Al-Zahrani et al., who found that diabetic patients with lower vitamin D levels had significantly higher HbA1c concentrations.[10] Another study by Kositsawat et al. demonstrated that vitamin D deficiency was independently associated with poor glycemic control in patients with T2DM.[11] Vitamin D is believed to influence insulin secretion through activation of vitamin D receptors in pancreatic β-cells and modulation of intracellular calcium metabolism, which is essential for insulin release.

The present study also demonstrated a significant negative correlation between serum vitamin D levels and fasting as well as postprandial blood glucose levels. Comparable findings were reported by George et al., who identified an inverse relationship between vitamin D levels and glycemic indices among diabetic patients.[12] Likewise, Kayaniyil et al. observed that lower vitamin D concentrations were associated with increased insulin resistance and impaired glucose homeostasis.[13] These findings suggest that vitamin D deficiency may aggravate insulin resistance and worsen metabolic control in T2DM.

The coexistence of vitamin D deficiency and diabetes may further increase the risk of long-term diabetic complications. Previous studies have shown that vitamin D possesses anti-inflammatory and immunomodulatory properties that may protect against endothelial dysfunction and vascular complications.[14] Therefore, maintaining adequate vitamin D status may have potential benefits not only in glycemic regulation but also in reducing diabetes-related morbidity.

CONCLUSION

The present study demonstrated a high prevalence of vitamin D deficiency among patients with Type 2 Diabetes Mellitus. A significant association was observed between low serum vitamin D levels and poor glycemic control, with vitamin D deficiency showing a negative correlation with HbA1c, fasting blood sugar, and postprandial blood sugar levels. These findings suggest that hypovitaminosis D may contribute to impaired glucose metabolism and worsening diabetic control. Routine screening and early correction of vitamin D deficiency in patients with T2DM may help improve metabolic outcomes and reduce the risk of diabetes-related complications. Further large-scale prospective and interventional studies are recommended to establish the therapeutic role of vitamin D supplementation in glycemic management.

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