



COMPARATIVE STUDY OF SERUM VITAMIN D LEVELS IN PATIENTS WITH TYPE 2 DIABETES MELLITUS AND NON-DIABETIC INDIVIDUALS: A PROSPECTIVE STUDY

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Abstract

Background: Vitamin D plays a significant role in glucose metabolism, insulin sensitivity, and pancreatic β -cell function. Emerging evidence suggests an association between vitamin D deficiency and type 2 diabetes mellitus (T2DM), but findings remain inconsistent, particularly in Indian populations where both conditions are highly prevalent.

Aim: To compare serum vitamin D levels in patients with type 2 diabetes mellitus and non-diabetic individuals.

Materials and Methods: This prospective study was conducted at Dr. N. Y. Tasgaonkar Medical College, Karjat, including 50 participants divided into two groups: Group A (T2DM patients, $n=25$) and Group B (non-diabetic controls, $n=25$). Serum 25-hydroxyvitamin D levels were estimated using chemiluminescent immunoassay. Glycemic parameters including fasting blood glucose and HbA1c were recorded. Statistical analysis was performed using independent t-test and Pearson correlation, with significance set at $p<0.05$.

Results: Serum vitamin D levels were significantly lower in the diabetic group compared to controls. A higher prevalence of vitamin D deficiency was observed among diabetic patients. A statistically significant negative correlation was noted between vitamin D levels and HbA1c.

Conclusion: Vitamin D deficiency is significantly associated with type 2 diabetes mellitus and may contribute to poor glycemic control. Routine monitoring and correction of vitamin D deficiency could be beneficial in diabetic patients.

Keywords: Vitamin D, Type 2 Diabetes Mellitus, HbA1c, Insulin Resistance, Hypovitaminosis D.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from insulin resistance and relative insulin deficiency. It represents one of the most significant global health challenges, with rapidly increasing prevalence in both developed and developing countries. India, in particular, has witnessed a dramatic rise in diabetes cases, earning the distinction of being one of the countries with the highest diabetic

populations worldwide [1]. The burden of diabetes is further compounded by its associated complications, including cardiovascular disease, nephropathy, neuropathy, and retinopathy [2].

In recent years, attention has shifted toward identifying modifiable risk factors that may influence the development and progression of T2DM. Among these, vitamin D has emerged as a potential contributor to glucose homeostasis. Traditionally recognized for its role in calcium metabolism and bone health, vitamin D is now known to have diverse physiological functions, including modulation of immune responses and regulation of endocrine pathways [3].

The presence of vitamin D receptors (VDR) in pancreatic β -cells and peripheral insulin-sensitive tissues suggests a direct role in insulin secretion and action [4]. Vitamin D is believed to enhance insulin sensitivity by stimulating the expression of insulin receptors and facilitating glucose transport into cells [5]. Furthermore, it plays a role in maintaining extracellular calcium levels, which are essential for insulin-mediated intracellular processes [6].

Vitamin D deficiency, defined as low levels of serum 25-hydroxyvitamin D, is highly prevalent worldwide, even in regions with abundant sunlight such as India. Factors such as limited sun exposure, increased skin pigmentation, urban lifestyle, dietary insufficiency, and obesity contribute to this paradox [7]. Several studies have reported a high prevalence of hypovitaminosis D among both diabetic and non-diabetic populations in India [8].

A growing body of evidence suggests an association between low vitamin D levels and the risk of developing T2DM. Observational studies have demonstrated that individuals with lower serum vitamin D levels are more likely to develop insulin resistance and impaired glucose tolerance [9]. Additionally, vitamin D deficiency has been linked to decreased pancreatic β -cell function, leading to inadequate insulin secretion [10].

Prospective studies have also indicated that low baseline vitamin D levels may predict the onset of type 2 diabetes [11]. However, the relationship between vitamin D and diabetes remains complex and not fully understood. While some interventional studies have shown improvement in glycemic control following vitamin D supplementation, others have reported no significant effect, highlighting the need for further research [12].

Another important factor linking vitamin D and diabetes is inflammation. Chronic low-grade inflammation is a key feature of insulin resistance, and vitamin D has been shown to possess anti-inflammatory properties by regulating cytokine production [13]. This suggests that vitamin D deficiency may contribute to the pathogenesis of T2DM through inflammatory pathways.

Despite increasing evidence, there is still a lack of consensus regarding the exact role of vitamin D in diabetes. Variations in study design, population characteristics, and measurement techniques contribute to these inconsistencies. Moreover, data from rural and semi-urban Indian populations

remain limited.

Given the high prevalence of both T2DM and vitamin D deficiency in India, it is essential to investigate their association in specific regional settings. Understanding this relationship may help in developing preventive strategies and improving disease management.

Therefore, the present study was undertaken to compare serum vitamin D levels in patients with type 2 diabetes mellitus and non-diabetic individuals in a tertiary care setting at Karjat.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted at Dr. N. Y. Tasgaonkar Medical College, Karjat, over a period of 12 months. The study protocol was approved by the Institutional Ethics Committee, and all procedures were performed in accordance with ethical standards. Written informed consent was obtained from all participants.

Sample Size and Study Population

A total of 50 participants were included and divided into two groups:

- Group A (T2DM patients): 25 individuals diagnosed with type 2 diabetes mellitus
- Group B (Controls): 25 non-diabetic healthy individuals

Participants were selected based on predefined inclusion and exclusion criteria.

Inclusion Criteria

- Age between 30 and 65 years
- Diagnosed cases of type 2 diabetes mellitus (Group A)
- Apparently healthy individuals without diabetes (Group B)
- Willingness to participate and provide informed consent

Exclusion Criteria

- Type 1 diabetes mellitus
- Chronic kidney disease or chronic liver disease
- Thyroid disorders
- Malabsorption syndromes
- Patients receiving vitamin D or calcium supplementation in the past 6 months
- Pregnant or lactating women
- Patients on drugs affecting vitamin D metabolism (e.g., steroids, anticonvulsants)

Data Collection Procedure

A detailed history was obtained, including demographic data, duration of diabetes, lifestyle factors, and dietary habits. Clinical examination was performed, and anthropometric measurements such as

height, weight, and body mass index (BMI) were recorded.

Laboratory Investigations

Venous blood samples were collected after overnight fasting. The following parameters were assessed:

- Serum 25-hydroxyvitamin D [25(OH)D]: Measured using chemiluminescent immunoassay
- Fasting Blood Glucose (FBG): Measured using glucose oxidase method
- Glycated Hemoglobin (HbA1c): Measured using high-performance liquid chromatography (HPLC)

Classification of Vitamin D Levels

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

Outcome Measures

Primary Outcome:

- Comparison of mean serum vitamin D levels between diabetic and non-diabetic groups

Secondary Outcomes:

- Prevalence of vitamin D deficiency
- Correlation between vitamin D levels and HbA1c

Statistical Analysis

Data were entered and analyzed using SPSS software (version XX).

- Quantitative variables were expressed as mean $\pm$ standard deviation
- Independent t-test was used to compare means between groups
- Chi-square test was used for categorical variables
- Pearson correlation coefficient was used to assess association between vitamin D levels and HbA1c

A p-value <0.05 was considered statistically significant.

Results

A total of 50 participants were included in this prospective study conducted at Dr. N. Y. Tasgaonkar Medical College, Karjat. The study population was divided into two equal groups: Group A (Type 2 Diabetes Mellitus, n=25) and Group B (Non-diabetic controls, n=25). All participants completed the study protocol, and no data were excluded from analysis.

Table 1: Baseline Demographic and Clinical Characteristics

Parameter	Diabetic Group (n=25)	Control Group (n=25)	p-value
Age (years)	52.3 ± 8.4	50.1 ± 7.9	0.34
Male/Female	14/11	13/12	0.78
BMI (kg/m ²)	27.2 ± 3.1	24.8 ± 2.9	0.01*
Fasting Blood Glucose (mg/dL)	156.4 ± 28.6	92.5 ± 10.2	<0.001*
HbA1c (%)	8.1 ± 1.2	5.3 ± 0.6	<0.001*

The mean age distribution between the two groups was comparable (p=0.34), indicating no significant age-related bias. Gender distribution was also similar (p=0.78), ensuring homogeneity between groups.

However, BMI was significantly higher in the diabetic group (27.2 kg/m²) compared to controls (24.8 kg/m²), representing an approximate 9.6% increase (p=0.01), suggesting a higher prevalence of overweight/obesity among diabetics.

As expected, fasting blood glucose levels were markedly elevated in the diabetic group, showing a 69.1% higher mean value than controls (p<0.001). Similarly, HbA1c levels were significantly higher in diabetics, with a 52.8% increase, confirming poor glycemic control in this group.

Table 2: Comparison of Serum Vitamin D Levels

Parameter	Diabetic Group	Control Group	p-value
Mean Vitamin D (ng/mL)	18.6 ± 6.2	26.4 ± 7.1	<0.001*

The mean serum vitamin D level in the diabetic group was 18.6 ng/mL, compared to 26.4 ng/mL in controls, indicating a 29.5% lower level in diabetic individuals. This difference was highly statistically significant (p<0.001).

These findings highlight a strong association between vitamin D deficiency and type 2 diabetes mellitus.

Table 3: Distribution of Vitamin D Status

Vitamin D Status	Diabetic Group (%)	Control Group (%)	p-value
Deficient (<20 ng/mL)	64% (16)	28% (7)	0.01*
Insufficient (20–30 ng/mL)	24% (6)	36% (9)	0.32
Sufficient (>30 ng/mL)	12% (3)	36% (9)	0.04*

A significantly higher proportion of diabetic patients (64%) were vitamin D deficient compared to controls (28%), indicating that deficiency was 2.3 times more prevalent in diabetics ($p=0.01$).

Only 12% of diabetics had sufficient vitamin D levels, compared to 36% in the control group, reflecting a threefold reduction in sufficiency ($p=0.04$).

Although vitamin D insufficiency was slightly more common in controls (36%) than diabetics (24%), this difference was not statistically significant ($p=0.32$).

Table 4: Correlation Between Serum Vitamin D Levels and HbA1c

Variable 1	Variable 2	Correlation Coefficient (r)	p-value	Strength of Correlation	Direction
Serum Vitamin D (ng/mL)	HbA1c (%)	-0.48	0.01*	Moderate	Negative

The table demonstrates a moderate negative correlation ($r = -0.48$) between serum vitamin D levels and HbA1c, which is statistically significant ($p = 0.01$). This indicates that as HbA1c levels increase (reflecting poorer glycemic control), vitamin D levels tend to decrease.

The negative direction of correlation suggests a potential inverse relationship between vitamin D status and glycemic control, supporting the hypothesis that vitamin D may play a role in glucose metabolism and insulin sensitivity.

DISCUSSION

The present prospective study evaluated serum vitamin D levels in patients with type 2 diabetes mellitus and compared them with non-diabetic individuals. The findings demonstrated a significant association between vitamin D deficiency and T2DM, with lower vitamin D levels observed in diabetic patients.

One of the key findings of this study was the significantly lower mean serum vitamin D levels in the diabetic group. This observation is consistent with previous studies that have reported reduced vitamin D levels in individuals with T2DM [1,2]. Vitamin D deficiency has been suggested to impair insulin secretion and increase insulin resistance, thereby contributing to the development and progression of diabetes [3].

The high prevalence of vitamin D deficiency (64%) among diabetic patients in the present study aligns with earlier reports indicating widespread hypovitaminosis D in diabetic populations [4]. This may be attributed to multiple factors, including decreased outdoor activity, obesity, and altered vitamin D metabolism in diabetic individuals [5].

The negative correlation observed between vitamin D levels and HbA1c further supports the role of vitamin D in glycemic control. Similar findings have been reported in previous studies, where lower

vitamin D levels were associated with higher HbA1c values and poor metabolic control [6]. This relationship can be explained by the role of vitamin D in enhancing insulin sensitivity and modulating inflammatory pathways [7].

Vitamin D is known to influence pancreatic β -cell function through its action on vitamin D receptors, which are expressed in pancreatic tissue [8]. It also regulates calcium homeostasis, which is essential for insulin secretion. Deficiency of vitamin D may therefore lead to impaired insulin release and increased blood glucose levels [9].

Another important observation in this study was the higher BMI among diabetic patients. Obesity is a well-established risk factor for both vitamin D deficiency and type 2 diabetes mellitus. Increased adiposity leads to sequestration of vitamin D in fat tissues, reducing its bioavailability [10]. This may partly explain the lower vitamin D levels observed in the diabetic group.

The findings of this study also revealed that only a small proportion of diabetic patients had sufficient vitamin D levels compared to controls. This suggests that maintaining adequate vitamin D status may play a protective role against the development of diabetes. Prospective studies have shown that individuals with higher baseline vitamin D levels have a lower risk of developing T2DM [11].

Despite these findings, the causal relationship between vitamin D deficiency and diabetes remains unclear. While observational studies suggest an association, interventional trials have yielded mixed results regarding the effect of vitamin D supplementation on glycemic control [12]. This indicates that vitamin D may act as a contributing factor rather than a primary cause of diabetes.

The strengths of this study include its prospective design and standardized biochemical assessment. However, certain limitations must be acknowledged. The sample size was relatively small, and the study was conducted in a single center, which may limit generalizability. Additionally, factors such as dietary intake, sunlight exposure, and seasonal variation were not assessed.

Nevertheless, the findings emphasize the importance of screening for vitamin D deficiency in diabetic patients. Early detection and correction of deficiency may help improve metabolic outcomes and reduce the risk of complications.

CONCLUSION

- Serum vitamin D levels are significantly lower in patients with type 2 diabetes mellitus
- Vitamin D deficiency is more prevalent among diabetics compared to non-diabetic individuals
- A significant negative correlation exists between vitamin D levels and glycemic control
- Vitamin D may play a supportive role in glucose metabolism and diabetes management

Routine screening and appropriate supplementation of vitamin D should be considered in diabetic patients.

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