RESEARCH PAPER

Assessment of Vitamin D and Calcium Levels in Type 2 Diabetes Mellitus

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Received: 28-03-2026, Revised: 13-05-2026, Accepted: 21-05-2026, Published: 30-05-2026

ABSTRACT

Background: Adequate insulin secretion and insulin sensitivity depend in part on sufficient vitamin D and calcium status; shortfalls in either nutrient is now widely documented among people living with diabetes.

Objective: The aim was to quantify serum vitamin D and calcium concentrations among T2DM patients and explore their link with glycemic outcomes.

Materials and Methods: The study Conducted across eight months from July, 2025 to February, 2026 at the Medicine Department, Aziz Fatimah Medical and Dental College Faisalabad, Pakistan, this cross-sectional analysis enrolled 180 confirmed T2DM cases through non-probability consecutive sampling.

Results: Deficient vitamin D status was recorded in 54.4% of participants, insufficiency in 28.9%, and adequate levels in just 16.7%. Compared with the sufficient group, deficient patients carried notably lower mean serum calcium (8.6 ± 0.6 mg/dL vs 9.3 ± 0.5 mg/dL, $p<0.001$). HbA1c rose in step with worsening vitamin D status, moving from 6.9 ± 0.8% among sufficient patients up to 8.9 ± 1.2% among deficient ones, consistent with a significant inverse relationship between the two markers ($p<0.001$).

Conclusions: Among T2DM patients, vitamin D deficiency occurs frequently, and hypocalcemia, though less pronounced is also common; both carry a statistically meaningful link to glycemic status.

Keywords: Vitamin D, Calcium, T2DM, HbA1c, Glycemic Control

How to cite this article: Malik S, Alam MA, Saleem K, Anjum MA, Iftikhar Z, Ali K. Assessment of vitamin D and calcium levels in type 2 diabetes mellitus. Int J Drug Deliv Technol. 2026;16(75s): 179-183. DOI: 10.25258/ijddt.16.75s.20

INTRODUCTION

Low vitamin D status is an increasingly recognized nutritional problem affecting people with (T2DM) globally. A pooled analysis by Taderegew and co-authors demonstrated that, regardless of geography, this shortfall stays persistently elevated across T2DM populations (1). Diabetic patients stand to gain metabolically from correcting such deficiency effects, such as lower HbA1c and improved quality of life, which have been tied to vitamin D and calcium supplementation, making micronutrient correction clinically meaningful (2). Along similar lines, an updated meta-analytic review by Dominguez and co-authors documented a marked connection between low vitamin D and elevated T2D risk, an effect most evident among older adults (3).

In patients with (T2DM), there are several lines of evidence that support the link among vitamin D status and glucose metabolism, including mechanistic studies and biomarker-based studies. Vitamin D is thought to act on glucose homeostasis via several biological processes, such as increasing pancreatic beta-cell function, improving insulin secretion and increasing insulin sensitivity in peripheral tissues (4). Pittas et al. conducted a comparison and systematic analysis of three randomised clinical trials including people with prediabetes. They discovered that the chance of T2D was marginally but statistically significantly reduced in those with greater vitamin D levels than in people with lower levels. Keeping an adequate amount of vitamin D can help prevent or postpone the progression of dyslipidaemia to overt diabetes, particularly

in high-risk patients, according to the scientists, even if the protection was very slight. The study's findings support the growing interest in vitamin D as a supplementary preventative intervention to lifestyle modifications (5,6).

Immune function is another aspect of calcium metabolism whose function is now crucial for preserving proper glucose control. Calcium is necessary for pancreatic β-cells to secrete insulin, and a disturbance in normal balance of calcium could affect both insulin production and insulin susceptibility. A dose-dependent meta-analysis and comprehensive review of nutritional calcium consumption and hyperglycemia and T2D were carried out by Hajhashemy et al. They discovered that the chance of hyperglycemia and type 2 diabetes was significantly inversely correlated with dietary calcium consumption. In the framework of a whole nutrition intervention plan for avoiding diabetes onset and management, the findings emphasise the need of appropriate calcium supplementation (7).

The potential therapeutic value of vitamin D in reducing diabetes risk indicators has also been studied in clinical studies. Kawahara et al. carried out the (DPVD) randomised controlled study in Japan to evaluate the effect of consistent vitamin D intake on T2D protection. The treatment helped among some high-risk segments, but it failed to significantly decrease the likelihood of diabetes within the research subjects as overall. These findings suggest that taking vitamin D supplements could prove more beneficial for individuals with particular metabolic traits or the ones that are more probable to encounter the development of a condition. Treatment regimens should thus be tailored to each patient (8,9). Results of observational studies in different populations have been consistent with results from systematic reviews and clinical trials.

In T2DM patients, Khan et al. investigated the correlation between bone metabolism markers (osteocalcin, vitamin D, parathyroid hormone) and glycemic indexes. They found strong links between these markers and glucose metabolism, indicating that changes in bone metabolism could affect metabolic control. The study also revealed the complex association between skeletal health and endocrine regulation and glucose metabolism in diabetes patients (10). Likewise, a cross sectional study was carried out by Vijay et al. to assess vitamin D insufficiency in people with type 2 diabetes. They found that a significant fraction of all diabetics had suboptimal levels of vitamin D, a strong indication that vitamin D deficiency is quite common among diabetics. They conclude that routine measurement of vitamin D levels should be done in all diabetic patients, especially those with suboptimal glycaemic control or other risk factors for vitamin D deficiency (11). In another cross-sectional study in Chinese T2DM patients, there was no association between blood vitamin D levels and cardiovascular disease (12).

There were no notable complications or serious safety concerns over the research period, and the measure was found to be acceptable and secure. The study's findings provide comfort for the long-term usage of vitamin D supplements in the appropriate groups (13). Lei et al. conducted a comparison and systematic examination to evaluate the connection between diabetes resistance along with serum vitamin D among T2DM patients. This is consistent with the hypothesis that the effects of vitamin D on insulin receptor expression, inflammatory pathways and calcium dependent intracellular signaling mechanisms may be responsible for improving insulin sensitivity (14). Several ethnic groups showed significant associations, reinforcing the importance of genetic factors in vitamin D metabolic regulation (15).

Additionally, there is confirmation that vitamin D provides beneficial benefits through antibacterial and antioxidant mechanisms. Insulin-resistant cells and a progressive decrease of β-cell activity have been linked to antioxidant stress and persistent inflammation. Gu et al. demonstrated that vitamin D prescription reduced oxidative stress indicators and cytokines that cause inflammation in plasma samples of T2DM patients, indicating that vitamin D may help regulate inflammatory processes throughout the course of T2DM (16,17). In summary, the literature currently available strongly suggests that vitamin D and calcium have a role in glucose metabolism, insulin secretion, insulin sensitivity, inflammatory regulation and oxidative stress. However, local information on the connection between blood vitamin D and calcium levels and glycaemic management is limited, despite growing evidence from throughout the globe. Further research is necessary to determine the frequency of these micronutrient deficiencies and their importance in the local diabetic community, as the lack of regional evidence highlights.

Objective

To measure serum vitamin D and calcium levels in T2DM patients and assess their association with glycemic control.

MATERIALS AND METHODS

Study Design: Cross-sectional Design.

Setting: The data was collected in the Medicine Department, Aziz Fatimah Medical and Dental College Faisalabad, Pakistan.

Study Duration: The fieldwork lasted for 8 months from July, 2025 to February, 2026.

Sample Size: Target sample size 180 using OpenEpi with 95% confidence level, 7% margin of error, and an anticipated 55% vitamin D insufficiency amongst people with type II diabetes mellitus.

Inclusion Criteria: The inclusion criteria were a confirmed diagnosis of T2DM for at least 6 months and an age range of 30-65 years. The participants had to be receiving regular follow-up care at the study center and agree to give written informed consent to participate in the study. All those who met the eligibility criteria and could undergo the necessary clinical evaluation and laboratory tests were included in the study.

Exclusion Criteria: Type 1 diabetes mellitus, patients with chronic kidney disease, hepatic dysfunction, malabsorption syndromes, pregnancy, and vitamin D

and/or calcium supplementation were excluded from the study. People with circumstances or treatment that could be expected to have a major impact on vitamin D metabolism, calcium homeostasis or glycemic parameters were also excluded. To ensure accuracy and reliability of the study findings, patients who did not give informed consent in writing and those with inadequate clinical and laboratory information were excluded from the final analysis.

Methods: After informed consent was obtained, a structured pro forma was given to each participant to record demographic, anthropometric, and clinical data. Standard laboratory tests of fasting glucose, glycated hemoglobin (HbA1c), serum 25-hydroxyvitamin D [25(OH)D], and serum calcium were performed on venous blood obtained after an overnight fast. The data collected were processed and entered into SPSS version 25.

RESULTS

A total of 180 patients with T2DM were finally included; the mean age was 51.8 ± 8.7 years, and there was a slight majority of females at 56.1%.

Table 1

Baseline Demographic and Clinical Characteristics (n = 180)

Variable	Frequency (%) / Mean ± SD
Age (years)	51.8 ± 8.7
Female	101 (56.1%)
Male	79 (43.9%)
Duration of Diabetes (years)	7.4 ± 4.2
BMI (kg/m²)	27.1 ± 4.0
Mean HbA1c (%)	8.1 ± 1.4

More than half of the study population showed deficient vitamin D, making this the dominant finding in the cohort.

Table 2

Distribution of Vitamin D Status Among Study Participants

Vitamin D Status	Frequency	Percentage
Deficients (<20 ng/mL)	98	54.4%
Insufficient (20–29.9 ng/mL)	52	28.9%
Sufficient (≥30 ng/mL)	30	16.7%

Across the vitamin D status groups, serum calcium and glycemic measures both showed significant, progressively worsening trends toward the deficient category.

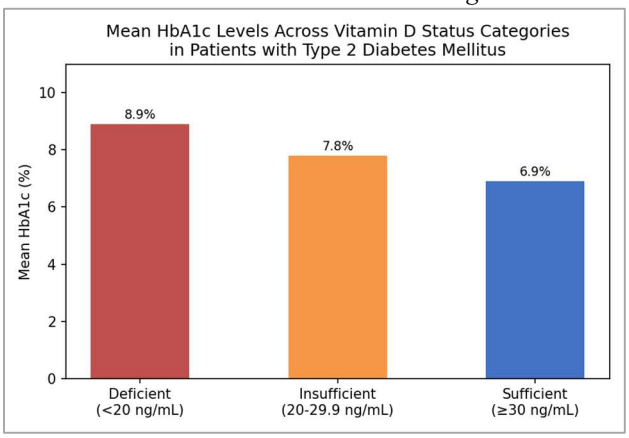
Table 3

Comparison of Serum Calcium and Glycemic Parameters Across Vitamin D Status Groups

Variable	Deficient (n=98)	Sufficient (n=30)	p-value
Serum Calcium (mg/dL)	8.6 ± 0.6	9.3 ± 0.5	<0.001
Fasting Blood Glucose (mg/dL)	182.4 ± 34.7	138.6 ± 26.9	<0.001
HbA1c (%)	8.9 ± 1.2	6.9 ± 0.8	<0.001

Graph (Bar Chart)

Mean HbA1c Across Vitamin D Status Categories



The graph illustrates a stepwise climb in mean HbA1c moving from sufficient through insufficient to deficient vitamin D status.

Table 4

Association of Vitamin D Status with Glycemic Control Category

Vitamin D Status	Good Control n (%)	Fair/Poor Control n (%)	Total
Deficient	14 (14.3%)	84 (85.7%)	98
Insufficient	19 (36.5%)	33 (63.5%)	52
Sufficient	19 (63.3%)	11 (36.7%)	30

Overall p-value <0.001 (chi-square test for trend).

Results from Pearson's correlation analysis showed that there is a significant negative association between vitamin D content and HbA1c. HbA1c levels in the blood raise when vitamin D content in the body declines ($r = -0.52$, $p<0.001$). Decrease in vitamin D concentration leads to an increase in blood HbA1c levels which suggests that vitamin D deficiency might worsen the glucose regulation abilities of an individual.

DISCUSSION

This study aimed to describe the blood calcium and vitamin D levels of (T2DM) patients and to assess the relationship between calcium and vitamin D levels and glycemic control. Low vitamin D affected the majority of participants (54.4%). Furthermore, each step down in vitamin D adequacy brought a further decline in blood calcium alongside progressively weaker glycemic control. Because serum vitamin D and HbA1c moved in opposite directions, poorer glycemic management consistently paired with lower vitamin D. Taken together, these observations point toward a possible role for vitamin D insufficiency in disrupted glucose regulation and glycemic control among T2DM patients. A meta-analytic review by Taderegew and co-authors placed the pooled vitamin D insufficiency prevalence among T2DM patients at roughly 54.4%, a figure nearly identical to that observed here (1).

Mehta and co-authors likewise showed that pairing vitamin D with calcium treatment improved HbA1c control and quality of life among diabetics (2). Dominguez and co-authors, too, connected lower vitamin D with

heightened diabetes risk among older populations, pointing to a possible dual role for vitamin D in both preventing and worsening the disease (3,4). Three randomized trials yielded a similar small reduction in diabetes risk for high-risk prediabetics taking vitamin D, as analyzed by Pittas and colleagues (5,6). Alfaqih and colleagues, on the one hand, linked the vitamin D receptor gene variation to an increase in the risk of type 2 diabetes, suggesting that the relationship between vitamin D status and glucose metabolism is due to the interaction between genes and the environment (7).

In T2DM patients, Isa et al. revealed that low vitamin D always correlated with poor metabolic outcomes such as poor glycemic control and increased insulin resistance (9). Vitamin D, parathyroid hormone, calcium metabolism, and glycemic parameters have been associated with bone-metabolism markers in (T2DM) patients in several previous studies (10). The study findings have direct clinical implications, as vitamin D supplementation is already proven to be safe and effective. In the D2d trial, the researchers Johnson and colleagues found that vitamin D supplements were safe to take in the long term with no adverse side effects reported (13).

Vitamin D's ability to have anti-oxidant and anti-inflammatory effects is another pathway by which it may help regulate metabolism. Beyond the control of glucose, vitamin D treatment significantly reduced inflammatory and oxidative stress markers in (T2DM) (16), indicating a broader beneficial effect. Similarly, Khan et al. did a meta-analysis that correlated vitamin D supplementation with a modest decrease in diabetes incidence, supporting the public health argument for ensuring sufficient vitamin D levels in at-risk populations (17). When combined with the current results, this evidence base is growing that vitamin D insufficiency and lower levels of blood calcium are associated with poorer glycemic control in individuals with T2DM.

CONCLUSION

Vitamin D deficiency is prevalent and is significantly associated with low serum calcium among the T2DM group. Vitamin D and calcium should be screened routinely in select patients who are at risk of being deficient, and supplemental vitamin D may be beneficial, especially in patients who are not managing their blood sugars well. These deficiencies will need to be confirmed by additional longitudinal and interventional studies to determine whether correction of these abnormalities improves long-term glycemic outcomes.

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