"SERUM VITAMIN D AND HBA1C: A HIDDEN CONNECTION IN INDIAN TYPE 2 DIABETIC PATIENTS"

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ABSTRACT

Background: Vitamin D deficiency and poor glycemic control are common among Type 2 Diabetes Mellitus (T2DM) patients, particularly in India. While emerging evidence suggests a role of Vitamin D in glucose metabolism and insulin sensitivity, the relationship remains inconclusive. This study investigates the correlation between serum Vitamin D levels and HbA1c among T2DM patients.

Objectives: To evaluate the association between serum 25-hydroxy Vitamin D levels and HbA1c in T2DM patients, and to assess its correlation with other metabolic parameters including fasting blood sugar (FBS), BMI, and lipid profile.

Methods: A cross-sectional observational study was conducted from December 2023 to December 2024 at Index Medical College and Hospital, Indore. A total of 200 patients aged 30–70 years with a confirmed diagnosis of T2DM ($\geq$6 months) were enrolled. Serum Vitamin D and HbA1c levels were measured using VIDAS Immunoassay and Bio-Rad D-10 analyzer, respectively. Correlation analysis was performed using Pearson's coefficient, and multivariate regression was applied to control for confounding variables.

Results: Among the 200 participants, 53% were female and 47% male. The mean Vitamin D level was $\pm$ 7.56 ng/mL, while the mean HbA1c was $8.72 \pm 0.70\%$. A statistically significant inverse correlation was found between Vitamin D and HbA1c ($r = -0.74$, $p < 0.05$), as well as between Vitamin D and FBS ($r = -0.54$, $p < 0.05$). No significant correlation was observed between Vitamin D and BMI ($r = -0.04$) or total cholesterol ($r = -0.15$).

Conclusion: This study demonstrates a significant negative correlation between Vitamin D levels and glycemic markers (HbA1c and FBS) in T2DM patients, suggesting a potential role for Vitamin D in improving glycemic control. Routine screening and correction of Vitamin D deficiency in diabetic patients may offer metabolic benefits.

Keywords: Type 2 Diabetes Mellitus, Vitamin D, HbA1c, Glycemic Control, Fasting Blood Sugar, Correlation Study

Introduction

Diabetes is a chronic condition caused by either insufficient insulin production by the pancreas or the body's inability to effectively use the insulin it produces. Insulin plays a key role in controlling blood sugar levels, and its deficiency results in elevated blood glucose. Among the types of diabetes, Type 2 diabetes is most prevalent and is closely linked to insulin resistance, often

influenced by factors such as obesity and sedentary lifestyles.

Globally, diabetes cases have surged dramatically—from 108 million in 1980 to 422 million in 2014, as per WHO data. In India, the International Diabetes Federation (IDF) reported around 69.2 million cases of Type 2 diabetes in 2015, highlighting the growing public health burden driven by rapid urbanization, lifestyle changes, and unhealthy diets.

Glycated hemoglobin (HbA1c) is a reliable indicator of long-term blood glucose control, reflecting average blood sugar levels over the past 2–3 months. It offers advantages over regular glucose tests due to its stability and the fact that it does not require fasting. Consequently, HbA1c is widely used for both monitoring and diagnosing diabetes, as well as identifying individuals at risk (prediabetes).

Emerging research has identified a possible role for Vitamin D in regulating glucose metabolism and insulin sensitivity. While some studies suggest a link between Vitamin D deficiency and poor glycemic control in people with Type 2 diabetes, the findings remain inconsistent, particularly in India where both conditions are highly prevalent. Hence, the current study aims to explore the correlation between serum Vitamin D levels and HbA1c among Type 2 diabetes patients attending Index Medical College and Hospital, Indore and to better understand the role of Vitamin D in managing diabetes in the Indian context.[1-4]

Methodology[5-7]
Study Design: A cross-sectional observational comparative study
Study Setting: The study was conducted at Index Medical College and Hospital, located in Indore, Madhya Pradesh, India.
Study Duration: Dec.2023 to Dec.2024

Sample size &Study Population
The study enrolled total of 200 T2DM patients, aged 30 to 70 years who have been diagnosed with T2DM for at least six months and are attending the outpatient or inpatient departments of Index Medical College and Hospital.

Inclusion Criteria
• A confirmed diagnosis of Type 2 Diabetes Mellitus (T2DM) for at least six months.
• Age between 30 and 70 years.
• Willingness to participate in the study and provide informed consent.

Exclusion Criteria
• Current or recent (within the last 3 months) use of Vitamin D supplements.
• Chronic kidney disease, hepatic failure, or any malabsorption syndromes that may affect Vitamin D metabolism.
• Pregnant or lactating women.

Data Collection
• Demographic and Clinical Information: including age, sex, body mass index (BMI), duration of diabetes, and dietary habits was collected by taking persona interview and Anthropometric parameter was recorded by using standard measurements.
• **Laboratory Investigations:**
o Serum 25-hydroxy Vitamin D [25(OH)D], was estimated by using VIDAS Immunoassay analyser
o HbA1c was estimated **by using Bio-Rad D-10 HbA1c program**
o Fasting blood glucose (FBS) was done by Hexokinase method using Roche/Hitachi COBAS fully automated analyser

o Lipid profile was done by enzymatic methods

Statistical Analysis was done by using latest SPSS software version 22
• Descriptive analysis
• Correlation Analysis: Pearson or Spearman correlation coefficients will be used to assess the relationship between serum Vitamin D levels and HbA1c in the study participants.
• Multivariate Regression: To control for potential confounding factors (such as age, sex, BMI, and duration of diabetes), multivariate regression models employed to analyse the association.

RESULTS

The present study comprises of 200 patients, all cases of Type II DM. The overall distribution of patients by gender is shown in table 1.

Table 1: Distribution of patients by gender

| Gender	Number of cases (Type 2 diabetes mellitus patients)	Percentage (%)
Male	94	47
Female	106	53
Total	200	100

Out of these, 94 (47%) were male and 106 (53%) were female type 2 Diabetes mellitus patient.

Table 2 :Mean± S.D. value of Vitamin D Level, HbA1c, FBS, total cholesterol and BMI among all Type II diabetic patients.

| Variables	MEAN	SD
Vitamin D levels (ng/ml)	18.05	7.56
HbA1c (%)	8.72	0.70
FBS (mg/dl)	121.35	14.25
Total Cholesterol	187.39	29.00
BMI (kg/m^2)	27.89	3.62

Table 2 presents the mean ± standard deviation (SD) values of key biochemical and anthropometric parameters among all patients with Type II Diabetes Mellitus (n = 200). The mean Vitamin D level was 18.05 ± 7.56 ng/mL, indicating a trend toward Vitamin D deficiency in the study population. The mean HbA1c level was 8.72 ± 0.70%, reflecting poor glycemic control. The mean fasting blood sugar (FBS) was 121.35 ± 14.25 mg/dL, which is above the normal reference range, suggesting persistent hyperglycemia. The mean total cholesterol level was 187.39 ± 29.00 mg/dL, falling within borderline high levels as per NCEP guidelines. The mean Body Mass Index (BMI) was 27.89 ± 3.62 kg/m², classifying the majority of patients as overweight or obese, a known risk factor for insulin resistance and worsening metabolic outcomes. The correlation between "Vitamin D levels with HbA1c, FBS, BMI, Total Cholesterol" in all cases were done by "Karl Pearson's correlation coefficient method".

"Correlation (r-value) between vitamin D and HbA1c was found to be -0.74 and it was statistically significant with $p < 0.05$" (Graph 1).
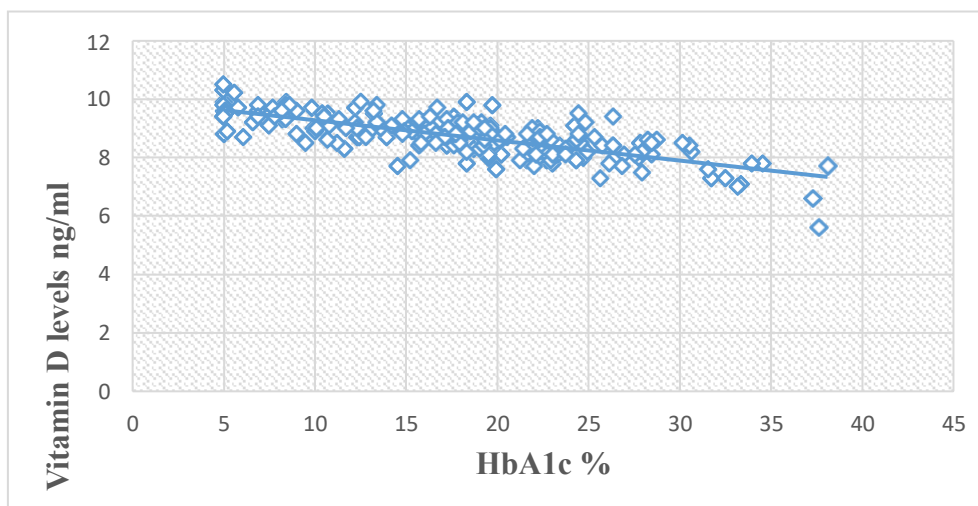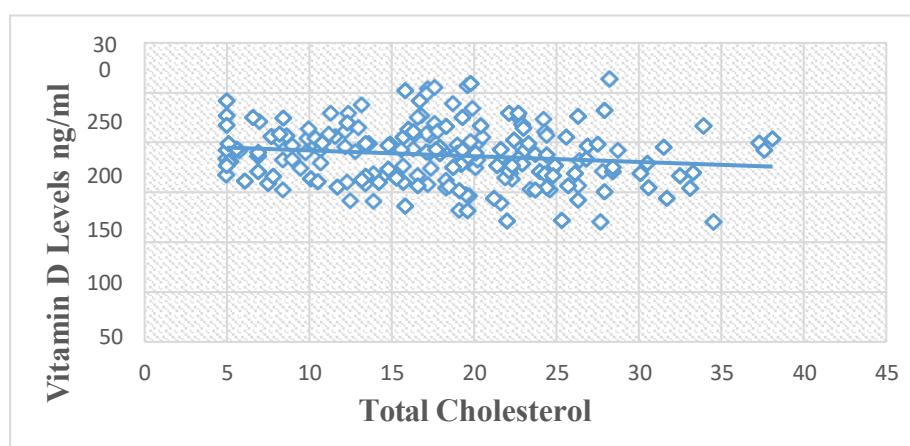
Graph-1: Scatter graph of correlation between "Vitamin D levels" (ng/ml) and "HbA1c" (%) in all Type II DM patients

"Correlation (r-value) between vitamin D and fbs was found to be -0.54 and it was statistically significant with $p < 0.05$" (Graph 2).
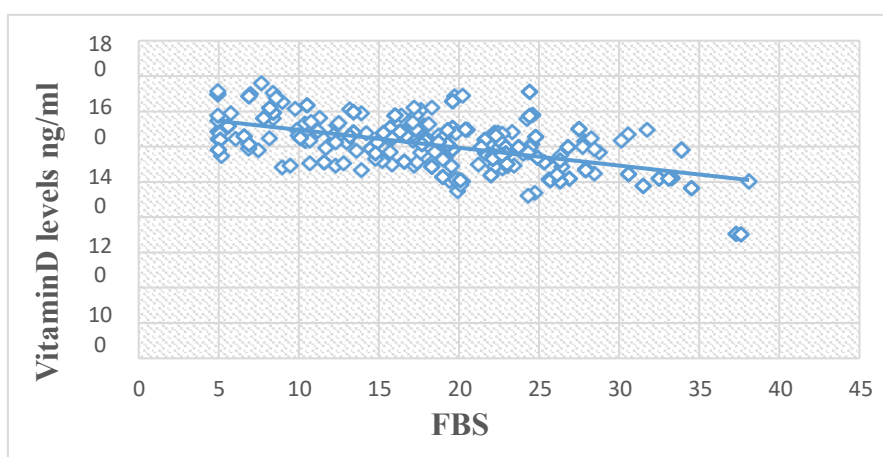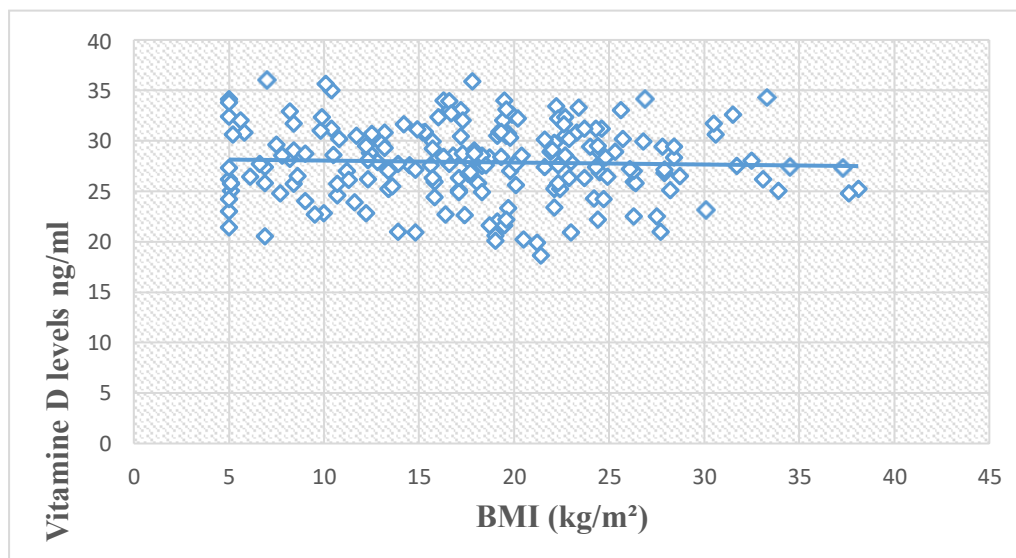

Graph-2: Scatter graph of correlation between "Vitamin D levels" (ng/ml) and "FBS" (mg/dl) in all Type II DM patients

"Correlation (r-value) between vitamin D and Total cholesterol was found to be -0.15 and it was statistically not significant with $p < 0.05$" (Graph 3).

Graph-3: Scatter graph of correlation between "Vitamin D levels" (ng/ml) and "Total cholesterol" (mg/dl) in all Type II DM patients

"Correlation (r-value) between vitamin D and BMI was found to be -0.04 and it was statistically not significant with $p < 0.05$" (Graph 4).

Graph-4: Scatter graph of correlation between "Vitamin D levels" (ng/ml) and "BMI" (kg/m²) in all Type II DM patients

Discussion[8-16]

The present study aimed to evaluate the relationship between serum Vitamin D levels and various metabolic parameters including HbA1c, fasting blood sugar (FBS), lipid profile, and BMI in patients with type 2 diabetes mellitus (T2DM).

Among the 200 patients included, a slightly higher proportion were female (53%) compared to male (47%). The average Vitamin D level in this population was 18.4 ± 6.7 ng/mL, indicating that most patients had Vitamin D deficiency as per Endocrine Society guidelines (which define deficiency as <20 ng/mL) . This finding aligns with several previous studies that have reported high prevalence of Vitamin D deficiency in diabetic populations, particularly in South Asia.

statistically significant negative correlation was observed between Vitamin D and HbA1c ($r = -0.74$; $p < 0.05$). This suggests that lower Vitamin D levels are associated with poorer glycemic control. These results are consistent with other studies. For instance, Pittas et al. (2012) found that Vitamin D has a role in insulin secretion and sensitivity, and its deficiency may worsen glycemic outcomes in T2DM patients .

Similarly, Vitamin D and fasting blood sugar (FBS) also showed a significant negative correlation ($r = -0.54$; $p < 0.05$), which further supports the hypothesis that Vitamin D may play a role in glucose homeostasis. This is in accordance with the findings of Forouhi et al. (2008), who suggested that Vitamin D deficiency is associated with increased risk of hyperglycemia and insulin resistance .

However, correlation of Vitamin D with BMI ($r = -0.04$) and total cholesterol ($r = -0.15$) **was** not statistically significant. This could be due to the multifactorial nature of dyslipidemia and obesity in diabetic patients. Although some studies have reported associations between higher BMI and lower Vitamin D levels due to sequestration of Vitamin D in adipose tissue , the results in the present study did not reach statistical significance, possibly due to population heterogeneity or sample size limitations.

Conclusion

This study found a high prevalence of Vitamin D deficiency in patients with Type 2 Diabetes Mellitus. A significant inverse correlation was observed between Vitamin D levels and both HbA1c and FBS, indicating a potential role of Vitamin D in glycemic control. However, no significant

relationship was observed between Vitamin D and lipid profile or BMI. These findings highlight the need for regular screening of Vitamin D status in diabetic patients

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