

Original Research Article

CORRELATION OF SERUM VITAMIN D3 LEVEL AND TRIGLYCERIDES AMONG DIABETES AND PRE DIABETES PATIENTS – A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a multifactorial disease involving genetic and environmental factors. It is characterized by dysregulation of carbohydrate, lipid, and protein metabolism due to impaired insulin secretion, increased insulin resistance, or a combination of both. Vitamin D regulates glucose homeostasis, but the effects of vitamin D on β cell functions remain unclear. **Aim:** To correlate serum vitamin D and triglycerides among diabetes and prediabetes patients.

Materials and Methods: Study population of three groups: group 1 consists of 26 T2DM patients, group 2 has 26 Prediabetes patients, and group 3 is 26 gender- and age-matched control group. T2DM and prediabetes were diagnosed as per ADA criteria. Serum vitamin D levels and triglyceride levels were measured and compared among diabetes, prediabetes and controls.

Results: Chi-Square test of association was used to test the association between different categorical parameters. Pearson's Correlation Coefficient was used to assess the correlation between continuous variables. The statistical analysis shows a negative correlation of Vitamin D with diabetic and prediabetic patients. A positive correlation is found between triglyceride levels and T2DM and prediabetic patients.

Conclusion: Vitamin D levels were decreased in prediabetic and moderately decreased in diabetic patients. But serum vitamin D levels are also associated with diet, exposure to sunlight, etc. So, with vitamin D levels, the severity of diabetes and prediction of conversion of prediabetes to diabetes is not clear. Triglyceride levels showed a positive correlation due to the derangement of the lipid profile in diabetes.

Keywords: Type 2 Diabetes, Prediabetes, Vitamin D, Triglycerides.

INTRODUCTION

Diabetes is rapidly becoming an epidemic in India, with more than 74 million individuals diagnosed with the disorder.^[1] It is predicted that by 2030, 80 million to 100 million individuals in India may have Type 2 Diabetes Mellitus.^[2] Type 2 Diabetes Mellitus (diabetes) is a multifactorial disorder involving genetic and environmental factors. It is characterized by dysregulation of carbohydrate, lipid, and protein metabolism due to impaired insulin secretion, increased insulin resistance, or both, resulting in hyperglycemia and chronic inflammation.^[3]

Prediabetic patients have fasting blood glucose (FBG) or glycated haemoglobin (HbA1c) levels are higher than normal but below the diabetic threshold. Prediabetes is becoming increasingly common in adults worldwide. People with prediabetes are more likely to develop diabetic complications, such as diabetic retinopathy, nephropathy, neuropathy, and cardiovascular diseases.^[4,5]

Vitamin D was originally classified as merely a vitamin, but it is now classified as a hormone and is involved in a plethora of physiological processes.^[6] Vitamin D has non skeletal effects on pancreatic insulin release and insulin sensitivity.^[7] It has been

hypothesized that Vitamin D may have anti-diabetic effects by regulating insulin secretion or insulin sensitivity, producing anti-inflammatory effects, and down-regulating elevated parathyroid hormone levels, which can impair insulin secretion.^[8] Vitamin D exerts its action in a variety of cell types through the vitamin D receptor.^[9] Molecular evidence has found that pancreatic β -cells express both cytosolic/nuclear VDR, thus enhancing β -cells' function.^[10]

Additionally, 25(OH) vitamin D protects pancreatic β cells from immune attack.^[11] 25(OH) D inhibits the release of the pro-inflammatory cytokines, TNF α , and regulates the activity of TLR 2 and TLR 4 proteins.^[12,13] Vitamin D helps to mitigate insulin resistance by maintaining the insulin signaling pathway through increasing cell-surface expression of the insulin receptor.^[14]

Vitamin D deficiency is diagnosed when 25(OH)D level in serum is <20 ng/mL and insufficiency as serum 25(OH)D level 20 to 30 ng/mL, which affects almost 1 billion people worldwide, representing a staggering 15% of the global population.^[15]

Diabetic dyslipidemia is defined by the American Diabetes Association, is used to describe dysregulated levels of lipids, including total cholesterol, triglycerides, very low-density lipoprotein, low-density lipoprotein, and high-density lipoprotein in type 2 diabetic patients.^[16] It has been found that Insulin resistance in obesity results largely from the high presence of serum fatty acids and associated metabolites, which have been shown to reduce insulin signalling by phosphorylating the insulin receptor substrate.^[17]

In case of prediabetes, a transition metabolic state from normoglycemia to T2DM, and the patient may have abnormalities in the lipid profile, leading to an increased risk of cardiovascular disease.^[18] Previous studies have shown that low serum vitamin D concentration was associated with adverse lipid status and vitamin D supplementation could improve serum TC, TG, and LDL-C in subjects with metabolic syndrome.^[19]

Although the relationship between vitamin D and insulin resistance is, relatively better investigated in patients with diabetes mellitus, data from individuals with prediabetes are limited.^[20]

So, it is important to understand the etiological role of Vitamin D deficiency in T2DM development, which may help to inform important public health efforts to reduce diabetes prevalence. Also, this study was conducted to understand the predictive role of triglycerides in the transition of diabetes from prediabetes.

MATERIALS AND METHODS

The present study is a cross-sectional study conducted between November 2023 to April 2024 among the patients attending the OPD of the General Medicine Department, Victoria Hospital, BMCRI,

Bangalore. After obtaining the clearance from institutional Ethics committee of Bangalore Medical College and Research Institute, Bangalore.

The estimated sample size was Based on the study by Srinath KM et al²¹ vitamin D levels among cases and controls were 17.09 + 5.8 and 23.67 + 11.02, respectively. The study participants who met the following inclusion and exclusion criteria were considered for the study. At the start of the study informed, written consent will be obtained from all the study participants.

A. Inclusion criteria

1. Patients gave written consent.
2. Age group of 30 – 50 years of both gender
3. Positive Family history of Diabetes
4. Control groups include healthy individuals.
5. Prediabetes group as per ADA criteria²² of impaired fasting blood glucose with HbA1c levels are between 5.7 to 6.4.
6. Diabetes group as per ADA criteria²² for Diabetes.

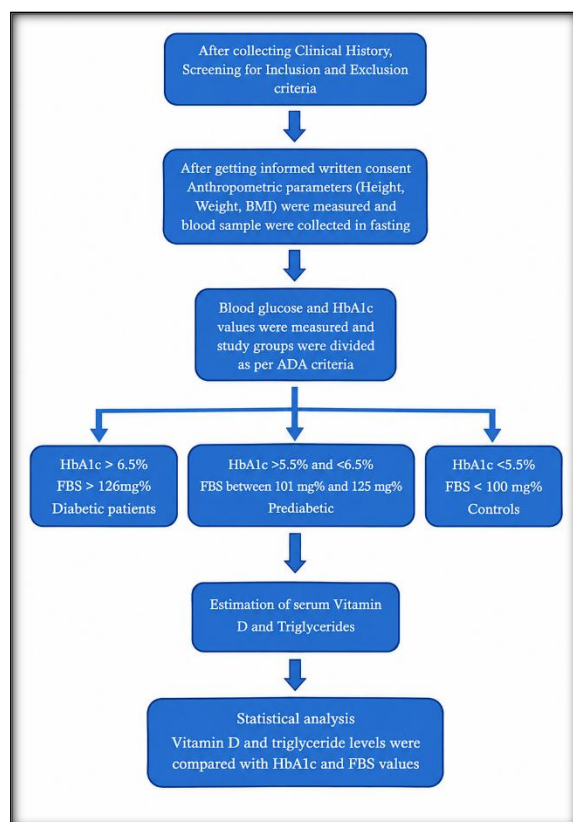
B. Exclusion criteria

1. Pregnant women
2. Critically ill patients
3. Patients with tuberculosis
4. Renal or hepatic impairment
5. Patients on Vitamin D supplementation
6. Patients on following medications – steroids, OCPs, phenytoin, diuretics.

Study group

1. Prediabetic individual (n=26)
2. Diabetes mellitus patients (n=26)
3. Age and gender-matched controls (n=26)

Sample collection procedure: After 8 hours of overnight fasting, 5 ml of peripheral venous blood shall be collected from the patients into plain vacutainers under aseptic conditions and the sample will be centrifuged for 15 minutes at approximately 1500 rpm. Another 5ml of venous blood shall be collected in EDTA tube for HbA1c. FBS and PPBS are measured by the Hexokinase method, lipid profile by, vitamin D levels are measured by Radio immunoassay method, HbA1c levels are measured by High performance liquid chromatography (HPLC) method using Biorad D10.



Statistical analysis: Statistical analysis was done using an open-source computer software, Jamovi (Version 2.4), which uses the programming language R (Version 4.1).

For hypothesis evaluation, $p < 0.05$ was considered statistically significant. (*) indicates $p < 0.05$, (**) indicates $p < 0.01$, and (***) indicates $p < 0.001$.

Welch's One Way ANOVA was used to test for the significance of the trend in continuous variables across different groups. Chi-Square test of association was used to test the association between different categorical parameters. Pearson's Correlation Coefficient was used to assess the correlation between continuous variables.

RESULTS

The study is cross-sectional in design, including 78 participants. The participants are divided into three study groups based on their HbA1C levels – Control, Pre-diabetic, and Diabetic, with 26 participants each.

The mean age of participants was 49.2 ± 10.74 years in the control group, 51.0 ± 11.08 years in the pre-diabetic group, and 53.7 ± 10.07 years in the diabetic group. [Table 1] shows the comparison of mean lab parameters FBS, PPBS, TGL, and Vitamin D among the three study groups, and Post hoc Games-Howell tests show pairwise differences in all three groups for these parameters. [Table 2] shows strength of correlation between Vitamin D and other lab parameters in the three study groups. Serum Triglycerides showed a statistically significant moderate positive correlation with Vitamin D levels in the prediabetic group ($r = 0.486$, $p = 0.012$), a weak negative correlation in the diabetic group ($r = -0.228$, $p = 0.263$), and no correlation in the control group ($r = -0.038$).

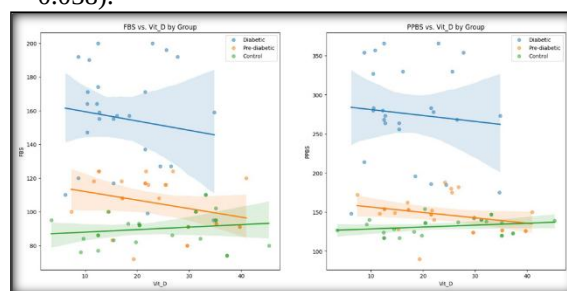


Figure 1: Correlation between FBS, PPBS, and Vitamin D among the three groups. Group 1, Diabetic patients (n=26), Group 2, prediabetic individuals (n=26), Group 3, age- and gender-matched controls (n=26)

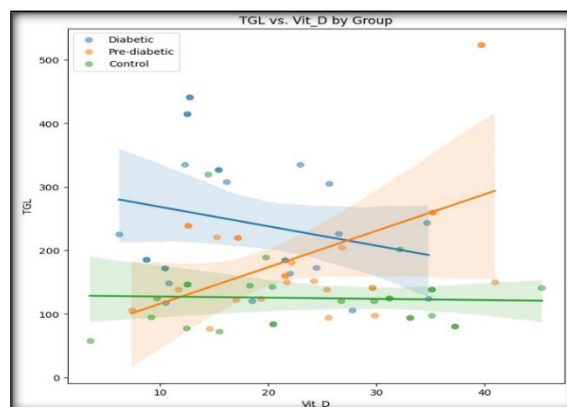


Figure 2: Correlation between Triglycerides and Vit D among the three groups; correlation between FBS, PPBS, and Vitamin D among the three groups. Group 1, Diabetic patients (n=26), Group 2, prediabetic individuals (n=26), Group 3, age- and gender-matched controls (n=26).

Table 1: Comparison of mean lab parameters FBS, PPBS, TGL, and Vitamin D among the three study groups is given below. Group 1, Diabetic patients (n=26), Group 2, prediabetic individuals (n=26), Group 3, age- and gender-matched controls (n=26) (Values expressed as Mean±SD).

Parameter	Control	Pre-diabetic	Diabetic	ANOVA P-value	Post hoc tests (Games-Howell)
FBS (mg/dL)	90 ± 10.1	105 ± 16	155 ± 31.1	< 0.001***	C-PD: < 0.001*** C-D: < 0.001*** PD-D: < 0.001***
PPBS (mg/dL)	132 ± 10.6	147 ± 22.1	275 ± 62.5	< 0.001***	C-PD: 0.009** C-D: < 0.001*** PD-D: < 0.001***
TGL (mg/dL)	125 ± 53.2	194 ± 110	246 ± 107	< 0.001***	C-PD: 0.017* C-D: < 0.001*** PD-D: 0.211
Vit D (ng/mL)	24.3 ± 11	23.6 ± 9.32	17.5 ± 7.96	0.015*	C-PD: 0.968 C-D: 0.039* PD-D: 0.039*

Table 2: Correlations between Vitamin D and other parameters, such as FBS, PPBS, and TGL, among the three study groups are given below. Group 1: Diabetic patients (n=26); Group 2: prediabetic individuals (n=26); Group 3: age- and gender-matched controls (n=26).

Vitamin D	Control		Pre-diabetic		Diabetic	
	r	p	r	p	r	p
FBS	0.162	0.429	-0.294	0.145	-0.142	0.49
PPBS	0.254	0.21	-0.291	0.15	-0.097	0.638
TGL	-0.038	0.853	0.486	0.012*	-0.228	0.263

DISCUSSION

Recent clinical trials have found that vitamin D supplements may help prediabetics prevent the development of diabetes. As a result, the early detection and intervention of prediabetes can reduce the incidence of diabetes and its complications^{23,24}. The estimated prevalence of Vitamin D deficiency ranges from 70% to 100% in the Indian population, despite India's tropical climate.^[25]

In a cross-sectional study done on Indian women with prediabetic found that low serum 25(OH)D levels are associated with higher blood glucose values.^[26] A systematic review identified 11 RCTs which reported positive effects of vitamin D supplementation on measures of glycemia or incident diabetes.^[27]

In some trials they found that there was no effect of vitamin D supplementation on measures of glycemia including fasting plasma glucose or glycated hemoglobin (HbA1C) and insulin resistance measured by homeostatic model assessment (HOMA) in participants with normal glucose tolerance.^[28] Nielsen, et al. from United States did not support an association between low vitamin D levels and risk of type 2 diabetes.^[29]

Dyslipidemia was an independent predictor of hypovitaminosis D and total cholesterol was inversely correlated with levels of 25(OH) D. They found that dyslipidemia had highly significant effect ($p < 0.001$) on vitamin D level among diabetes patients.^[30] In a study by Kansal S and Kamble TK which showed that prediabetes was significantly associated with higher TC levels, lower HDL levels, higher LDL levels, higher VLDL levels (p -value < 0.05) and the association between prediabetes and higher TG levels was not significant (p -value=0.056).^[31]

Lipid profile in prediabetic subjects including Total cholesterol, TG, TG/HDL ratio and LDL/HDL ratio are remarkably raised compared to normal healthy subjects. Prevalence of prediabetes was more in age group 26 to 30 years and in male participants. Total cholesterol, LDL, TG, and VLDL were significantly raised, whereas HDL was significantly lower in prediabetic individuals as compared to healthy subjects.

CONCLUSION

In our study, we found that the Vitamin D levels were decreased in prediabetics and moderately decreased in diabetic patients. But serum vitamin D levels were also associated with diet, exposure to sunlight etc. So,

with vitamin D levels, the severity of diabetes and the prediction of conversion of prediabetes to diabetes is not clear. Triglyceride levels showed a positive correlation due to the derangement of lipid profile in diabetes.

Limitations of the study: In the present study we could not obtain the previous vitamin D status of the patient. Hence cohort study is advisable to find a correlation of vitamin D and diabetes. Also, due to the small sample size, weak correlations were not detected with 95% confidence. A larger sample size can confirm the findings.

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