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CORRELATION BETWEEN VITAMIN D AND GLYCATED HEMOGLOBIN (HbA_1c) IN TYPE 2 DIABETES MELLITUS PATIENTS: A SINGLE CENTER CROSS-SECTIONAL STUDY

Pijush Karmakar[1*], Md Zakirul Islam[2], Md. Minuddin Hoshen[3], Mohammad Nurunnabi[4]

ABSTRACT

Background: Type2 diabetes mellitus (T2DM) is a common metabolic disorder, with increasing evidence relating vitamin D deficiency (VDD) to poor glycemic control. **Aim:** The aim of this study was to assess the correlation between vitamin D levels and Glycated hemoglobin (HbA_1c) in patients with T2DM. **Materials and Method:** This cross-sectional study was carried out at Eastern Medical College Hospital in Cumilla from January to December 2024, with 80 T2DM patients (aged 30-75 years) participating. Data were obtained using a pre-designed questionnaire; patients with renal disease or taking vitamin D supplements were excluded. **Results:** FBS and HbA_1c levels were highest in the vitamin D deficient group (10.9±4.7 mmol/L and 9.1±1.8%, respectively), indicating poorer glycemic control with lower vitamin D levels. Serum creatinine levels were similar across all groups, while serum vitamin D levels decreased from normal (32.2±0.4 ng/mL) to insufficient (23.1±2.2 ng/mL) and deficient (15.2±2.6 ng/mL). SerumVD levels also decreased with falling glycemic control: 22.2±4.5ng/mL to 19.0±6.2ng/m L and 18.4±3.8ng/mL, showing an inverse relationship between HbA_1c and vitamin D levels. Serum vitamin D levels were slightly higher in males (20.8±4.7 ng/mL) than females (18.8±5.6 ng/mL). Pearson correlation analysis showed a negative linear relationship between HbA_1c and serum vitamin D levels (r= -0.22; p=0.04). **Conclusion:** The study revealed an immense inverse relation between VD levels and HbA_1c in T2DM patients, indicating the potential importance of VD supplementation in glycemic management.

Keywords: Correlation, Vitamin D, HbA_1c, Type 2 diabetes mellitus, Bangladesh.

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INTRODUCTION

Vitamin D (VD), indispensable for bone well-being, also has a substantial role in metabolism and chronic disease management. Sunlight helps the skin synthesize it, and it can also be acquired through diet and supplementation[1]. There are two primary types of VD: vitamin D_2 (ergocalciferol), which is mostly found in plants and fungi, and vitamin D_3 (cholecalciferol), which is either formed in the skin from 7-dehydrocholesterol when exposed to UVB rays or derived from animal-based dietary regimens [2]. By enhancing intestinal absorption of calcium and phosphorus, which are necessary for optimal bone mineralization, it contributes a critical role in maintaining mineral homeostasis[3].

1*. Department of Biochemistry, Eastern Medical College, Cumilla, Bangladesh.
Email: dr.pijushkk@gmail.com , [Address of correspondence].

2. Department of Pharmacology & Therapeutics, Eastern Medical College, Cumilla, Bangladesh.

3. Department of Community Medicine and Public Health, Eastern Medical College, Cumilla, Bangladesh.

4. Department of Community Medicine and Public Health, Sylhet Women's Medical College, Sylhet, Bangladesh.

The serum 25 (OH) D concentration is the preeminent parameter of VD status[4]. The Recommended Dietary Allowance (RDA) is 400 IU daily for infants up to 12 months and 600 IU for children (1–18 years) and adults[5]. VD insufficiency and deficiency are widespread, with some referring to it as an 'epidemic' [6]. Although they are quite common in developed countries, severe VDD can result in osteomalacia in adults and rickets in children. Subclinical deficiency, is frequently observed and associated with osteoporosis, a higher incidence of fractures, and falls[7]. Beyond bone health, VD is thought to regulate insulin secretion and enhance insulin sensitivity, potentially impacting metabolic disorders like diabetes[1].

Serum 25 (OH)D values typically turn out declined in persons with T2DM or metabolic syndrome[8], and VDD is related to an increased incidence of diabetes[9].While the mechanisms remain unclear; VD may affect insulin secretion and glucose regulation by influencing pancreatic beta-cell function and inflammation, without altering glucagon secretion[10].

MATERIALS AND METHOD

This analytical cross-sectional study was conducted to assess the correlation between VD levels and HbA_1c in T2DM patients at Eastern Medical College Hospital, Cumilla from January to December 2024. A total of 80 diagnosed T2DM patients, aged 30 to 75 years, were selected purposively. Data were collected using a pre-designed questionnaire. Participants with renal failure and those on VD supplements were excluded.

Informed consent was taken from each participant before blood samples were collected. Following aseptic precautions, venous blood samples were drawn using a sterile disposable syringe. Fasting blood sugar (FBS), HbA_1c%, and serum VD levels were then measured. VD status was classified into three categories: sufficiency (≥30 ng/ml), insufficiency (20–29.9 ng/ml), and deficiency (<20 ng/ml)[11]. Based on the American Diabetes Association guidelines, diabetic patients were categorized into poor glycemic control (HbA_1c ≥7%) and good glycemic control (HbA_1c <7%) groups[12].

All data was compiled and analyzed using IBM SPSS v25.0 for Windows. The variables were expressed as mean, standard deviation (SD), frequency, and percentage. Statistical differences were assessed using one-way ANOVA, and independent sample t-test. The Pearson correlation coefficient was used to assess correlations. A p-value of <0.05 denoted statistical significance.

Participation was voluntary, and privacy and data security were ensured in accordance with Institutional Review Board guidelines and the ethical standards of the 2013 Declaration of Helsinki and its amendments. The study was permitted by the Ethical Review Committee of Eastern Medical College [Reference: EMC/2024/856(A)].

RESULTS

Table 1 showed the biochemical characteristics of the study participants. The mean age was 48.7±10.5 years (30–75), mean FBS 10.2±4.7 mmol/l (4.5–25.2), mean HbA_1c 8.6±1.9% (5.7–12.9), and mean serum creatinine 0.9±0.2 mmol/l (0.5–1.2).

Figure 1 showed more than half of the patients (57.5%) had VDD, 37.5% had VD insufficiency, and only 4.0% had normal VD levels.

Table 2 demonstrated that FBS and HbA_1c levels were highest in the VD deficient group (10.9±4.7 mmol/L and 9.1±1.8%, respectively), indicating poorer glycemic control with lower VD levels. Serum creatinine levels remained similar across all groups. VD levels showed a decreasing trend from normal (32.2±0.4 ng/mL) to insufficient (23.1±2.2 ng/mL) and deficient (15.2±2.6 ng/mL).

Table 3 showed that VD levels decreased with worsening glycemic control, from 22.2±4.5 ng/mL (HbA_1c 5.7–6.9%) to 19.0±6.2 ng/mL (HbA_1c 7–<9.9%) and 18.4±3.8 ng/mL (HbA_1c ≥10%). This indicates a significant inverse association between HbA_1c and VD levels.

Table 4 showed that VD levels were slightly higher in males (20.8±4.7 ng/mL) compared to females (18.8±5.6 ng/mL). However, this difference was not statistically significant (p=0.11), indicating that VD levels did not differ significantly between male and female participants.

Figure 2 showed a Pearson correlation analysis, demonstrating a negative linear relationship between HbA_1c and VD levels (r= -0.22; p=0.04).

Table1: Biochemical outlines of study participants (n=80)

Parameters	Value (Mean±SD)	Range
Age(in years)	48.7±10.5	30-75
FBS (mmol/l)	10.2±4.7	4.5-25.2
HbA_1c (%)	8.6±1.9	5.7-12.9
Serum creatinine (mmol/l)	0.9±0.2	0.5-1.2

FBS= Fasting Blood Sugar, HbA_1c: Glycated hemoglobin

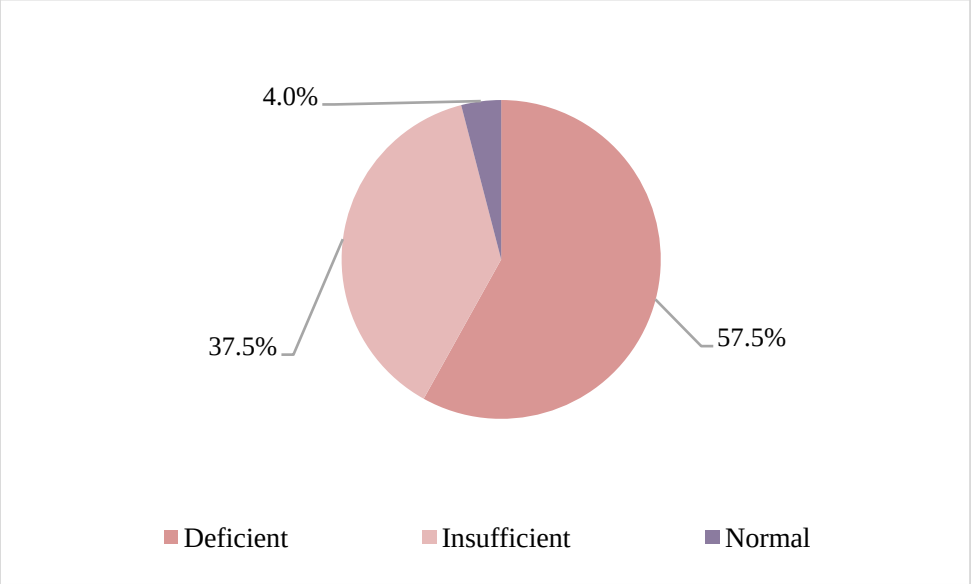

Figure 1: Diabetic patients based on their vitamin D levels (n=80)

Table 2: Comparison of biochemical parameters based on vitamin D levels (n=80)

Parameters	Normal VD	VD insufficient	VD deficient
	Mean±SD	Mean±SD	Mean±SD
FBS (mmol/l)	9.8±2.7	9.49±4.7	10.9±4.7
HbA_1c (%)	8.3±0.5	8.1±2.1	9.1±1.8
Serum creatinine (mmol/l)	0.9±0.1	0.9±0.2	0.9±0.2
Serum vitamin D (ng/mL)	32.2±0.4	23.1±2.2	15.2±2.6

FBS= Fasting Blood Sugar, HbA_1c: Glycated hemoglobin

Table 3: Vitamin D at different levels of glycaemia in type 2 diabetic patients (n =80)

Parameters	Levels of glycaemia			*p* value
HbA_1c (%)	(5.7-6.9)	(7-<9.9)	(≥10)	0.03
Serum vitamin D (ng/mL)	22.2±4.5	19.0±6.2	18.4±3.8	

One-way ANOVA test done, p<0.05 considered as statistically significant value; HbA_1c: Glycated hemoglobin.

Table 4: Serum vitamin D level within male and female diabetic patients (n=80)

Parameters	Male (n=33)	Female (n=47)	*p*-value
	Mean±SD	Mean±SD	
Serum vitamin D (ng/mL)	20.8±4.7 (12-32.9)	18.8±5.6 (10.5-32)	0.11

Independent sample t-test done, $p<0.05$ considered as statistically significant value

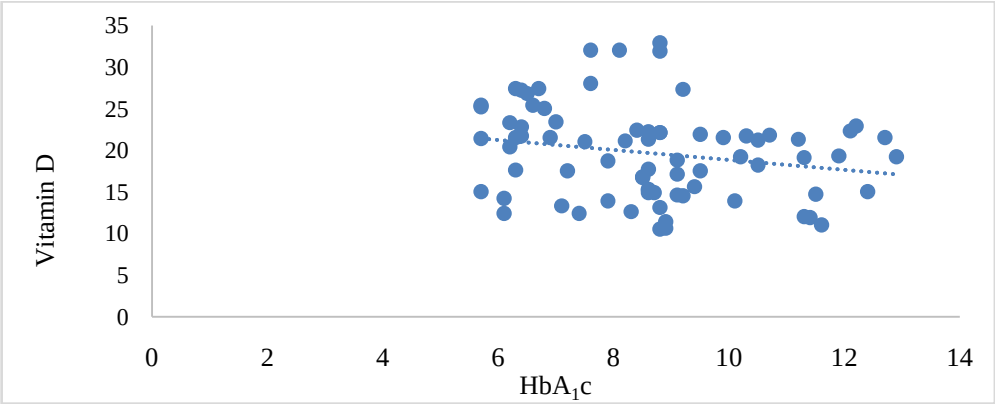

Figure 2 : Pearson correlation of vitamin D with HbA_1c in T2DM cases (n= 80); HbA_1c: Glycated hemoglobin.

DISCUSSION

T2DM is one of the most widespread metabolic conditions in the world and has become a significant threat to an individual[13]. Many experimental and epidemiological research suggested that VD insufficiency has been allied to lower insulin release, insulin resistance and T2DM[14]. This has been observed by previous research, supporting the notion that age and sex may not be primary factors influencing diabetes prevalence[15]. There was a significant difference in FBS and HbA_1c levels between individuals with diabetes and those without. These findings were consistent with our findings[16].

The study uncovered a substantial VDD in diabetic subjects. This finding aligns with other studies[9,17]. It suggests that ensuring adequate VD levels in diabetic patients could potentially improve HbA_1c levels.In the current study, a substantial proportion of patients (57.5%) were found to have VDD, while 37.5% of the patients exhibited VD insufficiency. In contrast, only 4.0% of the patients were identified as having sufficient VD levels. These findings highlight the substantial prevalence of VD insufficiency among patients with T2DM. Furthermore, these findings are comparable with previous research indicating lower levels of VD in individuals with T2DM[18,19].

Besides, the progress of T2DM has more recently been related to VDD, which has been related to increased insulin resistance and reduced insulin secretion[20]. It also found that HbA_1c and its highest category ($HbA_1c \geq 10\%$) were associated with severe VDD. One study also found association of VDD with HbA_1c status ($\geq 7\%$ vs. $<7\%$)[21]. In our study, female gender had lower VD than male diabetic patients. This is well documented in another study [22].Cultural, hormonal and nutritional factors have been proposed to contribute to such difference[23]. Pearson's correlation analysis indicated that VD levels were inversely correlated with concentrations of HbA_1c in the diabetic cases ($r= -0.22$; $p=0.04$). This correlation indicates that higher HbA_1c levels are generally associated with lower VD levels. These findings are nearly similar to previous studies[24,25].

The mechanism by which VD could be influencing glucose metabolism in diabetic patients include- improvement in insulin sensitivity and β cell survival; increased insulin secretion from pancreatic β cells and regulation of calcium flux for normalization of glucose tolerance and protection of beta cells against cytokine induced apoptosis[21].

CONCLUSION

The study indicates a significant inverse relationship among VD levels and HbA_1c in T2DM patients. Maintaining optimal vitamin D levels through supplementation may help reduce cardiovascular risk in these patients. However, additional research, especially large-scale, long-term randomized controlled studies, is required to validate the efficacy and safety of VD supplementation in this setting.

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CONFLICT OF INTEREST

There is no conflict of interest.

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