fortune Journals

Research Article

FORTUNE JOURNAL OF HEALTH SCIENCES

ISSN: 2644-2906

Vitamin D Deficiency and Its Association with Cardio-Metabolic Risk Factors in Type 2 Diabetes Mellitus Patients: A Cross-Sectional Study

Shoaib Asghar[*,1], Haider Tanvir[2], Salman Shahid[3], Asad Riaz[4], Muhammad Hamza Ejaz[5], Mamuna Akram[6], Al Muktadir Chowdhury Evan[7]

Abstract

Background: Vitamin D deficiency (VDD) is prevalent in type 2 diabetes mellitus (T2DM) patients. This study aimed to estimate the prevalence of VDD and to identify its association with cardio-metabolic risk factors in Pakistani T2DM patients.

Methodology: A cross-sectional study was conducted on 260 T2DM patients from 2022 to 2023. Interviews conducted and clinical variables were measured. Blood and urine samples were sent to quantify UACR as microalbuminuria, macroalbuminuria or normoalbuminuric. The levels of vitamin D were considered as a categorical dependent variable with binary outcomes including deficient and normal. Descriptive statistics and a chi-square test of association were carried out followed by univariate and multiple binary logistic regression analysis.

Results: The VDD was prevalent in 64.6% (n2=168) among 260 T2DM patients. Based on significant p-value <0.05, the logistic regression analysis showed that duration of diabetes, hypertension, fasting blood sugar (FBS), glycated-hemoglobin (HbA1c), low-density lipoprotein (LDL-C), obesity, serum creatinine and levels of albuminuria were found to be significant risk factors of VDD in T2DM patients.

Conclusion: This study found that around two-thirds of T2DM patients had a prevalence of VDD. The serum concentrations of vitamin D in T2DM patients were associated with several cardio-metabolic risk factors, including duration of diabetes, hypertension, obesity, poor glycemic control monitored with higher FBS or impaired HbA1c, levels of LDL-C in lipid profile, urinary levels of albuminuria and serum creatinine. Although further large-scale research is needed to investigate the causative relationship, controlling cardio-metabolic risk factors may be supportive in maintaining adequate serum levels of vitamin D in T2DM patients.

Categories: Endocrinology / Diabetes/Metabolism, Internal Medicine, Nephrology

Keywords: Diabetes and metabolic syndrome, Microalbuminuria, cardiometabolic risk factors, Obesity (bmi>30), Diabetic nephropathy (dn), Urinary albumin creatinine ratio (uacr), Type 2 diabetic mellitus (t2dm), Fasting blood sugar(fbs), Glycated haemoglobin (hba1c), Vitamin d deficiency (vdd)

Introduction

Type 2 Diabetes Mellitus (T2DM) is a complex and multifaceted metabolic

Affiliation:

[1]Internal Medicine, Sheikh Zayed Medical College / Hospital, Rahim Yar Khan, PAK

[2]Internal Medicine, City Hospital, Multan, Multan, PAK

[3]Medicine, Bedfordshire Hospitals NHS Foundation Trust, Bedford, Bedford, GBR

[4]Internal Medicine, East Kent Hospital University Foundation Trust, Ashford, GBR

[5]Obstetrics and Gynecology, Lincoln County Hospital, United Lincolnshire Hospitals NHS Trust (ULHT), Lincoln, GBR

[6]Obstetrics and Gynecology, Lincoln County Hospital, United Lincolnshire Hospitals NHS Trust (ULHT), Lincoln, GBR

[7]Internal Medicine, Arrowe Park Hospital, Wirral, GBR

***Corresponding author:**
Shoaib Asghar, Registrar, Internal Medicine, Sheikh Zayed Medical College / Hospital, Rahim Yar Khan, PAK.

Citation: Shoaib Asghar, Haider Tanvir, Salman Shahid, Asad Riaz, Muhammad Hamza Ejaz, Mamuna Akram, Al Muktadir Chowdhury Evan. Vitamin D Deficiency and Its Association with Cardio-Metabolic Risk Factors in Type 2 Diabetes Mellitus Patients: A Cross-Sectional Study. Fortune Journal of Health Sciences. 8 (2025): 82-91.

Received: December 20, 2024
Accepted: December 27, 2024
Published: January 28, 2025

syndrome defined by insulin resistance and relative insulin insufficiency, which presents as hyperglycemia [1]. Vitamin D exists in two fat-soluble forms: vitamin D3 (cholecalciferol) and vitamin D2. Vitamin D3 is produced in the skin using ultraviolet B (UV-B) light, whilst vitamin D2 is taken from food and converted into ergocalciferol using UV-B [2]. Cholecalciferol and ergocalciferol are metabolized in the liver into 25-hydroxy vitamin D2 and D3. The kidneys then use 1-alpha-hydroxylase to convert it into the active form, 1, 25-dihydroxy vitamin D. The significance of adequate levels of Vitamin D cannot be overlooked as Vitamin D receptors (VDR) are present in nearly all tissues, including the pancreas, heart, liver, thyroid, brain, and kidney [2-4]. Poor nutrition, lack of direct sunlight, cold weather or winter, darker skin complexion, the elderly, wearing clothing that covers the majority of the body, feminine gender, and obesity can all contribute to VDD [4-5]. Severe vitamin D deficiency causes osteomalacia in adults and rickets in children.

Serum 25-hydroxyvitamin D [25(OH)D] is the greatest indicator of vitamin D status; a level above 50 ng/mL contributes to optimum calcium-phosphorus haemostasis and bone metabolism [6]. In response to VDD, blood parathyroid hormone (PTH) levels rise, resulting in secondary hyperparathyroidism and increasing the likelihood of osteoporosis and fractures [6-7]. In the absence of underlying hyperparathyroidism or renal failure, elevated PTH levels can be employed as an alternative indicator of VDD [6-7]. Vitamin D has been identified as a potential modifiable risk factor among T2DM patients, and VDD is correctable if associated cardiometabolic risk factors are addressed or controlled [8]. The reversal of VDD results in significant improvements in HbA1c levels and overall glycaemic management, and vice versa [8-9]. Diabetic nephropathy (DN) is a prevalent progressive microvascular consequence that causes increased urine albumin excretion, reduced eGFR and renal failure [10]. UACR is an effective biomarker for detecting proteinuria and is widely utilized in clinical settings to assess kidney function [11]. Vitamin D influences insulin secretion and action directly by affecting cytokines and nuclear transcription factors like NF-B. With low vitamin D levels, beta-cell dysfunction is associated with 48 percent reductions in insulin secretion and insulin resistance, as well as Metabolic syndrome [8-9].

Vitamin D inhibits kidney endothelial damage that leads to microalbuminuria through its role in negative regulation of the renin-angiotensin-aldosterone pathway; thus, VDD has been associated with worsening of DN [10-11]. There is a well-established association between proteinuria and cardiovascular morbidity and mortality, therefore managing proteinuria in T2DM may have broader consequences for cardiovascular health [11-12]. Dyslipidemia and high levels of lipid profile is established as an individual predictive indicator of poor glycemic control and metabolic syndrome [13]. Despite recent studies, further research remains crucial to establish the association of cardiometabolic risk factors with the levels of vitamin D in patients with diabetes mellitus. These risk factors fuel the risk of developing microvascular and macrovascular complications of diabetes [1, 7-10, 12]. Although the importance of adequate vitamin D among patients with T2DM is acknowledged worldwide, more in-depth investigations are needed to further explore the determinants of VD in Pakistan. Hence, the current study sought to examine the prevalence of VDD and the relationship significance between cardio-metabolic risk factors and vitamin D levels among patients with T2DM in Pakistan.

Materials & Methods

Operational definitions

Cardio-Metabolic risk is defined as a cluster of metabolic syndrome [1] and cardiovascular abnormalities, including abdominal obesity, poor glycemic control, hypertension, dyslipidemia, age, male sex, smoking and additional factors such as family history, that predispose individuals to cardiovascular disease and T2DM. Considering serum 25-hydroxyvitamin D levels, *deficiency of vitamin D* is defined as a level of less than 25 nmol/L and insufficiency as 25-50 nmol/L. For categorization purposes, vitamin D deficient or insufficient are classified as Deficient, whereas a serum levels of greater than 50nmol/L are classified as adequate or normal vitamin D. [2].

Hypertension is a blood pressure of 140/90 mmHg or above, or treatment of pre-existing hypertension. BMI categories are normal weight (18.5-24.9 kg/m²), overweight (25-29.9) kg/m²) and obese (>30 kg/m²) [3]. A BMI greater than 28 kg/m² is considered preobese [3-4]. Target *glycemic control* is defined as fasting blood sugar (FBS) values of less than 8 mmol/l or 144 mg/dL, and HbA1c levels of less than 7.5%. The desired serum creatinine level is <1.30mg/dL with eGFR of more than 60 ml/min/1.72m² [8-9]. *UACR,* a measure of the ratio of albumin to creatinine excreted per decilitre of urine, falls into the following three categories according to the 2012 Kidney Disease Improving Global Outcomes (KDIGO) CKD classification: Normoalbuminuria (A1<30 mcg/mg), Microalbuminuria is the excretion of 30 to 300 mcg/mg of albumin (A2) protein in urine, and values (A3) beyond 300 mcg/mg are considered Macroalbuminuria [5, 10-11].

Dyslipidemia is triglycerides above 150 mg/dl, serum cholesterol over 200mg/dl, LDL-C over 130mg/dl, and HDL-C of less than 40 mg/dl or specific treatment for lipid abnormalities [12-13].

Study Design and Setting

We conducted a cross-sectional study at the Outpatient Diabetes Clinic and the Medicine Department of Sheikh

Citation: Shoaib Asghar, Haider Tanvir, Salman Shahid, Asad Riaz, Muhammad Hamza Ejaz, Mamuna Akram, Al Muktadir Chowdhury Evan. Vitamin D De iciency and Its Association with Cardio-Metabolic Risk Factors in Type 2 Diabetes Mellitus Patients: A Cross-Sectional Study. Fortune Journal of Health Sciences. 8 (2025): 82-91.

Zayed Medical College / Hospital, Rahim Yar Khan, Pakistan, from December 18, 2022 to December 20, 2023. The study comprised 260 patients with T2DM who met the inclusion and exclusion criteria and were approved by the institutional ethical research board (permission reference number 165/IRB/SZMC/SZH).

Selection Criteria

The inclusion criteria were patients having T2DM for at least 5 years aged between 30-60 years, having Asian natural brown skin tone and adequate exposure to sunlight. This study excluded diabetes patients who were newly diagnosed, were pregnant, had secondary diabetes or type 1 diabetes mellitus (T1DM), had HbA1c >10%, were on medications that could interfere with vitamin absorption like steroids or anticonvulsants in the last three months and those who had a history of supplementation of folic acid, vitamin B12 or Vitamin D. Moreover, patients with incomplete medical records, surgical histories and suffering from concomitant comorbidities such as chronic kidney disease stage 3B (eGFR < 45ml/min) or end-stage renal disease, macroalbuminuria, liver diseases, gastrointestinal disorders, or malabsorption syndromes that could affect their VD levels were also excluded.

Data collection

To collect the required information for this study, the interview method was used. Informed consent was obtained after detailing the study's aims. Explanatory variables include socio-demographic, clinical and laboratory variables. Age, gender and smoking were included as socio-demographic factors. Pre-obese (BMI>28) or obesity (BMI >30), duration of diabetes and hypertension were among the clinical variables assessed. BMI was calculated by dividing weight in kilograms by height in meters squared (kg/m²). Blood pressure was taken in the right arm while seated using a standard mercury manometer. A blood sample was analyzed to assess and evaluate variables such as FBS, HbA1c, serum creatinine, eGFR, serum Vitamin 25(0H) D, serum cholesterol, TG, HDL-C, and LDL-C. A spot urine sample or a 24-hour urine sample was collected and sent to the lab to quantify UACR as microalbuminuria, macroalbuminuria or normoalbuminuric. The levels of vitamin D were considered as a categorical dependent variable in this study with binary outcomes including deficient and normal. Hence, the dependent variable was categorized as the deficient level and the normal level.

Statistical analysis

Data were initially entered in Microsoft Excel (Microsoft Corporation, Redmond, WA) and then statistically analyzed using SPSS version 21 (IBM Corp., Armonk, NY, USA) and RStudio IDE (Posit PBC, Boston, USA). The statistical analysis was employed in three steps. Descriptive statistics and a chi-square test of association were carried out in the first step for computing the main features of observed data including frequencies, cross-tabulation and percentages. Regarding the categorical nature of variables, the chi-square test of association was executed to check the association of levels of vitamin D with other variables. A univariate binary logistic regression was conducted in the second step to explore the relationship between a categorical dependent variable and the independent variables. Considering a level of vitamin D as a dependent variable having values for the deficient level and the normal level, the analysis was executed to compute the crude odds ratio (cOR) and p-values by considering each explanatory variable separately. Finally, multiple logistic regression was executed for the final model selection by regressing all explanatory variables on the dependent variable. The association between the occurrence of VDD and the most significant risk factors was examined. By considering explanatory variables altogether, adjusted odds ratios (aOR) and p-values are observed.

Results

A total of 260 patients with T2DM aged between 30 and 60 years were included in this study, of whom 136 (52.3%) were aged 30 to 49 years, and 124 (47.7%) were aged 50 to 60 years. Females were prevalent with 133 (51.2%) as compared to males 127 (48.8%). A majority of females were obese, having an average BMI of 31.58 kg/m², as compared to males having an average BMI of 29.81 kg/m² with the majority being overweight. Based on the 25 (OH) vitamin D serum levels of the studied T2DM patients, VDD was prevalent in 64.6% (n2=168), while 35.4% (n1=92) had adequate levels of vitamin D in their serum. A comparison between adequate vitamin D and VDD groups showed no statistically significant difference for age (p-value=0.284), gender (p-value=0.123), smoking (p-value=0.169) and pre-obese or obesity (p-value=0.084). An estimated 65.4% (170) of T2DM patients have had diabetes for more than 10 years, and 60.4% (157) had hypertension. A statistically significant difference was observed for the duration of diabetes (p-value=0.0023) and hypertension (p-value=0.0001). Table 1 displays the demographic and clinical variables of studied T2DM patients based on comparing serum levels of 25 (OH) Vitamin D.

There was a statistically significant correlation between impaired HbA1c of more than 7.5% (117, p-value=0.003) and fasting blood sugar of more than 8 mmol/L (121, p-value 0.0113) among the 260 T2DM patients in the study, with 66.5% (173) having high fasting blood sugar > 8 mmol/l and 63.1% (164) having higher HbA1c of more than 7.5%. In terms of diabetic nephropathy or reduced kidney function, 37.7% (98) had raised serum creatinine of more than 1.30 mg/dl, while 36.2% (94) had an eGFR value of less than 60ml/

Asghar S, et al., Fortune J Health Sci 2025
DOI:10.26502/fjhs.256

Table 1: Descriptive Characteristics of demographic & clinical variables of studied Type 2 Diabetes Mellitus Patients according to serum levels of Vitamin D (n=260)

Demographic & Clinical Variables			Cross-tabulation and Chi-Square Test				
Total N= 260		**Prevalence (%)**	**Levels of 25-hydroxyvitamin D**				**P-Value**
			Adequate >50 nmol/L (n1=92)	**VD Deficient**			
				Insufficient 25-50 nmol/L	**Deficient <25nmol/L**	**Total VDD (n2=168)**	
Age (Years)	50-60 Years		48	17	59	76	0.284
	30-49 Years	136 (52.3)	44	30	62	92	
Gender	Female	133 (51.2)	53	31	49	80	0.123
	Male	127 (48.8)	39	47	41	88	
Smoking	Yes	132 (50.8)	52	32	48	80	0.169
	No	128 (49.2)	40	46	42	88	
Pre-Obese or Obesity	Yes	109 (41.9)	32	24	53	77	0.084
	No	151 (58.1)	60	30	61	91	
Diabetes Duration (Years)	> 10	170 (65.4)	49	29	92	121	**0.0023**
	05-Oct	90 (34.6)	43	18	29	47	
Hypertension (>140/90 mmHg)	Yes	157 (60.4)	41	31	85	116	**0.0001**
	No	103 (39.6)	51	15	37	52	

min/1.72 m². An insignificant relation was noted for raised serum creatinine (p-value=0.154) and low impaired eGFR (p-value=0.2008) concerning vitamin D groups. A majority of studied participants 60.8% (158) had microalbuminuria with increased urinary albumin excretion of 30 to 300 mcg/mg. A statistically significant correlation was observed for the urinary levels of albuminuria (p-value=0.035) and serum levels of vitamin D. Table 2 displays the laboratory variables of studied T2DM patients and compares them using the serum levels of Vitamin D 25 (OH) D.

About dyslipidemia, increased LDL-C had a statistically significant impact with a p-value of 0.028 associated with the VDD group. Whereas, no significant relation was noted for serum cholesterol (p-value=0.652), triglycerides (p-value=0.665) and HDL-C (p-value=0.961). Table 3 represents univariate and multiple logistic regression analysis to examine the significant factors of VDD.

On the bases of significant p-value<0.05, the univariate analysis showed that duration of being diabetic, hypertension, FBS and HbA1c, LDL-C and levels of albuminuria were found to be significant risk factors of VDD in T2DM patients. The multiple logistic regression model identified two additional factors along with significant variables found in univariate analysis. The results depicted that obesity and serum creatinine were also shown as important factors of VDD by multiple logistic model. The logistic regression analysis further evidenced that age, gender, smoking, eGFR, serum Cholesterol, triglycerides, and HDL-C having the p-value > 0.05 are non-significant factors of VDD in T2DM patients for the observed data.

The multiple logistic regression analysis showed that patients with T2DM for more than 10 years (OR=3.20) have more than 3 times greater odds of VD deficiency compared to patients with T2DM for 5–10 years. It is also found that T2DM hypertensive patients (OR=5.08) have five-fold greater odds to be VD deficient than T2Dm patients without hypertension. Greater than or equal to 8 mmol/L FBS (OR=2.71) increased 171% odds of VD deficiency than the odds of less than 8 mmol/L FBS in T2DM patients. The logistic analysis also evidenced that the higher percentage of HbA1c (OR=3.36) increased the odds of VD deficiency by 3.36 times in diabetic patients in comparison with a lower percent of HbA1c. In contrast with T2DM patients with less than 130 mg/dl LDL-C, respondents with 130 mg/dl or higher LDL-C (OR=3.24) showed greater than 3 times higher odds of VD deficiency. The T2DM patients with microalbuminuria (OR=2.67) are observed to be 167% higher odds of being

Citation: Shoaib Asghar, Haider Tanvir, Salman Shahid, Asad Riaz, Muhammad Hamza Ejaz, Mamuna Akram, Al Muktadir Chowdhury Evan. Vitamin D De iciency and Its Association with Cardio-Metabolic Risk Factors in Type 2 Diabetes Mellitus Patients: A Cross-Sectional Study. Fortune Journal of Health Sciences. 8 (2025): 82-91.

Asghar S, et al., Fortune J Health Sci 2025
DOI:10.26502/fjhs.256

Table 2: Descriptive Characteristics of laboratory variables of studied Type 2 Diabetes Mellitus Patients according to serum levels of Vitamin D (n=260).

Laboratory Variables			Cross-tabulation and Chi-Square Test				
Total N= 260		**Prevalence (%) / Mean ± SD**	**Serum Levels of 25-hydroxyvitamin D**				**P-Value**
			Adequate >50 nmol/L (n1=92)	**VD Deficient**			
				Insufficient 25-50 nmol/L	**Deficient <25nmol/L**	**Total VDD (n2=168)**	
Fasting Blood Sugar (mmol/L)	≥ 8	173 (66.5)	52	35	86	121	**0.0113**
	< 8	87 (33.5)	40	18	29	47	
HbA1c (%)	≥ 7.5	164 (63.1)	47	28	89	117	**0.003**
	< 7.5	96 (36.9)	45	15	36	51	
Serum Creatinine (mg/dl)	≥ 1.30	98 (37.7)	40	27	31	58	0.154
	< 1.30	162 (62.3)	52	31	79	110	
eGFR (ml/ min/1.72m²)	≥ 60	166 (63.8)	54	34	78	112	0.2008
	< 60	94 (36.2)	38	27	29	56	
Serum Cholesterol (mg/dl)	≥ 200	163 (62.7)	56	33	74	107	0.652
	< 200	97 (37.3)	36	22	39	61	
Triglycerides (mg/dl)	≥ 150	174 (66.9)	60	43	71	114	0.665
	< 150	86 (33.1)	32	19	35	54	
LDL-C (mg/dl)	≥ 130	167 (64.2)	51	47	69	116	**0.028**
	< 130	93 (35.7)	41	14	38	52	
HDL-C (mg/dl)	≥ 40	139 (53.5)	49	36	54	90	0.961
	< 40	121 (46.5)	43	34	44	78	
Levels of Albuminuria (mcg/mg)	Normoalbuminuria < 30	102 (39.2)	44	23	35	58	**0.035**
	Microalbuminuria 30-300	158 (60.8)	48	37	73	110	

Legend: HbA1c=glycated haemoglobin, eGFR= estimated Glomerular filtration rate, LDL-C= Low-density lipoprotein cholesterol, HDL-C= High-density lipoprotein cholesterol

Citation: Shoaib Asghar, Haider Tanvir, Salman Shahid, Asad Riaz, Muhammad Hamza Ejaz, Mamuna Akram, Al Muktadir Chowdhury Evan. Vitamin D De iciency and Its Association with Cardio-Metabolic Risk Factors in Type 2 Diabetes Mellitus Patients: A Cross-Sectional Study. Fortune Journal of Health Sciences. 8 (2025): 82-91.

Asghar S, et al., Fortune J Health Sci 2025
DOI:10.26502/fjhs.256

Table 3: Classification analysis of Serum Levels of Vitamin D based on univariate and multiple binary logistic regression models (n=260)

Variables		Univariate Regression Analysis		Multivariable Regression Analysis	
		cOR (CI 95%)	**P-value**	**aOR (CI 95%)**	**P-value**
Age (Years)	30-49	1	0.285	1	0.9822
	50-60	1.32 (0.79-2.20)		1.01(0.37-2.8)	
Gender	Female	1	0.1	1	0.088
	Male	1.53(0.92-2.57)		2.31(0.91-6.30)	
Smoking	No	1	0.17	1	0.184
	Yes	0.70(0.42-1.16)		0.60(0.28-1.27)	
Pre-Obese or Obesity	No	1	0.085	1	**0.000***
	Yes	1.59(0.94-2.70)		4.43(2.04-10.17)	
Diabetes Duration (Years)	05-10	1	**0.003***	1	**0.001***
	> 10	2.26(1.33-3.85)		3.20(1.60-6.60)	
Hypertension (>140/90 mmHg)	No	1	**0.000***	1	**0.001***
	Yes	2.70(1.60-4.58)		5.08(2.50-10.85)	
Fasting Blood Sugar (mmol/L)	< 8	1	**0.011***	1	**0.004***
	≥ 8	1.98(1.16-3.38)		2.71(1.40-5.38)	
HbA1c (%)	<7.5	1	**0.003***	1	**0.000***
	≥7.5	2.20(1.30-3.72)		3.36(1.68-6.93)	
Serum Creatinine (mg/dl)	< 1.30	1	0.155	1	**0.034***
	≥1.30	0.69(0.41-1.16)		0.44(0.20-0.93)	
eGFR (ml/min/1.72m²)	<60	1	0.2016	1	0.269
	≥ 60	1.41(0.83-2.38)		0.67(0.33-1.34)	
Serum Cholesterol (mg/dl)	< 200	1	0.7233	1	0.644
	≥200	1.10(0.65-1.85		1.18(0.59-2.33)	
Triglycerides (mg/dl)	< 150	1	0.665	1	0.971
	≥150	1.13(0.66-1.92)		1.01(0.49-2.08)	
LDL-C (mg/dl)	< 130	1	**0.029***	1	**0.000***
	≥130	1.80(1.06-3.04)		3.24(1.68-6.42)	
HDL-C (mg/dl)	< 40	1	0.962	1	0.742
	≥ 40	1.01(0.61-1.69)		0.89(0.44-1.81)	
Levels of Albuminuria (mcg/mg)	< 30	1	**0.0365***	1	**0.004***
	30-300	1.74(1.04-2.92)		2.67(1.38-5.32)	

Legend: cOR= crude Odds Ratio, aOR= adjusted Odds Ratio, HbA1c=glycated haemoglobin, eGFR= estimated Glomerular filtration rate, LDL-C= Low-density lipoprotein cholesterol, HDL-C= High-density lipoprotein cholesterol

Citation: Shoaib Asghar, Haider Tanvir, Salman Shahid, Asad Riaz, Muhammad Hamza Ejaz, Mamuna Akram, Al Muktadir Chowdhury Evan. Vitamin D De iciency and Its Association with Cardio-Metabolic Risk Factors in Type 2 Diabetes Mellitus Patients: A Cross-Sectional Study. Fortune Journal of Health Sciences. 8 (2025): 82-91.

Asghar S, et al., Fortune J Health Sci 2025
DOI:10.26502/fjhs.256

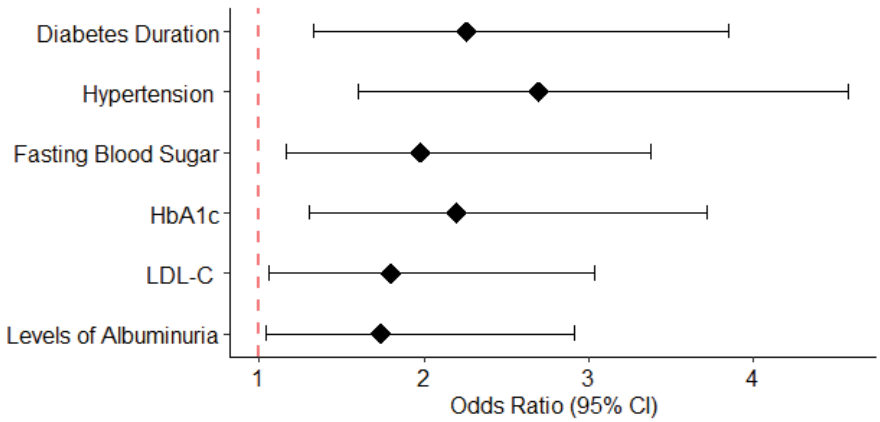

Figure 1: Forest plot of significant variables obtained by executing univariate binary logistic regression model.

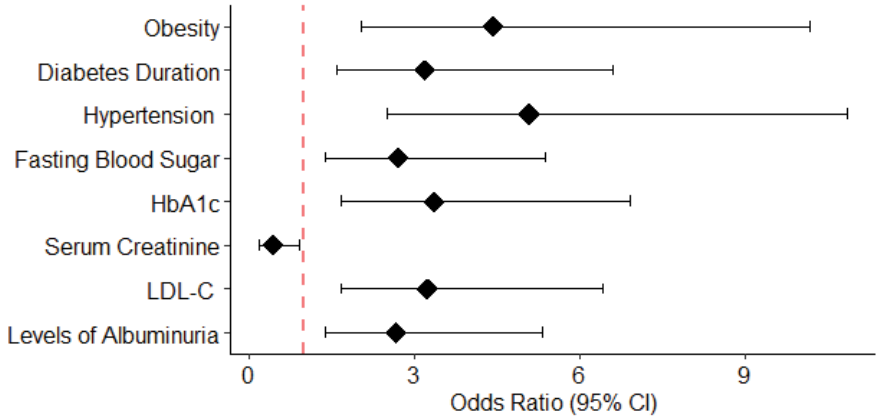

Figure 2: Forest plot of significant variables obtained by executing multivariable binary logistic regression model.

VD deficient than patients with normoalbuminuria. Multiple logistic regression model further evidence that T2DM patients with obesity (OR=4.43) have more than four-fold higher odds of suffering from VD deficiency than non-obese respondents. Serum Creatinine level of greater than 1.30 mg/dl (OR=1.18) increased the odds of VD deficiency by 18% in T2DM patients than the patients with less than 1.30 mg/dl level of Serum Creatinine.

Figure 1 visually displays the cOR of significant variables along with their confidence intervals obtained by executing univariate binary logistic regression model. The plot showed that all variables have cOR of greater than 1 revealing the significance of these factors with VD deficiency. The forest plot further evidence highest odds (OR=2.70) for hypertension showing highest significance of this variable along with widest CI (CI: 1.60-4.58).

Forest plot showing the OR for significant variables over multivariable logistic regression analysis is displayed in Figure 2. Hypertension (OR=5.08, CI:2.50-10.85) is found to be most significant variable followed by obesity (OR=4.43, CI:2.04-10.17) and both factors have wider intervals of confidence.

Discussion

Metabolic syndrome precedes or coexists with diabetes and is associated with an elevated risk of cardiovascular disease and early death [1]. According to available literature, insulin resistance and beta-cell dysfunction are associated with low vitamin D levels and an increase in HbA1C levels [4, 6]. ACE inhibitors and ARBs have a proven role in avoiding diabetic nephropathy by lowering albuminuria, a well-known cause of ESRD among patients with uncontrolled and long-term T2DM [10-11]. Recent studies have demonstrated the growing significance of Vitamin D in regulating the renin-angiotensin-aldosterone mechanism, enhancing glycaemic control and renal functioning [11, 12]. The 25-hydroxyvitamin serum levels were inversely correlated with microalbuminuria, dyslipidemia and poor glycemic control [8, 9, 12, 13] and closely related with hypertension and metabolic syndrome [14]. The VDD of less than 25 has a predictive value for microalbuminuria and macroalbuminuria

[15-16]. According to a study by Sivritepe R. et al. [17], cardiovascular risk as measured by the Framingham risk calculator rises when the serum concentration of Vitamin D falls. The present study reported a higher prevalence of VD deficiency (64.6%) among the participants with T2DM. In a meta-analysis, Taderegew MM et al. [18] consistently reported an overall 64.2% pooled prevalence of deficient levels of VD with the highest rate of 71% in African countries. Wang C et al. [19] also evidenced an increased rate (65%) of lower VD among T2DM patients in North China. Another research conducted in Saudi Arabia by AlHewishel MA et al. [20] concluded that the majority (89%) of diabetes patients suffered from a low VD. Inconsistent with the results of the present study, Gowri K, et al. [12] found that only 29.5% of T2DM patients had been diagnosed with VD deficiency for the observed data in Qatar.

This study concluded that hypertension is the most significant risk factor for deficient levels of VD in Pakistani T2DM patients. A systematic review conducted in 2023 comprised of 54 articles published between 2006 and 2022, reported the concluding pooled estimate of significant association between hypertension and VDD based on seven studies [18]. Contrary to this study, another past investigation conducted in India by Vijay GS, et al. [21] found no conclusive relationship between hypertension and VD levels in T2DM patients.

In the current study, the age range of 30-60 years was determined with the exclusion of patients with poor glycemic control (HbA1c > 10%) and disease duration of less than 5years to minimize the effect on albuminuria as reported by Syed Bakht Ruidar et al. [16] and Ucak S, et al. [22]. Regarding the inclusion criteria, HbA1c, duration of diabetes, and FBS are observed to be the significant factors of VDD in T2DM patients. Similar outcomes about HbA1c were reported in the study by Darraj H, et al. for Saudi Arabia [8], Yu JR, et al. for Korea [23] and Iqbal K, et al. for Pakistan [24] that investigated the relationship of vitamin D insufficiency with glycemic control and reported that VDD was highly prevalent in T2DM patients and was related with poor glycaemic control with high HbA1c levels. Another study by AlHewishel MA, et al. [20] reported an evident role of VDD on glucose tolerance in diabetic patients and found that levels of Vitamin D were inversely proportional to the levels of fasting glucose and HbA1c. This proved further evidence that low serum VD has a significant role in impaired glucose metabolism, and by good glycemic control, VDD can be prevented [16].

Investigation of the impact of duration of diabetes on VDD showed that longer duration of diabetes results in lower VD in T2DM patients. A case-control study held in the Arab Gulf in 2017-18 by Nasr MH, et al. [25] found that the duration of diabetes is positively associated with reduced serum vitamin D levels. According to this study, higher FBS levels are associated with lower levels of VD in T2DM patients. An article for Vietnam by Tran Huu TT, et al. [26] indicated that diabetic patients with better fasting blood sugar have a better vitamin D status. Hwang Y, et al. [27] suggested no significant effect of fasting glucose levels on VDD in Korean adults. Previous research studies assessed the relationship between serum Vitamin D and diabetic nephropathy [10-12], but uncontrolled diabetes and chronic kidney disease were not considered, and lower glomerular filtration rate can lead to rising albuminuria, therefore this study excluded all patients with eGFR < 45 ml/min/1.73m² to lower the influence of low glomerular filtration on albuminuria [22].

In agreement with the findings of Chida S, et al. [28], and Felício JS, et al. [29], a statistically significant relation between serum levels of vitamin D with urinary levels of albuminuria (p-value=0.004) and serum creatinine (p-value=0.034) is observed. The findings of this research revealed that T2DM patients with obesity or higher LDL-C had a relatively higher risk of VDD compared to their counterparts. It is noteworthy reported in the literature that VDD is significantly affected by high BMI and higher LDL-c levels [30]. Consistent with various previous studies [18, 29, 30], age, gender, dark natural skin tone, eGFR, serum cholesterol, triglycerides, and HDL-C are not evidenced to be significantly associated with VDD in T2DM patients over the observed data.

The strengths of this study were its ability to assess the prevalence of VDD and establish its connection with cardiometabolic risk factors in a South Asian 30-60 year old general population with T2DM for at least 5 years, natural Asian brown skin tone, and appropriate sunlight exposure. People of South Asian heritage may not obtain enough vitamin D from sunlight, even if they spend as much time outside as others. This could be because they avoid the sun amid hot weather, cover up for religious reasons, have dark skin that does not synthesize enough vitamin D from sunlight, and consume less vitamin D. This study excluded diabetes patients who were newly diagnosed, were pregnant, had secondary diabetes or type 1 diabetes mellitus (T1DM), had HbA1c >10%, were on medications that could interfere with vitamin absorption like steroids or anticonvulsants in the last three months and those who had a history of supplementation of folic acid, vitamin B12 or Vitamin D. Moreover, patients with incomplete medical records, surgical histories and suffering from concomitant comorbidities such as chronic kidney disease stage 3B (eGFR < 45ml/min) or end-stage renal disease, macroalbuminuria, liver diseases, gastrointestinal disorders, or malabsorption syndromes that could affect their VD levels were also excluded.

Despite the scientific merits, the limitations of the present

investigation should be acknowledged. Because this was a cross-sectional study, it did not assess long-term follow-up data pertaining to vitamin D levels and related cardio-metabolic variables. Some potential confounders such as sun exposure, outdoor exercise, nutritional status, and seasonal detection of vitamin D were not included in the analysis. Given the single-center scope, these findings may not be generalizable to the total Pakistani population.

Conclusions

Since vitamin D deficiency is common around the world, this study found that around two-thirds of patients with T2DM had a greater prevalence of VDD. The results revealed that serum concentrations of vitamin D in T2DM patients were associated with several cardio-metabolic risk factors, including duration of diabetes, hypertension, obesity, poor glycemic control monitored with higher FBS or impaired HbA1c, levels of LDL-C in lipid profile, urinary levels of albuminuria and serum creatinine. Although further large-scale research is needed to investigate the causative relationship, controlling cardio-metabolic risk factors may be crucial in regulating and maintaining adequate serum levels of vitamin D in T2DM patients.

Concept and design: Shoaib Asghar, Salman Shahid, Asad Riaz, Al Muktadir Chowdhury Evan, Haider Tanvir, Muhammad Hamza Ejaz, Mamuna Akram

Acquisition, analysis, or interpretation of data: Shoaib Asghar, Salman Shahid, Asad Riaz, Al Muktadir Chowdhury Evan, Haider Tanvir, Muhammad Hamza Ejaz, Mamuna Akram

Drafting of the manuscript: Shoaib Asghar, Salman Shahid, Asad Riaz, Al Muktadir Chowdhury Evan, Haider Tanvir, Muhammad Hamza Ejaz, Mamuna Akram

Critical review of the manuscript for important intellectual content: Shoaib Asghar, Salman Shahid, Asad Riaz, Al Muktadir Chowdhury Evan, Haider Tanvir, Muhammad Hamza Ejaz, Mamuna Akram

Supervision: Shoaib Asghar, Salman Shahid

Ethics Statement and Conflict of Interest Disclosures

Human subjects: Consent for treatment and open access publication was obtained or waived by all participants in this study. Sheikh Zayed Medical College and Hospital, Rahim Yar Khan issued approval 165/IRB/SZMC/SZH. Your research study titled "Vitamin D Deficiency and Its Association With Cardio-Metabolic Risk Factors in Type 2 Diabetes Mellitus Patients: A Cross-Sectional Study" has been approved in the expedited review. You are allowed to conduct the study.

Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue.

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following:

Payment/services info: All authors have declared that no financial support was received from any organization for the submitted work.

Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Acknowledgements

SA, SS: supervision, conception, design of work, acquisition, analysis, data interpretation, drafting, critical review, and final approval; HT, AR, ME, MA, AC: conception, design of work, acquisition, analysis, data interpretation, drafting, critical review and final approval. All authors should be considered joint-first authors. All authors approved the final version and have agreed to be accountable for all aspects of the work.

References

1. Asghar S, Asghar S, Shahid S, et al. Metabolic Syndrome in Type 2 Diabetes Mellitus Patients: Prevalence, Risk Factors, and Associated Microvascular Complications. Cureus 15 (2023): 39076.
2. Condoleo V, Pelaia C, Armentaro G, et al. Role of vitamin D in cardiovascular diseases. Endocrines 18 (2021): 417-26.
3. Zakhary CM, Rushdi H, Hamdan JA, et al. Protective Role of Vitamin D Therapy in Diabetes Mellitus Type II. Cureus 20 (2021): 17317.
4. Khudayar M, Nadeem A, Lodi MN, A Aleem AS, Mirza REF, et al. The Association Between Deficiency of Vitamin D and Diabetes Mellitus Type 2 (DMT2). Cureus 14 (2022): 22221.
5. Zomorodian SA, Shafiee M, Karimi Z, et al. Assessment of the relationship between 25-hydroxyvitamin D and albuminuria in type 2 diabetes mellitus. BMC Endocrine Disorders 4 (2022): 171.
6. Wimalawansa SJ. Associations of vitamin D with insulin resistance, obesity, type 2 diabetes, and metabolic syndrome. The. Journal of steroid biochemistry and molecular biology 175 (2018): 177-89.
7. Cheng S, Massaro JM, Fox CS, et al. Adiposity, cardiometabolic risk, and vitamin D status: the Framingham Heart Study. Diabetes 59 (2010): 242-8.

8. Darraj H, Badedi M, Poore KR, et al. Vitamin D deficiency and glycemic control among patients with type 2 diabetes mellitus in Jazan City, Saudi Arabia. Diabetes Metab Syndr Obes 5 (2019): 853-862.

9. Zhao H, Zhen Y, Wang Z, et al. The Relationship Between Vitamin D Deficiency and Glycated Hemoglobin Levels in Patients with Type 2. Diabetes Mellitus. Diabetes Metab Syndr Obes 13 (2020): 3899-3907.

10. Riaz MH, Jamil A, Yousaf H, et al. Incidence of Vitamin D Deficiency and Its Association with Microalbuminuria in Patients with Type 2 Diabetes Mellitus. Cureus 24 (2023): 45854.

11. Tian XQ, Zhao LM, Ge JP, Zhang Y, Xu YC. Elevated urinary level of vitamin D-binding protein as a novel biomarker for diabetic nephropathy. Exp Ther Med 7 (2014): 411-416.

12. Gowri K, Shaikha A, Aseel S, et al. Association of Vitamin D deficiency with dyslipidemia, glycemic control and microalbuminuria in patients with type 2 Diabetes mellitus in Qatar. Yemen Journal of Medicine (2023): 17-21.

13. Artha IMJR, Bhargah A, Dharmawan NK, et al. High level of individual lipid profile and lipid ratio as a predictive marker of poor glycemic control in type-2 diabetes mellitus. vasc Health Risk Manag 15 (2019): 149-157.

14. Reis JP, von Mühlen D, Miller III ER, et al. Vitamin D status and cardiometabolic risk factors in the United States adolescent population. Pediatrics 1 (2009): 371-9.

15. Zhou T, Shen L, Li Z, et al. Severe 25-Hydroxyvitamin D Deficiency May Predict Poor Renal Outcomes in Patients with Biopsy-Proven Diabetic Nephropathy. Front Endocrinol Lausanne 13 (2022): 871571-2022.

16. Syed Bakht Ruidar, Wang N, Abulikam T, et al. Assessment of The Impact of Vitamin D Supplementation on Proteinuria in Individuals with Type 2 Diabetes Mellitus. Journal of Population Therapeutics and Clinical Pharmacology 31 (2024): 1242-1249.

17. Sivritepe R, Basat S, Ortaboz D. Association of vitamin D status and the risk of cardiovascular disease as assessed by various cardiovascular risk scoring systems in patients with type 2 diabetes mellitus. The Aging Male 3 (2019): 156-62.

18. Taderegew MM, Woldeamanuel GG, Wondie A, et al. Vitamin D deficiency and its associated factors among patients with type 2 diabetes mellitus: a systematic review and meta-analysis. BMJ Open 5 (2023): 075607.

19. Wang C, Li H, Huo L, et al. Serum 25-Hydroxyvitamin D Levels in Type 2 Diabetes Patients in North China: Seasonality and the Association between Vitamin D Status and Glycosylated Hemoglobin Levels. Int J Clin Pract (2023): 4151224-2023.

20. AlHewishel MA, Bahgat M, Al Huwaiyshil A, et al. 25(OH)D Serum Level in Non-Diabetic and Type II Diabetic Patients: A Cross-Sectional Study. Cureus 126 (2020): 8910:2020.

21. Vijay GS, Ghonge S, Vajjala SM, et al. Prevalence of Vitamin D deficiency in type 2 diabetes mellitus patients: a cross-sectional study. Cureus 15 (2023).

22. Ucak S, Sevim E, Ersoy D, et al. Evaluation of the relationship between microalbuminuria and 25-(OH) vitamin D levels in patients with type 2 diabetes mellitus. Aging Male 22 (2019): 116-120.

23. Yu JR, Lee SA, Lee JG, et al. Serum vitamin d status and its relationship to metabolic parameters in patients with type 2 diabetes mellitus. Chonnam medical journal 1 (2012): 108-15.

24. Iqbal K, Islam N, Mehboobali N, et al. Association of vitamin D deficiency with poor glycaemic control in diabetic patients. J Pak Med Assoc 66 (2016): 1562-5.

25. Nasr MH, Hassan BA, Othman N, et al. Prevalence of vitamin D deficiency between type 2 diabetes mellitus patients and non-diabetics in the Arab Gulf. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy 1 (2022): 647-57.

26. Tran Huu TT, Tran HD, Tran TN, et al. Relationship between vitamin D status and the relevant parameters of glucose in patients with type 2 diabetes. Diabetes, Metabolic Syndrome and Obesity 3 (2021): 2489-94.

27. Hwang Y, Jang J, Shin MH. Associations of fasting glucose and glycated hemoglobin with vitamin D levels according to diabetes mellitus status in Korean adults. Epidemiology and Health 44 (2022).

28. Chida S, Fujita Y, Ogawa A, et al. Levels of albuminuria and risk of developing macroalbuminuria in type 2 diabetes: historical cohort study. Scientific reports 23 (2016): 26380.

29. Felício JS, de Rider Britto HA, Cortez PC, et al. Association Between 25(OH)Vitamin D, HbA1c and Albuminuria in Diabetes Mellitus: Data from a Population-Based Study (VIDAMAZON). Front Endocrinol Lausanne 12 (2021): 723502-2021.

30. Rolim MC, Santos BM, Conceicao G, et al. Relationship between vitamin D status, Glycemic control and cardiovascular risk factors in Brazilians with type 2 diabetes mellitus. Diabetol Metab Syndr 8 (2016): 77.

Citation: Shoaib Asghar, Haider Tanvir, Salman Shahid, Asad Riaz, Muhammad Hamza Ejaz, Mamuna Akram, Al Muktadir Chowdhury Evan. Vitamin D De iciency and Its Association with Cardio-Metabolic Risk Factors in Type 2 Diabetes Mellitus Patients: A Cross-Sectional Study. Fortune Journal of Health Sciences. 8 (2025): 82-91.