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RELATIONSHIP OF HBA1C WITH SERUM TOTAL CHOLESTEROL AND TRIGLYCERIDE IN DIABETIC PATIENTS

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Abstract

Background: *Type 2 diabetes mellitus (T2DM) is frequently accompanied by dyslipidemia, contributing to cardiovascular risk. Glycated hemoglobin (HbA1c) reflects long-term glycemic control and may be associated with lipid abnormalities.*

Objective: *To determine correlation of HbA1c with serum total cholesterol and triglyceride in diabetic patients.*

Methods: *A cross-sectional study was conducted on 217 patients with T2DM. HbA1c, serum cholesterol, and triglycerides were measured. Correlation was assessed using Spearman's correlation coefficient. Stratified analyses were performed to determine variations by demographic and clinical factors.*

Results: *Mean HbA1c was 9.20% ± 2.43. Significant positive correlations were observed between HbA1c and triglycerides ($r = 0.271$, $p < 0.05$), and between HbA1c and cholesterol ($r = 0.212$, $p < 0.05$). Post-stratification, stronger correlations were noted in females (HbA1c–triglycerides: $r = 0.3074$, $p = 0.0003$) and non-hypertensive individuals ($r = 0.3881$, $p < 0.0001$). Smokers showed the highest correlation between HbA1c and triglycerides ($r = 0.4876$, $p = 0.0051$).*

Conclusion: *HbA1c shows a statistically significant correlation with lipid parameters in T2DM patients, with notable variation across subgroups. These findings highlight the importance of individualized risk assessment in diabetic care.*

INTRODUCTION

Type 2 diabetes mellitus is a worldwide medical issue found in every single country of the globe particularly in developing nations and it is on the rise day by day. Earlier it was believed that diabetes is a disease of urban & affluent population but now because of ongoing urbanization, rise in sedentary life style & consumption of fast food in place of traditional food has impacted even low & middle income population. In Pakistan too there is vast percentage of population suffering from diabetes [1]

Diabetes mellitus is characterized by chronic hyperglycemia and disturbances in carbohydrate, fat, and protein metabolism [2]. An HbA1c level equal to or exceeding 6.5% is now considered a diagnostic benchmark for diabetes. Dyslipidemia is frequently observed in individuals with type 2 diabetes mellitus (T2DM) [3]. The disease is also linked to multiple long-term complications, particularly cardiovascular disorders, hypertension, stroke, nephropathy, retinopathy, neuropathy, and diabetic foot, among others [4].

Dyslipidemia involves abnormalities in lipoprotein metabolism, often characterized by elevated total cholesterol, triglycerides, or LDL-C levels, and/or decreased HDL-C levels [5]. It is a frequent comorbidity in T2DM patients [6]. HbA1c levels are a known predictor of diabetes-related complications. Beyond traditional cardiovascular risk factors such as dyslipidemia, elevated HbA1c independently contributes to increased cardiovascular risk. Evidence suggests that for each 1% increase in HbA1c, there is an associated 18% rise in cardiovascular disease risk among diabetic patients. Notably, this relationship has also been observed in non-diabetic individuals, even when HbA1c remains within normal limits [7].

In one study it was found that raised serum cholesterol was found in 41.4% patients with type 2 diabetes and raised serum triglyceride were found in 35.9% patients. In patients with HbA1c was less than 7% total cholesterol was 176 (154-199) md/dl and triglyceride level were 98 (80-130) md/dl while in patients with HbA1c more than 7% total cholesterol was 196 (165-229) md/dl and triglyceride level were 133 (98-197) md/dl. Significant correlation was found between HbA1C, and total cholesterol ($r=0.189$, $p \leq 0.001$) and triglyceride ($r=0.243$, $p \leq 0.001$) [7]

The aim of this study is to determine the correlation of lipid profile with HbA1c in T2DM patients.

METHODOLOGY

Study Design and Setting

This was a cross-sectional study conducted at the Department of Medicine, Khyber Teaching Hospital (KTH), Peshawar. The Sampling technique were a consecutive non-probability.

Sample Size and Sampling Technique

Sample size has been calculated based on online sample size calculator for correlation studies (https://sample-size.net/correlation-sample-size/), using the assumptions below, 1) Anticipated for value for correlation coefficient between Hba1c and serum cholesterol = 0.189 [7]. Test power = 80%, confidence level=95%, sample size= 217; 2) Anticipated for value for correlation coefficient between Hba1c and serum triglyceride = 0.243 [7]. Test power = 80%, confidence Level=95%, and sample size= 131.

Inclusion criteria were patients age greater or equal to 18 years with a confirmed diagnosis of diabetes mellitus. Patients with known thyroid disorders, type 1 diabetes mellitus, renal failure, or on lipid-lowering medications were excluded from the study.

Data Collection

Demographic data such as age, gender, smoking status, and history of hypertension and obesity were recorded. Anthropometric measurements including height (cm), weight (kg), and BMI (kg/m^2) were taken using standard protocols. BMI was categorized according to WHO criteria.

Venous blood samples were drawn after an overnight fast to measure serum cholesterol, triglycerides, and glycated hemoglobin (HbA1c) levels. All laboratory analyses were performed using standardized automated techniques in the hospital laboratory.

Statistical Analysis

Stata 18 Basic Edition (BE) program was employed for data analysis. Mean and standard deviation (SD) are utilized to present quantitative variables. frequency and percentages are some of the categorical variables. Because the data was not normally distributed, the correlation was determined using Spearman correlation coefficient. Statistical significance was taken at a p-value of less than 0.05.

Post-stratification analysis was performed by dividing the data according to gender, smoking status, hypertension, and obesity to observe the correlation differences in subgroups. Scatter plots were generated to visually assess the correlation between HbA1c and lipid parameters.

RESULTS

A total of 217 patients were included in the study. Of total, 135 (62.2%) were female. Hypertension was present in 94 (43.3%) patients, while 123 (56.7%) had no history of hypertension. Smoking was reported in 32 (14.7%) patients, and 185 (85.3%) were non-smokers. Obesity was found in 41 (18.9%) patients, whereas 176 (81.1%) were not obese.

The mean height was 168.53 ± 4.54 cm, mean weight was 72.62 ± 12.11 kg, and mean BMI was 25.55 ± 4.03 kg/m². Based on BMI classification, 2 (0.9%) participants were underweighted, 105 (48.4%) had normal weight, 69 (31.8%) were overweight, and 41 (18.9%) were obese.

The average duration of diabetes mellitus was 70.68 ± 56.20 months. The mean serum cholesterol level was 166.42 ± 64.95 mg/dl, triglycerides 186.21 ± 107.38 mg/dl, and mean HbA1c was 9.20 ± 2.44%.

Table 1: Demographic characteristics of the study sample

Variable	**Category**	**Frequency (n)**	**Percentage (%)**
Gender	Female	135	62.2
	Male	82	37.8
Hypertension	No	123	56.7
	Yes	94	43.3
Smoking	No	185	85.3
	Yes	32	14.7
Obesity	No	176	81.1
	Yes	41	18.9
Height (cm)	Mean ± SD	168.53±4.536	
Weight (Kg)	Mean ± SD	72.62±12.113	
BMI (Kg/m2)	Mean ± SD	25.553±4.029	
BMI Category	Underweight	2	0.9
	Normal	105	48.4
	Overweight	69	31.8
	Obese	41	18.9
Duration of DM (months)	Mean ± SD	70.68 ± 56.201	
Cholesterol (mg/dl)	Mean ± SD	166.42±64.954	
Triglyceride	Mean ± SD	186.21±107.376	
HbA1c (%)	Mean ± SD	9.2011±2.43636	

DM: Diabetes mellitus; BMI: Body Mass Index

Statistically significant positive correlation between HbA1c and serum triglyceride concentrations ($r = 0.2710$, $p < 0.05$) and between HbA1c and cholesterol concentrations ($r = 0.2124$, $p < 0.05$) was established by Spearman correlation analysis. Additionally, Table 2 shows that there is a significant correlation between cholesterol and triglycerides ($r = 0.4093$, $p < 0.05$).

Table 2: Spearman correlation between HbA1c and lipid parameters

	HbA1c	Triglyceride	Cholesterol
HbA1c	1.0000		
Triglyceride	0.2710*	1.0000	
Cholesterol	0.2124*	0.4093*	1.0000

* shows p value < 0.05

Correlation was further analyzed after stratifying by gender, hypertension, obesity, and smoking status (Table 4)

Table 3: Post-Stratification correlation analysis

Stratified By	Group	HbA1c vs Triglyceride (r, p)	HbA1c vs Cholesterol (r, p)
Gender	Male	0.2053, 0.0644	0.1604, 0.1498
	Female	0.3074, 0.0003	0.2358, 0.0060
Hypertension	Yes	0.1036, 0.3199	0.1957, 0.0589
	No	0.3881, 0.0000	0.2183, 0.0154
Obesity	Yes	0.3787, 0.0151	0.1128, 0.4808
	No	0.2494, 0.0009	0.2259, 0.0026
Smoking	Yes	0.4876, 0.0051	0.3042, 0.0905
	No	0.2422, 0.0009	0.1930, 0.0086

HbA1c was significantly and positively related to total cholesterol (r = 0.2358, p = 0.0060) and triglycerides (r = 0.3074, p = 0.0003) in female participants. There were significant correlations between HbA1c and triglycerides (r = 0.3881, p < 0.001) and cholesterol (r = 0.2183, p = 0.0154) in the non-hypertensive group. HbA1c and triglycerides were found to be strongly correlated in the obese subgroup (r = 0.3787, p = 0.0151), though the correlation with cholesterol was not statistically significant. HbA1c was significantly correlated with cholesterol (r = 0.1930, p = 0.0086) and triglycerides (r = 0.2422, p = 0.0009) in nonsmokers.

Figure 1: Scatter plot showing correlation between HbA1c and lipid parameter

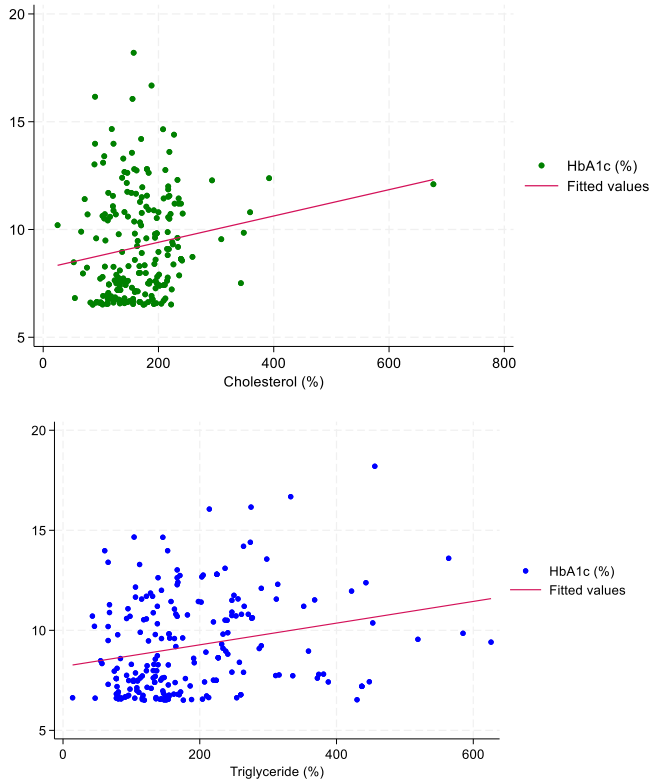

Figure 1 shows the scatterplots depicting the relationship of HbA1c with triglycerides and cholesterol, supporting the observed positive correlations.

DISCUSSION

Amongst type 2 diabetes mellitus (T2DM) patients, the current study analyzed how glycated hemoglobin (HbA1c) related to lipid profile parameters, viz., blood triglycerides, and total cholesterol. There was a highly significant positive relation of HbA1c with total cholesterol ($r = 0.212$, $p < 0.05$) and triglyceride concentration ($r = 0.271$, $p < 0.05$). These findings are consistent with previous studies suggesting that poor glycemic control is commonly accompanied by diabetic dyslipidemia, characterized by raised triglycerides, decreased HDL-C, and increased LDL [8,9].

In our stratified analysis, the correlation between HbA1c and triglycerides was more pronounced in females ($r = 0.3074$, $p = 0.0003$) than in males. Similar findings were reported by Khan et al. in a study conducted on diabetic patients in Pakistan, where gender differences were observed in lipid profiles and their correlation with HbA1c [10]. Moreover, stronger correlations were observed in patients without hypertension and those who were non-obese. These findings highlight the possible modifying effects of comorbid conditions and obesity on lipid metabolism in the diabetic population.

Interestingly, the strongest correlation between HbA1c and triglycerides was noted among smokers ($r = 0.4876$, $p = 0.0051$). Smoking has been independently associated with increased oxidative stress, endothelial dysfunction, and lipid peroxidation, all of which may worsen insulin resistance and lipid abnormalities [11, 12]. This interaction may potentiate the metabolic disturbances of diabetes and increase cardiovascular risk.

The observed correlation between HbA1c and cholesterol ($r = 0.2124$, $p < 0.05$) also supports previous reports. According to a study by Sharahili et al, a positive correlation was found between HbA1c and total cholesterol in a Saudi cohort with T2DM, suggesting that chronic hyperglycemia might contribute to increased hepatic cholesterol synthesis or impaired clearance [13]. Furthermore, Kumar et al. emphasized that elevated HbA1c levels can reflect poor metabolic control and are often associated with adverse lipid profiles and subclinical atherosclerosis [14].

The clinical implications of these findings are important. Regular assessment of both glycemic control and lipid levels is essential in T2DM management. Early identification of patients with concurrent hyperglycemia and dyslipidemia can allow for intensified lifestyle and pharmacological interventions to prevent cardiovascular complications.

Limitations of the current study include its cross-sectional design, which precludes causality inference. Also, the study did not account for confounders such as dietary patterns, physical activity, or medication use (e.g., statins or antidiabetics), which could influence both HbA1c and lipid parameters. Further longitudinal studies with a larger and more diverse population are warranted to validate these associations and evaluate their impact on clinical outcomes.

CONCLUSION

This study found a significant positive correlation between HbA1c and both serum triglycerides and cholesterol in type 2 diabetic patients. The association was stronger in females, non-obese individuals, non-hypertensives, and smokers. These results highlight the need for integrated management of glycemic control and lipid levels to reduce cardiovascular risk in diabetic patients.

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