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Co-relation of Dyslipidemia with Glycated Hemoglobin in Type 2 Diabetic patients

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Abstract:

Objectives:

1- To determine the correlation of HbA1c with mean serum lipid profile parameters.
2- To compare mean lipid profile among type 2 diabetics with ≤7 and >7 HbA1c.

Materials and Methods: The present Cross Sectional study was approved by the REU of CPSP and conducted at Holy Family Hospital, Rawalpindi, involving both inpatients and diabetic clinic attendees who met the criteria. After obtaining written consent, demographic and clinical data were recorded, including diabetes duration and comorbidities. Fasting lipid profile and HbA1c were measured using the AU680 machine. Data were grouped by HbA1c levels (≤7% and >7%) and analyzed using SPSS Version 25.

Results: The mean age was 58.15±11.88 years, with diabetes duration averaging 6.47±1.85 years. Most patients were male (58%), urban (56.5%), and literate (70%). HbA1c was ≤7% in 41.5% and >7% in 58.5%. Lipid levels showed no significant differences between HbA1c groups, except for HDL, which was significantly higher in the ≤7% group (p=0.006). Pearson correlation showed a negative link only between HbA1c and HDL (r=–0.191, p=0.006). Post-stratification revealed significantly higher HDL in males, those aged 40–50, and urban residents with HbA1c ≤7%, while other lipid values showed no significant variation.

Conclusion: It was concluded that HDL cholesterol exhibited a significant inverse association with HbA1c in patients with T2DM, whereas other lipid parameters showed no notable variation with glycemic control. These findings highlight the importance of monitoring and managing HDL cholesterol as part of diabetes care to help reduce cardiovascular risk..

Key words: HbA1c, lipid profile, type 2 diabetes.

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INTRODUCTION:

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disease characterized by persistently elevated blood glucose levels due to insulin resistance and/or impaired insulin secretion.(1) This disease represents a significant global health problem and is associated with a variety of micro- and macrovascular complications.(2) One of the most common comorbidities in T2DM is dyslipidemia, which manifests as alterations in lipid profile, including elevated triglycerides, elevated LDL cholesterol, and decreased HDL cholesterol.(3)

Dyslipidemia in T2DM plays a central role in the pathophysiology of diabetic macroangiopathies and contributes significantly to the increased risk of cardiovascular disease.(4) Glycated hemoglobin (HbA1c) is an established marker for assessing medium-term glycemic control and serves as a key parameter for therapy monitoring in diabetic patients.(5) Several studies indicate a close relationship between glycemic control and changes in lipid profile.(6, 7)

Understanding the relationship between dyslipidemia and HbA1c in patients with T2DM is of great clinical importance, as it not only allows conclusions to be drawn about individual cardiovascular risk but can also facilitate targeted preventive and therapeutic measures. The aim of this study is therefore to investigate the correlation between dyslipidemia and HbA1c levels in patients with type 2 diabetes in order to provide a better basis for comprehensive risk management.

Objective:

1- To determine the correlation of HbA1c with mean serum lipid profile parameters.
2- To compare mean lipid profile among type 2 diabetics with ≤7 and >7 HbA1c.

MATERIALS AND METHODS:

Study Design: Cross Sectional Study.

Study setting: Medicine Department of Holy Family Hospital, both the Diabetic Clinic and admitted patients in the Ward.

Duration of the study: Duration of the study was 6 months ().

Sample size: By using the correlation coefficient calculator, the Sample size: 207

Level of significance: 5%

Power of test: 80%

Correlation coefficient: 0.223(8)

Sampling Technique:

Non-Probability Convenience sampling technique was used for the recruitment of patients.

Inclusion Criteria:

- Both male and female.
- Age 40- 85 years.

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- Known case of type 2 Diabetes Mellitus with duration between 5 to 10 years.

Exclusion Criteria:

- Known case of type 1 Diabetes Mellitus.
- Patients already on lipid lowering drugs.
- Diabetic patients known to be suffering from macrovascular complications i.e stroke, ischemic heart disease, perivascular disease and microvascular complications like nephropathy, renal failure, retinopathy.
- Patients suffering from other endocrinopathies like thyroid disease, cushing disease, adrenal diseases.
- Patient having uncontrolled or refractory hypertension.

Methods: The study was conducted after obtaining approval from the REU of CPSP. Patients who fulfilled the inclusion and exclusion criteria were inducted from the Department of Medicine, Holy Family Hospital, Rawalpindi, including both indoor patients and those attending the Diabetic Clinic. Written informed consent was obtained from each patient.

Data were collected using a self-designed form that included demographic details (age, gender, occupation, residency, and comorbidities) along with medical records focusing on the duration of diabetes and any additional illnesses. Fasting lipid profile and HbA1c for each participant were performed using the AU680 machine at the Pathology Department of Holy Family Hospital, in accordance with the operational definitions. Cholesterol, Triglycerides, LDL, HDL, and HbA1c were expressed as mean and standard deviation for quantitative variables. Group-wise data, i.e., HbA1c ≤ 7 (Group 1) and > 7 (Group 2), were also recorded. The collected data were entered and analyzed using the Statistical Package for Social Sciences (SPSS) Version 25 software.

RESULTS:

The mean age of all enrolled patients was 58.15±11.88 years, and the mean duration of diabetes was 6.47±1.85 years. The age distribution showed that 36.2% of patients were between 40–50 years, 22.2% between 51–60 years, 26.1% between 61–70 years, and 15.5% were older than 70 years. Males comprised 58.0% of the participants, while females made up 42.0%. Regarding place of residence, 56.5% were from urban areas and 43.5% from rural areas. In terms of educational status, 70.0% were literate and 30.0% illiterate. Based on HbA1c levels, 41.5% of patients had HbA1c ≤ 7%, whereas 58.5% had HbA1c> 7% (Table 1). The mean total cholesterol level among the study participants was 179.58±40.86 mg/dL, while the mean triglyceride level was 173.14 ± 13.64 mg/dL. The mean LDL level was recorded at 116.94±7.82 mg/dL, and the mean HDL level was 41.40±3.84 mg/dL (Table 2). A comparison of serum lipid profile between the two HbA1c groups (≤7% and >7%)

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revealed that the mean total cholesterol was 178.97±39.58 mg/dL in the ≤7% group and 180.44±42.82 mg/dL in the >7% group (p= 0.800). The mean triglyceride level was 172.71±13.73 mg/dL in the ≤7% group and 173.75 ± 13.56 mg/dL in the >7% group (p= 0.588). The LDL levels were 116.66±7.70 mg/dL in the ≤7% group and 117.22±8.08 mg/dL in the >7% group (p= 0.614). A statistically significant difference was observed in HDL levels, with a higher mean of 42.26±3.65 mg/dL in the ≤7% group compared to 40.78±3.86 mg/dL in the >7% group (p = 0.006) (Table 3). Pearson correlation analysis between HbA1c and serum lipid profile parameters showed no significant correlation with total cholesterol (r= –0.018, p = 0.800), triglycerides (r= –0.038, p = 0.588), or LDL (r = –0.035, p = 0.614). However, a statistically significant negative correlation was observed between HbA1c and HDL levels (r= –0.191, p = 0.006), indicating that higher HbA1c levels were associated with lower HDL cholesterol (Table 4). Post-stratification analysis comparing serum lipid profiles based on HbA1c levels (≤7% vs >7%) across gender, age groups, residence, and educational status showed no statistically significant differences in total cholesterol, triglycerides, or LDL values across any subgroup (p>0.05). Among males, total cholesterol was 180.80±38.54 mg/dL (HbA1c ≤7%) vs 183.77±44.54 mg/dL (>7%); and among females, 176.78±41.08 vs 176.00±41.48 mg/dL. Similar nonsignificant patterns were observed in all age brackets, residential status, and literacy groups. Triglyceride levels were also comparable, with values such as 173.56±15.31 vs 173.33±14.44 mg/dL in males and 171.32±10.68 vs 174.21±12.68 mg/dL in females. LDL levels remained consistent across stratifications, with no meaningful variation observed. However, HDL showed statistically significant differences in a few groups: males (42.26±3.76 vs 40.76±4.07 mg/dL, p=0.04), individuals aged 40–50 years (42.58±3.64 vs 40.71±3.85 mg/dL, p=0.04), and urban residents (42.69±3.43 vs 40.88±3.89 mg/dL, p=0.01), indicating that individuals with HbA1c ≤7% had higher HDL in these subgroups. No significant HDL differences were noted by educational status or in other age groups and female participants (Table 5).

Table 1: Base line demographic and clinical characteristics *(n=207)*

Variables	
Age (Years)	58.15±11.88
Duration of diabetes (years)	6.47±1.85
Age Groups	
40-50 years	75(36.2%)
51-60 years	46(22.2%)
61-70 years	54(26.1%)
>70 years	32(15.5%)
Gender	
Male	120(58.0%)
Female	87(42.0%)
Place of Residence	
Urban	117(56.5%)
Rural	90(43.5%)
Educational status	
Literate	145(70.0%)
Illiterate	62(30.0%)
HbA1c	

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≤7%	86(41.5%)
>7%	121(58.5%)

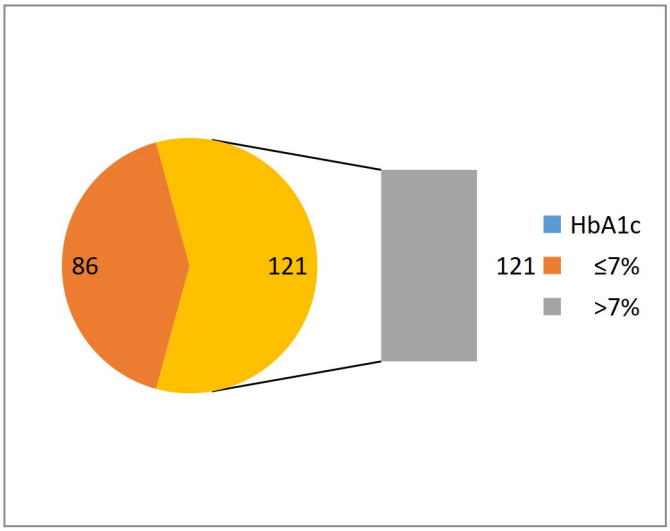

Fig 1: Frequency of patients on the basis of HbA1c level

Table 2: Mean±SD of lipid profile parameters *(n=207)*

Variables	
Lipid profile	
Total Cholesterol (mg/dL)	179.58±40.86
Triglycerides (mg/dL)	173.14±13.64
LDL (mg/dL)	116.94±7.82
HDL (mg/dL)	41.40±3.84

Table 3: Comparison of Serum Lipid Profile Based on HbA1c Groups (n = 207)

Variables	**Groups**		**p-value**
	HbA1c ≤ 7% (Mean ± SD)	HbA1c >7% (Mean ± SD)	
Lipid Profile Parameter			

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Total Cholesterol	178.97±39.58	180.44±42.82	0.800
Triglycerides	172.71±13.73	173.75±13.56	0.588
LDL	116.66±7.695	117.22±8.08	0.614
HDL	42.26±3.653	40.78±3.86	0.006

Table 4: Pearson Correlation between HbA1c and Lipid Profile Parameters

Variables	**r**	**p-value**
Lipid profile		
Total Cholesterol	-0.018	0.800
Triglycerides	-0.038	0.588
LDL	-0.035	0.614
HDL	-0.191	0.006

Table 5: Stratification comparison of serum lipid profile by gender, age, educational status and place of birth according to HbA1c level

	HbA1c	**Total Cholesterol**	**p-value**
Gender		Mean±SD	
Male	≤ 7% vs >7%	180.80±38.54 vs183.77±44.54	0.70
Female	≤ 7% vs >7%	176.78±41.08 vs176.00±41.48	
Age groups			
40-50 years	≤ 7% vs >7%	174.84±38.90 vs 179.17±34.09	0.62
51-60 years	≤ 7% vs >7%	176.59±30.30 vs 186.10±55.78	0.46
61-70 years	≤ 7% vs >7%	189.96±47.39 vs 187.12±41.74	0.81
>70 years	≤ 7% vs >7%	174.77±39.11 vs 163.92±40.85	0.45
Place of Residence			
Urban	≤ 7% vs >7%	180.64±41.88vs183.43±41.32	0.72
Rural	≤ 7% vs >7%	176.60±36.34vs177.00±44.76	0.72
Educational status			
Literate	≤ 7% vs >7%	176.96±37.31vs 180.92±45.64	0.56
Illiterate	≤ 7% vs >7%	183.20±44.17 vs179.13±34.82	0.70
		Triglycerides	
Gender		Mean±SD	
Male	≤ 7% vs >7%	173.56±15.31 vs1 173.33±14.44	0.93

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Female	≤ 7% vs >7%	171.32±10.68 vs 174.21±12.68	0.25
Age groups			
40-50 years	≤ 7% vs >7%	174.86±13.68 vs 171.37±14.16	0.29
51-60 years	≤ 7% vs >7%	170.62±12.02 vs 173.68±13.76	0.42
61-70 years	≤ 7% vs >7%	170.63±13.60 vs 175.79±13.65	0 .17
>70 years	≤ 7% vs >7%	173.77±16.44 vs 175.28±12.48	0 .77
Place of Residence			
Urban	≤ 7% vs >7%	171.00±13.21vs 172.95±13.35	0.43
Rural	≤ 7% vs >7%	175.14±14.22vs 174.67±13.90	0.87
Educational status			
Literate	≤ 7% vs >7%	173.15±13.48 vs 173.33±13.22	0.93
Illiterate	≤ 7% vs >7%	171.76± 14.37 vs 174.91± 14.69	0.41
		LDL	
Gender			
Male	≤ 7% vs >7%	116.32±7.73 vs 117.75±7.97	0.33
Female	≤ 7% vs >7%	117.21±7.68 vs 116.63±8.25	0.73
Age groups			
40-50 years	≤ 7% vs >7%	116.43±7.29 vs 116.06±7.56	0.83
51-60 years	≤ 7% vs >7%	115.40±8.34 vs 117.94±7.67	0.29
61-70 years	≤ 7% vs >7%	116.10±8.00 vs 116.66±8.63	0.80
>70 years	≤ 7% vs >7%	120.05±6.67 vs 119.57±8.96	0.86
Place of Residence			
Urban	≤ 7% vs >7%	116.90±7.88 vs 116.91±8.35	0.99
Rural	≤ 7% vs >7%	116.32±7.48 vs 117.57±7.84	0.44
Educational status			
Literate	≤ 7% vs >7%	116.25±7.57 vs116.22±8.33	0.98
Illiterate	≤ 7% vs >7%	117.51±7.96 vs 119.95±6.77	0.22
		HDL	
Gender			
Male	≤ 7% vs >7%	42.26±3.76 vs 40.76±4.07	0.04
Female	≤ 7% vs >7%	42.26±3.57vs 40.82±3.54	0.06
Age groups			
40-50 years	≤ 7% vs >7%	42.58±3.64vs 40.71±3.85	0.04
51-60 years	≤ 7% vs >7%	42.10±2.96vs41.37±3.66	0.47
61-70 years	≤ 7% vs >7%	42.12±4.08vs41.00±3.87	0.30
>70 years	≤ 7% vs >7%	42.07±4.08vs 39.72±4.28	0.12
Place of Residence			
Urban	≤ 7% vs >7%	42.69±3.43vs40.88±3.89	0.01
Rural	≤ 7% vs >7%	41.77±3.87vs 40.64±.863	0.17
Educational status			
Literate	≤ 7% vs >7%	42.60±3.50vs 40.65±3.72	0.22
Illiterate	≤ 7% vs >7%	41.34±3.96vs 41.05±4.41	0.78

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Discussion: Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia and insulin resistance.(1) One of the common complications associated with T2DM is dyslipidemia.(9) The main aim of the present study was evaluate the relationship between dyslipidemia and glycated hemoglobin (HbA1c) levels among patients with type 2 diabetes mellitus (T2DM). The mean age of participants was 58.15 years, with a predominance of male patients and a slightly higher representation from urban areas. More than half of the participants (58.5%) had suboptimal glycemic control (HbA1c > 7%).

Analysis of lipid profiles revealed that, although mean values for total cholesterol, triglycerides, and LDL cholesterol were within moderately elevated ranges, no statistically significant differences were observed between patients with controlled (HbA1c ≤ 7%) and uncontrolled (HbA1c > 7%) glycemic status for these parameters. The only lipid fraction showing a significant association with glycemic control was HDL cholesterol, which was higher in the well-controlled group. This finding was further supported by Pearson's correlation analysis, which demonstrated a statistically significant negative correlation between HbA1c and HDL levels, suggesting that poor glycemic control is linked with reduced HDL cholesterol. According to Nivedhini and Jamuna Rani (2023), there is a substantial correlation between HbA1c and triglyceride levels.

High triglycerides raise the amount of free fatty acids in the blood, which disrupts the communication between glucose transporters and insulin receptors.(10) This disturbance encourages subclinical inflammation, which damages beta cells in the pancreas and results in insulin receptor malfunction. Therefore, glycemic control is more difficult to achieve in individuals with higher triglyceride levels than in those with normal triglyceride levels.

These findings align with several previous studies indicating that dyslipidemia is a common metabolic abnormality in T2DM and that low HDL cholesterol is particularly associated with poor glycemic regulation.(11-13) This relationship may be attributed to insulin resistance and hyperglycemia-induced alterations in lipid metabolism, including increased HDL catabolism and impaired reverse cholesterol transport.

In the present study, subgroup analyses revealed that the association between HbA1c and HDL was more pronounced among males, individuals aged 40–50 years, and urban residents. This may reflect gender-related differences in lipid metabolism, age-related hormonal changes, and lifestyle factors more prevalent in urban populations, such as reduced physical activity and dietary habits. The absence of significant associations for LDL, triglycerides, and total cholesterol might be explained by the influence of

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confounding factors such as dietary patterns, genetic predisposition, medication use, and variability in disease duration.

The clinical implications of these results are noteworthy. Low HDL cholesterol is an established independent risk factor for cardiovascular disease (CVD), and its strong association with poor glycemic control reinforces the need for comprehensive management strategies in T2DM.(14) Beyond glycemic control, lifestyle interventions focusing on physical activity, dietary modification, and weight reduction, along with pharmacological therapy when indicated, may help improve HDL levels and reduce CVD risk.(15, 16)

Limitations of this study include its cross-sectional design, which precludes establishing a causal relationship, and the exclusion of patients on lipid-lowering therapy, which, while necessary for data accuracy, may limit generalizability to the broader diabetic population. Furthermore, other lipid subfractions and markers of insulin resistance were not evaluated, which could provide additional insight into the observed associations.

Conclusion: It was concluded that HDL cholesterol was found to have a substantial inverse connection with HbA1c in T2DM patients, while other lipid parameters did not significantly change with glycemic management. In order to reduce cardiovascular risk, our data emphasize how crucial it is to monitor and treat HDL cholesterol in diabetic treatment.

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