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Original Research Article

Correlation of HbA1c with Lipid Profile in Patients with Type 2 Diabetes Mellitus: A Retrospective Study

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Abstract:

Background: Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by impaired insulin secretion and insulin resistance, resulting in persistent hyperglycemia. Dyslipidemia frequently coexists with poor glycemic control and contributes significantly to cardiovascular morbidity and mortality. Glycated hemoglobin (HbA1c) reflects long-term glycemic status and may serve as a predictor of lipid abnormalities.

Aim: To evaluate the correlation between HbA1c and lipid profile parameters among patients with Type 2 diabetes mellitus.

Methods: A retrospective observational study was conducted in the Department of Biochemistry, DRIEMS Institute of Health Sciences & Hospital, Tangi, Cuttack, Odisha, India, over six months. Medical records of 100 patients diagnosed with T2DM were reviewed. Demographic characteristics, HbA1c levels, and lipid profile parameters were collected. Statistical analysis included descriptive statistics, Pearson correlation and independent t-test. Significance was considered at $p<0.05$.

Results: Among 100 patients, 62% demonstrated poor glycemic control (HbA1c ≥7%). Mean HbA1c was 8.42±1.63%. HbA1c showed significant positive correlation with total cholesterol (r=0.42), triglycerides (r=0.58), LDL cholesterol (r=0.47), VLDL cholesterol (r=0.55), and negative correlation with HDL cholesterol (r=-0.36) ($p<0.05$). Patients with uncontrolled diabetes demonstrated significantly worse lipid profiles.

Conclusion: HbA1c showed significant association with lipid abnormalities and may function as a practical marker for identifying diabetic patients at higher risk for dyslipidemia and cardiovascular complications.

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Introduction

Diabetes mellitus represents one of the fastest-growing global health challenges, affecting millions worldwide and contributing substantially to morbidity and mortality [1]. Type 2 diabetes mellitus (T2DM) constitutes nearly 90–95% of all diabetes cases and is characterized by chronic hyperglycemia resulting from insulin resistance and impaired β-cell function [2].

Persistent hyperglycemia contributes to both microvascular and macrovascular complications, including nephropathy, retinopathy, neuropathy, and cardiovascular disease [3]. Cardiovascular complications remain the leading cause of mortality among diabetic patients and are strongly associated with dyslipidemia [4].

HbA1c reflects average blood glucose concentrations over approximately three months and is widely utilized for monitoring long-term glycemic control [5]. Elevated HbA1c levels have been associated with an increased risk of diabetic complications and adverse cardiovascular outcomes [6].

Diabetic dyslipidemia commonly manifests as elevated triglycerides, increased LDL cholesterol, elevated VLDL cholesterol, and reduced HDL cholesterol [7]. Insulin resistance promotes increased hepatic lipogenesis, impaired lipoprotein metabolism, and enhanced free fatty acid release, resulting in characteristic lipid abnormalities [8].

Several studies suggest that HbA1c may correlate with lipid abnormalities and therefore could serve as an indirect indicator of cardiovascular risk [9,10]. However, findings remain inconsistent across

populations due to ethnic, lifestyle, and healthcare variations [11].

India carries a substantial burden of diabetes and associated cardiovascular disease [12]. Limited data exist regarding the relationship between HbA1c and lipid profile parameters among diabetic patients in Eastern India [13].

Therefore, this study was undertaken to evaluate the correlation between HbA1c and lipid profile parameters among patients with Type 2 diabetes mellitus.

Materials and Methods

Study Design: Retrospective observational study.

Study Setting: Department of Biochemistry, DRIEMS Institute of Health Sciences & Hospital, Tangi, Cuttack, Odisha, India.

Study Duration: 6 months (November 2025–April 2026).

Study Population: Patients diagnosed with Type 2 diabetes mellitus.

Sample Size: 100 patients.

Inclusion Criteria

- Confirmed Type 2 diabetes mellitus patients
- Age ≥30 years
- Availability of complete biochemical records

Exclusion Criteria

- Type 1 diabetes mellitus
- Pregnancy
- Chronic liver disease
- Chronic kidney disease
- Patients receiving lipid modifying therapy
- Incomplete records

Variables Collected

- Age
- Gender
- HbA1c
- Total cholesterol
- Triglycerides
- HDL cholesterol
- LDL cholesterol
- VLDL cholesterol

Operational Definitions

Controlled diabetes: HbA1c <7%.

Uncontrolled diabetes: HbA1c ≥7%.

Statistical Analysis: Data were analyzed using SPSS version 26.

Statistical methods included:

- Mean ± standard deviation
- Pearson correlation
- Independent t test

$p<0.05$ considered significant

Results

A total of 100 patients diagnosed with Type 2 diabetes mellitus were included in the retrospective analysis. The study evaluated demographic characteristics, glycemic status, lipid profile parameters, and correlation between HbA1c and lipid abnormalities. Statistical analysis demonstrated significant associations between poor glycemic control and adverse lipid profile parameters.

Demographic Characteristics of Study Population: Among the 100 study participants, males constituted the majority (58%), while females accounted for 42% of the study population. The age distribution revealed that most patients belonged to the 46–60 years age group. The demographic characteristics are summarized in Table 1.

Table 1. Demographic Characteristics of Study Population (n=100)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	58	58.0
	Female	42	42.0
Age (years)	30–45	28	28.0
	46–60	47	47.0
	>60	25	25.0

As shown in Table 1, middle-aged individuals constituted the largest proportion of the study population.

Distribution According to Glycemic Control: Patients were categorized according to HbA1c values into controlled and uncontrolled diabetes groups.

The mean HbA1c level among all participants was 8.42 ± 1.63%.

As illustrated in Table 2, uncontrolled diabetes (HbA1c ≥7%) was observed in 62% of patients.

Table 2: Distribution According to Glycemic Status

Glycemic Category	Frequency (n)	Percentage (%)
Controlled (HbA1c <7%)	38	38.0
Uncontrolled (HbA1c ≥7%)	62	62.0

The findings presented in Table 2 indicate that poor glycemic control was common among study participants.

Lipid Profile Characteristics of Study Population: The mean lipid profile values are summarized in Table 3.

Table 3: Mean Lipid Profile Parameters Among Study Population

Parameter	Mean ± SD (mg/dL)
Total Cholesterol	214.8 ± 42.1
Triglycerides	192.4 ± 61.7
HDL Cholesterol	40.8 ± 7.2
LDL Cholesterol	131.2 ± 36.4
VLDL Cholesterol	38.5 ± 12.4

As shown in Table 3, elevated triglycerides and LDL cholesterol were observed among study participants.

Correlation Between HbA1c and Lipid Parameters: Correlation analysis demonstrated significant positive correlations between HbA1c and total cholesterol, triglycerides, LDL cholesterol, and VLDL cholesterol, while HDL cholesterol showed negative correlation.

These findings are summarized in Table 4.

Table 4: Correlation Between HbA1c and Lipid Profile Parameters

Parameter	Correlation Coefficient (r)	p value
Total Cholesterol	0.42	0.001
Triglycerides	0.58	<0.001
HDL Cholesterol	-0.36	0.002
LDL Cholesterol	0.47	<0.001
VLDL Cholesterol	0.55	<0.001

The strongest positive correlation was observed between HbA1c and triglyceride levels (r=0.58), followed by VLDL cholesterol (r=0.55). The negative correlation between HbA1c and HDL cholesterol indicates worsening HDL levels with increasing glycemic burden.

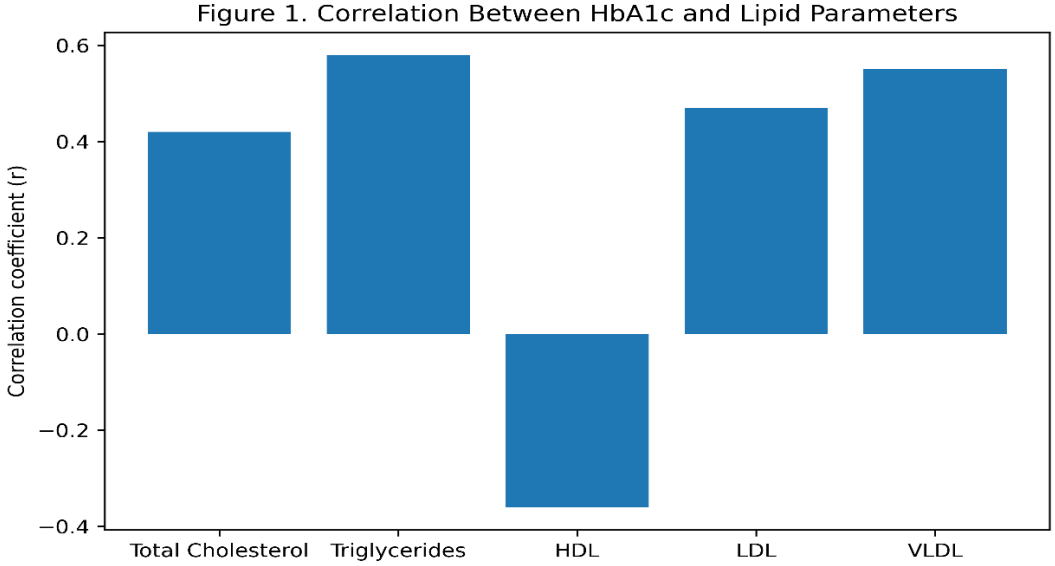

Figure 1: Correlation Between HbA1c and Lipid Parameters

Figure 1 demonstrates the magnitude and direction of correlation coefficients between HbA1c and lipid profile parameters.

The graphical representation in Figure 1 demonstrates that triglycerides and VLDL showed the strongest association with HbA1c.

Comparison Between Controlled and Uncontrolled Diabetic Groups: A comparison of lipid parameters between controlled and uncontrolled diabetic groups revealed statistically significant differences.

These findings are summarized in Table 5.

Table 5: Comparison of Lipid Parameters Between Controlled and Uncontrolled Diabetic Patients

Parameter	Controlled Diabetes Mean ± SD	Uncontrolled Diabetes Mean ± SD	t value	p value
Total Cholesterol	189.4 ± 31.2	228.7 ± 40.3	5.12	0.001
Triglycerides	154.2 ± 44.5	215.8 ± 58.1	6.03	<0.001
HDL Cholesterol	44.2 ± 6.8	38.6 ± 6.7	3.24	0.003
LDL Cholesterol	115.3 ± 28.4	142.1 ± 35.8	4.17	0.001

Patients with uncontrolled diabetes demonstrated significantly higher levels of total cholesterol, triglycerides, and LDL cholesterol, whereas HDL cholesterol was significantly lower.

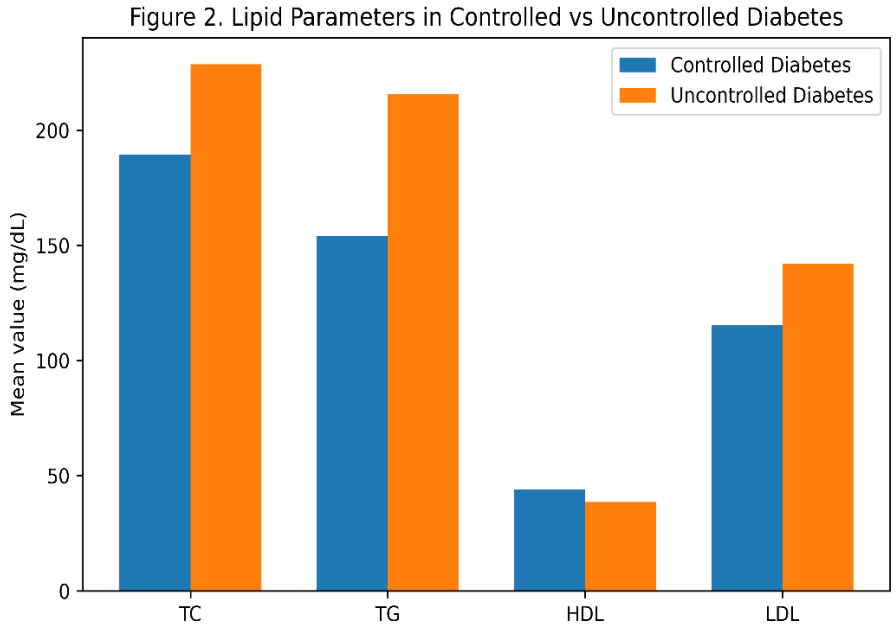

Figure 2: Comparison of Lipid Parameters Between Controlled and Uncontrolled Diabetes Groups

Figure 2 demonstrates worsening lipid abnormalities among patients with poor glycemic control.

The graphical comparison shown in Figure 2 demonstrates markedly elevated atherogenic lipid parameters among uncontrolled diabetic patients.

Overall Interpretation of Findings: Collectively, the findings indicate that worsening glycemic control was associated with progressively abnormal lipid profiles. Elevated HbA1c showed strong association with triglycerides, LDL cholesterol, and VLDL cholesterol, while HDL cholesterol demonstrated inverse association. These findings suggest that poor glycemic control may contribute to increased cardiovascular risk among patients with Type 2 diabetes mellitus.

Discussion

The present study evaluated the relationship between glycemic control and lipid abnormalities among patients with Type 2 diabetes mellitus. The findings demonstrated significant associations between elevated HbA1c levels and unfavorable lipid profiles.

The majority of patients exhibited poor glycemic control, which is consistent with previous reports suggesting that suboptimal diabetes management remains common in developing countries [14].

Triglycerides demonstrated the strongest correlation with HbA1c in the present study. Chronic hyperglycemia increases hepatic fatty acid synthesis

and impairs lipoprotein lipase activity, thereby contributing to elevated triglyceride concentrations [13,16].

The positive association between HbA1c and LDL cholesterol observed in this study supports previous findings indicating that insulin resistance promotes increased production of atherogenic lipoproteins [17].

Reduced HDL cholesterol levels among poorly controlled diabetic patients may be explained by increased triglyceride exchange and altered lipoprotein metabolism [18].

Several investigators have proposed HbA1c as a surrogate marker of dyslipidemia because of its association with lipid abnormalities and cardiovascular risk [19,20].

Our findings are consistent with studies demonstrating significant correlations between HbA1c and triglycerides, LDL cholesterol, and total cholesterol among patients with Type 2 diabetes mellitus [21-23].

The retrospective design and relatively limited sample size represent important limitations of the present study. Furthermore, medication adherence, dietary habits, physical activity, and other lifestyle factors could not be assessed because of the retrospective nature of data collection.

Despite these limitations, the study suggests that HbA1c may provide clinically useful information beyond glycemic control alone and may serve as an accessible indicator for identifying diabetic patients at increased risk of dyslipidemia and cardiovascular complications.

Conclusion

HbA1c demonstrated significant correlation with multiple lipid parameters among patients with Type 2 diabetes mellitus. Poor glycemic control was associated with worsening dyslipidemia. Regular assessment of HbA1c may help identify patients at increased risk for cardiovascular complications.

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