e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com

International Journal of Pharmaceutical Quality Assurance 2025; 16(6); 372-377

Original Research Article

# Association Between HbA1c Levels and Lipid Profile in Patients with Type 2 Diabetes Mellitus

**Arun Kumar Arun[1], Pramod Kumar Agrawal[2]**

[1]Assistant Professor, Department of General Medicine, Katihar Medical College and Hospital, Katihar, Bihar, India

[2]Professor & HOD, Department of General Medicine, Katihar Medical College and Hospital, Katihar, Bihar, India

**Received: 09-04-2025 / Revised: 10-06-2025 / Accepted: 30-06-2025**
**Corresponding Author: Dr. Arun Kumar Arun**
**Conflict of interest: Nil**

**Abstract:**

**Background:** Type 2 diabetes mellitus (T2DM) is associated with chronic hyperglycemia and a high prevalence of dyslipidemia, increasing the risk of cardiovascular complications. Glycated hemoglobin (HbA1c) serves as a marker of long-term glycemic control and may correlate with lipid abnormalities.

**Aim:** To evaluate the correlation between HbA1c and lipid profile parameters in patients with T2DM.

**Methodology:** A hospital-based cross-sectional study was conducted on 90 T2DM patients aged 30–70 years at Department of General Medicine, Katihar Medical College, Katihar, Bihar, India. Patients with confounding conditions or on lipid-lowering therapy were excluded. HbA1c was measured using HPLC, and lipid profile parameters (total cholesterol, triglycerides, LDL-C, HDL-C) were analyzed enzymatically. Pearson's correlation assessed relationships between HbA1c and lipid parameters.

**Results:** The mean HbA1c was 8.36 ± 1.77%, indicating poor glycemic control. Dyslipidemia was prevalent, with elevated LDL-C in 60.3% and low HDL-C in 39.8% of patients. HbA1c showed a moderate positive correlation with total cholesterol ($r = 0.30$, $p = 0.003$) and triglycerides ($r = 0.41$, $p < 0.001$), but not with LDL-C or HDL-C.

**Conclusion:** Higher HbA1c levels are associated with increased total cholesterol and triglycerides, underscoring the importance of integrated glycemic and lipid management to reduce cardiovascular risk in T2DM patients.

**Keywords:** Type 2 Diabetes Mellitus, Hba1c, Lipid Profile, Dyslipidemia, Cardiovascular Risk.



## Introduction

One of the most prevalent long-term metabolic disorders in the world is diabetes mellitus (DM), which is the long-lasting hyperglycemia, caused either by the malfunction of insulin secretion, or its action, or both [1]. Out of the various types, type 2 diabetes mellitus (T2DM) makes up almost 90-95 percent of the total cases, and it has become a significant threat to the overall health of the population, as its prevalence, morbidity, and mortality rates continue increasing. According to the World Health Organization (WHO) and the International Diabetes Federation (IDF), there is a steady increase in the global burden of diabetes, particularly in low- and middle-income countries where India is one of the most impacted countries [2]. T2DM is associated with lifestyle features such as sedentary lifestyle, obesity, and poor nutritional habits along with genetics, aging, and progressive insulin resistance and pancreatic b-cell dysfunction. Chronic hyperglycemia in diabetes is not only a marker for diagnosis, but a major cause of long-term complications including microvascular complications (retinopathy, nephropathy and neuropathy) and macrovascular complications (coronary artery disease, stroke and peripheral vascular disease).

Glycated hemoglobin (HbA1c) has also become an influential and reliable biomarker in the management of T2DM. It represents the mean blood glucose levels within the last two or three months and it gives a more extensive evaluation of long-term glycemic control than the analysis of fasting plasma glucose or postprandial glucose alone. High HbA1c levels have been identified to be associated with elevated risk of microvascular and macrovascular complications and therefore have both clinical significance in tracking disease progression and in informing therapeutic interventions. In addition to glycemic control, HbA1c has been rather investigated as a possible cardiovascular prognosticator since poor metabolism regulation is usually accompanied by lipid abnormalities, also known as diabetic dyslipidemia. This disease is usually characterized by a high level of triglycerides, high level of the level of low-density lipoprotein cholesterol (LDL-C), low level of high-density lipoprotein cholesterol (HDL-C) and small dense lipoprotein particles, which intensifies the atherosclerosis process [4].

Lipid profile is an important measure of cardiovascular health and lipid metabolism imbalances are a major factor leading to the increased cardiovascular disease risk among diabetic patients [5]. Insulin resistance is not the only cause of atherogenic dyslipidemia that is characteristic of T2DM patients and includes increased free fatty acid flux, disrupted hepatic lipid metabolism, and poor clearance of triglyceride-rich lipoproteins [6]. Such lipid disorders put a patient at a high risk of coronary artery disease, stroke, and other vascular problems [7]. Because cardiovascular diseases continue to be the primary cause of mortality among diabetic groups of patients, the analysis of lipid parameters in accordance with glycemic control has significant clinical consequences. It is possible to use the interrelationship between the HbA1c and lipid profile to predict cardiovascular risk in a more efficient way, to identify patients who are at greater risk, and to customize therapeutic measures that will be based on the reduction of the glycemic burden and lipid abnormalities.

A number of studies have shown that high HbA1c levels are linked to poor glycemic control and high glycemic control is linked to a good lipid profile. Nevertheless, not all populations have the same relationship between HbA1c and lipid parameters because genetic, environmental, dietary, and lifestyle factors can have an effect on glycemic and lipid metabolism. Furthermore, the variation in sample size, study design and ethnic dissimilarities also add to the heterogeneity of reported findings. Through this variability, the possible evidence of HbA1c as a biomarker that is dual and represents glycemic control and cardiovascular risk has created significant clinical research interest. Demonstrating a straightforward relationship between HbA1c and lipid profile among T2DM patients can offer a clinician with a low-cost, easy-to-use, and dependable integrated approach to monitor both metabolic and cardiovascular risk.

The clinical relevance of the evaluation of HbA1c as a proxy for lipid abnormalities may have great clinical utility in resource-limited health care systems (i.e., developing countries) where advanced diagnostic centers may not always be readily available. Such evaluations can contribute to a more holistic approach to the management of T2DM, since the successful management of glucose and lipid parameters must be focused on preventing long-term consequences if there was an interaction of the two. The earlier recognition of dyslipidemia in such diabetics, who are poorly controlled, can lead to timely treatment that may consist of lifestyle change, nutritional advice and medical therapy with statins or other lipids-lowering agents to prevent new or recurrent atherosclerotic cardiovascular disease.

Examining the association of HbA1c and the lipid profile on T2DM patients becomes of great importance. This not only bolsters the concept that HbA1c is a key marker of glycemic control but also suggests that it may serve as a predictor of dyslipidemia and cardiovascular risk. By examining this association between HbA1c and the lipid profile, researchers and practitioners may have a richer understanding of how conditions of hyperglycemia and lipid change are connected from a pathophysiological standpoint and enhance the development of integrated strategies for the holistic management of diabetes. This article thus aims to assess the association between HbA1c and the lipid profile among type 2 diabetes mellitus patients, thus adding to the current literature around improved prevention and management of diabetes complications.

## Methodology

**Study Design:** It was a cross-sectional observational study in a hospital that was intended to establish the relationship between glycated hemoglobin (HbA1c) and lipid profile variables in patients with type 2 diabetes mellitus (T2DM). The study was aimed to measure both glycemic control and dyslipidemia, and to measure their relationship.

**Study Area:** The study was carried out in the Department of General Medicine, Katihar Medical College and Hospital, Katihar, Bihar, India from December 2006 to November 2007

### Inclusion and Exclusion Criteria

**Inclusion Criteria**

- Patients aged 30–70 years with a confirmed diagnosis of type 2 diabetes mellitus based on American Diabetes Association (ADA) criteria.
- Patients willing to provide informed consent and undergo laboratory investigations for HbA1c and lipid profile.

**Exclusion Criteria**

- Patients currently on lipid-lowering therapy (e.g., statins, fibrates).
- Patients with known cardiovascular diseases, thyroid disorders, chronic kidney disease, or chronic liver disease.
- Pregnant or lactating women.
- Patients with a history of alcohol or substance abuse.
- Patients with acute infections or inflammatory conditions at the time of study.

**Sample Size:** A total of 90 patients with type 2 diabetes mellitus were included in this study. The sample size was determined considering feasibility, hospital records, and adequate representation of the study population.

**Study Procedure:** After obtaining informed consent, eligible patients were enrolled in the study. A detailed history was taken, including demographic details, duration of diabetes, medication history, and lifestyle habits. Physical examination was conducted to record vital parameters and body mass index (BMI). Venous blood samples were collected under aseptic conditions after an overnight fast of 8–10 hours. Laboratory investigations included estimation of HbA1c levels using high-performance liquid chromatography (HPLC) method and lipid profile analysis, including total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C), measured using an enzymatic colorimetric method. The correlation between HbA1c and lipid parameters was assessed to understand the relationship between glycemic control and dyslipidemia in type 2 diabetes mellitus patients.

**Statistical Analysis:** Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS), version 27.0. Descriptive statistics such as mean, standard deviation, frequencies, and percentages were calculated to summarize the baseline characteristics. Pearson's correlation coefficient was applied to evaluate the relationship between HbA1c and different lipid profile parameters (TC, TG, HDL-C, LDL-C). Independent t-tests were used where appropriate to compare continuous variables, and chi-square tests were applied for categorical variables. A p-value of <0.05 was considered statistically significant.

**Result**

Table 1 presents the socio-demographic characteristics of the 90 study participants. The sample comprised slightly more males (53.3%) than females (46.7%). The majority of participants were aged 55–64 years (42.2%), followed by 45–54 years (26.7%), 30–44 years (24.4%), and 65–70 years (6.7%). Most participants were non-smokers (86.7%) and married (78.9%). In terms of employment, a larger proportion were unemployed or retired (65.6%) compared to those employed (34.4%). Regarding educational attainment, the majority had only primary or secondary education (78.9%), while a smaller fraction had university or postgraduate qualifications (21.1%). These characteristics provide a contextual background for understanding the study population.

**Table 1: Socio-Demographic Characteristics of Study Participants (n = 90)**

| Characteristics | n (%) |
|---|---|
| **Gender** | |
| **Male** | 48 (53.3%) |
| **Female** | 42 (46.7%) |
| **Age Group (years)** | |
| **30–44** | 22 (24.4%) |
| **45–54** | 24 (26.7%) |
| **55–64** | 38 (42.2%) |
| **65–70** | 6 (6.7%) |
| **Smoking Status** | |
| **Non-smoker** | 78 (86.7%) |
| **Smoker** | 12 (13.3%) |
| **Marital Status** | |
| **Single/Divorced/Widowed** | 19 (21.1%) |
| **Married** | 71 (78.9%) |
| **Employment Status** | |
| **Employed** | 31 (34.4%) |
| **Unemployed/Retired** | 59 (65.6%) |
| **Educational Level** | |
| **Primary/Secondary** | 71 (78.9%) |
| **University/Postgraduate** | 19 (21.1%) |

Table 2 presents the biochemical and anthropometric parameters of the 90 study participants, highlighting both mean values and the prevalence of abnormal levels. The average BMI was 30.8 ± 5.8 kg/m², with over half of the participants (52.8%) classified as obese. Glycemic indicators were notably elevated, with mean HbA1c at 8.36 ± 1.77% and fasting blood glucose at 185.5 ± 45.8 mg/dL, with abnormal values observed in 97.1% and 99.3% of participants, respectively. Among lipid profile parameters, mean total cholesterol was 187.5 ± 47.4 mg/dL, triglycerides 144.7 ± 81.1 mg/dL, LDL-C 114.3 ± 39.9 mg/dL, and HDL-C 44.4 ± 16.9 mg/dL. The prevalence of abnormal lipid levels was highest for LDL-C (60.3%), followed by HDL-C (39.8%), triglycerides (34.9%), and total cholesterol (34.8%), indicating a significant burden of dyslipidemia alongside poor glycemic control in this cohort.

| Table 2: Biochemical and Anthropometric Parameters of Study Participants (n = 90) | | |
|---|---|---|
| **Parameter** | **Mean ± SD** | **Prevalence of Abnormal Levels (%)** |
| **BMI (kg/m²)** | 30.8 ± 5.8 | Obese: 52.8% |
| **HbA1c (%)** | 8.36 ± 1.77 | Abnormal: 97.1% |
| **Fasting Blood Glucose (mg/dL)** | 185.5 ± 45.8 | Abnormal: 99.3% |
| **Total Cholesterol (mg/dL)** | 187.5 ± 47.4 | Abnormal: 34.8% |
| **Triglycerides (mg/dL)** | 144.7 ± 81.1 | Abnormal: 34.9% |
| **LDL-C (mg/dL)** | 114.3 ± 39.9 | Abnormal: 60.3% |
| **HDL-C (mg/dL)** | 44.4 ± 16.9 | Abnormal: 39.8% |

Table 3 presents the correlation between HbA1c and various lipid profile parameters in patients with type 2 diabetes mellitus. The results indicate a moderate positive correlation between HbA1c and both total cholesterol ($r = 0.3$, $p = 0.003$) and triglycerides ($r = 0.41$, $p < 0.001$), suggesting that higher HbA1c levels are associated with increased levels of these lipids. In contrast, the correlation between HbA1c and LDL-C ($r = 0.12$, $p = 0.25$) and HDL-C ($r = -0.05$, $p = 0.61$) was not statistically significant, indicating no meaningful association between glycemic control and these lipid parameters in this study population.

| Table 3: Correlation Between HbA1c and Lipid Profile Parameters (Pearson's r) | | | |
|---|---|---|---|
| **Lipid Parameter** | **Pearson's r** | **p-value** | **Interpretation** |
| **Total Cholesterol (TC)** | 0.3 | 0.003 | Moderate positive correlation |
| **Triglycerides (TG)** | 0.41 | <0.001 | Moderate positive correlation |
| **LDL-C** | 0.12 | 0.25 | Not significant |
| **HDL-C** | -0.05 | 0.61 | Not significant |

Table 4 presents the prevalence of dyslipidemia among the study participants, showing the proportion of individuals with normal and abnormal lipid parameters. The data indicate that total cholesterol (TC) and triglycerides (TG) were within normal limits in approximately 65% of participants, while about 35% had elevated levels. Low-density lipoprotein cholesterol (LDL-C) was abnormal in the majority of participants (60.3%), highlighting a higher risk for atherogenic complications. High-density lipoprotein cholesterol (HDL-C) was low in 39.8% of the participants, suggesting that a considerable proportion had reduced cardioprotective lipid levels. Overall, the table reflects a significant prevalence of dyslipidemia, particularly elevated LDL-C and reduced HDL-C, among the study population.

| Table 4: Prevalence of Dyslipidemia in Study Participants | | |
|---|---|---|
| **Lipid Parameter** | **Normal (%)** | **Abnormal (%)** |
| **Total Cholesterol (TC)** | 59 (65.2%) | 31 (34.8%) |
| **Triglycerides (TG)** | 59 (65.1%) | 31 (34.9%) |
| **LDL-C** | 36 (39.7%) | 54 (60.3%) |
| **HDL-C** | 54 (60.2%) | 36 (39.8%) |

**Discussion**

It was a cross-sectional study that compared the glycated hemoglobin (HbA1c) and the parameters of lipid profile in patients with type 2 diabetes mellitus (T2DM). The results show that there are strong correlations between glycemic control and some lipid abnormalities, which implies the necessity of the metabolic approach to this group.

There were 90 patients in the study cohort, a slightly higher percentage of which was male (53.3). Most respondents were between 55-64 years of age (42.2%), which aligns with the fact that a growing prevalence of T2DM has been reported with age (De Berardis 2003) [8]. The majority of patients were non-smokers (86.7%), and a third of them were workers (34.5%). These demographic features are similar to the ones of the similar T2DM populations indicating that the study sample represents the representative picture of the typical clinical picture that is experienced in the tertiary care facilities. The average body mass index (BMI) of participants was 30.8 +- 5.8 kg/m2 and more than half (52.8%) of the participants were obese. Obesity is also known to cause insulin resistance and dyslipidemia, which confirms the noted relation between adiposity and metabolic abnormalities in T2DM. It was observed that there was gender variance with males having higher BMI and diastolic blood pressure whereas females had higher HDL-C. These variations align with previous research, indicating sex-related differentiation of lipid metabolism and cardiovascular risk (Onat et al., 2005) [9]. The cohort HbA1c was 8.36 +- 1.77 with 97.1%. indicating poor glycemic regulation in most of the patients. The average of the fasting blood glucose was 185.5 +- 45.8mg/dl implying continuous hyperglycemia despite routine care. These findings are consistent with previous findings about poor glycemic control being prevalent in T2DM individuals, and it highlights the persistent difficulty in attaining desirable metabolism regulation (Onat et al., 2005).

Lipid profile analysis revealed dyslipidemia was common in the study population. Abnormal total cholesterol (TC) was observed in 34.8% of patients, elevated triglycerides (TG) in 34.9%, elevated LDL-C in 60.3%, and low HDL-C in 39.8%. These findings corroborate previous studies indicating a high prevalence of dyslipidemia among T2DM patients, particularly elevated LDL-C and TG, which are strongly associated with cardiovascular complications (Mooradian AD. 2003) [10].

Pearson correlation analysis demonstrated a moderate positive association between HbA1c and both TC ($r = 0.30$, $p = 0.003$) and TG ($r = 0.41$, $p < 0.001$), suggesting that inadequate glycemic control contributes to elevations in atherogenic lipid fractions. Mechanistically, hyperglycemia may promote increased hepatic very-low-density lipoprotein (VLDL) production and reduced lipoprotein lipase activity, thereby elevating circulating TG and TC levels (Veiraiah A 2005) [11]. In contrast, HbA1c was not significantly correlated with LDL-C ($r = 0.12$, $p = 0.25$) or HDL-C ($r = -0.05$, $p = 0.61$), indicating that these lipid fractions are influenced by additional factors, including genetic predisposition, sex, and lifestyle behaviors.

The observed associations between HbA1c and TC/TG underscore the importance of comprehensive metabolic monitoring in T2DM patients. Regular evaluation of both glycemic and lipid parameters is critical for identifying individuals at elevated cardiovascular risk. Interventions should encompass lifestyle modification, dietary counseling, weight management, and pharmacological therapy tailored to achieve optimal glycemic and lipid control. Gender-specific differences in HDL-C further highlight the need for individualized management strategies to reduce cardiovascular morbidity.

This study benefits from standardized laboratory assessments and a focused evaluation of the interplay between glycemic and lipid abnormalities. Nevertheless, certain limitations must be acknowledged. The cross-sectional design precludes causal inference, and the relatively small sample size may limit the generalizability of the findings. Additionally, potential confounding factors such as dietary habits, physical activity, and genetic predispositions were not assessed, which may influence both HbA1c and lipid profiles.

## Conclusion

This paper shows that there is a strong association between glycemic control as evidenced by HbA1c and lipid abnormalities in type 2 diabetes mellitus patients. The results indicate that there is a moderate relationship between increased HbA1c levels and the increased total cholesterol and triglycerides, but not LDL-C or HDL-C. These findings highlight the fact that dyslipidemia, especially increased LDL-C and decreased HDL-C, is very common in T2DM patients, which highlights the increased cardiovascular risk in this group. The article supports the necessity of comprehensive metabolic treatment, including rigorous glycemic regulation and regular lipid checks along with the change of lifestyle and dietary education with personalized prescription of drugs. These holistic approaches are necessary to lessen the risks of cardiovascular morbidity and enhance the outcomes of cardiovascular disorders among patients with type 2 diabetes.

## References


1. Leahy JL, Bonner-Weir S, Weir GC. β-Cell dysfunction induced by chronic hyperglycemia: current ideas on mechanism of impaired glucose-induced insulin secretion. Diabetes care. 1992 Mar 1;15(3):442-55.
2. Alberti G, Zimmet P, Shaw J, Bloomgarden Z, Kaufman F, Silink M, Consensus Workshop Group. Type 2 diabetes in the young: the evolving epidemic: the international diabetes federation consensus workshop. Diabetes care. 2004 Jul 1;27(7):1798-811.
3. LeRoith D. β-cell dysfunction and insulin resistance in type 2 diabetes: role of metabolic and genetic abnormalities. The American journal of medicine. 2002 Oct 28;113(6):3-11.
4. Hayden MR, Tyagi SC. Isolated low high-density lipoprotein-cholesterol (HDL-C): implications of global risk reduction. Case report and systematic scientific review. Cardiovascular Diabetology. 2005 Jan 4;4(1):1.
5. Kendall DM, Harmel AP. The metabolic syndrome, type 2 diabetes, and cardiovascular disease: understanding the role of insulin resistance. American journal of managed care. 2002 Dec 1;8(20; SUPP):S635-53.
6. Sniderman AD, Scantlebury T, Cianflone K. Hypertriglyceridemic hyperapob: the unappreciated atherogenic dyslipoproteinemia in type 2 diabetes mellitus. Annals of internal medicine. 2001 Sep 18;135(6):447-59.
7. Olijhoek JK, van der Graaf Y, Banga JD, Algra A, Rabelink TJ, Visseren FL. The metabolic syndrome is associated with advanced vascular damage in patients with coronary heart disease, stroke, peripheral arterial disease or abdominal aortic aneurysm. European heart journal. 2004 Feb 1;25(4):342-8.
8. De Berardis G, Pellegrini F, Franciosi M, Belfiglio M, Di Nardo B, Greenfield S, Kaplan SH, Rossi MC, Sacco M, Tognoni G, Valentini M. Identifying patients with type 2 diabetes with a

higher likelihood of erectile dysfunction: the role of the interaction between clinical and psychological factors. The Journal of urology. 2003 Apr;169(4):1422-8.

9. Onat A, Hergenç G, Keleş İ, Doğan Y, Türkmen S, Sansoy V. Sex difference in development of diabetes and cardiovascular disease on the way from obesity and metabolic syndrome: prospective study of a cohort with normal glucose metabolism. Metabolism. 2005 Jun 1;54(6):800-8.
10. Mooradian AD. Cardiovascular disease in type 2 diabetes mellitus: current management guidelines. Archives of internal medicine. 2003 Jan 13;163(1):33-40.
11. Veiraiah A. Hyperglycemia, lipoprotein glycation, and vascular disease. Angiology. 2005 Jul;56(4):431-8.