

## ARTICLE / INVESTIGACIÓN

## Assessment of lipid profile with HbA1c in type 2 diabetic Iraqi patients

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**Abstract:** Insulin-induced hyperglycemia is the hallmark of diabetes mellitus (DM), including various metabolic disorders. Diabetic people are more likely to develop dyslipidemia, hypertension, and obesity. Type 2 diabetes (T2DM), the most common illness, is generally asymptomatic in its early stages and can go misdiagnosed for years. Diabetes screening may be beneficial in some cases since early identification and treatment can lessen the burden of diabetes and its consequences. This study aimed to find the relationship between Glycated hemoglobin (HbA1c) and lipid profile components in T2DM patients. Methods: This descriptive-analytical and cross-sectional study was performed on the control group and T2DM patients in Medical City in Baghdad between March and June 2021. A total of 90 patients with T2DM and 45 healthy control were included in this study. In the control group, healthy volunteer individuals participated. For all subjects, HbA1c, fasting blood sugar/FBS, and lipid profile (Total Cholesterol/TC, Triglyceride/TG, High-density Lipoprotein/HDL, Low-density Lipoprotein/LDL, and Very Low-density Lipoprotein/VLDL) were assessed. Among T2DM patients, 62.22% (n= 56) were male, and 37.78% (n= 34) were female. Mean  $\pm$  SD levels of HbA1c, TC, TG, LDL, VLDL, HDL, and FBS were 7.33 $\pm$ 0.56 % (168.21 $\pm$ 9.23, 146.10 $\pm$ 9.64, 137.23 $\pm$ 8.32, 41.05 $\pm$ 5.86, 43.85 $\pm$ 6.17, and 208.81 $\pm$ 52.1) mg/dl respectively in the T2DM group. In the control group, the Mean  $\pm$  SD results of the same parameters were 4.91 $\pm$ 0.27%, (171.20 $\pm$ 3.57, 116.60 $\pm$ 8.25, 105.05 $\pm$ 2.11, 41.83 $\pm$ 4.92, 44.04 $\pm$ 5.54, 96.20 $\pm$ 7.8) mg/dl respectively. Results demonstrated statistically significant differences between T2DM patients and control groups in HbA1c (p equal to 0.0025), TG (p equal to 0.015), LDL (p=0.0029), and FBS (p=0.02). Pearson correlation analysis of HbA1c with other variables showed a significant positive correlation with serum TC, TG, LDL, and FBS (r=0.573, P<0.01; r=0.655, P <0.001; r=0.498, P<0.05; r=0.691, P<0.001; respectively). At the same time, the data showed a negative connection between HbA1c and HDL (r= - 0.562, P<0.01). The findings of this study reveal that diabetic people do not have a satisfactory HbA1c level. Furthermore, HbA1c shows a significant correlation with TC, TG, LDL, and VLDL, whereas it has a significant negative correlation with HDL. The study's findings showed that HbA1c might be a useful marker for predicting dyslipidemia in T2DM patients.

**Key words:** T2DM, Lipid profile, HbA1c.

## Introduction

Hyperglycemia, which can be induced by insulin production, insulin action, or a combination of both, is the hallmark of diabetes mellitus. Diabetic people have a high chance of developing hyperlipidemia, obesity, and hypertension. T2DM, the most common illness, is generally asymptomatic in its early stages and can go misdiagnosed for years. DM is a long-term metabolic condition brought on by a complicated interplay of genetic, environmental, and behavioral variables. Death rates from diabetes are rising for various reasons, including poor nutrition, obesity, smoking, and physical inactivity<sup>1</sup>. Diabetes screening may be beneficial in some cases since early identification and treatment can lessen the burden of diabetes and its consequences<sup>2</sup>.

Moreover, it was a condition marked by hyperglycemia brought on by a deficiency in insulin action, secretion, or both (insulin resistance)<sup>3</sup>. Noncommunicable illnesses affect not just adults but children and adolescents throughout the

world<sup>4</sup>. In both emerging and developed countries, people should be aware of the high rate of diabetes in their populations. In 2012, 1.9 million persons in the United States were diagnosed with diabetes, while worldwide, the prevalence of diabetes was reported to be 8.3%<sup>5</sup>. An estimated 451 million individuals between 18 and 99 years with diabetes today. According to the latest estimates, nearly half (49.7 %) of patients are undiagnosed. Diabetes implications include coronary heart disease (CHD), peripheral artery disease (PAD), stroke, and other ailments. Endothelial dysfunction will very probably become more common as diabetes rates rise<sup>6</sup>.

The long-term glycemic control marker HbA1c is frequently utilized to reflect the typical blood glucose level in diabetics, suggesting the probability of diabetic complications. The HbA1c is currently considered an independent risk factor for cardiovascular disease (CVD) in diabetics and non-diabetics, among other well-established risk factors, in-

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cluding hyperlipidemia and hypertension<sup>6</sup>. The HbA1c is a valuable diabetes biomarker because it provides information on average blood glucose levels over the last few months<sup>7</sup>. Monitor glycemic management in people with diabetes by testing their HbA1c. The objective is to go down to less than 7%. Multiple variables can influence HbA1c levels, including sugar intake, exercise, and medication adherence. HbA1c might likely predict dyslipidemia and CVD in some studies<sup>8,9</sup>.

The risk of diabetic complications was strongly associated with the leading causes of CVD in diabetics. Cardiovascular disease is one of the primary causes of mortality among diabetes people. As a result, in addition to HbA1c management, it is critical to analyze diabetes patients' blood lipid profiles and take appropriate treatment based on age and type of illness<sup>10</sup>. T2DM patients are four times as likely than healthy people to die from CVD<sup>11</sup>. Diabetic management, early screening, and prompt prevention of diabetes complications dramatically improve disease prognosis and save treatment cost<sup>12</sup>. Therefore, our study aimed to estimate the relationship between HbA1c and lipid profile components in T2DM patients.

## Materials and methods

This study was performed on control and T2DM patients in Medical City in Baghdad between March and June 202. In the control group, healthy volunteer individuals participated. Patients with type 1 diabetes, gestational diabetes, or prednisolone-induced diabetes were not acceptable. Ninety patients with T2DM and 45 with control were included in this study. 5 ml of blood was collected from the patients by venepuncture after overnight fasting for 12 hours. Blood samples were divided into two aliquots; the first contains EDTA and is used for the HbA1c estimation. The second one was in a plain tube to collect serum and stored at -20°C until used. Assessment of FBS and lipid profile were measured by an enzymatic colorimetric method with a commercially available kit (Spinreact, Spain). HbA1c levels measurement was performed with an available kit (Roche, Germany) using Roche Diagnostics Cobas e411 analyzer. These parameters define the DM as having HbA1C ≥ 6.5%, FBS of ≥ 126 mg/dl, and 2-hour plasma glucose levels of ≥ 200 mg/dl (11.1 mmol/l). In a study of the data, the usual descriptive statistics (Mean ± Standard Deviation) for the directly measured variables were calculated. The relationships between FBS, HbA1c, and lipid profiles were established using an unpaired t-test. SPSS (Statistical Package for Social Science) version 25.0 was used to analyze the data.  $p > 0.05$  was used as the statistical significance criterion.

## Results

The age range for the patients and control groups was between 45 and 70. Among those with T2DM patients, 62.22%

( $n = 56$ ) were male, 37.78% ( $n = 34$ ) were female, as shown in (Table 1), and in the control group, 26.67% ( $n = 12$ ) were male, and 73.33% ( $n = 33$ ) were female. The mean ± SD of age for the T2DM ( $50.10 \pm 12.86$  years) and control group ( $49.05 \pm 9.66$  years) showed no statistical difference ( $p = 0.106$ ).

Mean ± SD of TC, HbA1c, LDL, TG, VLDL, HDL, and FBS were  $7.33 \pm 0.56$  % ( $168.21 \pm 9.23$ ,  $146.10 \pm 9.64$ ,  $137.23 \pm 8.32$ ,  $41.05 \pm 5.86$ ,  $43.85 \pm 6.17$ , and  $208.81 \pm 52.1$ ) mg/dl respectively in the T2DM group. In the control group, the mean ± SD results of the same parameters were  $4.91 \pm 0.27$ %, ( $171.20 \pm 3.57$ ,  $116.60 \pm 8.25$ ,  $105.05 \pm 2.11$ ,  $41.83 \pm 4.92$ ,  $44.04 \pm 5.54$ ,  $96.20 \pm 7.8$ ) mg/dl respectively. Results demonstrated statistically significant differences between T2DM patients and control groups in HbA1c ( $p = 0.0025$ ), TG ( $p = 0.015$ ), LDL ( $p = 0.0029$ ), and FBS ( $p = 0.02$ ). On the other hand, the mean ± SD of TC, VLDL, and HDL in serum between study groups showed no significant difference between levels  $p > 0.01$ , as shown in Table (2) and Figure (1).

Pearson correlation of HbA1c with other variables revealed a substantial positive connection with serum TC, TG, LDL, and FBS ( $r = 0.573$ ,  $P < 0.01$ ;  $r = 0.655$ ,  $P < 0.001$ ;  $r = 0.498$ ,  $P < 0.05$ ;  $r = 0.691$ ,  $P < 0.001$ ) respectively. While results demonstrated a negative correlation between HbA1c and HDL ( $r = -0.562$ ,  $P < 0.01$ ), as shown in Table (3).

## Discussion

Some lipid profile parameters showed a significant increase in T2DM groups in table (3) many contradicting findings in the literature regarding the correlation between HbA1c and lipid profile parameters. The present study revealed increasing HbA1c levels with an increase in lipid profile parameters like TC, TG, LDL, and VLDL. Moreover, the study demonstrated a negative correlation between HbA1c levels and HDL in DM patients. The positive association between HbA1c and lipid profile parameters has been found in several studies, such as research in Turkey which identified a substantial correlation between TC, LDL, TG, and HbA1c<sup>13</sup>. According to one study, there is a significant negative connection between HbA1c and LDL<sup>14</sup>. Another study stated that HbA1c had no significant correlation with lipid profile except TG<sup>15</sup>. HbA1c has been linked to elevated TG levels suggesting that it may predict CVD and is a risk factor in T2DM<sup>15</sup>.

Based on the results of this investigation, FBS levels were found to be greater than the upper limit for patients with a clinical diagnosis. In T2DM, the HbA1c test is used to check blood glucose management. The HbA1c is a strong predictor of diabetes complications and the length of time a person has had diabetes<sup>16</sup>. HDL, LDL, TG, and TC levels are well-known risk factors for diabetes complications such as coronary heart disease and CVD. In a study by Rani *et al.* (2005), when compared to control, FBS and postprandial plasma glucose, TC, VLDL, LDL, TG, and HDL levels were higher in the survey respondents<sup>17</sup>.

Selvin *et al.* (2005) studied the relationship between

	Diabetic Patients (n =90)	Control (n= 45)	P value
Female	37.78% (34)	73.33% (33)	
Male	62.22% (56)	26.67% (12)	
Age (year)	50.10 ± 12.86	49.05 ± 9.66	0.106

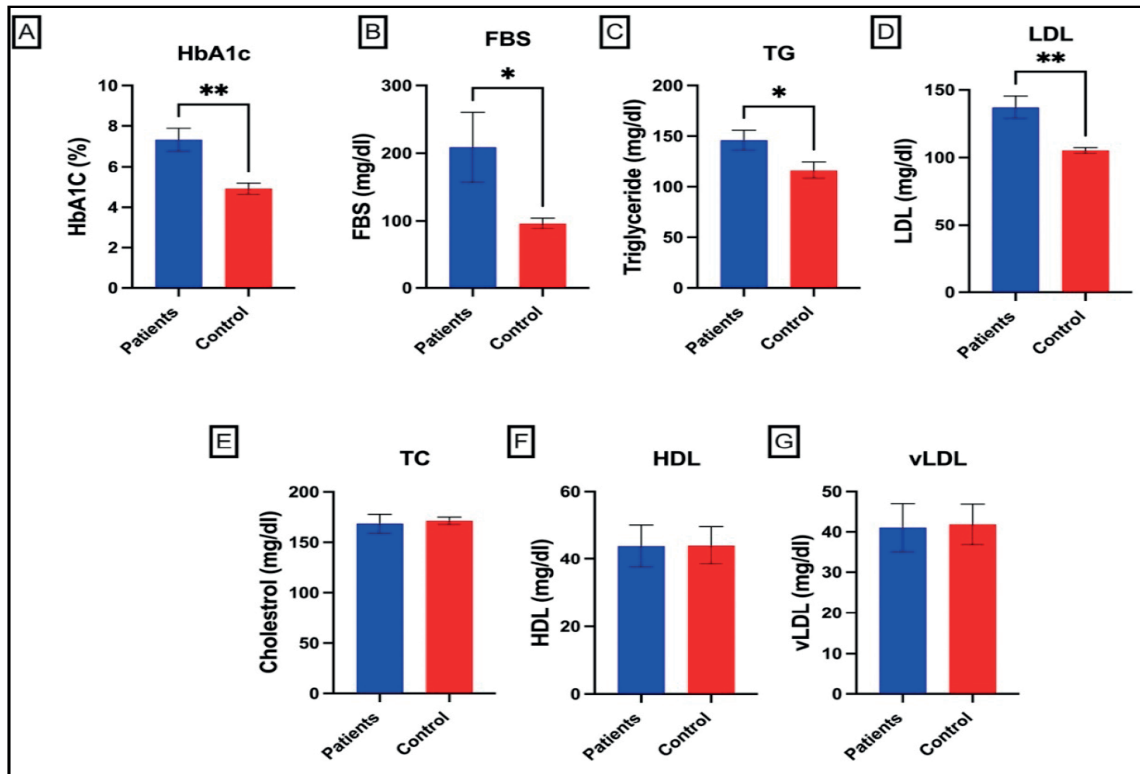
**Table 1.** Distribution of age and gender in T2DM and control group. Age represents as mean ± SD.

Biochemical Parameters	Diabetic patients (n =90)	Control (n= 45)	P value
HbA1c %	7.33±0.56	4.91±0.27	<b>0.0025**</b>
TC (mg/dl)	168.21±9.23	171.01±3.57	0.64
TG (mg/dl)	146.10±9.64	116.60±8.25	<b>0.015*</b>
LDL (mg/dl)	137.23±8.32	105.05±2.11	<b>0.0029**</b>
VLDL (mg/dl)	41.05±5.86	41.83±4.92	0.86
HDL (mg/dl)	43.85±6.17	44.04±5.54	0.97
FBS (mg/dl)	208.81±52.1	96.20±7.8	<b>0.02*</b>

\* ( $P \leq 0.05$ ) significant,  
 \*\* ( $P \leq 0.01$ ) highly significant.

Glycated hemoglobin (HbA1c), fasting blood sugar (FBS), Total Cholesterol (TC), Triglyceride (TG), High-density Lipoprotein HDL, Low-density Lipoprotein (LDL), and Very Low-density Lipoprotein (VLDL). All the data represented as mean ± SD

**Table 2.** Comparison between biochemical parameters (Mean± SD) in T2DM and control groups.



**Figure 1.** Comparison of biochemical parameters between T2DM and control groups; the highly significant difference between control and T2DM in HbA1c, FBS, TG, and LDL, no significant difference in cholesterol, HDL, and VLDL, independent sample t-test. All data are presented as mean ± SD.

HbA1c and LDL and HDL TC. In addition, our results agree with Selvin *et al.* (2005) study, which represents that the correlation between HbA1c and HDL was negative, but the correlation between HbA1c and LDL was positive<sup>18</sup>. Our results go along with a study by Patil *et al.*<sup>16</sup>. People with diabetes often have abnormalities in their lipids, and people with T2DM are no exception. Insulin resistance has previously been linked to the T2DM aberrant lipid profile because insulin resistance causes an increase in fatty acid release, reduces insulin-dependent muscle-free fatty acid uptake, and increases hepatic fatty acid production in the liver<sup>19</sup>. Diabetic individuals often have high LDL and tri-

acylglycerol values and low HDL. The current investigation results revealed that diabetes individuals had a higher lipid profile. Our study showed a statistically strong positive correlation between HbA1c and lipid profile parameters. Our results are consistent with Wexler *et al.*, 2005 who found that HbA1c and lipid profiles (TC and LDL) have a very positive significant correlation<sup>20</sup>; Other researchers have shown a relationship between HbA1c and these lipid profiles in T2DM patients<sup>15, 21</sup>.

**Monte Carlo Simulation Analysis (MCS)**

After structuring costs, the most influential cost com-

Parameters	HbA1c	
	r	P value
TC (mg/dl)	0.573	0.01*
TG (mg/dl)	0.655	0.001**
LDL (mg/dl)	0.498	0.05*
VLDL (mg/dl)	0.647	0.001**
HDL (mg/dl)	-0.562	0.01*

\* ( $P \leq 0.05$ ) significant,  
 \*\* ( $P \leq 0.01$ ) highly significant.  
 Glycated hemoglobin (HbA1c), Fasting Blood Sugar (FBS), Total Cholesterol (TC), Triglyceride (TG), High-density Lipoprotein HDL, Low-density Lipoprotein (LDL), and Very Low-density Lipoprotein (VLDL)

**Table 3.** Person Correlation analysis between HbA1c and FBS and lipid parameters of diabetic patients.

ponent was direct labor, representing 53% of the total cost. The cost of culture media was 12% of the total, IMC represented 5%, and operating expenses, including administrative expenses and infrastructure, were 30% (Figure 2).

## Conclusions

According to the results of this study, diabetic people do not have appropriate HbA1c values. Furthermore, HbA1c showed a significant positive correlation with TC, TG, LDL, and VLDL and a significant negative correlation with HDL. In T2DM patients, HbA1c may be a valuable marker for predicting dyslipidemia and CVD.

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This research received no external funding.

## Competing interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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