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Original Article

Lipid Profile and Glycemic Control in Type 2 Diabetic Patients in Zawia, Libya: A Cross-Sectional Study

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Abstract

Background: Diabetes mellitus (DM) is a prevalent endocrine disorder commonly associated with dyslipidemia, a major cardiovascular risk factor. This study evaluated total cholesterol and triglyceride levels among patients with type 2 diabetes mellitus (T2DM) in Zawia city, Libya. **Methods**: A cross-sectional study was conducted at the Diabetes Center in Zawia city, including 100 adults (50 T2DM patients and 50 non-diabetic controls). Fasting blood sugar (FBS), HbA1c, total cholesterol, triglycerides, and uric acid were measured using standard assays. Statistical analyses included independent t-tests, one-way ANOVA, and Pearson correlation ($p<0.05$). **Results**: Compared with controls, T2DM patients had significantly lower total cholesterol ($p=0.015$), whereas triglycerides did not differ ($p=0.47$). FBS was markedly higher in the diabetes group ($p<0.001$). HbA1c showed a positive correlation with body weight ($r=0.259$, $p=0.039$) and was positively associated with age, with no significant sex difference. **Conclusion**: In this cohort, diabetic status was associated with lower total cholesterol but similar triglycerides compared with non-diabetic controls. Findings support prioritizing comprehensive risk reduction—glycemic optimization and weight management—while assessing lipid fractions beyond total cholesterol. Larger, multicenter studies with detailed lipoprotein profiling are recommended.

Keywords: Type 2 Diabetes Mellitus; Dyslipidemia; HbA1c; Cholesterol; Triglycerides; Cardiovascular Risk; Libya.

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INTRODUCTION:

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia arising from insulin resistance, impaired insulin secretion, or both. The prevalence of T2DM has been rising worldwide, driven by demographic transitions and lifestyle changes, with major implications for health systems and cardiovascular risk [1,2,8]. Dyslipidemia is among the most common metabolic abnormalities accompanying T2DM and plays a central role in accelerating atherosclerosis and cardiovascular disease (CVD) in affected individuals. Diabetic dyslipidemia typically presents as a characteristic pattern of elevated triglycerides, increased very low–density lipoprotein (VLDL), low high-density lipoprotein cholesterol (HDL-C), and a predominance of small dense low-density lipoprotein (LDL) particles—even when total LDL-C is not markedly elevated [7]. The coexistence of diabetes and dyslipidemia markedly increases the risk of atherosclerotic CVD; contemporary guidance emphasizes comprehensive risk reduction and indicates that people with T2DM have substantially higher CVD risk than non-diabetic peers [2,11]. In North Africa and Libya, the burden of diabetes and related metabolic complications is increasing. According to the International Diabetes Federation (IDF), an estimated 634,800 adults (20–79 years) in Libya were living with diabetes in 2025 [8]. Regional syntheses similarly highlight high burdens of diabetes, metabolic syndrome, and lipid abnormalities [5,6]. Within Libya, early reports from Benghazi documented frequent metabolic syndrome among patients with T2DM, with low HDL as a prominent component [9]. However, previous studies have documented a significant micronutrient deficiency among other vulnerable groups in Northwestern Libya, including a high prevalence of magnesium deficiency and anemia in pregnant women 10], highlighting the multifaceted nature of nutritional-metabolic challenges in the population."Against this backdrop, the present study evaluates total cholesterol and triglyceride levels in patients with T2DM in Zawia city compared with non-diabetic controls. It explores their associations

MATERIAL AND METHOD:

Study Design and Setting: A cross-sectional study was conducted at the Diabetes Center in Zawia city, Libya.

Participant Selection: A total of 100 participants were enrolled: 50 adults with T2DM and 50 non-diabetic controls. T2DM patients were consecutively recruited from the center's registry during routine visits. Non-diabetic controls were recruited from the community or other hospital visitors and were confirmed to have no prior diagnosis of diabetes (FBS < 126 mg/dL). Groups were matched for age and sex.

Ethical Considerations: The study protocol was approved by the Scientific Committee of the Faculty of Medical Technology at Sabratha University. Written informed consent was obtained from all participants prior to their inclusion in the study.

Data Collection: Demographic and clinical data included age, sex, weight, disease duration, treatment type, and smoking status.

Laboratory Analyses: Venous blood was collected after an overnight fast. FBS, HbA1c, total cholesterol, triglycerides, and uric acid were measured using standard clinical chemistry methods (e.g., enzymatic colorimetric assays for lipids). Analyses were performed on a Mindray BS-200 analyzer; HbA1c was measured using accepted clinical protocols.

Statistical Analysis: Data were analyzed with SPSS version 25 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± standard deviation (SD). Independent t-tests compared diabetic and control groups; one-way ANOVA assessed differences across age strata; Pearson correlation evaluated associations between HbA1c and weight. A two-sided $p<0.05$ was considered statistically significant.

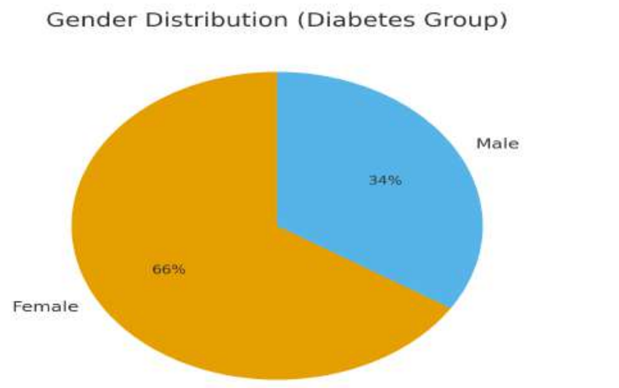
Results

Participant Characteristics: In the diabetes group (n=50), females represented 66% and males 34%. Most patients were older than 50 years. Detailed distributions are provided in Table 1 and Table 2 and visualized in Figure 1 and Figure 2.

Table 1. Gender distribution among diabetic patients (n=50).

Gender	Frequency	Percent
Female	33	66%
Male	17	34%
Total	50	100%

Figure 1. Gender distribution among diabetic patients.



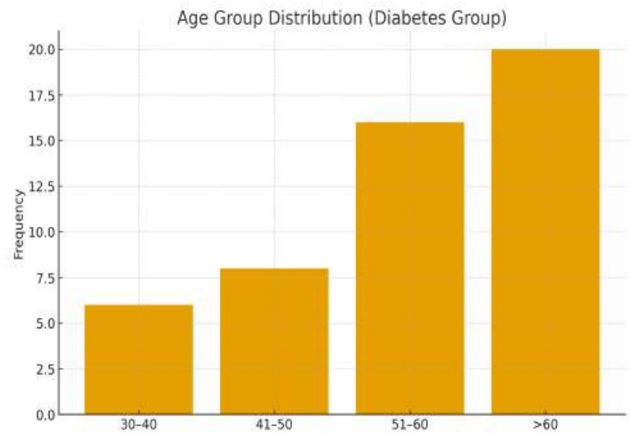
A pie chart shows females as the largest proportion of participants.

Table 2. Age-group distribution among diabetic patients (n=50).

Age Group (years)	Frequency	Percent
30–40	6	12%
41–50	8	16%
51–60	16	32%
>60	20	40%
Total	50	100%

Most participants were aged ≥51 years, consistent with the typical age profile of T2DM.

Figure 2. Age-group distribution among diabetic patients.



A bar chart illustrates the predominance of older age groups in the sample. Biochemical Parameters: Group comparisons between non-diabetic controls and T2DM patients are summarized in Table 3. As shown in Figure 3, FBS was markedly higher in the T2DM group, total cholesterol was lower, and triglycerides were similar between groups.

Table 3. Biochemical parameters in non-diabetic controls vs. T2DM patients (mean ± SD).

Parameter	Non-diabetic (Mean ± SD)	Diabetic (Mean ± SD)	p-value
FBS (mg/dL)	103.39 ± 14.12	192.48 ± 85.30	<0.001
Triglycerides (mg/dL)	127.35 ± 70.00	140.19 ± 102.80	0.47
Cholesterol (mg/dL)	200.02 ± 45.50	176.34 ± 49.30	0.015

Between-group differences are provided with p-values from independent t-tests.

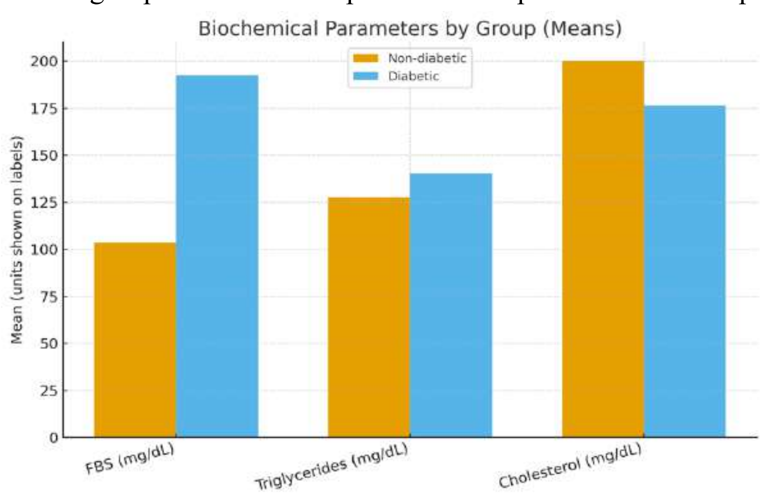


Figure 3. Comparison of biochemical parameters by group.

Grouped bars visualize mean differences between non-diabetic and diabetic groups.

HbA1c by Sex and Age: HbA1c did not differ significantly by sex (Table 4; p=0.212), but varied across age groups (Table 5; p=0.047).

Table 4. HbA1c by sex among T2DM patients (mean ± SD).

Sex	HbA1c (Mean ± SD)	p-value
Male	8.11 ± 1.65	0.212
Female	8.88 ± 1.61	

No statistically significant difference in HbA1c was observed between male and female patients.

Table 5. HbA1c by age group among T2DM patients (mean ± SD).

Age Group (years)	HbA1c (Mean ± SD)	p-value (ANOVA)
30–40	8.05 ± 1.31	0.047
41–50	8.47 ± 1.84	
51–60	8.71 ± 1.45	
>60	8.68 ± 1.73	

HbA1c increased with advancing age, with a statistically significant overall difference across age strata.

Correlation: HbA1c showed a small positive correlation with body weight (Table 6). A scatter plot is not displayed because individual-level data were not available; the analysis is reported from summary statistics.

Table 6. Correlation between HbA1c and body weight among T2DM patients.

Variables	Correlation coefficient (r)	p-value
HbA1c vs Weight	0.259	0.039

The positive r indicates higher HbA1c is associated with greater body weight in this cohort.

DISCUSSION:

In this cross-sectional study from Zawia city, patients with T2DM exhibited lower total cholesterol but similar triglyceride levels compared with non-diabetic controls, while FBS was markedly higher in the diabetes group. The lower total cholesterol among patients with diabetes is a notable finding that contrasts with the typical metabolic profile but is consistent with widespread statin use recommended for primary and secondary prevention in T2DM [2,3]. Contemporary guidelines, such as those from the American Diabetes Association and the ESC/EAS, advocate for moderate to high-intensity statin therapy in most diabetic patients, which can effectively lower total and LDL cholesterol and thereby invert the crude differences often observed in cross-sectional comparisons [2,11].

The lack of a significant difference in triglyceride levels, contrary to the classic diabetic dyslipidemia profile which features hypertriglyceridemia [7], may be attributed to several factors. These include the widespread use of lipid-lowering agents, dietary variability, or the relatively modest sample size which limits statistical power to detect a difference. It is also recognized that triglyceride levels exhibit high intra-individual variability and are strongly influenced by recent dietary intake and glycemic control, which might have attenuated group differences in this cross-sectional snapshot [12].

HbA1c correlated positively with body weight and increased with age, underscoring the interconnectedness of glycemic control, adiposity, and aging. This aligns with established pathophysiological understanding, where greater adiposity exacerbates insulin resistance, leading to poorer glycemic control [7]. The positive association with age could reflect longer disease duration, beta-cell function decline, or age-related complexities in self-management. These findings reinforce the importance of weight management as a cornerstone of diabetes care and highlight the need for age-aware care pathways [2]. A recent study reported a higher prevalence of T2DM among females (66%). In T2DM patients, prolonged diabetes duration, hyperlipidemia, hypertension, and diabetic retinopathy have been associated with an increased risk of advanced CKD [13]. Interestingly, despite the higher prevalence of T2DM in females, previous studies suggest that males are more susceptible to CKD, potentially due to differences in lifestyle, comorbidities, and environmental exposures [14].These findings align with contemporary guidance emphasizing comprehensive cardiovascular risk reduction in diabetes, which includes universal consideration of statin therapy and periodic assessment of advanced lipid profiles beyond total cholesterol (e.g., LDL-C, non–HDL-C, or ApoB) [3,11]. From a clinical perspective, our data suggest that in this Libyan cohort, routine lipid optimization—likely already underway given the lower cholesterol—should continue to accompany diligent glycemic management and weight control. The Libyan context, with its rising diabetes burden and specific healthcare challenges as noted by Gana et al. [6], makes this integrated approach particularly crucial.

Future work should incorporate direct measurements of HDL-C, LDL-C (or ApoB), and markers of insulin resistance to better characterize the atherogenic risk in the Libyan population. As highlighted by regional reviews [5] and local pilot studies [9], understanding the specific nuances of the dyslipidemic pattern in North Africa is essential. Therefore, multicenter studies with larger sample sizes and detailed lipid and medication profiles are strongly recommended to improve the generalizability and clinical applicability of the findings.

Strengths of this work include a clearly defined case–control framework and pragmatic outcomes relevant to frontline diabetes care. Key limitations are the modest sample size, single-center setting, lack of detailed medication data (e.g., statin use), and absence of HDL-C/LDL-C fractions. Addressing these gaps in future studies would help refine risk stratification and inform targeted interventions in the region.

CONCLUSTION:

Adults with T2DM in Zawia city demonstrated lower total cholesterol than non-diabetic controls, similar triglyceride levels, and substantially higher FBS. HbA1c increased with age and correlated positively with body weight. Clinical programs should integrate weight management and lipid optimization with glycemic control to mitigate cardiovascular risk. Larger, multicenter studies with extended lipid profiling are warranted.

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