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Studies on Kidney Function and Lipid Profile among Type 2 Diabetic Patients Attending Tetteh Quarshie Memorial Hospital

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Abstract:

Background: Type 2 diabetes mellitus (T2DM) is a major public health concern and is frequently complicated by renal dysfunction and dyslipidemia, which significantly increase cardiovascular morbidity and mortality. Evidence on the combined burden of kidney impairment and lipid abnormalities among diabetic patients in Ghana remains limited. This study assessed kidney function and lipid profile patterns and examined their relationship with glycemic control and lifestyle factors among patients with T2DM attending Tetteh Quarshie Memorial Hospital.

Methods: A hospital-based cross-sectional study was conducted among 121 adults with T2DM aged ≥30 years. Data on socio-demographic characteristics and lifestyle factors were collected using a structured questionnaire. Fasting blood samples were analyzed for renal function indices, lipid profile parameters, and glycated hemoglobin (HbA1c) using standard laboratory methods. Dyslipidemia was defined using NCEP ATP III criteria, and kidney disease was classified according to KDIGO 2012 guidelines. Statistical analyses were performed using STATA version 18, with significance set at $p < 0.05$.

Results: The mean age of participants was 61.02 ± 13.32 years, and 70.25% were female. The prevalence of dyslipidemia was 22.31%, while kidney disease was observed in 76.86% of participants. Estimated glomerular filtration rate (eGFR) showed strong negative correlations with serum creatinine ($r = -0.898$, $p < 0.001$) and urea ($r = -0.610$, $p < 0.001$). Triglyceride levels were significantly higher among participants with poor glycemic control ($p = 0.033$), whereas other lipid parameters did not vary significantly across HbA1c categories. Advancing age, physical inactivity, and inadequate sleep duration were significantly associated with kidney disease.

Conclusion: This study demonstrates a high burden of renal dysfunction and a moderate prevalence of dyslipidemia among patients with T2DM. Poor glycemic control was specifically associated with elevated triglyceride levels, while lifestyle and demographic factors played a significant role in renal impairment. Routine monitoring of renal and lipid parameters, alongside targeted lifestyle interventions, is essential to reduce diabetes-related complications.

Keywords: *Type 2 diabetes mellitus; Kidney disease; Dyslipidemia; Lipid profile; Glycemic control; Ghana.*

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Introduction

One of the main forms of diabetes mellitus (DM), type II diabetes mellitus (T2DM), is a major cause of illness that necessitates ongoing medical care, self-management, and support to prevent or lessen complications from hyperglycemia, hypoglycemia, hypertension, cardiovascular diseases, or kidney failure (Brutsaert, 2020). T2DM accounts for almost 90% of all instances of diabetes (Facts, 2021). In 2019, the International Diabetes Federation (IDF) estimated that 9.3% of people worldwide had diabetes, which translates to 713.9 million people with the disease. By 2030 and 2045, the International Diabetes Federation (IDF) predicted that this number would increase to 10.2% and 10.9%, respectively.

Africa has a type 2 diabetes prevalence that is comparable to the global average. The IDF estimates that the illness affects 19.4 million adults in the area, with a 3.9% prevalence rate. That figure is predicted to increase to 45 million by the end of 2045 (IDF Diabetes Atlas, 2021). According to the World Health Organization, more than 45 million people in Africa between the ages of 20 and 79 have impaired glucose tolerance, which puts them at a high risk of developing type 2 diabetes soon (Katey *et al*., 2022b).

According to (Shani *et al.* (2022), the Greater Accra Region observed a prevalence of 3.3% among Ghanaians living in rural areas and 6.3% among urban people who were unaware

of their status. Therefore, more research is needed to provide data on the condition's prevalence across the entire nation.

Disproportions in electrolyte levels, urea, creatinine and lipid profiles can cause problems in diabetes. For proper operation, the body requires lipids, serum electrolytes, urea, and creatinine. Thus, variations in the levels of urea, creatinine, lipids, and electrolytes are markers of the advancement of diabetes mellitus (Billah *et al*., 2018). Dyslipidemia is defined as variations in blood triglyceride levels, total cholesterol (TC), low-density lipoprotein (LDL), and high-density lipoprotein (HDL). Because insulin resistance or insufficiency affects the key enzymes and pathways involved in lipid metabolism, lipid profiles may be abnormal in diabetic mellitus (DM). Apoprotein synthesis, lipoprotein lipase control, cholesteryl ester activity, and the hepatic and peripheral effects of insulin are all impacted in diabetes mellitus (Hirano, 2018a).

Decompensated diabetics often have renal electrolyte imbalances. Electrolytes are essential for maintaining the acid-base balance (pH), regulating bodily fluid levels, facilitating neuronal transmission, encouraging blood coagulation, and assisting in muscle contraction. Maintaining sodium, potassium, and chloride levels is necessary for an appropriate electrolyte balance (Chekol Tassew *et al.*, 2024). Nowadays, an uneven distribution of electrolytes or its relationship to osmotic fluid shifts brought on by hyperglycemia are the main causes of electrolyte imbalance in diabetes patients. Because electrolyte concentrations are diluted, hyperglycemia creates the internal conditions for osmotic diuresis (Khan *et al*., 2019). Because of its osmotic impact, glucose can cause a decrease in the volume of blood in circulation, which can ultimately cause cellular dehydration (Ni *et al*., 2020).

Dyslipidemia includes variations in total cholesterol, triglyceride levels, low-density lipoprotein cholesterol (LDL-C) size and density, and high-density lipoprotein cholesterol (HDL-C). Since important enzymes and pathways in lipid metabolism are impacted by insulin resistance or insufficiency, altered lipid profiles are common in diabetes mellitus. The following processes are specifically impacted: apo-protein synthesis, lipoprotein lipase control, cholesteryl ester activity, transfer proteins, and insulin's hepatic and peripheral activities. The fundamental link between dyslipidemia and atherosclerosis is widely acknowledged(Lee & Lee, 2023). Patients with diabetes often have a constellation of renal problems, and the progression to atherosclerosis is further accelerated by hyperglycemia, obesity, and aberrant insulin functioning. When diabetic ketoacidosis or non-ketotic hyperglycemic hyperosmolar syndrome are present, these abnormalities are more prevalent in decompensated diabetics (Umpierrez *et al*., 2024). Numerous bodily functions, including fluid regulation, acid-base balance (pH), neuronal transmission, blood coagulation, and muscle contraction, depend on electrolytes. Bicarbonate, sodium, potassium, and chloride are all necessary for appropriate electrolyte balance(Lovegrove & Dubbs, 2023). One of the possible causes of the difficulties seen in diabetes and other endocrine disorders is electrolyte imbalance brought on by renal failure, dehydration, fever, and vomiting. Hyperglycemia dilutes electrolyte concentrations and creates the internal conditions for osmotic diuresis (Khanduker *et al.*, 2018).

The goal of our current study is to determine the lipid profile and renal function status of type 2 diabetic patients between the ages of 30 and 70 who visit Tetteh Quarshie Memorial Hospital. Since the purpose of this study is to assess the serum electrolyte and lipid profiles in patients with type 2 diabetes, we will choose this age range to the best of our knowledge.

Methods

Study Design

A cross-sectional study was employed to collect data on patients attending OPD at the Tetteh Quarshie Memorial Hospital for diabetes management and care.

Sampling Technique

The participants who fulfilled the inclusion criteria were recruited using a convenience sample procedure. Participation was open to all patients diagnosed with type 2 diabetes who were 30 years of age or older. Patients who consented were then enrolled consecutively until the required sample size was attained.

Study Area

The study was conducted at the Tetteh Quarshie Memorial Hospital, the major government Hospital located in the Akwapim North Municipality in the Eastern Region of Ghana. The Municipality has 105,315 residents The study was conducted at the Tetteh Quarshie Memorial Hospital, the major government hospital located in the Akwapim North Municipality in the Eastern Region of Ghana. The Municipality has 105,315 residents, accounting for 3.6% of the Eastern Region's total population of 2,925,653 (2021 Population and Housing Census Report: Ghana Statistical Service). It is predominantly female population (53%) and male population (47%), with urban areas comprising over half (55.6%) and a youthful (36.7%) population according to the 2021 Population & Housing Census Report. The municipal area is around 58 kilometres from the capital city, Accra, and is situated in the southeast of the Eastern Region and shares boundary with Yilo Krobo District in the northeast, New Juaben Municipal in the north, Dangbe-west in the Southeast, Akwapim South District in the southwest, and Suhum-Kraboa-Coalter District in the west. The district makes up 2.3% of the Eastern Region's overall size, with a land area of around 450 square kilometres with a population density 234.03 persons per square kilometre (2021 Population & Housing Census Report: Ghana Statistical Service).

The municipality has 47 health facilities including two (2) hospitals, one (1) Health Research, Centre, eight (8) health centres, thirty-three (33) community-based health planning services (CHPS), two (2) clinics, and one (1) maternity home. The map below shows the major health facilities in Akwapim North; however, the study was conducted at Tetteh Quarshie Memorial Hospital, the only district hospital in the Municipality.

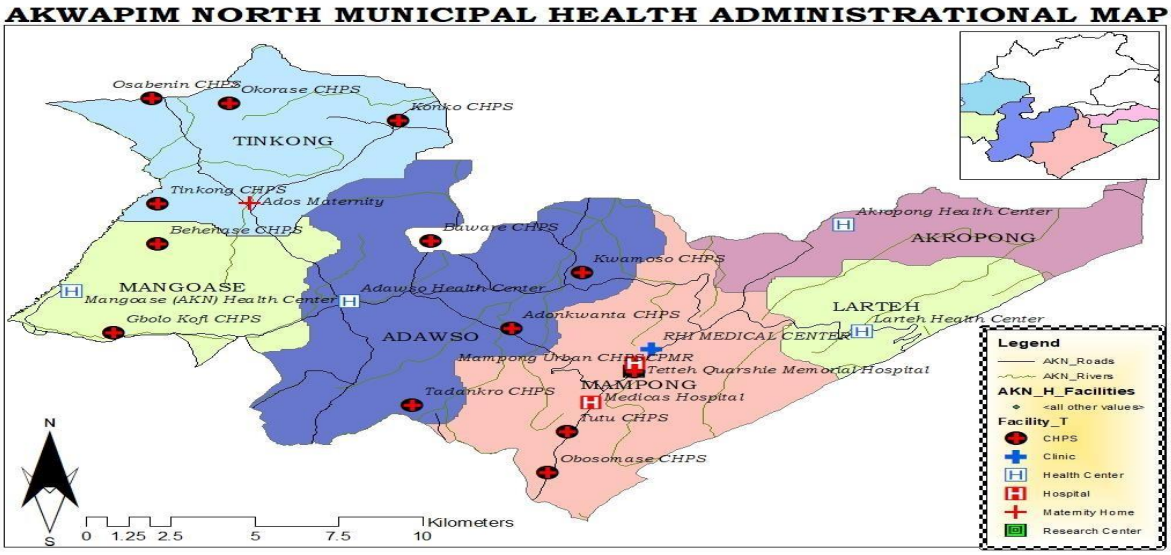

Figure 1: Map of Akwapim North Municipality

Study Population

The study population comprised patients diagnosed with type 2 Diabetes Mellitus (DM) who were receiving care and management at the Tetteh Quarshie Memorial Hospital.

Sample Size Determination

Using Cochran's formula

$$n_o = \frac{Z^2PQ}{e^2}$$

n_o = sample size

Z = value found in the Z table given at a confidence level

P = value estimated proportion of an attribute that is present in the population.

(0.5) often used when there is no prior knowledge or estimate about the population.

Q = 1-P

e = Margin of error

$$n_o = \frac{1.96^2 \times 0.5 \times (1-0.5)}{0.05^2}$$

n_o= 384.5

Correction factor: $n = \frac{no}{1+\frac{no-1}{N}}$

N = Population size

Average number of type 2 diabetic patients attending Tetteh Quarshie Memorial Hospital is

$$n = \frac{384.5}{1+\frac{384.5-1}{187}}$$

n = 121

Therefore, the total sample size for the study will be 121.

Inclusion Criteria

Participants were eligible for inclusion in this study if they met all of the following criteria:

1. Were 30 years of age or older at the time of enrollment;
2. Had a clinically confirmed diagnosis of type 2 diabetes mellitus, as documented in their medical records; and
3. Were receiving routine diabetes management and follow-up care at Tetteh Quarshie Memorial Hospital during the study period.

Exclusion Criteria

Participants were excluded from the study if they met any of the following conditions:

1. Were younger than 30 years of age;
2. Had a diagnosis of type 1 diabetes mellitus, gestational diabetes, or other specific types of diabetes;
3. Were acutely ill, hospitalized, or clinically unstable at the time of recruitment; or
4. Declined or were unable to provide informed consent to participate in the study.

Data Collection Tools

Data and Sample collection

Data were collected using a structured, interviewer-administered questionnaire designed to obtain information on participants' socio-demographic characteristics, lifestyle behaviors (including physical activity, sleep duration, dietary habits, alcohol intake, and smoking status), medical history, and diabetes management practices. The questionnaire was administered by trained research personnel to ensure clarity, completeness, and consistency of responses.

Anthropometric and clinical data were obtained from participants and corroborated with medical records where necessary. Prior to data collection, all eligible participants provided written informed consent. Participants were instructed to fast for 8–

12 hours before blood sample collection to ensure accurate biochemical measurements.

Venous blood samples were collected under aseptic conditions by qualified laboratory personnel. Approximately 5 mL of blood was drawn from the antecubital vein and dispensed into serum separator tubes (SST) and EDTA tubes as appropriate. Samples in SST were allowed to clot and subsequently centrifuged for serum separation, while EDTA samples were used for glycated hemoglobin analysis. All specimens were properly labeled with unique participant identifiers, date, and time of collection to ensure traceability.

Laboratory analyses were conducted using standardized procedures and calibrated automated analyzers. Serum samples were analyzed for lipid profile parameters (total cholesterol, triglycerides, HDL-cholesterol, LDL-cholesterol, and VLDL-cholesterol) and renal function indices (urea, creatinine, electrolytes, and estimated glomerular filtration rate). Glycated hemoglobin (HbA1c) was measured from EDTA samples following internal quality control procedures. Control samples were analyzed concurrently with participant samples to ensure analytical accuracy and reliability.

All collected data were recorded in a secured database accessible only to the research team, and confidentiality of participant information was strictly maintained throughout the study period.

Data Analysis

Data from completed questionnaires, physical and biochemical measurements from respondents were entered onto Microsoft Excel. The data was checked for consistency and completeness, cleaned and transported into STATA Statistical software version 18 for statistical analysis. Data was first analysed descriptively by running for frequencies and proportions. Continuous variables such as age were summarized into means, standard deviations and range. Age of respondents were then recategorized into age groups of 10 years interval. Categorical variables were presented as proportions and frequencies in tables. The dependent variables “dyslipidaemia” and “kidney disease” was recorded as a binary outcome. Responses were categorized as ‘1’ as having the outcome and ‘0’ as no outcome. Dyslipidemia was defined according to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria as the presence of at least one abnormal lipid parameter (total cholesterol ≥ 200 mg/dL, LDL-C ≥ 130 mg/dL, HDL-C < 40 mg/dL in men or < 50 mg/dL in women, or triglycerides ≥ 150 mg/dL); a stricter definition required all parameters to be abnormal (Basile, 2001). Kidney disease was defined based on kidney disease: Improving Global Outcomes (KDIGO 2012) guidelines as eGFR < 60 mL/min/1.73 m² or concurrent elevation of serum creatinine (> 1.4 mg/dL in men; > 1.2 mg/dL in women) and urea (> 20 mg/dL), with electrolyte abnormalities (Na, Cl, K) considered as complications rather than diagnostic criteria (Andrassy, 2013).

To assess the association between the dependent and independent variables, we used a chi-square test. Fisher's exact test was applied to variables that did not fit the chi-square assumptions. The relationships between biochemical parameters were evaluated using Spearman's rank correlation coefficients. The Kruskal-Wallis test was used to examine group differences in lipid profiles among glycated groups, and a one-way ANOVA was used to compare mean eGFR across these categories. With a p-value of 0.05 denoting statistical significance, Bartlett's test verified variance assumptions.

Ethical Considerations

Ethical approval for this study was obtained from the Koforidua Technical University Ethical Review Board prior to the commencement of data collection. Permission to conduct the study was also granted by the management of Tetteh Quarshie Memorial Hospital.

All eligible participants were adequately informed about the purpose, procedures, potential risks, and benefits of the study in a language they understood. Written informed consent was obtained from each participant before enrollment. Participation was entirely voluntary, and participants were informed of their right to withdraw from the study at any time without any consequences to their medical care.

Confidentiality and privacy of participant information were strictly maintained throughout the study. Personal identifiers were replaced with unique study codes, and all data were securely stored with access restricted to members of the research team only. Biological samples were used solely for the purposes outlined in the study protocol and were handled in accordance with standard laboratory safety and ethical guidelines.

The study was conducted in accordance with the principles of the Declaration of Helsinki and relevant national and institutional ethical standards for research involving human participants.

Results

Socio-demographic characteristics among study participants

A total of 121 participants diagnosed with type 2 diabetes mellitus were included in the study. The age of participants ranged from 30 to 89 years**,** with a mean age of 61.02 ± 13.32 years. The largest proportion of participants fell within the 60–69-year age group (29.75%)**,** while those aged 30–39 years constituted the smallest proportion (4.96%)**.**

Female participants predominated, accounting for 70.25% (n = 85) of the study population, whereas males represented 29.75% (n = 36)**.** The majority of participants identified as Christians (73.55%)**,** followed by Muslims (23.97%)**,** with a small proportion practicing traditional religion (2.48%).

With respect to marital status, most participants were married (68.60%)**,** while 27.27% were widowed, and a minority were single (3.31%) or divorced (0.83%). In terms of occupation, the majority of participants were self-employed (71.90%)**,** followed by those who were unemployed (23.14%), whereas only 4.96% were formally employed.

Overall, the study population was predominantly older, female, married, and self-employed, reflecting the socio-demographic profile of patients receiving routine diabetes care at Tetteh Quarshie Memorial Hospital.

Table 1: Socio-demographic characteristics of study participants

	Mean Age	SD
	61.02	13.32
Variables	**Frequency**	**Percentage**
Age group		
30-39	6	4.96
40-49	25	20.66
50-59	21	17.36
60-69	36	29.75
70-79	21	17.36
80 and above	12	9.92
Sex		
Female	85	70.25
Male	36	23.97
Religion		
Christian	89	73.55
Islam	29	23.97
Traditional	3	2.48
Marital status		
Single	4	3.31
Married	83	68.60
Divorced	1	0.83
Widowed	33	27.27
Occupation		
Unemployed	28	23.14
Self-employed	87	71.90
Employed	6	4.96

Prevalence of Dyslipidemia and kidney disease among type 2 diabetes patients

The prevalence of dyslipidemia and kidney disease among participants with type 2 diabetes mellitus attending Tetteh Quarshie Memorial Hospital is presented in Figure 1. Of the 121 study participants, 22.31% (95% CI: 15.71–30.68) were identified as having dyslipidemia, defined according to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria, which classify dyslipidemia based on abnormalities in total cholesterol, triglycerides, LDL-cholesterol, and HDL-cholesterol levels (NCEP ATP III, 2001).

In contrast, 76.86% (95% CI: 68.43–83.58) of participants were classified as having kidney disease, based on the Kidney Disease: Improving Global Outcomes (KDIGO 2012) guidelines, using reduced estimated glomerular filtration rate (eGFR) and elevated serum creatinine and urea levels as diagnostic indicators (KDIGO, 2012).

Overall, kidney disease was substantially more prevalent than dyslipidemia among the study population, highlighting the significant burden of renal impairment among individuals with type 2 diabetes mellitus, a finding consistent with reports from other low- and middle-income settings (Fenta et al., 2023; Boadu et al., 2022).

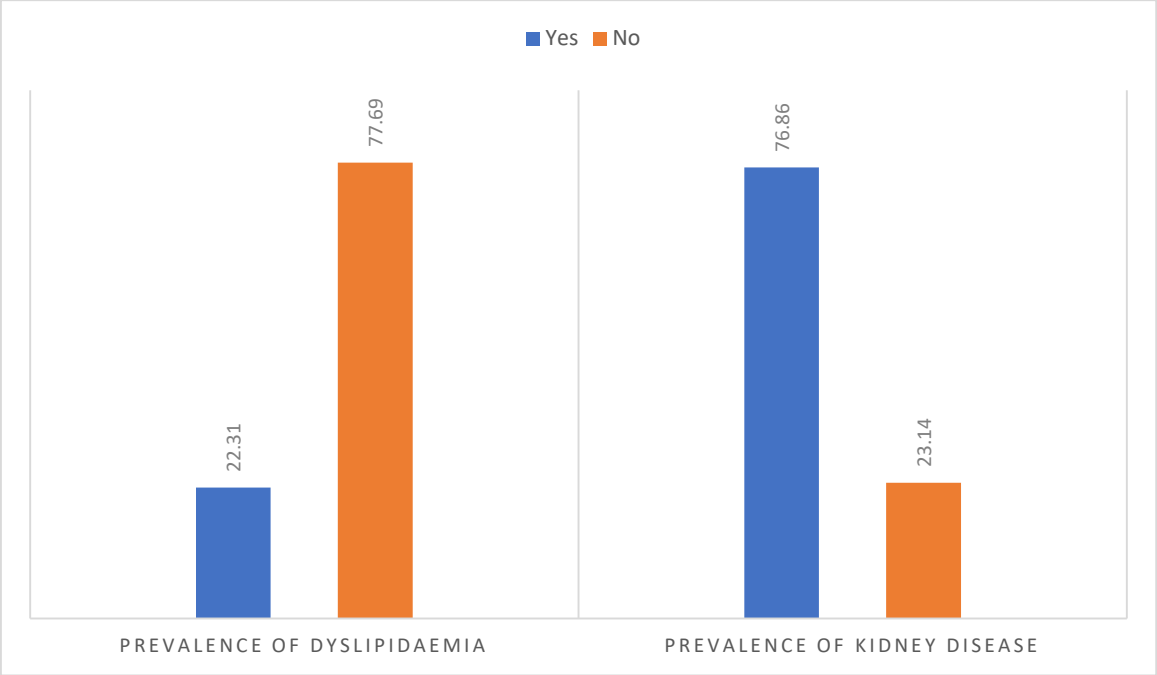

Figure 1: Prevalence of Dyslipidemia and kidney disease among type 2 diabetic patients.

Table 3 Correlation between Renal function and lipid profile parameters

	EGFR	UREA	CREATININE	K	NA	CL	TG	HDL	LDL	TC
EGFR	—									
UREA	**-0.610****	—								
CREATININE	**-0.898*****	**0.695*****	—							
K	**-0.209***	**0.235***	**0.232***	—						
NA	**0.011**	**-0.194***	**-0.150**	**-0.248****	—					
CL	**-0.166**	**0.091**	**0.130**	**0.114**	**0.110**	—				
TG	**-0.165**	**0.017**	**0.104**	**0.058**	**-0.070**	**0.050**	—			
HDL	**-0.190**	**-0.049**	**0.065**	**-0.075**	**0.061**	**-0.173**	**0.354*****	—		
LDL	**-0.066**	**-0.174**	**-0.101**	**-0.175**	**0.096**	**-0.180**	**0.131**	**0.743*****	—	
TC	**-0.145**	**-0.130**	**-0.022**	**-0.140**	**0.075**	**-0.166**	**0.418*****	**0.861*****	**0.900*****	—

Table 3 presents the Spearman's rank correlation coefficients between renal function indices and lipid profile parameters among participants with type 2 diabetes mellitus. Estimated glomerular filtration rate (eGFR) showed a strong negative correlation with serum creatinine ($r = -0.898$, $p < 0.001$) and urea ($r = -0.610$, $p < 0.001$), indicating that declining renal filtration capacity was associated with increasing levels of renal waste products. A strong positive correlation was observed between urea and creatinine ($r = 0.695$, $p < 0.001$), reflecting their shared role as markers of impaired kidney function, as described in chronic kidney disease assessment guidelines (KDIGO, 2012).

Electrolyte parameters demonstrated weak but statistically significant correlations with renal function indices. Potassium showed a weak negative correlation with eGFR and weak positive correlations with urea and creatinine, consistent with the kidney's role in potassium homeostasis (Khan et al., 2019). Sodium and chloride exhibited weak associations with renal parameters, which may reflect the influence of compensatory mechanisms and medication use in patients with diabetes.

Lipid profile parameters were strongly correlated with one another, with significant positive correlations observed between HDL-cholesterol and LDL-cholesterol ($r = 0.743$, $p < 0.001$), HDL-cholesterol and total cholesterol ($r = 0.861$, $p < 0.001$), and LDL-cholesterol and total cholesterol ($r = 0.900$, $p < 0.001$). These findings are consistent with the interrelated metabolic pathways involved in lipid transport and metabolism in diabetes mellitus (Hirano, 2018; Lee & Lee, 2023). However, correlations between renal function markers and lipid parameters were generally weak, suggesting limited direct association between renal impairment and lipid abnormalities in this study population.

Table 4: Effect of Glycemic control (HbA1c) on lipid profile parameters

Variable	Median(IQR)	Rank Sum	Chi^2 (df = 2)	p-value
Total Cholesterol (TC)			1.429	0.4895
Normal	5.25(4.05-6.51)	3121.00		
Controlled DM	4.96(4.14-6.60)	1355.50		
Uncontrolled DM	5.42(4.71-6.35)	2904.50		
Triglycerides (TG)			6.806	**0.0333**
Normal	1.12(0.90-1.80)	2824.00		
Controlled DM	1.20(1.03-2.09)	1442.50		
Uncontrolled DM	1.49(1.22-2.04)	3114.50		
HDL			1.604	0.4485
Normal	1.29(0.99-1.64)	3127.00		
Controlled DM	1.21(0.97-1.74)	1335.00		
Uncontrolled DM	1.35(0.45-1.19)	2919.00		
LDL			0.274	0.8722
Normal	3.55(2.43-4.37)	3273.00		
Controlled DM	3.16(2.4-4.35)	1340.50		
Uncontrolled DM	3.38(2.87-4.00)	2767.50		

p-values indicate statistical significance at $p < 0.05$.

Table 5: Post hoc pairwise comparisons of Triglyceride levels among HbA1c groups

Glycemic groups comparison	Z test statistic	Adjusted p-value
Normal vs Controlled	-1.18	0.238
Normal vs Uncontrolled	-2.60	0.009*
Controlled vs Uncontrolled	-0.88	0.380

p-values adjusted using Bonferoni correction for multiple comparisons. P-value <0.05 considered statistically significant

Effect of Glycemic control on lipid profile parameters

The effect of glycemic control on lipid profile parameters among participants with type 2 diabetes mellitus is presented in Table 4. Glycemic control was categorized based on glycated hemoglobin (HbA1c) levels into normal, controlled diabetes, and uncontrolled diabetes groups. The Kruskal–Wallis test was used to assess differences in lipid parameters across these glycemic categories.

There were no statistically significant differences in median total cholesterol ($p = 0.490$), high-density lipoprotein cholesterol (HDL-C; $p = 0.449$), or low-density lipoprotein cholesterol (LDL-C; $p = 0.872$) across the three glycemic control groups. These findings suggest that overall cholesterol fractions were not significantly influenced by glycemic status in this study population, a pattern

that has also been reported in previous studies among individuals with type 2 diabetes (Hirano, 2018; Addis et al., 2024).

In contrast, triglyceride (TG) levels differed significantly across glycemic control groups (p = 0.033). Post hoc pairwise comparisons using the Wilcoxon rank-sum test with Bonferroni correction (Table 5) revealed that participants in the uncontrolled glycemic group had significantly higher triglyceride levels compared with those in the normal glycemic group (p = 0.009). No significant differences were observed between the normal and controlled groups (p = 0.238) or between the controlled and uncontrolled groups (p = 0.380).

The observed elevation in triglyceride levels among participants with poor glycemic control is consistent with established evidence that hyperglycemia and insulin resistance promote increased hepatic triglyceride synthesis and very-low-density lipoprotein (VLDL) secretion (Scherer et al., 2016; Lee & Lee, 2023). This finding underscores the sensitivity of triglycerides to glycemic dysregulation compared with other lipid fractions and highlights their relevance as a metabolic marker in the management of type 2 diabetes mellitus.

Table 6: Relationship between HbA1c and eGFR

Source	**Sum of Squares (SS)**	**Df**	**Mean Square (MS)**	**F**	**p-value**
Between Groups	1292.03	2	646.01	1.00	0.3704
Within Groups	76117.97	118	645.07		
Total	**77410.00**	120			
Bartlett's Test for Equal Variances	**Chi² (df = 2)**		**p-value**		
	14.188		**0.001**		

Table 6 presents the relationship between glycemic control categories, defined by glycated hemoglobin (HbA1c) levels, and estimated glomerular filtration rate (eGFR) among participants with type 2 diabetes mellitus. A one-way analysis of variance (ANOVA) was conducted to compare mean eGFR values across the three glycemic control groups (normal, controlled diabetes, and uncontrolled diabetes).

The analysis showed no statistically significant difference in mean eGFR across the HbA1c categories (F = 1.00, p = 0.370), indicating that renal filtration function did not differ significantly according to glycemic control status at the time of assessment. This finding suggests that short-term variations in glycemic control, as reflected by HbA1c, may not be directly associated with differences in eGFR in a cross-sectional setting, a pattern previously reported in similar studies among patients with type 2 diabetes mellitus (An et al., 2021; Rout & Jialal, 2025).

However**,** Bartlett's test for homogeneity of variances demonstrated significant variance heterogeneity among the glycemic control groups (χ^2 = 14.19, p = 0.001), indicating unequal variability in eGFR across groups. This suggests that although mean eGFR values were comparable, individuals with poorer glycemic control exhibited greater variability in renal function. Such variability may reflect early or subclinical renal changes that are not yet captured by mean eGFR comparisons alone (KDIGO, 2012; Tang et al., 2024).

These findings are consistent with evidence that diabetic kidney disease often develops gradually and may not show clear associations with glycemic control in cross-sectional analyses, particularly in populations with varying disease duration and comorbid risk factors (Kanasaki et al., 2012; Rout & Jialal, 2025)

Table 7: Comparison of kidney function test among participants with and without kidney disease

Variables	**Kidney disease**	**No kidney disease**	**p-value**
Urea	4.28 (1.76-46.02)	2.71 (1.52-5.99)	<0.001
Creatinine	99.60 (57.10-88.0)	61.05 (40.00-88.00)	<0.001
Sodium	139.10 (127.80-144.80)	139.65 (130.40-142.10)	0.792
Potassium	4.41 (3.22-6.88)	4.35 (3.24-6.66)	0.322
Chloride	100.70 (91.20-109.80)	100.20 (95.20-107.10)	0.230
eGfr	61 (3.00-89.00)	103.50 (92.00-119.00)	<0.001

Table 7 compares kidney function parameters between participants classified as having kidney disease and those without kidney disease. Participants with kidney disease exhibited significantly higher median serum urea and creatinine levels compared with those without kidney disease ($p < 0.001$ for both parameters). Additionally, median estimated glomerular filtration rate (eGFR) was significantly lower among participants with kidney disease ($p < 0.001$).

These findings are consistent with established clinical evidence that impaired renal filtration leads to the accumulation of nitrogenous waste products such as urea and creatinine, alongside a reduction in eGFR (KDIGO, 2012). In contrast, serum sodium, potassium, and chloride levels did not differ significantly between the two groups, suggesting that electrolyte abnormalities may occur later in the disease course or be influenced by compensatory mechanisms and medication use in patients with diabetes (Khan et al., 2019; Lovegrove & Dubbs, 2023).

Overall, the results confirm the validity of the kidney disease classification used in this study and align with prior reports on biochemical alterations associated with diabetic kidney disease (Adem et al., 2024).

Table 8: Comparison of lipid function parameters among participants with and without Dyslipidemia

Variables	Dyslipidemia	No Dyslipidemia	p-value
Total Cholesterol	5.35 (2.86-11.61)	5.21 (3.36-9.72)	<0.001
Triglycerides	1.32 (0.51-10.84)	1.27 (0.62-3.98)	<0.001
HDL	1.36 (0.63-4.28)	1.21 (0.71-2.02)	<0.001
LDL	3.30 (1.00-8.45)	3.59 (1.73-7.32)	<0.001

Table 8 presents a comparison of lipid profile parameters between participants with dyslipidemia and those without dyslipidemia. Participants classified as having dyslipidemia demonstrated significantly higher median levels of total cholesterol, triglycerides, HDL-cholesterol, and LDL-cholesterol compared with participants without dyslipidemia ($p < 0.001$ for all parameters).

These differences reflect the diagnostic criteria used to define dyslipidemia and are consistent with the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) guidelines, which identify dyslipidemia based on abnormalities in one or more lipid fractions (NCEP ATP III, 2001). The observed elevations across multiple lipid parameters highlight the clustering of lipid abnormalities commonly seen in individuals with type 2 diabetes mellitus due to insulin resistance and altered lipoprotein metabolism (Hirano, 2018; Lee & Lee, 2023).

These findings further emphasize the importance of comprehensive lipid profiling in diabetic populations, as isolated lipid measurements may underestimate the burden of dyslipidemia and associated cardiovascular risk (Addis et al., 2024).

Table 9: Association between Risk factors and dyslipidemia and kidney disease

Variables	Dyslipidemia (%)	p-value	Kidney disease (%)	p-value
Age Group		0.823		**0.004**
30-39	0(0.00)		2(33.33)	
40-49	6(24.00)		18(72.00)	
50-59	4(19.05)		12(57.14)	
60-69	9(25.00)		30(83.33)	
70-79	6(28.57)		20(95.24)	
80 and above	2(16.67)		11(91.67)	
Physical activity		0.153		**0.007**
Everyday	1(50.00)		1(50.00)	
Once a week	19(26.39)		62(86.11)	
Regularly	17(14.89)		30(63.83)	
Vegetable consumption		0.503		1.000
Everyday	0(0.00)		1(100.00)	
Once a week	7(16.67)		32(76.19)	
Regularly	20(25.64)		60(76.92)	
Average hours of sleep		0.351		**0.026**
Less than 6 hours	17(20.00)		61(71.76)	

6-8 hours	0(0.00)		1(50.00)	
More than 8 hours	10(30.30)		30 (90.91)	
Salt consumption		0.378		0.385
Everyday	0(0.00)		2(100.00)	
Once a week	0(0.00)		4(57.10)	
Regularly	27(24.11)		87(77.68)	
Alcohol consumption		0.510		0.488
Yes	1 (14.29)		6(85.71)	
No	26(22.81)		87(76.32)	
Smoking		0.777		0.769
Yes	0(0.00)		1(100.00)	
No	27(22.50)		92(76.67)	

Table 9 examines the association between selected demographic and lifestyle factors and the prevalence of dyslipidemia and kidney disease among participants with type 2 diabetes mellitus. Age group was significantly associated with kidney disease (p = 0.004), with prevalence increasing progressively among older age categories. This finding is consistent with existing evidence that advancing age is associated with structural and functional renal decline, which is further exacerbated by diabetes-related metabolic and vascular changes (Tang et al., 2024; Kanasaki et al., 2012).

Physical activity was also significantly associated with kidney disease (p = 0.007), with higher prevalence observed among participants who reported lower levels of physical activity. Reduced physical activity has been linked to increased insulin resistance, systemic inflammation, and progression of renal dysfunction in individuals with diabetes (Shi et al., 2024; Colberg et al., 2016). Additionally, average hours of sleep showed a significant association with kidney disease (p = 0.026), supporting previous studies that have linked abnormal sleep duration to metabolic dysregulation and impaired renal function (Hemati et al., 2023).

In contrast, none of the examined factors including age, physical activity, dietary habits, alcohol consumption, or smoking showed a statistically significant association with dyslipidemia. This lack of association may reflect the influence of unmeasured confounders such as lipid-lowering therapy, genetic predisposition, and long-term dietary patterns, which were not fully captured in this study (Elkanawati et al., 2024; Boadu et al., 2023).

Collectively, these findings suggest that kidney disease among individuals with type 2 diabetes is more strongly influenced by age and lifestyle factors, whereas dyslipidemia may be shaped by additional metabolic and therapeutic determinants.

Discussion

This study investigated the burden of dyslipidemia and renal dysfunction among patients with type 2 diabetes mellitus (T2DM) attending Tetteh Quarshie Memorial Hospital, and further explored the relationships between glycemic control, lipid abnormalities, renal function, and selected lifestyle factors. The findings provide important insights into the metabolic and renal complications of T2DM in a low- and middle-income setting.

The prevalence of dyslipidemia observed in this study (22.31%) was lower than that reported in several studies conducted in Ghana and other sub-Saharan African countries, where prevalence rates ranging from 30% to over 70% have been documented (Azagew et al., 2024; Omodanisi et al., 2020; Belle-Ovosi et al., 2019). Similarly, Boadu et al. (2023) reported that more than one-third of Ghanaian adults experience dyslipidemia, contributing significantly to cardiovascular risk. The relatively lower prevalence in the present study may be attributable to differences in study populations, diagnostic thresholds, or the possible use of lipid-lowering medications among participants, which was not comprehensively assessed. Variations in lifestyle patterns and healthcare access may also account for the observed differences across studies.

In contrast, the prevalence of kidney disease was markedly high (76.86%), highlighting a substantial burden of renal impairment among individuals with T2DM in this setting. This finding is comparable to reports by Joshi et al. (2023), who documented a prevalence of 81.6%, and underscores the growing impact of diabetic kidney disease in low- and middle-income countries, where delayed diagnosis and limited access to specialist care remain common challenges (Adoba et al., 2025). The higher prevalence observed in this study compared with reports from Ethiopia (31.5%) may be explained by the older age distribution of participants (mean age 61.02 years), as advancing age is strongly associated with progressive nephron loss and reduced renal reserve (Adem et al., 2024; Kanasaki et al., 2012). These findings emphasize the need for targeted screening and early intervention for chronic kidney disease, particularly among older adults with T2DM.

The strong inverse correlations observed between estimated glomerular filtration rate (eGFR) and serum creatinine and urea reinforce the validity of these biomarkers as indicators of renal dysfunction. These associations are consistent with established pathophysiological mechanisms, whereby declining renal filtration capacity results in the accumulation of nitrogenous waste products (KDIGO, 2012). The strong positive correlation between urea and creatinine further reflects their shared role in assessing renal impairment. Similar patterns have been reported in previous studies examining renal function in diabetic populations (Adem et al., 2024).

Electrolyte parameters showed generally weak associations with renal function indices. Potassium demonstrated modest correlations with eGFR, urea, and creatinine, reflecting the kidney's central role in potassium homeostasis and the tendency toward hyperkalemia in renal impairment (Khan et al., 2019). In

contrast, sodium and chloride levels did not differ significantly between participants with and without kidney disease, suggesting that electrolyte disturbances may occur later in the disease course or be influenced by compensatory mechanisms and pharmacological interventions, such as diuretics (Lovegrove & Dubbs, 2023).

Analysis of lipid parameters revealed strong correlations among total cholesterol, LDL-cholesterol, and HDL-cholesterol, which is biologically plausible given their shared metabolic pathways and roles in lipid transport. However, renal function markers demonstrated weak associations with lipid parameters, differing from studies that have reported stronger links between dyslipidemia and renal dysfunction (Nagayama et al., 2023). This discrepancy may reflect differences in disease severity, genetic predisposition, or the modifying effects of lipid-lowering therapy in the study population.

With respect to glycemic control, triglyceride levels were significantly higher among participants with poor glycemic control, while total cholesterol, HDL-cholesterol, and LDL-cholesterol did not differ significantly across HbA1c categories. This pattern is consistent with evidence that triglycerides are more sensitive to hyperglycemia and insulin resistance than other lipid fractions (Hirano, 2018; Scherer et al., 2016). Hyperglycemia promotes hepatic triglyceride synthesis and very-low-density lipoprotein (VLDL) secretion, leading to elevated circulating triglyceride levels. Similar associations between poor glycemic control and hypertriglyceridemia have been reported among diabetic populations in Ghana and elsewhere (Lopez et al., 2025; Lee & Lee, 2023).

Lifestyle factors played an important role in renal outcomes in this study. Physical inactivity and inadequate sleep duration were significantly associated with kidney disease, findings that align with previous studies demonstrating that sedentary behavior and sleep disturbances contribute to insulin resistance, systemic inflammation, and metabolic dysregulation, thereby accelerating renal decline (Shi et al., 2024; Hemati et al., 2023). Regular physical activity has been shown to improve insulin sensitivity, enhance glucose uptake, and reduce cardiometabolic risk, which may explain its protective role against renal dysfunction (Colberg et al., 2016). In contrast, these lifestyle factors were not significantly associated with dyslipidemia, possibly due to confounding influences such as medication use and long-term dietary patterns that were not fully captured in this study.

Age emerged as a significant determinant of kidney disease, with prevalence increasing across older age groups. This finding is consistent with previous reports indicating that aging is associated with structural and functional renal changes, including glomerulosclerosis, reduced renal mass, and declining eGFR, which are further exacerbated in individuals with diabetes (Tang et al., 2024; Kanasaki et al., 2012). Although some studies have reported associations between age and dyslipidemia (Elkanawati et al., 2024), no such relationship was observed in the present study, suggesting that the influence of age on lipid levels may be overshadowed by stronger metabolic determinants such as obesity, hypertension, and glycemic control.

Finally, no significant differences in mean eGFR were observed across HbA1c categories, although variability in eGFR was greater among participants with poorer glycemic control. This finding supports the notion that diabetic kidney disease develops insidiously and may not be readily detected through cross-sectional comparisons of glycemic status alone (An et al., 2021; Rout & Jialal, 2025). The absence of a direct association between HbA1c and eGFR in this study may reflect its cross-sectional design, which limits the ability to capture cumulative glycemic exposure and disease duration—key factors in the progression of diabetic nephropathy.

Overall, the findings highlight a substantial burden of renal impairment and a moderate prevalence of dyslipidemia among patients with T2DM, underscoring the need for integrated metabolic and renal monitoring to reduce diabetes-related morbidity and mortality.

Conclusion

This study assessed the prevalence of dyslipidemia and renal dysfunction and examined their associations with glycemic control and lifestyle factors among patients with type 2 diabetes mellitus attending Tetteh Quarshie Memorial Hospital. The findings revealed a high burden of kidney disease and a moderate prevalence of dyslipidemia in the study population, underscoring the substantial metabolic and renal complications associated with type 2 diabetes in this setting.

Renal function markers, including estimated glomerular filtration rate, serum creatinine, and urea, demonstrated strong interrelationships, confirming their reliability in identifying renal impairment among diabetic patients. In contrast, lipid abnormalities were more selectively associated with glycemic control, with poor glycemic control significantly linked to elevated triglyceride levels, while total cholesterol, HDL-cholesterol, and LDL-cholesterol showed no significant variation across glycemic categories. These findings highlight triglycerides as a particularly sensitive lipid marker in the context of glycemic dysregulation.

Additionally, advancing age, physical inactivity, and inadequate sleep duration were significantly associated with kidney disease, emphasizing the influence of demographic and lifestyle factors on renal outcomes in individuals with type 2 diabetes. The absence of a direct association between HbA1c and mean eGFR further suggests that diabetic kidney disease may develop gradually and may not be readily detected through cross-sectional assessment of glycemic control alone.

Overall, the study underscores the need for routine and integrated monitoring of renal function and lipid profiles, alongside targeted lifestyle interventions, to enable early detection and management of diabetes-related complications. Strengthening such preventive and monitoring strategies is essential to reducing morbidity and improving long-term outcomes among individuals living with type 2 diabetes mellitus.

Recommendations

1. Routine and comprehensive monitoring of renal function (including eGFR, serum creatinine, and urea) should be prioritized in the clinical management of patients with type 2 diabetes mellitus, particularly among older adults and those with poor glycemic control. Given the strong association between poor glycemic control and elevated triglyceride levels observed in this study, regular lipid profile assessment, with particular attention to triglycerides, should be

integrated into standard diabetes care protocols. Additionally, healthcare providers should emphasize lifestyle modification counseling, including promotion of regular physical activity and adequate sleep, as part of holistic diabetes management to mitigate the progression of renal complications (KDIGO, 2012; Colberg et al., 2016).

2. Public health programs should strengthen early screening and surveillance systems for renal impairment and dyslipidemia among individuals with type 2 diabetes mellitus, especially in low- and middle-income settings. National diabetes management guidelines should explicitly incorporate periodic renal and lipid function testing as essential components of routine care. Furthermore, community-based health education initiatives should be intensified to improve awareness of the risks associated with uncontrolled diabetes and to promote healthy lifestyle behaviors, including balanced nutrition, regular physical activity, and adequate sleep, which are critical for preventing diabetes-related complications (Boadu et al., 2023; Fenta et al., 2023).
3. Longitudinal studies are recommended to better elucidate the temporal relationships between glycemic control, lipid abnormalities, and renal function decline, which cannot be fully captured in a cross-sectional design. Future research should also account for potential confounders, such as duration of diabetes, medication use (including lipid-lowering and antihypertensive therapies), and genetic factors. Expanding research to include multi-center and community-based populations would further enhance the generalizability of findings and inform targeted interventions for diabetes-related renal and metabolic complications.

Limitations

1. This study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design limits the ability to establish causal or temporal relationships between glycemic control, lipid abnormalities, and renal dysfunction. Consequently, observed associations cannot confirm directionality or long-term effects.
2. The study was conducted at a single tertiary health facility, which may limit the generalizability of the findings to other healthcare settings or to the broader population of individuals with type 2 diabetes mellitus in Ghana and similar low- and middle-income countries. Participants were also recruited using a convenience sampling technique, which may introduce selection bias.
3. Important clinical factors such as duration of diabetes, use of lipid-lowering agents, antihypertensive medications, and nephroprotective therapies were not fully accounted for. These factors may have influenced lipid levels and renal function and could partially explain the observed variability in outcomes.
4. Additionally, lifestyle behaviors including physical activity, dietary intake, sleep duration, alcohol consumption, and smoking were self-reported and therefore subject to recall bias and social desirability bias. Objective measurements of these variables may have provided more accurate estimates.
5. Finally, although renal function was assessed using established biochemical markers, albuminuria and urinary protein measurements important early indicators of diabetic kidney disease were not included. Their absence may have resulted in under or misclassification of early renal impairment.

Despite these limitations, the study provides valuable insight into the burden of renal dysfunction and dyslipidemia among patients with type 2 diabetes and highlights key associations relevant to clinical practice and public health.

Conflict of interest

Theres no conflict of interest

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