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Prevalence, knowledge, and lifestyle-associated risk factors of dyslipidemia among Ghanaian type-2 diabetes mellitus patients in rural and urban areas: A multicenter cross-sectional study

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Abstract

Background and Aims: Dyslipidemia in diabetes mellitus has been linked to unhealthy lifestyle and bad eating habits. However, this association has not been well studied among rural and urban Ghanaian populations. In this study, we determined the prevalence, knowledge, and lifestyle-associated risk factors of dyslipidemia among Ghanaian type-2 diabetes mellitus (T2DM) patients in rural and urban areas.

Methods: This comparative multicentre-cross-sectional study recruited 228 T2DM outpatients attending the St. Michael Hospital, Pramso (rural) and Kumasi South Regional Hospital (urban), Ghana for routine check-ups. Self-structured questionnaire was used to collect sociodemographic, knowledge, and lifestyle characteristics. Fasting blood samples were taken to measure lipid profiles. Dyslipidemia was defined per the American Diabetes Association criteria. All $p < 0.05$ were considered statistically significant.

Results: The overall prevalence of dyslipidemia was 79/228 (34.7%). Dyslipidemia was more prevalent among urban participants 43 (18.9%) than rural participants 36 (15.8%). Twenty-seven (11.7%) had adequate knowledge about the risk factors, complications, and management of diabetes. Eating supper after 7 p.m. [adjusted odds ratio = 3.77, 95% confidence interval (1.70–8.37), $p = 0.001$] significantly increased one's risk of having dyslipidemia by 3.8-fold compared to eating supper earlier (before 5 p.m.).

Conclusion: Dyslipidemia is increasing among T2DM patients in both urban and rural areas and it's independently influenced by eating supper after 7 p.m. Most participants were ignorant of the risk factors, complications, and management of diabetes. Adjusting eating habits and increasing diabetes awareness programs to sensitize the general public can mitigate the increasing prevalence of dyslipidemia in both urban and rural areas.

KEYWORDS

dyslipidemia, risk factors, rural, type-2 diabetes mellitus, urban

1 | INTRODUCTION

The global prevalence of diabetes is increasing rapidly. The worldwide diabetes prevalence for individuals aged 20–79 was 10.5% in 2021 (536.6 million) and was projected to increase to 12.2% (783.2 million) by 2045.[1] The health burden of diabetes mellitus cannot be understated. The World Health Organization (WHO) estimated that about 43% of diabetes-related deaths affect individuals under the age of 70 years and accounts for 3.7 million deaths annually.[2] Therefore, diabetes mellitus is considered a global epidemic, with an increasing prevalence of type-2 diabetes mellitus (T2DM) among children, adolescents, and young adults.[3] In Ghana alone, the prevalence of diabetes was approximately 6.5% in 2019.[4]

Diabetes is a metabolic disorder clinically manifesting as hyperglycemia. The burden diabetes presents stem from the fact that approximately 90% of diabetic cases are classified as type 2 diabetes.[5] T2DM is characterized by insulin resistance and development of hyperglycemia.[6] T2DM is associated with some of the most severe complications such as neuropathy, retinopathy nephropathy as well as an increased risk of cardiovascular diseases.[5,7] T2DM is known to induce oxidative stress in endothelial cells leading to atherosclerosis as well as affecting lipid metabolism pathways leading to abnormalities in plasma lipids seen in diabetes-associated dyslipidemia.[8,9]

Dyslipidemia is characterized by low levels of high-density lipoprotein cholesterol (HDL-c), high triglyceride (TG), high total cholesterol (TC), and elevated levels of low-density lipoprotein cholesterol (LDL-c).[10] Approximately more than 50% of T2DM patients develop dyslipidemia, a risk for cardiovascular disease which is the leading cause of death and with a mortality rate of 17.3 million deaths.[11]

The rise in the number of diabetes-associated dyslipidemia cases is due to rapid urbanization and the adoption of western diet and lifestyle,[12,13] and this is gaining prominence in Ghana. A previous study conducted by Anto and colleagues among the Ghanaian population found that dyslipidemia was associated with obesity, sedentary lifestyle, socioeconomic status, and family history of diabetes.[14] Similarly, an Ethiopian study linked dyslipidemia among individuals with diabetes to factors such as age, gender, obesity, and the duration of living with the condition.[15]

Despite these findings in the general population, there is a paucity of data on the prevalence of dyslipidemia in patients with T2DM, particularly in rural areas, in comparison to urban dwellers. However, varying prevalence rates have been observed in other places such as Pakistan[16] and China.[17] Furthermore, the scarcity of data is compounded by a lack of knowledge about diabetes and its complications. This study sought to investigate the prevalence, knowledge, and lifestyle-related risk factors associated with dyslipidemia among Ghanaian patients with T2DM in both rural and urban areas.

2 | MATERIALS AND METHODS

2.1 | Study design

This multicenter hospital-based cross-sectional study was conducted between March 2022 and July 2022 at an urban hospital (Kumasi South Regional Hospital) and a rural hospital (St. Michael Hospital, Ghana) after obtaining permission from the Institutional Ethics Committee. We used the STROBE cross-sectional checklist in writing this report.[18]

2.2 | Study sites

St. Michael's Hospital is a member of the Christian Health Association of Ghana and the National Catholic Health Service of Ghana. St Michael's Hospital is located at Jachie Pramso and serves as the main referral point for health facilities within the Bosomtwe District of the Ashanti Region. The district serves a population of approximately 104,471 people.

Kumasi South Government Hospital is a government regional hospital in Ashanti, Chirapatre Ghana. The hospital serves approximately 400,000 people and provides a diabetic clinic for diabetes management.

2.3 | Inclusion and exclusion criteria

This study included the following participants: those who were recently diagnosed with T2DM 18 years and above and not had the disorder for more than 5 years; and those who were not on any lipid-lowering drug. The study excluded participants who had gestational diabetes, type 1 diabetes, pregnant women, and other comorbidities like cardiovascular diseases and chronic liver disease. Participants who did not give formal consent to participate in the study were also excluded.

2.4 | Ethical consideration

Ethical approval for this study was sought from the Committee on Human Research, Publication and Ethics of the School of Medical Sciences (SMS), Kwame Nkrumah University of Science and Technology (KNUST) with reference number CHRPE/AP/227/21. Approval and written consent were equally sought from the study sites and participants respectively before the study was commenced.

2.5 | Sample size estimation

To address potential sampling bias, we randomly recruited a total of 228 participants after the aim of the study had been clearly explained to them. A total of 110 of the total participants were selected from an urban area and 118 from a rural setting. The sample size was estimated using the formula $N = Z^2 \times P\ (1 - P)/D^2$.[19] Using a prevalence of 6.46% obtained from a similar study[4] the estimated sample size (N) was 93.4. To increase statistical power and account for nonresponse bias, 228 T2DM patients were sampled for the study.

2.6 | Data collection

A well-structured questionnaire was developed by reviewing relevant journals.[20–22] A pilot study involving 20 diabetic individuals was conducted to ensure the questionnaire's content and clarity. The questions were asked through face-to-face interviews with the patients. The validity and reliability of the questionnaire were assessed using reliability coefficients, which range from 0 to 1. Higher coefficients indicate greater reliability. The reliability coefficients for all the questions were 0.903. The questionnaire was originally in English but was carefully translated into the local language of the study population during the interviews. The participants' responses were then translated back into English while maintaining their intended meaning. The questionnaire was structured in three sections. The first section was used to obtain sociodemographic data such as age, gender, and educational level. The second section was used to assess participant knowledge. Participants' knowledge was assessed based on risk factors, complications, and management of diabetes. Patients were said to have adequate knowledge if they answered all questions correctly. Participants were scored to have inadequate knowledge if they answered one or two questions correctly and scored as having no knowledge if they answered all questions wrongly. Section three was used to obtain information on participants' nutritional lifestyle and physical activity.

2.7 | Anthropometric measurements

Weight was measured (to the nearest 0.1 kg with participants in light clothing) using a bathroom scale (Zhongshan Camry Electronic Co. Ltd.). Height was measured (to the nearest 0.1 cm without shoes) with a stadiometer (Seca 213 mobile stadiometer, Germany) whiles they stood upright with their back straight, heels together, and their feet slightly apart at a 60° angle. Body mass index (BMI) was defined as the body weight divided by the square of the body height (expressed in units of kg/m^2).

2.8 | Blood sampling and biochemical measurements

A total of 4 mL of venous blood samples were collected after an overnight fast and dispensed into a serum separator tube. After centrifugation at 3000 rpm for 15 min, the serum was stored at −80°C until assayed. TC, TG, and HDL-c were assayed using the LE SCIENTIFIC Automated Chemistry Analyzer (SPINREACT Co. Ltd.). The protocol for the determination of the parameters was as indicated in the manufacturer's instructions.

LDL-c was calculated using the Friedewald formula[23]: [LDL-c] = [TC] − [HDL Chol] − [TG]/2.2 mmol/L.

2.9 | Definition of dyslipidemia

Dyslipidemia was defined per American Diabetes Association (ADA) criteria[24]: High TC ≥ 200 mg/dL or ≥5.17 mmol/L, high TG ≥ 150 mg/dL or ≥1.70 mmol/L, elevated LDL-c ≥100 mg/dL or ≥2.59 mmol/L, and decreased HDL-c ≤40 mg/dL or ≤1.03 mmol/L in males and ≤50 mg/dL or ≤1.29 mmol/L in females.

2.10 | Data analysis

Data entry was done using Microsoft Excel 2016 and analysis was performed using SPSS version 26.0 (SPSS Inc.) and GraphPad Prism 8.0.1 (GraphPad LLC). Categorical data were presented as frequency (proportion). The normality of continuous variables was tested by Kolmogorov–Smirnov. Nonparametric data were presented as median (interquartile range). Differences between groups were tested for significance by Mann–Whitney U-test for nonparametric data (for continuous variables) and χ^2 or Fisher exact test was used to determine the association of sociodemographic characteristics including age categories, gender, and marital status with geographic location (rural vs. urban) among the participants. Multivariate logistic regression analysis was performed to compare the odds ratio of sociodemographic and lifestyle characteristics for those with dyslipidemia. All tests were done two-sided and all statistical results obtained were considered at a significant value of $p < 0.05$.

3 | RESULTS

3.1 | Sociodemographic characteristics of the study population

A total of 228 participants (type 2 diabetics) were recruited into the study of which 110 (48.4%) were from an urban residence and 118 (51.6%) were from a rural residence. About half 98 (43.2%) of the participants were between 50 and 59 years. There were more females, 175 (76.8%) than males 53 (23.2%). Out of 101 (44.2%) participants who had no education (illiterates) majority were from the rural area 68 (57.1%). Over half of the participants were married (68.5%) and self-employed (57.9%). Majority of participants who did not know their family history of diabetes were from the rural residence 17 (14.3%). Sex ($p = 0.020$), age category ($p = 0.014$), education ($p < 0.0001$), marital status ($p = 0.045$), and duration of diabetes ($p = 0.012$) were significantly associated with residence of participants. However, occupation and family history of diabetes did not significantly differ in proportion between rural and urban residence (Table 1).

TABLE 1 Sociodemographic distribution of study participants.

Variable	Total (*N* = 228)	Rural (*N* = 118)	Urban (*N* = 110)	*p* Value
Sex				
Male	53 (23.2%)	20 (16.8%)	33 (30.4%)	**0.020**
Female	175 (76.8%)	98 (83.2%)	77 (69.6%)	
Age categories				**0.014**
30–39 years	10 (4.2%)	5 (4.1%)	5 (4.1%)	
40–49 years	48 (21.0%)	29 (24.5%)	19 (17.3%)	
50–59 years	98 (43.2%)	58 (49.0%)	40 (36.8%)	
60 years and above	72 (31.6%)	26 (22.4%)	46 (41.8%)	
Education				**<0.0001**
None	101 (44.2%)	68 (57.1%)	33 (30.4%)	
Primary	74 (32.6%)	36 (30.6%)	38 (34.8%)	
Secondary	48 (21.1%)	12 (10.2%)	36 (32.5%)	
Tertiary	5 (2.1%)	2 (2.1%)	3 (2.3%)	
Marital status				**0.045**
Single	3 (1.2%)	0 (0.0%)	3 (2.3%)	
Married	156 (68.5%)	87 (73.5%)	69 (63.1%)	
Divorced	3 (1.2%)	0 (0.0%)	3 (2.3%)	
Widowed	66 (29.1%)	31 (26.5%)	35 (32.3%)	
Occupation				0.134
Unemployed	89 (38.9%)	41 (34.7%)	48 (43.5%)	
Self-employed	132 (57.9%)	75 (63.3%)	57 (52.2%)	
Government employed	7 (3.2%)	2 (2.0%)	5 (4.3%)	
Family history of diabetes				0.141
Don't know	24 (10.5%)	17 (14.3%)	7 (6.5%)	
Yes	122 (53.7%)	60 (51.0%)	62 (56.5%)	
No	82 (35.8%)	41 (34.7%)	41 (37.0%)	
Duration of diabetes				**0.012**
≤3 years	34 (14.7%)	24 (20.4%)	9 (8.7%)	
4 years	65 (28.4%)	36 (30.6%)	29 (26.1%)	
5 years	130 (56.8%)	58 (49.0%)	72 (65.2%)	

Note: Data are presented as frequency (%); compared using χ^2 or Fisher's test. $p < 0.05$ was considered statistically significant and are in bold font for Type 2 Diabetics among rural and urban participants.
Abbreviation: N, number.

3.2 | Prevalence of dyslipidemia among the urban and rural study population

Out of the 228 total participants, 79 (34.7%) presented with dyslipidemia. Of the participants with dyslipidemia, 43 (18.9%) were from the urban residence, while 36 (15.8%) were from the rural residence (Figure 1).

3.3 | Prevalence of dyslipidemia by gender

Of the 79 participants with dyslipidemia, 67 (29.5%) were females, whereas 12 (5.3%) were males (Figure 2).

3.4 | Knowledge of urban and rural participants in diabetes risk factors, complications, and management

Out of the 228 participants, 27 (11.7%) had adequate knowledge, 103 (45.2%) representing the majority, had inadequate knowledge, and 98 (43.1%) had no knowledge about risk factors, complications, and management of diabetes. Most of those who did not know of this were rural participants, 62 (27.3%) (Figure 3).

3.5 | Biochemical parameters and anthropometrics among study participants

Participants from the rural areas had higher levels of TC (6.31 mmol/L) than those from urban areas (6.16 mmol/L). However, HDL-c and TG levels were lower (0.57 mmol/L vs. 0.67 mmol/L) and higher (1.76 mmol/L vs. 1.70 mmol/L), respectively in urban participants than in rural participants. LDL-c levels were the same for both rural and urban participants (5.00 mmol/L). Nonetheless, there was no observed significance between residence and the lipid profile measures (all $p > 0.05$).

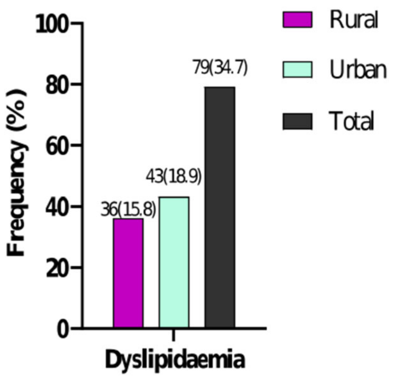

FIGURE 1 Prevalence of dyslipidemia among the rural and urban study population.

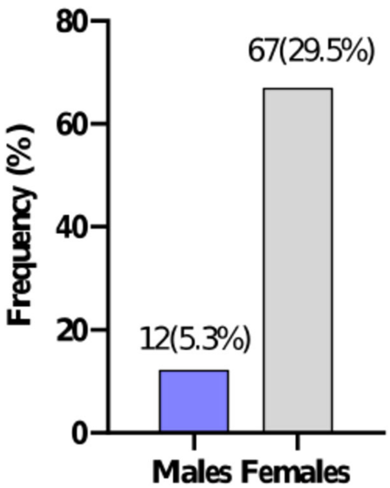

FIGURE 2 Prevalence of dyslipidemia by sex.

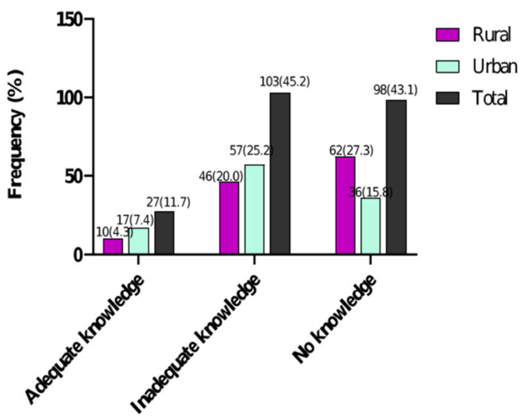

FIGURE 3 Distribution of knowledge of diabetes among participants.

BMI observed among urban participants (24.57 kg/m^2) was also higher as compared to rural participants (23.53 kg/m^2), however, there was no significant difference between the two groups (Table 2).

3.6 | Distribution of lifestyle risk factors among participants

As seen in Table 3, 53 (23.2%) of participants ate late of which the majority were from urban residence 36 (32.6%) and the minority were from rural residence 17 (14.3%). There was a significant association between eating late and participants' residence ($p = 0.001$).

The majority of participants 130 (56.8%) eat supper before 5 p.m., whereas, few 26 (11.6%) ate supper after 7 p.m.; a significant difference was found between supper time and settlement of participants ($p = 0.0002$). Most of the subjects 127 (55.8%) did not engage in any exercise. The number of meals per day ($p = 0.020$), food preference ($p = 0.012$), and alcohol status ($p = 0.025$) were significantly associated with the residence of participants. However, exercise, type of exercise, and smoking did not significantly differ in proportion between rural and urban participants (all $p > 0.05$).

3.7 | Lifestyle behaviors associated with dyslipidemia among T2DM patients

In the univariate logistic regression model, the odds of participants who ate thrice per day [crude odds ratio (cOR) = 1.90, 95% confidence interval (CI) (1.10–3.27), $p = 0.021$] having dyslipidemia significantly increased 1.9-fold as compared to the participants who ate twice per day. Also, the odds of participants who ate late [cOR = 2.89, 95% CI (1.51–5.54), $p = 0.001$] and those who ate supper after 7 p.m. [cOR = 3.39, 95% CI (1.84–6.25), $p < 0.0001$] having dyslipidemia significantly increased 2.9 and 3.4-fold as compared to the participants who ate early and those who ate before 5 p.m., respectively.

After adjusting for possible confounders in the multivariate logistic regression model, eating supper after 7 p.m. was the independent predictor of dyslipidemia among the T2DM subjects. Eating supper after 7 p.m. [adjusted odds ratio = 3.77, 95% CI (1.70–8.37), $p = 0.001$] increased one's odds of having dyslipidemia significantly by 3.8-fold compared to those who ate supper before 5 p.m. (Table 4).

4 | DISCUSSION

Dyslipidemia is a major risk factor for cardiovascular disease and stroke.[25] In Ghana, there is limited data on the prevalence of dyslipidemia among patients with diabetes.[14,26] Previous studies have shown that prevalence of dyslipidemia is associated with sociodemographic characteristics and lifestyle behaviors.[27–29] However, few studies have examined the severity of this association among the urban and rural Ghanaian populations. Therefore, this study aimed to assess the prevalence of dyslipidemia among urban and rural populations with type 2 diabetes, examine participants' knowledge about diabetes and its complications, and also assessed various lifestyle risk factors of dyslipidemia.

TABLE 2 Biochemical parameters and anthropometrics among study participants.

Variables	Total (*N* = 228)	Rural (*N* = 118)	Urban (*N* = 110)	*p* Value
Biochemical	Median (IQR)	Median (IQR)	Median (IQR)	
TC (mmol/L)	6.20 (5.17–7.37)	6.31 (5.17–7.18)	6.16 (5.21–7.55)	0.815
HDL-c (mmol/L)	0.67 (0.43–0.88)	0.67 (0.35–0.87)	0.57 (0.48–0.89)	0.650
TG (mmol/L)	1.75 (1.10–2.19)	1.70 (1.19–2.17)	1.76 (1.04–2.55)	0.832
LDL-c (mmol/L)	5.00 (4.00–6.00)	5.00 (4.00–5.00)	5.00 (4.00–6.00)	0.975
Anthropometrics				
Height (cm)	163.00 (156.00–166.00)	163.00 (155.50–168.00)	162.50 (156.75–166.00)	0.878
Weight (kg)	61.00 (58.00–64.00)	60.00 (58.00–63.00)	62.00 (58.75–65.25)	0.055
BMI (kg/m^2)	23.53 (21.90–24.91)	23.53 (21.61–24.88)	24.57 (21.95–25.20)	0.321

Note: Nonparametric data are presented as median (IQR); compared using Mann–Whitney test. $p < 0.05$ was considered statistically significant for Type 2 diabetics in rural and urban participants.

Abbreviations: BMI, body mass index; HDL-c, high-density lipoprotein cholesterol; IQR, interquartile range; LDL-c, low-density lipoprotein cholesterol; N, number; TC, total cholesterol; TG, triglyceride.

4.1 | Sociodemographic distribution of the study population

This study showed that dyslipidemia is more common among women (29.5%) than men (5.3%). This finding is consistent with the study by Gilani et al.[30] and Al- Zakwani et al.[31] who found abnormal lipid profile indices to be more common in women than men. Furthermore, Feingold et al. found that women with diabetes have 3–4 fold risk of developing cardiovascular disease, a common complication as a result of dyslipidemia.[32] Women in postmenopausal phases are also known to be at risk of developing abnormal lipid profiles[33] and in this case, the majority of women were in their postmenopausal age (50–59) (35.8%) and this might have accounted for this observed high prevalence among the women in our cohort. There were more females in this study than males and this could be another possible reason for the higher prevalence of dyslipidemia among females than in males. Further, educational level was significantly associated with residence (rural and urban) ($p < 0.0001$). This finding is consistent with a previous study by Aung and colleagues.[34]

4.2 | Prevalence of dyslipidemia among rural and urban participants

Overall, prevalence of dyslipidemia was 34.7%. This corresponds to a prevalence of 34.4%–94.0% recorded in numerous studies conducted across the world.[35–39] In Malawi, Katundu and colleagues found a much higher prevalence (58%) of dyslipidemia among persons with diabetes mellitus.[36] In Nepalese T2DM patients, Mehta et al. found a much higher prevalence of dyslipidemia of 63.1%.[38] This divergent range of dyslipidemia prevalence among T2DM could be due to differences in sample sizes and dyslipidemia cut-off thresholds used in most of the studies. In the current study, we used ADA criteria, some studies used the National Cholesterol Education Program-Adult Treatment Panel III threshold for dyslipidemia with a tighter cut-off,[40] while others used the WHO dyslipidemia threshold.

Furthermore, dyslipidemia was more prevalent in the urban population (18.9%) than in the rural population (15.8%) in this current study. This finding is consistent with a study conducted in India,[41] where dyslipidemia was more prevalent in the urban group than in the rural group. This could be a result of many factors such as the adoption of the Western diet, rapid urbanization, and a high tendency to live a sedentary lifestyle.

The distribution of cholesterol, HDL-C, LDL-C, and TG among the participants of both groups were abnormal and the lipid profile also showed that the urban group had higher levels of TGs but lower HDL levels compared with the rural group. However, there was no significant difference in the levels between the groups. Diabetic dyslipidemia is a condition that occurs when DM interferes with a patient's lipid profile. In T2DM patients, the pattern of dyslipidemia usually includes an increase in TGs and LDL, as well as a reduction in HDL. The reason why no significant relationship exists between lipid components and residence can be attributed to the rapid urbanization of rural communities and the lack of education on self-management of the condition among both groups. Furthermore, in this study, it was observed that BMI of the urban group was higher than that of the rural group. However, this difference was not statistically significant. This finding contradicts the results of T2DM research conducted in Xinjiang, China[42] and Rwanda,[43] where significant disparities in BMI between rural and urban groups were identified. These studies attributed the observed disparities to unhealthy lifestyles and eating habits.

4.3 | Knowledge level of rural and urban participants

This current study assessed participant knowledge based on the risk factors, complications, and management of diabetes. Among the total

TABLE 3 Distribution of Lifestyle risk factors among participants.

Variable	Total (*N* = 228)	Rural (*N* = 118)	Urban (*N* = 110)	*p* Value
No. of meals/day				**0.020**
Twice	86 (37.9%)	36 (30.6%)	50 (45.7%)	
Thrice	142 (62.1%)	82 (69.4%)	60 (54.3%)	
Eat late				**0.001**
Yes	53 (23.2%)	17 (14.3%)	36 (32.6%)	
No	175 (76.8%)	101 (85.7%)	74 (67.4%)	
Supper time				**<0.001**
Before 5 p.m.	130 (56.8%)	53 (44.9%)	77 (69.6%)	
6 p.m.	72 (31.6%)	51 (42.9%)	21 (19.6%)	
After 7 p.m.	26 (11.6%)	14 (12.2%)	12 (10.9%)	
Food preference				**0.012**
None	158 (69.5%)	79 (67.3%)	79 (71.7%)	
Soft drinks	41 (17.9%)	27 (22.4%)	14 (13.0%)	
Fried food	22 (9.5%)	12 (10.2%)	10 (8.7%)	
Fast foods	7 (3.2%)	0 (0.0%)	7 (6.5%)	
Exercise				0.110
Yes	101 (44.2%)	46 (38.8%)	55 (50.0%)	
No	127 (55.8%)	72 (61.2%)	55 (50.0%)	
Type of exercise				0.110
None	127 (55.8%)	72 (61.2%)	55 (50.0%)	
Walking	101 (44.2%)	46 (38.8%)	55 (50.0%)	
Alcohol status				**0.025**
Current drinker	5 (2.1%)	0 (0.0%)	5 (4.3%)	
Nondrinker	223 (97.9%)	118 (100.0%)	105 (95.7%)	
Smoking status				
Current smoker	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.999
Nonsmoker	228 (100.0%)	118 (100.0%)	110 (100.0%)	

Note: Data are presented as frequency (%); compared using χ^2 or Fisher's test. $p < 0.05$ was considered statistically significant and are bold font.
Abbreviation: N, number.

participants, 11.7% demonstrated adequate knowledge, 45.3% had inadequate knowledge, and 43.1% had no knowledge regarding the risks, complications, and management of diabetes. Notably, there was a difference in knowledge levels between urban and rural participants with urban displaying higher knowledge about diabetes compared to rural participants. This is consistent with the report by Deepa and colleagues.[44] In their study, they found that compared to the urban population, the rural population had low knowledge of diabetes and even among the total population had knowledge about the condition, they had an unsatisfactory knowledge level. Once a patient is well informed about diabetes, they conformed to better practices to manage the condition.[44] In the United States, The National Diabetes Education Program in a study found that improved diabetes awareness has resulted in improved health outcomes.[45] A previous study in Ghana by Obirikorang et al.[21] suggests that a lack of awareness about diabetes and its complications has an impact on its incidence. In that study, 60.0% of participants did not know about the condition as compared to 43.1% in this current study. Also, the finding of this study is similar to a study conducted in Pakistan, where type 2 diabetic patients who lived in cities were more informed than those who lived in rural areas.[46]

4.4 | Lifestyle-associated risk factors associated with dyslipidemia among participants

There was a significant association between the time of the day participant ate supper and dyslipidemia among the urban and rural groups. This study showed that as compared to participants who ate

TABLE 4 Lifestyle behaviors associated with dyslipidemia among type 2 diabetics.

Variable	cOR (95% CI)	*p* Value	aOR (95% CI)[a]	*p* Value
No. of meals/day				
Twice	Reference		Reference	
Thrice	1.90 (1.10–3.27)	**0.021**	0.54 (0.21–1.39)	0.202
Eat late				
Yes	2.89 (1.51–5.54)	**0.001**	0.0 (0.0–inf)	0.999
No	Reference		Reference	
Supper time				
Before 5 p.m.	Reference		Reference	
6 p.m.	1.83 (0.79–4.22)	0.158	2.03 (0.76–5.42)	0.157
After 7 p.m.	3.39 (1.84–6.25)	**<0.0001**	3.77 (1.70–8.37)	**0.001**
Food preference				
None	Reference		Reference	
Soft drinks	1.93 (0.94–3.95)	0.073	-	-
Fried food	1.33 (0.53–3.34)	0.539	-	-
Fast foods	0.0 (0.0–inf)	0.999	-	-
Alcohol status				
Current drinker	0.0 (0.0–inf)	0.999	-	-
Nondrinker	Reference	-	Reference	

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; cOR, crude odds ratio; inf, infinity.

[a]Adjusted for sex, age category, education, marital status, and duration of diabetes. Compared using univariate and multivariate logistic regression. $p < 0.05$ was considered statistically significant and are in bold font.

supper earlier, that is, before 5 p.m. (17:00 Greenwich Mean Time [GMT]), participants who ate supper after 7 p.m. (19:00 GMT) were at higher risk of developing the condition. This could be backed by the fact that it's usually around that time the general population becomes sedentary—seated behind the television. A sedentary lifestyle is associated with increased fat levels.[47] Furthermore, Tursinawati et al.[48] found that poor eating habits, such as frequent consumption of high-carbohydrate, high-fat foods, and fast foods, are all linked to an increased risk of dyslipidemia among diabetics. There is a school of thought that suggests that it's not when you eat supper but what you eat. This is noticeably not true per this current study and as stated earlier, poor eating habit largely contribute to dyslipidemia in diabetics.

Smoking was not significantly associated with dyslipidemia. Alcohol intake was, however, significantly associated with dyslipidemia but failed to independently predict dyslipidemia after possible confounders were adjusted for in the multivariate logistic model. This is, however, contradictory to a study conducted by Liu and colleagues.[49] These lifestyles, according to their study, were significantly associated with dyslipidemia and also remained significant even after adjustment for socioeconomic status and demographics. The variations seen in both studies could be because participants recruited in this current study were self-reported patients and clinical advice had been given to manage the condition. Hence, it was a sign of adherence to medical advice. Another possible reason could be due to ethnic differences and sample size differences between these studies.

This study, however, had limitations worth mentioning. One selected area for both urban and rural settlement may not be enough to represent the urban and rural populations. Also, the research design of this study is cross-sectional. The exposure variables and the outcome variables of the study coexist, and the time sequence between the exposure and the outcome cannot be judged. Therefore, the causal relationship between the two groups cannot be obtained. Finally, since the lifestyle data were collected through a questionnaire, this may have led to a recall bias.

5 | CONCLUSION

The prevalence of dyslipidemia among type 2 diabetics is high in both urban and rural groups and it's influenced by eating supper after 7 p.m. Most participants were ignorant of the risk factors, complications, and management of diabetes. Adjusting eating habits and increasing diabetes awareness programs to sensitize the general public can mitigate the increasing prevalence of dyslipidemia in both urban and rural areas. Future research should prioritize conducting a cohort study to evaluate the long-term impact of dyslipidemia and cardiovascular outcomes in Ghanaian T2DM patients in rural and urban areas.

AUTHOR CONTRIBUTIONS

Wina I. O. Boadu: Conceptualization; data curation; funding acquisition; methodology; project administration; supervision; writing—review and editing. **Enoch O. Anto**: Conceptualization; data curation; investigation; methodology; supervision; writing—review and editing. **Joseph Frimpong**: Formal analysis; investigation; methodology; writing—original draft; Writing—review and editing. **Felix Ntiful**: Formal analysis; investigation; methodology; writing—original draft; writing—review and editing. **Emmanuel E. Korsah**: Formal analysis; investigation; writing—review and editing. **Ezekiel Ansah**: Formal analysis; investigation; software; writing—review and editing. **Valentine C. K. T. Tamakloe**: Formal analysis; investigation; writing—review and editing. **Afia Agyapomaa**: Investigation; methodology; resources; writing—review and editing. **Stephen Opoku**: Formal analysis; methodology; writing—review and editing. **Ebenezer Senu**: Formal analysis; investigation; methodology; resources; writing—review and editing. **Michael Nyantakyi**: Investigation; software; visualization; writing—review and editing. **Albright Etwi-Mensah**: Investigation; methodology; writing—original draft; writing—review and editing. **Emmanuel Acheampong**: Data curation; investigation; methodology; writing—review and editing. **Kwame O. Boadu**: Data curation; investigation; methodology; supervision; writing—review and editing. **Emmanuel Timmy Donkoh**: Data curation; investigation; methodology; writing—review and editing. **Christian Obirikorang**: Data curation; methodology; supervision; writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

All authors have read and approved the final version of the manuscript [CORRESPONDING AUTHOR or MANUSCRIPT GUARANTOR] had full access to all of the data in this study and take complete responsibility for the integrity of the data and the accuracy of the data analysis.

TRANSPARENCY STATEMENT

The lead author Wina I. O. Boadu affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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