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Link Between Blood Glucose and Lipids in Adult Women at Rural Diabetes Center (RDC), Garoddwar, Baishari, Banaripara, Barishal, Bangladesh

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Abstract

Background: Diabetes and dyslipidemia are increasing in South Asia, including rural Bangladesh, driven by rapid lifestyle and dietary transitions. This study assessed the association between fasting blood glucose (FBG) and lipid parameters among rural Bangladeshi women.

Methods: A retrospective observational study was conducted among 60 female participants attending a rural community diabetes checkup center. Fasting and post-breakfast glucose (mmol/L) and lipid profile parameters (mg/dL) were analyzed using SPSS version 25. Pearson correlation and multiple linear regression were applied to assess associations.

Results: The mean age was 49.73 ± 12.54 years. Mean FBG was 12.06 ± 4.31 mmol/L, and post-breakfast glucose was 16.88 ± 5.38 mmol/L. The mean total cholesterol, LDL-C, triglycerides, and HDL-C were 226.67 ± 45.86, 153.19 ± 42.51, 223.57 ± 115.52, and 40.88 ± 14.27 mg/dL, respectively. Diabetic participants (83.3%) showed higher triglycerides and lower HDL-C compared with non-diabetic groups. FBG showed no significant correlation with any lipid variable, while post-breakfast glucose was inversely associated with HDL-C ($r = –0.296$, $p = 0.022$). Regression analysis showed no significant predictors of FBG (adjusted $R^2 = 0.021$, $p = 0.63$).

Conclusion: Dyslipidemia and hyperglycemia coexist at high levels among rural Bangladeshi women, reflecting a transition toward urban-like metabolic risk. These results emphasize the need for early biochemical screening and preventive public health programs in rural communities.

Keywords: Fasting blood glucose; Dyslipidemia; Rural Bangladesh; HDL cholesterol; Cardiovascular risk.

Introduction

Diabetes mellitus is a major global public health concern and one of the fastest-growing non-communicable diseases worldwide. The International Diabetes Federation (IDF) estimated that 10.5% of adults aged 20–79 years were living with diabetes in 2021, a figure projected to rise to 12.2% by 2045, with the greatest increase occurring in low- and middle-income countries [1]. The 9th IDF Diabetes Atlas similarly reported that approximately 463 million adults had diabetes in 2019, two-thirds of whom resided in developing regions, underscoring the shifting global burden of metabolic disorders [2]. Among the various forms of diabetes, type 2 diabetes mellitus (T2DM) constitutes more than 90% of all cases and is closely linked with obesity, insulin resistance, and cardiovascular complications [3]. The escalating prevalence of T2DM has significant implications for cardiovascular morbidity and mortality, particularly

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through its association with dyslipidemia, a key modifiable risk factor for atherosclerotic disease [4].

Fasting blood glucose (FBG) serves as a reliable measure of glycemic control and a surrogate indicator of insulin sensitivity in peripheral tissues. Abnormal glucose metabolism disrupts lipid homeostasis primarily through insulin resistance, which enhances hepatic triglyceride synthesis, elevates very-low-density lipoprotein (VLDL) secretion, and suppresses high-density lipoprotein (HDL) formation [5]. This metabolic imbalance results in a characteristic atherogenic lipid profile—marked by elevated triglycerides, increased low-density lipoprotein (LDL), and reduced HDL levels—commonly observed in diabetic and prediabetic states [6]. Mechanistically, insulin resistance accelerates endothelial dysfunction, oxidative stress, and chronic vascular inflammation, collectively promoting atherosclerosis and cardiovascular disease [7, 8]. The interplay between hyperglycemia and dyslipidemia is thus central to the pathophysiology of metabolic syndrome and cardiovascular risk progression. These biochemical relationships highlight the importance of simultaneous assessment of glucose and lipid parameters in both clinical and community settings.

Within South Asia, and particularly in Bangladesh, diabetes has emerged as a significant public health challenge. Recent national estimates indicate a steady rise in diabetes prevalence, with urban prevalence exceeding 11% and rural rates around 8–9%, reflecting a clear urban–rural gradient [9, 10]. However, evidence also suggests that the burden of metabolic disorders is rapidly expanding in rural populations due to changing dietary habits, reduced physical activity, and socioeconomic transitions [11]. Despite this, the majority of epidemiological data and screening efforts remain urban-focused, leaving substantial gaps in understanding the metabolic health of rural communities. Field-based investigations in rural Bangladesh have revealed a high prevalence of lipid abnormalities even among non-diabetic individuals, with low HDL-C (64%) and high triglyceride levels (35%) observed in otherwise healthy adults [12]. These findings underscore an emerging metabolic risk profile in rural regions where limited healthcare access and diagnostic infrastructure contribute to underdiagnosis and inadequate management of chronic conditions [13].

Understanding the association between fasting blood glucose and lipid parameters is essential for early identification of individuals at risk of cardiovascular disease, especially in resource-limited contexts. Routine biochemical parameters such as FBG, total cholesterol (TC), LDL-C, HDL-C, and triglycerides are widely available, cost-effective, and reliable indicators of early metabolic disturbance [14]. The European Society of Hypertension Working Group on Cardiovascular Risk emphasizes these tests as practical screening tools for low-resource settings, enabling early risk stratification and preventive interventions [15]. Evidence from sub-Saharan Africa and Asia confirms that combined assessment of FBG and lipid markers significantly improves prediction of cardiovascular risk, particularly when used in community-based screening programs [16, 17]. The inclusion of these markers in routine surveillance not only facilitates timely diagnosis but also allows clinicians to implement preventive strategies targeting both glycemic and lipid abnormalities before the onset of overt cardiovascular disease [18, 19].

Despite accumulating global evidence, there remains a paucity of data exploring these associations within rural Bangladeshi populations, particularly among women. Rural communities often face compounded challenges of healthcare inaccessibility, socioeconomic vulnerability, and limited public health infrastructure, which contribute to late detection of diabetes and its complications. Moreover, most existing Bangladeshi studies have evaluated lipid abnormalities or glycemic status independently rather than examining their interrelationship. Addressing this evidence gap is crucial for developing locally relevant, evidence-based strategies for cardiovascular risk reduction in community settings. Therefore, the present study aimed to examine the association between fasting blood glucose and lipid parameters, including total cholesterol, LDL-C, HDL-C, and triglycerides among adult females in a rural Bangladeshi community. By analyzing these interrelationships using standardized biochemical assessments, this study seeks to provide empirical insight into the metabolic risk profile of rural women and contribute to the evidence base for cost-effective cardiovascular risk screening and prevention strategies in resource-constrained environments.

Methods

This retrospective observational study was conducted at the Rural Diabetes Center (RDC), located in Garaddar, Baishari, Banaripara, Barishal, Bangladesh. The analysis used secondary data collected from routine screening records of adult female patients who attended the center between January and December 2024. All patient data were anonymized before analysis. Ethical approval for the study was obtained from the institutional review committee, and all procedures followed the ethical principles outlined in the Declaration of Helsinki. A total of 60 female participants aged 18 years and above were included. Only patients with complete fasting blood glucose (FBG) and lipid profile results were eligible. Individuals with missing biochemical values, chronic liver or renal disease, or those receiving lipid-lowering or antidiabetic medications were excluded. All included participants were residents of the surrounding rural area and visited the center voluntarily for diabetes and lipid screening. Data were extracted from laboratory records

and verified for completeness and accuracy. FBG and after-breakfast glucose (ABF) were measured after an overnight fast of at least eight hours and recorded in mmol/L. Lipid parameters included total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C), measured in mg/dL. Biochemical analyses were performed using standard enzymatic colorimetric methods under routine internal quality control. Anthropometric data such as age and body mass index (BMI) were also collected when available. The dataset was reviewed to identify and remove outliers, duplicate entries, and implausible values. No data imputation was performed. The normality of continuous variables was assessed using the Shapiro–Wilk test. Normally distributed data were expressed as mean and standard deviation (SD), and non-normal data as median with interquartile range (IQR). For statistical analysis, participants were classified into three groups based on fasting blood glucose levels: normoglycemic (<6.1 mmol/L), prediabetic (6.1–6.9 mmol/L), and diabetic (≥7.0 mmol/L). Group comparisons were performed using one-way analysis of variance (ANOVA) for parametric data and the Kruskal–Wallis test for nonparametric data, followed by appropriate post-hoc tests. The relationships between fasting blood glucose and lipid parameters were analyzed using Pearson's correlation coefficient for normally distributed variables and Spearman's rank correlation for non-normally distributed variables. All analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (Armonk, NY, USA). A two-tailed p-value of less than 0.05 was considered statistically significant. Results were presented in tables summarizing descriptive characteristics, group comparisons, and correlation analyses between fasting glucose and lipid parameters.

Results

Table 1: Descriptive characteristics of study participants (n = 60)

Variable	Mean ± SD	Minimum	Maximum
Age (years)	49.73 ± 12.54	25	80
Fasting Blood Glucose (mmol/L)	12.06 ± 4.31	4.48	21.37
After Breakfast Glucose (mmol/L)	16.88 ± 5.38	7.82	33.75
Total Cholesterol (mg/dL)	226.67 ± 45.86	140.98	369.72
LDL Cholesterol (mg/dL)	153.19 ± 42.51	102.45	250.19
Triglycerides (mg/dL)	223.57 ± 115.52	58.05	635.82
HDL Cholesterol (mg/dL)	40.88 ± 14.27	16.55	71.42

The study included 60 adult female participants with a mean age of 49.73 ± 12.54 years, ranging from 25 to 80 years. The mean fasting blood glucose level was 12.06 ± 4.31 mmol/L, while the mean after-breakfast glucose level was 16.88 ± 5.38 mmol/L, indicating that most participants had elevated glycemic values consistent with diabetes. The average total cholesterol concentration was 226.67 ± 45.86 mg/dL, and mean LDL cholesterol was 153.19 ± 42.51 mg/dL, suggesting a high prevalence of hypercholesterolemia in the sample. The mean triglyceride level was 223.57 ± 115.52 mg/dL, with a wide range extending up to 635.82 mg/dL, showing considerable interindividual variation. The mean HDL cholesterol concentration was 40.88 ± 14.27 mg/dL, indicating a generally low cardioprotective lipid fraction among participants.

Table 2: Distribution of fasting blood glucose (FBG) categories

FBG Category	Frequency (n)	Percentage (%)
Diabetic (≥7.0 mmol/L)	50	83.3
Impaired (5.6–6.9 mmol/L)	7	11.7
Normal (<5.6 mmol/L)	3	5

Most participants had fasting blood glucose levels in the diabetic range, with 83.3% (n = 50) meeting the threshold of ≥7.0 mmol/L. A smaller proportion, 11.7% (n = 7), fell within the impaired fasting glucose range of 5.6–6.9 mmol/L, while only 5.0% (n = 3) had normal fasting glucose levels below 5.6 mmol/L.

Table 3: Lipid profile (mg/dL) across fasting glucose categories (mmol/L)

FBG Category	CHOL (mg/dL)	LDL (mg/dL)	TG (mg/dL)	HDL (mg/dL)
Diabetic (≥7.0 mmol/L)	225.78 ± 43.74	151.53 ± 43.80	229.86 ± 107.69	39.53 ± 14.29
Impaired (5.6–6.9 mmol/L)	231.77 ± 70.60	160.72 ± 43.16	221.85 ± 176.05	51.80 ± 11.58
Normal (<5.6 mmol/L)	229.64 ± 9.97	163.28 ± 17.08	122.75 ± 17.84	37.79 ± 11.13

(Values are mean ± SD; glucose categories based on mmol/L.)

Lipid parameters showed varying trends across fasting glucose categories. Participants with diabetes had mean total cholesterol of 225.78 ± 43.74 mg/dL and LDL cholesterol of 151.53 ± 43.80 mg/dL, both elevated above optimal clinical ranges. Those with impaired fasting glucose had slightly higher mean total cholesterol (231.77 ± 70.60 mg/dL) and LDL cholesterol (160.72 ± 43.16 mg/dL) compared to diabetic participants, though the difference was not marked. Mean triglyceride levels were highest in the diabetic group (229.86 ± 107.69 mg/dL) and lowest among normoglycemic

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participants (122.75 ± 17.84 mg/dL). HDL cholesterol showed an inverse pattern, with the impaired fasting glucose group displaying the highest mean HDL level (51.80 ± 11.58 mg/dL), whereas both diabetic (39.53 ± 14.29 mg/dL) and normoglycemic (37.79 ± 11.13 mg/dL) participants had lower mean HDL values.

Table 4: Pearson correlation between glucose variables (mmol/L) and lipid parameters (mg/dL)

Glucose Variable	Lipid Variable	r	p-value
FBG	Total Cholesterol	-0.037	0.781
FBG	LDL Cholesterol	0.028	0.834
FBG	Triglycerides	0.02	0.88
FBG	HDL Cholesterol	-0.113	0.39
ABF	Total Cholesterol	-0.182	0.165
ABF	LDL Cholesterol	0.068	0.604
ABF	Triglycerides	-0.169	0.197
ABF	HDL Cholesterol	-0.296	0.022

(Pearson correlation coefficients; $p < 0.05$ considered significant.)

Correlation analysis between glucose and lipid parameters revealed weak linear relationships overall. Fasting blood glucose showed no significant correlation with total cholesterol ($r = –0.037$, $p = 0.781$), LDL cholesterol ($r=0.028, p=0.834$), triglycerides ($r=0.020, p=0.880$), or HDL cholesterol ($r = –0.113$, $p = 0.390$). After-breakfast glucose exhibited a similar pattern, with non-significant correlations for total cholesterol ($r = –0.182$, $p = 0.165$), LDL cholesterol ($r = 0.068$, $p = 0.604$), and triglycerides ($r = –0.169$, $p = 0.197$). However, a statistically significant negative correlation was observed between after-breakfast glucose and HDL cholesterol ($r = –0.296$, $p = 0.022$), indicating that higher postprandial glucose levels were associated with lower HDL concentrations.

Multiple linear regression analysis was performed to identify predictors of fasting blood glucose using lipid parameters and age as independent variables. The overall model was not statistically significant (adjusted $R^2 = 0.021$, $p = 0.63$), indicating that the included variables explained only about 2% of the variance in fasting glucose. None of the lipid parameters showed a significant association with fasting glucose levels. Total cholesterol ($B = –0.0077$, $p = 0.615$), LDL cholesterol ($B = 0.0054$, $p = 0.733$), triglycerides ($B = 0.0023$, $p = 0.678$), and HDL cholesterol ($B = –0.0212$, $p = 0.626$) all demonstrated weak and non-significant effects. Age also showed no significant relationship with fasting glucose ($B = –0.0531$, $p = 0.271$).

Discussion

This study documents a high burden of hyperglycemia and dyslipidemia among adult women in a rural Bangladeshi community, and it places these findings in the context of rapid rural urbanization in Bangladesh. Participants were middle aged, mean age 49.73 ± 12.54 years, and showed poor glycemic control, mean fasting blood glucose 12.06 ± 4.31 mmol/L and after breakfast glucose 16.88 ± 5.38 mmol/L. Lipid parameters reflected an atherogenic profile, total cholesterol 226.67 ± 45.86 mg/dL, LDL cholesterol 153.19 ± 42.51 mg/dL, triglycerides 223.57 ± 115.52 mg/dL, HDL cholesterol 40.88 ± 14.27 mg/dL. 83.3% were diabetic by fasting criteria, 11.7 percent had impaired fasting glucose, and only 5.0 percent were normoglycemic. These values align with community based Bangladeshi data reporting similar mean lipids and low HDL among rural adults, and they are consistent with recent national evidence that dyslipidemia exceeds fifty percent in adults and is more common in women, a pattern linked to lifestyle change with urbanization pressures that now reach rural districts [12, 13, 20]. The high diabetic share in our convenience screened sample exceeds national prevalence, which is expected in a screening cohort, but it mirrors the urban–rural gradient reported in national surveys, urban about 11.5 percent versus rural about 8.3 percent, and

Table 5: Multiple linear regression predicting fasting blood glucose (dependent variable: FBG, mmol/L)

Variable	B	SE	t-value	p-value
Constant	15.9782	3.9857	4.009	0.0002
Total Cholesterol (mg/dL)	-0.0077	0.0152	-0.506	0.615
LDL Cholesterol (mg/dL)	0.0054	0.0157	0.343	0.733
Triglycerides (mg/dL)	0.0023	0.0055	0.418	0.678
HDL Cholesterol (mg/dL)	-0.0212	0.0432	-0.49	0.626
Age (years)	-0.0531	0.0477	-1.112	0.271

Model summary: Adjusted $R^2 = 0.021$, $p = 0.63$ (not significant)

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the broader meta analytic signal that cardiometabolic risk is rising in non-urban settings as food environments and activity patterns shift with economic transition [9, 11].

Groupwise lipid means followed the expected direction but without statistical separation. Diabetic participants had raised triglycerides 229.86 ± 107.69 mg/dL and LDL cholesterol 151.53 ± 43.80 mg/dL, while HDL cholesterol was low at 39.53 ± 14.29 mg/dL. The impaired fasting glucose group showed slightly higher mean total cholesterol 231.77 ± 70.60 mg/dL and LDL cholesterol 160.72 ± 43.16 mg/dL than diabetics, differences that were not significant, and HDL cholesterol was highest in this intermediate group at 51.80 ± 11.58 mg/dL. Normoglycemic women had the lowest triglycerides 122.75 ± 17.84 mg/dL yet still showed relatively low HDL cholesterol 37.79 ± 11.13 mg/dL. Rural and national datasets in Bangladesh describe the same pattern of high triglycerides and low HDL across glycemic strata, with modest separation between impaired and diabetic groups, and a prominent female disadvantage for HDL cholesterol, supporting our observations and the role of shared environmental drivers linked to urbanization in rural areas [13, 20, 21]. Correlation results showed no significant linear association between fasting glucose and any lipid measure, fasting blood glucose versus total cholesterol $r = -0.037$, LDL cholesterol $r = 0.028$, triglycerides $r = 0.020$, HDL cholesterol $r = -0.113$, all $p > 0.05$. After breakfast glucose correlated negatively with HDL cholesterol, $r = -0.296$, $p = 0.022$, while associations with total cholesterol, LDL cholesterol, and triglycerides were not significant. Regional studies report similarly weak fasting glucose–lipid correlations, and a more consistent inverse relationship between postprandial glycemia and HDL cholesterol, likely reflecting acute dysmetabolism superimposed on chronic insulin resistance in South Asian women [12, 22-24]. In multivariable analysis, lipid parameters and age did not predict fasting glucose, adjusted R^2 0.021, model $p = 0.63$, which is consistent with large Bangladeshi datasets showing that dyslipidemia and hyperglycemia often coexist yet vary largely independently after adjustment for adiposity and behavioral factors that accompany rural urbanization, such as diet quality and physical inactivity [13, 20, 21].

Taken together, these findings indicate that rural women now bear a combined burden of uncontrolled diabetes and atherogenic dyslipidemia that resembles urban patterns, a signal of epidemiologic transition extending into rural Bangladesh as communities adopt urban lifestyles and face constrained access to preventive care [9, 11, 25]. The absence of strong linear coupling between fasting glucose and lipids should not be interpreted as clinical independence. Rather, it underscores the need to screen and manage both risks in parallel, since each adds to cardiovascular risk even when the other is controlled. Facility based studies show that lipid abnormalities persist despite treatment, and population surveys show low awareness and control, which supports integrated community screening that includes fasting glucose and a full lipid panel for women in rural settings, followed by practical counseling and linkage to care [26, 27]. This approach matches the observed data in this cohort, mean fasting blood glucose 12.06 mmol/L with HDL cholesterol 40.88 mg/dL, and addresses the broader structural drivers of risk tied to rapid rural urbanization in Bangladesh [12, 20].

Limitations of the Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

Conclusion

This study demonstrates that rural Bangladeshi women exhibit a high prevalence of both hyperglycemia and dyslipidemia, with mean fasting blood glucose of 12.06 ± 4.31 mmol/L and total cholesterol of 226.67 ± 45.86 mg/dL, reflecting poor metabolic control. Although fasting glucose showed no significant correlation with lipid parameters, post-breakfast glucose was inversely associated with HDL cholesterol, suggesting postprandial metabolic stress. The absence of a strong linear relationship between fasting glucose and lipid variables indicates that these risk factors often coexist independently, amplifying cardiovascular risk. These findings highlight a shifting health landscape in rural Bangladesh, where rapid urbanization and lifestyle changes are driving the emergence of metabolic disorders once confined to urban populations. Early community-based screening using simple biochemical markers can facilitate timely detection and prevention of diabetes and dyslipidemia. Public health interventions targeting diet, physical activity, and awareness among rural women are essential to mitigate the growing burden of metabolic and cardiovascular diseases.

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Ethical approval

The study was approved by the Institutional Ethics Committee

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