Prevalence Patterns of Dyslipidemia and Impaired Renal Function in Rural Bangladesh – A Cross-Sectional Profile

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ABSTRACT

Background: CKD and dyslipidemia are emerging public health burdens in Bangladesh, especially in rural areas where structured screening is scarce. This study aimed to assess the interrelationship between renal dysfunction and lipid abnormalities comprehensively to delineate preventive strategies. **Methods & Materials:** This cross-sectional study was conducted in a rural community in the Narayanganj District of Bangladesh from July, 2023 to June, 2024, including 201 adults with a mean age of 41.4±13.8 years. Comprehensive clinical assessment for anthropometric measurements, blood pressure, and biochemical analyses was performed. Traditional lipid markers (triglycerides, total cholesterol, LDL-C, HDL-C) and non-traditional markers such as apolipoprotein A1, apolipoprotein B, and lipoprotein(a) were assayed along with renal function parameters like serum creatinine, estimated glomerular filtration rate, and urinary albumin-creatinine ratio. Association was assessed using Pearson correlation analyses and unpaired t-tests. **Results:** The prevalence of traditional dyslipidemia was 31.8%, while non-traditional dyslipidemia affected 33.8% of participants. Albuminuria (ACR ≥30 mg/g) was present in 23.4% of the cohort. Significant positive correlations were observed between triglycerides, total cholesterol, and LDL-C with serum total protein, albumin, and uric acid (p<0.05). Conversely, these lipid markers showed inverse correlations with eGFR (r=-0.242 to -0.342, p<0.001). Participants with combined renal impairment exhibited significantly higher mean values of triglycerides (212.74±96.65 vs 170.90±106.07 mg/dL, p=0.010), total cholesterol (217.94±42.66 vs 187.58±46.59 mg/dL, p<0.001), and LDL-C (137.43±38.25 vs 114.39±37.51 mg/dL, p<0.001) compared to those with normal renal status. **Conclusion:** This study demonstrated a high prevalence of dyslipidemia and early renal dysfunction among rural Bangladeshi people and significant associations between traditional lipid abnormalities and declining renal function. The findings highlight the need for integrated screening programs targeting metabolic and renal health in resource-limited settings in order to facilitate early intervention and reduce disease progression.

Keywords: *Chronic kidney disease, Dyslipidemia, Albuminuria, Apolipoprotein*

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Introduction

CKD has emerged as a major health crisis globally, affecting an estimated 850 million people, and is considered one of the leading causes of morbidity and mortality worldwide [1]. The prevalence of CKD in Bangladesh is very high, about 22.48%, which is higher than the global estimates; this disease burden is highly concentrated in rural and disadvantaged populations of Bangladesh, where access to health services is still limited [2]. Recent community-based screening studies conducted in rural Bangladesh have recorded a prevalence of CKD of 22%, which is significantly higher than that of urban areas, thus reflecting serious shortcomings regarding the early diagnosis and management of the disease [3]. Dyslipidemia is one of the most important modifiable risk factors contributing to both cardiovascular disease and renal dysfunction. It has been shown in Bangladeshi adults that the prevalence of dyslipidemia is alarmingly high, at 89%, with low HDL cholesterol being the most prevalent abnormality [4]. The mechanisms behind how these lipid abnormalities influence CKD progression are complex and multifaceted, relating to endothelial dysfunction, oxidative stress, inflammation, and direct glomerular injury via the accumulation of lipids within renal cells [5]. CKD is characterized by a distinct pattern of dyslipidemia, including elevated triglycerides, low HDL cholesterol, and altered lipoprotein composition that establishes a vicious cycle, accelerating further metabolic and renal deterioration [6]. Traditional lipid parameters, including total cholesterol, triglycerides, LDL cholesterol, and HDL cholesterol, have been widely investigated regarding their relation to cardiovascular risk. However, there is growing evidence that non-traditional lipid markers such as apolipoprotein B (ApoB), apolipoprotein A1 (ApoA1), and lipoprotein(a) [Lp(a)] may offer improved predictive value for both cardiovascular events and renal outcomes. ApoB-containing lipoproteins have been implicated in the initiation and perpetuation of atherosclerosis, while accumulation of these particles in glomerular structures contributes to progressive renal dysfunction [7]. Hyperlipidemia was shown to cause ApoB accumulation in the glomeruli, glomerular hypertrophy, increased urinary albumin excretion, and continuous renal injury [8]. In a study conducted on CKD in type 2 diabetes patients, a prevalence of 21.3% was reported in Bangladesh, while important risk factors were identified to include female gender, hypertension, and advancing age [9]. However, there is still limited comprehensive data available on the interrelationship between the various lipid parameters and indicators of renal function in the general rural population. The estimation of the disease burden and the implementation of effective prevention are necessary through community-based screening activities when resources are poor [10]. Thus, the identification of early markers of renal dysfunction, along with lipid abnormalities, could enable targeted interventions before the disease has fully progressed to end-stage renal disease, which carries with it devastating socioeconomic consequences in low-income populations. With the growing prevalence of diabetes, hypertension, and obesity, established risk factors for dyslipidemia and CKD need of the hour is to characterize the lipid-renal health nexus in rural communities. This study aimed to assess the prevalence of dyslipidemia and impaired renal function in a rural Bangladeshi population and investigate traditional and non-traditional lipid markers associated with key parameters of renal function.

Methods & Materials

This cross-sectional observational study was carried out over 12 months at the National Institute of Kidney Diseases and Urology (NIKDU), Dhaka, in collaboration with the Kidney Care and Research Center (KCRC), which operates a community-based screening program in Baidyerbazar Union of Sonargaon Upazila, Narayanganj District in Bangladesh from July, 2023 to June, 2024. Adults aged 18 years or older residing permanently in the community were considered eligible, and recruitment followed a systematic sampling approach using the local voter list as the sampling frame. Individuals were invited to weekly screening sessions at community health centers, and enrollment proceeded consecutively after confirming eligibility. Exclusion criteria included pregnancy or lactation, known malignancy requiring active therapy, recent acute kidney injury, chronic kidney disease under specialist care, severe cognitive impairment, or inability to provide adequate biological samples. A total of 201 participants meeting the inclusion criteria were considered for this study. After written informed consent, each participant underwent a detailed interview capturing sociodemographic characteristics, medical history, and lifestyle factors. Standardized anthropometric measurements were obtained, including height, weight, and BMI, along with resting blood pressure recorded twice using a calibrated sphygmomanometer. Fasting venous blood samples were collected after an overnight fast of at least 8 hours and analyzed at a KCRC-affiliated laboratory using established enzymatic and immunoturbidimetric methods. The biochemical panel included a full lipid profile, triglycerides, total cholesterol, HDL, LDL, apolipoprotein A1, apolipoprotein B, lipoprotein(a), alongside fasting glucose, HbA1c, serum creatinine, uric acid, hemoglobin, total protein, and albumin. Spot urine samples were analyzed for routine parameters and albumin-creatinine ratio (ACR), and eGFR was calculated using the MDRD equation. Dyslipidemia and albuminuria classifications were based on standard diagnostic thresholds, and abnormal renal status was defined as eGFR <60 mL/min/1.73m² and/or ACR ≥30 mg/g. Data were entered and analyzed on SPSS version 26, including descriptive analysis, Pearson correlations for continuous variables, and unpaired t-tests for group comparisons, with statistical significance set at $p<0.05$. Ethical approval was obtained, and all participants gave written informed consent; individuals with clinically significant abnormalities received appropriate counseling and referral.

Results

Table I shows the baseline sociodemographic and clinical profile of the study participants. The mean age in this cohort is 41.4±13.8 years, and gender distribution was relatively balanced (47.8% male, 52.2% female). High prevalence rates regarding overweight and obesity status (combined rate of 48.2%), high blood pressure (19.9%), diabetes mellitus (14.4%), and clinical nephropathy (12.9%) were noted. Similarly, blood pressure parameters showed values on the borderline of hypertension, with a mean of 129±18 and 81±11 mmHg for systolic and diastolic blood pressure, respectively, indicating a very high burden of cardiometabolic risk factors in the rural population under consideration that necessitates targeted intervention strategies.

Table I
Sociodemographic and Clinical Characteristics of the Study Population (*n* = 201).

Variable	Frequency (n)	Percentage (%)
Age Groups (years)	-	-
≤30	45	22.4%
31-40	63	31.3%
41-50	48	23.9%
51-60	25	12.4%
>60	20	10%
Mean ± SD	41.4 ± 13.8	-
Gender	-	-
Male	96	47.8%
Female	105	52.2%
BMI Categories	-	-
Underweight (<18.5)	10	5%
Normal (18.5-24.9)	94	46.8%
Overweight (25.0-29.9)	76	37.8%
Obese (≥30.0)	21	10.4%
Mean ± SD		25.0 ± 4.2
Primary Comorbidities	-	-
Diabetes mellitus	29	14.4%
Hypertension	40	19.9%
Clinical nephropathy	26	12.9%
Blood Pressure	-	-
Systolic Blood Pressure	129 ± 18	
Diastolic Blood Pressure	81 ± 11	

Table II provides an overview of some important renal and metabolic biomarkers among the participants. A mean eGFR of 94.28±23.41 mL/min/1.73m² indicates that the majority had preserved renal function, although a wide range of values from 6 to 148 mL/min/1.73m² suggests marked heterogeneity with cases of severe impairment. Mean urinary ACR was 37.57±89.54 mg/g, with maximum values exceeding 700 mg/g, reflecting significant albuminuria in some participants. Glycemic parameters of a mean of 6.26±2.36 mmol/L of fasting glucose and 6.17±1.57% of HbA1c indicate suboptimal control of diabetes among affected participants. Mean uric acid was elevated at 5.57±1.11 mg/dL and may reflect both metabolic syndrome and renal dysfunction, as hyperuricemia has bidirectional associations with CKD progression.

Table II
Renal Function, Glycemic Status, and Serum Biochemistry of Participants (*n* = 201).

Parameter	Mean ± SD	Range (min-max)
Serum creatinine (mg/dL)	0.82 ± 0.22	0.50-1.80
eGFR (mL/min/1.73m²)	94.28 ± 23.41	6-148
Urine ACR (mg/g)	37.57 ± 89.54	1.6-713.5
Fasting blood sugar (mmol/L)	6.26 ± 2.36	4.1-20.0
HbA1c (%)	6.17 ± 1.57	4.6-14.6
Uric acid (mg/dL)	5.57 ± 1.11	2.2-10.3
Serum total protein (g/dL)	7.59 ± 0.73	5.4-8.9
Serum albumin (g/dL)	4.84 ± 0.57	3.0-6.0
Hemoglobin (g/dL)	13.52 ± 1.68	8.4-16.8

Table III describes the lipid profile of the study participants and shows alarming dyslipidemia patterns. The mean triglycerides were 182.98±104.94 mg/dL, and total cholesterol was 196.35±47.44 mg/dL, indicating borderline elevation in the population. Notably, the mean HDL cholesterol was markedly low at 38.97±6.65 mg/dL, representing a critical cardiovascular and renal risk factor. Other non-traditional markers included ApoA-I at 1.39±0.97 g/L, ApoB at 1.07±0.45 g/L, and Lp(a) at 20.02±12.78 mg/dL; all provided added value to traditional lipid parameters in terms of risk stratification, with an elevated ApoB indicative of increased atherogenic lipoprotein burden that might contribute to an acceleration in renal disease progression.

Table III
Traditional and Non-Traditional Lipid Markers of the Study Population (*n* = 201).

Lipid Marker	Mean ± SD
Triglycerides (mg/dL)	182.98 ± 104.94
Total cholesterol (mg/dL)	196.35 ± 47.44
LDL cholesterol (mg/dL)	121.04 ± 39.07
HDL cholesterol (mg/dL)	38.97 ± 6.65
ApoA-I (g/L)	1.39 ± 0.97
ApoB (g/L)	1.07 ± 0.45
Lipoprotein(a) (mg/dL)	20.02 ± 12.78

Table IV quantifies disease burden in this rural cohort. Almost one-third of participants demonstrated traditional dyslipidemia (31.8%) and non-traditional dyslipidemia (33.8%), indicating considerable metabolic derangement. The 23.4% prevalence of significant albuminuria (ACR ≥30 mg/g) represents early kidney damage and substantially elevated cardiovascular risk.

Table IV
Prevalence of Dyslipidemia and Albuminuria (*n* = 201).

Category	Frequency (n)	Percentage (%)
Traditional dyslipidaemia	64	31.8%
Non-traditional dyslipidaemia	68	33.8%
Albuminuria (ACR)		
ACR < 30 mg/g	154	76.6%
ACR ≥ 30 mg/g	47	23.4%

Table V shows that traditional lipid markers are significantly associated with renal function parameters. Triglycerides, total cholesterol, and LDL-C were positively correlated with serum total protein, albumin, and uric acid (all $p<0.05$), indicating a coordinated metabolic derangement. Importantly, these lipid markers were inversely correlated with eGFR (r = -0.242 to -0.342, $p<0.001$), indicating higher lipid levels with declining renal function.

Table V
Pearson Correlation Between Lipid Markers and Renal Function Parameters (*n* = 201).

Renal Parameter	Lipid Marker	r	p-value
Serum total protein	TG	0.162	0.022
	Total cholesterol	0.405	<0.001
	LDL	0.326	<0.001
Uric acid	TG	0.298	<0.001
	Total cholesterol	0.395	<0.001
	LDL	0.296	<0.001
Serum albumin	TG	0.235	0.001
	Total cholesterol	0.403	<0.001
	LDL	0.310	<0.001
Serum creatinine	TG	0.020	0.783
	Total cholesterol	0.164	0.020
	LDL	0.190	0.007
eGFR	TG	-0.242	0.001
	Total cholesterol	-0.342	<0.001
	LDL	-0.258	<0.001

Table VI compares participants with abnormal versus normal renal status according to combined ACR and eGFR criteria. Compared with those who had normal renal status, participants with renal impairment were older (47.81±15.11 vs 38.86±12.43 years, p<0.001), had higher serum creatinine (0.88±0.29 vs 0.79±0.17 mg/dL, p=0.009), and had remarkably higher ACR (108.62±144.34 vs 8.75±5.44 mg/g, p<0.001). Importantly, compared with those who had normal renal function, the abnormal renal function group showed significantly worse lipid profiles across triglycerides, total cholesterol, and LDL-C (all p≤0.010), together with higher systolic blood pressure (138.05±20.72 vs 128.09±17.70 mmHg, p=0.001), confirming the clustering of cardiovascular-renal-metabolic risk factors.

Table VI
Comparison of Renal and Metabolic Parameters by Renal Impairment Status (ACR + eGFR Combined) (*n* = 201).

Variable	Abnormal (n = 58) Mean ± SD	Normal (n = 143) Mean ± SD	p-value
Age (years)	47.81 ± 15.11	38.86 ± 12.43	<0.001
BMI (kg/m²)	25.84 ± 5.01	24.66 ± 3.76	0.071
Serum creatinine (mg/dL)	0.88 ± 0.29	0.79 ± 0.17	0.009
eGFR (mL/min/1.73m²)	93.87 ± 17.83	98.49 ± 17.83	<0.001
ACR (mg/g)	108.62 ± 144.34	8.75 ± 5.44	<0.001
Triglycerides (mg/dL)	212.74 ± 96.65	170.90 ± 106.07	0.010
Total cholesterol (mg/dL)	217.94 ± 42.66	187.58 ± 46.59	<0.001
LDL (mg/dL)	137.43 ± 38.25	114.39 ± 37.51	<0.001
HDL (mg/dL)	39.86 ± 7.01	38.60 ± 6.49	0.225
SBP (mmHg)	138.05 ± 20.72	128.09 ± 17.70	0.001

Table VII shows the relationship in reverse, comparing participants with abnormal versus normal combined traditional lipid profiles (TG + TC + LDL). Subjects with dyslipidemia had significantly higher serum creatinine (0.83±0.21 vs 0.75±0.21 mg/dL, p=0.036), lower eGFR (91.70±23.68 vs 105.00±19.06 mL/min/1.73m², p=0.001), and increased uric acid (5.69±1.11 vs 5.03±0.93 mg/dL, p=0.001). Notably, non-traditional markers such as ApoB (1.10±0.42 vs 0.91±0.53 g/L, p=0.019) and Lp(a) (19.82±13.93 vs 14.20±9.24 mg/dL, p=0.017) were also significantly higher in the dyslipidemia group.

Table VII
Comparison of Participants with Abnormal vs Normal TG + TC + LDL Cluster (*n* = 201).

Variable	Abnormal (n = 162) Mean ± SD	Normal (n = 39) Mean ± SD	p-value
Age (years)	42.12 ± 13.13	38.64 ± 16.31	0.159
Serum creatinine (mg/dL)	0.83 ± 0.21	0.75 ± 0.21	0.036
eGFR (mL/min/1.73m²)	91.70 ± 23.68	105.00 ± 19.06	0.001
ACR (mg/g)	43.09 ± 97.62	14.64 ± 33.91	0.075
FBS (mmol/L)	6.44 ± 2.54	5.49 ± 1.14	0.023
Uric acid (mg/dL)	5.69 ± 1.11	5.03 ± 0.93	0.001
TG (mg/dL)	201.53 ± 108.47	105.90 ± 23.43	<0.001
Total cholesterol (mg/dL)	211.40 ± 39.23	133.82 ± 18.63	<0.001
LDL (mg/dL)	132.01 ± 34.98	75.46 ± 14.25	<0.001
HDL (mg/dL)	39.31 ± 6.59	37.51 ± 6.82	0.129
SBP (mmHg)	132.11 ± 19.45	126.21 ± 17.09	0.083
DBP (mmHg)	81.76 ± 11.32	76.64 ± 9.40	0.010
ApoB (g/L)	1.10 ± 0.42	0.91 ± 0.53	0.019
Lp(a) (mg/dL)	19.82 ± 13.93	14.20 ± 9.24	0.017

Discussion

This cross-sectional study provides comprehensive evidence of a substantial dyslipidemia burden and early renal dysfunction in the rural Bangladeshi population and significant associations of traditional lipid abnormalities with declining renal function. These results provide important epidemiological data from an underserved region where systematic health surveillance remains limited. The observed dyslipidemia prevalence was 31.8% for traditional markers and 33.8% for non-traditional markers. Bikbov et al. reported an overall dyslipidemia prevalence of 89% in adult Bangladeshi populations, while 78.8% of participants had low HDL cholesterol [11]. Our study confirmed a particularly severe HDL-C deficiency (mean 38.97±6.65 mg/dL), a hallmark of South Asian populations, driven by a pattern influenced by genetic predisposition, dietary factors, and components of metabolic syndrome [12]. The prevalence of albuminuria was 23.4%, showing a high level of early kidney damage and calling for immediate concern, since albuminuria is an independent predictor of cardiovascular events, renal disease progression, and mortality [13]. The strong negative correlations between traditional lipid parameters (triglycerides, total cholesterol, LDL-C) and eGFR ($r = -0.242$ to -0.342, $p < 0.001$) confirm the mechanistic relationships observed in various populations. Suh et al. reported that dyslipidemia is a potentially modifiable cardiovascular risk factor for CKD, although therapeutic strategies should be individualized because of the peculiar lipid abnormalities in this population [6]. The pathophysiological mechanisms of dyslipidemia leading to renal injury include lipid-mediated glomerular endothelial dysfunction, mesangial cell foam cell formation, tubular epithelial cell injury, and stimulation of both inflammatory and fibrotic pathways [14]. It has been shown that the association between high ApoB and increased risk for CKD remained significant even after adjustments for traditional risk factors, thus suggesting that mechanisms other than classical atherosclerosis may play roles in renal damage [7]. These results are in accordance with the established patterns of CKD-associated dyslipidemia by Matsushita et al. [13], as participants with abnormal renal status had significantly higher triglycerides (212.74 vs 170.90 mg/dL, p=0.010), total cholesterol (217.94 vs 187.58 mg/dL, p<0.001), and LDL-C (137.43 vs 114.39 mg/dL, p<0.001). CKD patients characteristically demonstrate elevated triglycerides together with low HDL cholesterol and increased apolipoprotein B, due to impaired lipolysis that results in the accumulation of atherogenic remnant particles [15]. The bidirectional nature of this relationship, which dyslipidemia accelerates CKD progression while CKD exacerbates dyslipidemia-creates a vicious cycle requiring integrated therapeutic strategies [16]. Whereas the inclusion of non-traditional lipid markers, such as ApoB, ApoA-I, and Lp(a), provides enhanced risk stratification beyond conventional lipid panels. High ApoB, low ApoA1, and a higher ApoB/ ApoA1 ratio have been associated with CKD progression, cardiovascular events, and post-transplant complications [17]. It was consistent that ApoB at p=0.019 and Lp(a) at p=0.017 were significantly higher in dyslipidemic participants, thus supporting their inclusion in regular screening protocols. Liu et al. demonstrated that Lp(a) is an independent risk factor for incident CKD with genetically determined elevations contributing to the burden of both cardiovascular and renal disease [18]. The profound clustering of cardiovascular-renal-metabolic risk factors in our cohort, with renal impairment being associated with higher age, increased blood pressure, poorer glycemic control, and adverse lipid profiles, underlines the need for holistic, integrated care models. Mach et al. recommended statin therapy for most CKD patients, with treatment goals including non-HDL cholesterol below 130 mg/dL and LDL-C below 100 mg/dL for those with eGFR 30-59 mL/min/1.73m^2 [19]. However, there are substantial barriers to the implementation of these recommendations in rural Bangladesh, including limited healthcare infrastructure, medication costs, and insufficient awareness among both patients and primary care providers. Our findings have major implications for public health. Community-based screening studies in rural Bangladesh reported 22% prevalence of CKD, which is markedly higher than urban prevalence rates and thus calls for an urgent scale-up of surveillance and intervention programs [3]. Indeed, early detection by integrated screening for lipid abnormalities and renal dysfunction may facilitate timely intervention before the development of end-stage renal disease, which carries devastating socioeconomic consequences in resource-limited settings. This should involve training community health workers, creating peripheral laboratory capacity, establishing referral pathways, and implementing subsidized or free medication programs for those individuals found at high risk [20]. Our study adds notable findings from an underrepresented rural population and clearly demonstrates the feasibility of community-based integrated screening programs. The comprehensive assessment of both traditional and emerging lipid biomarkers alongside detailed renal function parameters provides a robust foundation for future longitudinal investigations to establish temporal relationships and evaluate intervention efficacy.

Limitations

The cross-sectional design does not allow the establishment of a temporal or causal relationship between dyslipidemia and renal dysfunction. Single-center recruitment from one rural district may limit generalization to other regions of Bangladesh, given demographic, dietary, and environmental differences.

Conclusion

This study demonstrated a high prevalence of dyslipidemia and early renal impairment among rural Bangladeshi people and a strong association between lipid abnormalities and declining renal function. The study found that about one-third of participants had dyslipidemia, while one-quarter had significant albuminuria, reflecting a high prevalence of undiagnosed metabolic and renal diseases. The presence of strong inverse correlations between conventional lipid markers and eGFR, along with an increase in non-traditional biomarkers in high-risk subgroups, helps further establish the vicious cycle between lipid metabolism and renal health. Such findings point out the urgent need for integrated, community-based screening programs that include testing for metabolic and renal diseases in rural areas, to facilitate early detection and timely intervention that could prevent disease progression and decrease the considerable burden of cardiovascular-renal complications.

Recommendations

There is a need for longitudinal cohort studies to establish temporal relationships between lipid abnormalities and the progression of CKD, to assess the effects of lipid-lowering interventions on renal outcomes, and to determine the predictive value of non-traditional biomarkers. Scale-up of community-based integrated screening programs that feature point-of-care testing for both metabolic and renal parameters will be crucial to expand early detection and thus enable timely referral and treatment.

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