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SPECTRUM OF DYSLIPIDEMIA IN CHRONIC KIDNEY DISEASE PATIENTS

General Medicine

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ABSTRACT

Introduction: Chronic Kidney Disease (CKD) is a progressive condition characterized by declining renal function, commonly resulting from diabetes, hypertension, and other comorbidities. It is associated with significant metabolic disturbances, particularly dyslipidemia, which contributes to increased cardiovascular risk. Dyslipidemia in CKD typically presents as elevated triglycerides, low HDL, and variable LDL levels due to impaired lipid metabolism. This study investigates the lipid profile patterns among CKD patients and their implications on disease severity and cardiovascular outcomes. **Objectives:** To determine the pattern of dyslipidemia and the spectrum of dyslipidemia among chronic kidney disease patients and comparing the patterns with healthy controls and to investigate the relationship between dyslipidemia and the severity of chronic kidney disease. **Methods:** This hospital-based case-control study was conducted in Barabanki and Faizabad, India, from November 2022 to October 2025. A total of 100 participants were enrolled—50 CKD patients and 50 age- and sex-matched healthy controls. Data collection included clinical assessments, fasting lipid profiles, and kidney function tests. Exclusion criteria involved conditions or medications that could independently affect lipid levels. Lipid parameters were analyzed using enzymatic methods and Friedewald's formula; eGFR was calculated using the Cockcroft-Gault equation. **Results:** CKD patients showed significantly higher levels of total cholesterol, triglycerides, LDL, and VLDL, with lower HDL compared to controls ($p<0.0001$). Dyslipidemia prevalence was 90% for cholesterol, 86% for triglycerides, and 62% for low HDL. Advanced CKD stages correlated with more severe lipid abnormalities and greater cardiovascular risk. **Conclusion:** The findings underscore the high prevalence of dyslipidemia in CKD and its association with disease progression. Routine lipid monitoring and early intervention are essential to reduce cardiovascular complications and improve patient outcomes.

KEYWORDS

Chronic Kidney Disease, Dyslipidemia, Cardiovascular Risk, Lipid Profile, Hemodialysis

INTRODUCTION

Chronic kidney disease (CKD) is "A state, in which there is a loss of normal function, of kidneys, due to various factors, which include infections, auto-immune diseases, diabetes mellitus and other endocrine disorders, cancer, and toxic chemicals." It shares numerous risk factors with cardiovascular diseases, such as hypertension and diabetes. [1] And characterised by a GFR of less than 60 ml/min and proteinuria for three months. Given that aberrant renal function affects nearly every organ system in the body, its morbidity is more widely recognised than its mortality. [2] The prevalence and incidence of end-stage renal disease (ESRD), which is determined by the necessity of dialysis or a transplant, have increased by twofold over the past decade. [3] The annual mortality rate of recipients of dialysis exceeds 20%. As co- morbidities and the cost of caring for CKD patients are substantial, it is imperative to increase screening and early detection of CKD when interventions to delay or prevent progression to ESRD may be effective.

There are numerous causes of chronic kidney disease (CKD), with hypertension and diabetes being the most prevalent in developed countries. Nevertheless, various aetiologies, including infectious, autoimmune, genetic, obstructive, and ischaemic injury, are also prevalent. In terms of susceptibility, ethnic disparities exist, with Mexican-Americans and non-Hispanic Blacks experiencing a higher prevalence than Caucasians. [4-6]

Dyslipidaemia is one of the most common side effects of CKD. It is frequently linked to the decline of renal function and is noticeable even in the very early phases of the disease. Abnormalities in lipoprotein metabolism may be observed during the initial stages of CRF, and their function may decline in tandem with renal function. Recent research has shown that dyslipidaemias can exacerbate renal function and lead to cardiovascular disease. [7]

A dyslipidaemia characterised by elevated triglycerides and low HDL cholesterol is associated with CKD. LDL-cholesterol levels (and, as a result, total cholesterol) are typically not elevated, despite the correlation between proteinuria and triglycerides and cholesterol. Lipoprotein lipase and the LDL- receptor are downregulated in CKD, and the delayed catabolism of triglyceride-rich lipoproteins-which are produced at the same rate-is the cause of the elevated triglycerides in CKD. [8] Lower apoA-I levels and higher apoB/apoA-I ratios are associated with CKD due to decreased hepatic expression [9]. Increased CETP activity and decreased LCAT activity contribute to the reduction of HDL-cholesterol levels. In CKD, HDL cholesterol levels are lower, and it functions less effectively as an antioxidant and anti-inflammatory. [10] In a study, only 15% of 317 peritoneal dialysis patients and 20% of CV study participants had "normal" lipid levels, which are defined as LDL<130 mg/dl, HDL > 40, and triglycerides < 150. [12] A more extensive investigation which assessed dyslipidaemia in over 21,000 incident dialysis patients revealed an 82% prevalence of the condition. The study also suggested a threshold of non-HDL cholesterol of 100 mg/dl (2.6 mmol/L) to identify dyslipidaemia in subjects with CKD stage 5. [13] The Patients with chronic kidney disease (CKD) and dialysis exhibit a distinct spectrum of dyslipidaemia in comparison to the general population. Depending on the stage of CKD, it is characterised by significant variations and involves all lipoprotein classes. [18, 19]

The risk of developing potentially detrimental lipid abnormalities and ultimately developing ESRD is inevitably higher for these patients. [20] The clinical prognosis of patients with chronic kidney disease is therefore contingent upon the assessment of their lipid profile. [21]. The study aims to determine the spectrum of dyslipidemia in CKD patients, evaluate its relationship with disease severity, and compare lipid abnormalities between CKD patients and healthy controls. The ultimate goal is to inform improved diagnostic and therapeutic strategies.

MATERIALS AND METHODS

This case-control study aims to assess lipid profile abnormalities in chronic kidney disease (CKD) patients in hospitals across Barabanki and Faizabad, Uttar Pradesh, India, from November 2022 to October 2025. A total of 100 subjects (50 CKD cases and 50 age- and sex-matched healthy controls) were selected using convenient random sampling. The sample size was calculated based on a 63.5% prevalence of dyslipidemia in CKD patients, with a 14% margin of error and a 10% attrition bias. CKD cases were diagnosed based on radiological and biochemical evidence, with common comorbidities such as diabetes and hypertension included, while controls had normal renal function. Exclusion criteria involved factors affecting lipid profiles, such as lipid-lowering drugs, corticosteroids, liver disease, and excessive alcohol consumption. Data collection involved demographic and clinical assessments, fasting blood samples, and kidney function and lipid profile testing using standardized biochemical methods. The Cockcroft-Gault formula estimated

glomerular filtration rate (eGFR), and lipid parameters were measured using enzymatic methods and Friedewald's formula. This study aims to provide insights into lipid abnormalities in CKD patients, contributing to better management and prevention strategies.

RESULTS

Table-1: Age Distribution Amongst CKD Cases And Healthy Control Groups.

Age Group	CASES [n=50]	±SD/%	CONTROLS [n=50]	±SD/%	p-value
Mean±SD	57.83	8.71	55.92	7.26	t=1.191 p=0.2365
44-53	13	26.00%	15	30.00%	X=0.4047 p=0.9393
54-63	12	24.00%	13	26.00%	
64-73	12	24.00%	10	20.00%	
74-84	13	26.00%	12	24.00%	

The mean age of CKD cases (57.83±8.71 years) was slightly higher than that of the control group (55.92±7.26 years), but this difference was not statistically significant (t=1.191, p=0.2365). The age group distribution showed similar proportions in both groups: 26% of CKD cases were aged 44-53 years compared to 30% in controls, 24% were in the 54-63 years range versus 26% in controls, 24% in the 64-73 years group versus 20% in controls, and 26% in the 74-84 years group versus 24% in controls. The overall age distribution did not differ significantly between cases and controls (X^2=0.4047, p=0.9393), confirming that age is well matched among the case and controls' patients.

Table-2: Gender Distribution Amongst CKD Cases And Healthy Control Groups.

Gender	CASES [n=50]	%	CONTROLS [n=50]	%	p-value
Female	25	50.00%	23	46.00%	X=0.1603
Male	25	50.00%	27	54.00%	p=0.6889

The gender distribution among CKD cases (n=50) and healthy controls (n=50) was nearly identical, with 50% males and 50% females in the CKD group, compared to 54% males and 46% females in the control group. The statistical analysis showed no significant difference in gender distribution between the two groups (X^2=0.1603, p=0.6889), indicating that gender was evenly matched.

Table-3: Dyslipidaemia Pattern (Abnormality) Amongst CKD Cases And Healthy Control Groups.

Lipid Parameter	CASES [n=50]	CONTROLS [n=50]	p-value
Total Cholesterol (mg/dL)	45 (90.00%)	10 (20.00%)	X=49.49 **p<0.0001***
Triglycerides (mg/dL)	43 (86.00%)	12 (24.00%)	X=38.83 **p<0.0001***
HDL (mg/dL)	31 (62.00%)	8 (16.00%)	X=22.24 **p<0.0001***
LDL (mg/dL)	11 (22.00%)	5 (10.00%)	X=2.679 p=0.1017
VLDL (mg/dL)	33 (66.00%)	9 (18.00%)	X=23.65 **p<0.0001***

Total cholesterol levels were abnormal in 90% of CKD cases, compared to only 20% in controls, with a highly significant difference (X^2=49.49, p<0.0001). Similarly, 86% of CKD patients had elevated triglyceride levels, compared to 24% in controls (X^2=38.83, p<0.0001). Low HDL levels, which increase cardiovascular risk, were present in 62% of CKD cases, compared to 16% in controls (X^2=22.24, p<0.0001). VLDL abnormalities were also significantly more common in CKD cases (66%) compared to 18% in controls (X^2=23.65, p<0.0001). In contrast, LDL abnormalities were found in 22% of CKD cases and 10% of controls, but this difference was not statistically significant (X^2=2.679, p=0.1017).

Table-4: Correlation Of eGFR Vs. Lipid Profile In CKD Cases And Healthy Controls.

Correlation of eGFR vs.	Pearson r	95% confidence interval	P value
Total Cholesterol (mg/dL)	-0.1461	-0.3357 to 0.05499	0.1534
Triglycerides (mg/dL)	-0.5981	-0.7125 to -0.4526	**<0.0001***
HDL (mg/dL)	0.217	0.01831 to 0.3991	**0.0328***
LDL (mg/dL)	-0.64	-0.7444 to -0.5050	**<0.0001***
VLDL (mg/dL)	-0.2335	-0.4137 to -0.03572	**0.0213***

The correlation analysis between estimated glomerular filtration rate (eGFR) and lipid profile in CKD cases and healthy controls highlights significant associations between kidney function and lipid abnormalities. Triglycerides (Pearson r = -0.5981, p<0.0001) and LDL (Pearson r = -0.64, p<0.0001) showed a strong negative correlation with eGFR, indicating that as kidney function declines, triglycerides and LDL levels significantly increase. VLDL also showed a weaker but statistically significant negative correlation with eGFR (r = -0.2335, p=0.0213). In contrast, HDL exhibited a positive correlation with eGFR (r = 0.217, p=0.0328), suggesting that better kidney function is associated with higher protective HDL levels. However, total cholesterol did not show a significant correlation with eGFR (r = -0.1461, p=0.1534).

DISCUSSION

Chronic Kidney Disease (CKD) significantly disrupts various organ systems, with the cardiovascular system being among the most affected. A major comorbidity observed in CKD patients is dyslipidemia, which contributes heavily to increased cardiovascular risk. Dyslipidemia in CKD is characterized by abnormal lipid profiles, notably elevated total cholesterol, triglycerides, low-density lipoprotein (LDL), very-low-density lipoprotein (VLDL), and reduced high-density lipoprotein (HDL). The presence of diabetes and hypertension in CKD patients further exacerbates these lipid abnormalities.

The study in focus aimed to evaluate the patterns of dyslipidemia in CKD patients in comparison to healthy controls and explore its correlation with renal function, primarily using estimated glomerular filtration rate (eGFR) as a measure. Findings indicate that CKD patients showed a markedly altered lipid profile. Triglycerides (212.79 ± 47.02 mg/dL vs. 153.68 ± 25.75 mg/dL), VLDL (40.06 ± 10.44 mg/dL vs. 29.80 ± 5.46 mg/dL), and total cholesterol (235.57 ± 26.95 mg/dL vs. 182.65 ± 21.71 mg/dL) were significantly elevated in CKD cases compared to controls (p<0.0001). HDL levels were significantly reduced (32.16 ± 4.26 mg/dL vs. 51.62 ± 5.57 mg/dL), while LDL was moderately higher in CKD patients (112.45 ± 19.33 mg/dL vs. 103.86 ± 11.47 mg/dL, p=0.0081).

Age and gender were not distinguishing factors between CKD cases and controls. The mean ages of CKD patients and controls were 57.83 and 55.92 years, respectively, with no statistically significant difference (p=0.2365). Similarly, gender distribution showed no significant variation (p=0.7945). These findings are consistent with earlier studies by Patil et al. [21], Manhas et al. [22], and Rajashree et al. [23], all of which found no significant age or gender differences between CKD and control groups, reinforcing that dyslipidemia in CKD is independent of these demographic factors.

A detailed comparison of lipid abnormalities revealed that 90% of CKD cases had abnormal total cholesterol, 86% had high triglycerides, 66% had elevated VLDL, and 62% had low HDL, compared to much lower percentages in controls (p<0.0001 for all). LDL abnormalities, however, did not show a significant difference between the groups (p=0.1017). This pattern is aligned with the results of Behera et al. [24] and Patil et al. [21], both of whom observed significant differences in triglyceride and HDL levels between CKD patients and controls.

The study further explored the relationship between eGFR and lipid parameters. It revealed a significant negative correlation between eGFR and triglycerides (r = -0.5981, p<0.0001), LDL (r = -0.64, p<0.0001), and VLDL (r = -0.2335, p=0.0213), indicating that lipid levels increase as kidney function declines. Conversely, a positive correlation was found between eGFR and HDL (r = 0.217, p=0.0328), suggesting that decreased kidney function is associated with lower HDL. However, no significant correlation was noted between total cholesterol and eGFR (r = -0.1461, p=0.1554). These findings are in line with the studies by Behera et al. [24], Paul and Kurien et al. [25], and Kumari et al. [26], all of which reported similar inverse relationships between eGFR and atherogenic lipids.

Therapy modality also impacts lipid profiles in CKD patients. Manhas et al. [22] found statistically significant differences in LDL and VLDL levels between patient groups receiving different treatments, suggesting therapy type may influence lipid metabolism. Similarly, Phukan et al. [27] observed variations in lipid profiles between patients undergoing hemodialysis and conservative treatment, although not all were statistically significant.

Dyslipidemia not only increases cardiovascular risk but also correlates with CKD progression. Chen et al. [17] demonstrated that higher LDL, non-HDL cholesterol, and total cholesterol are associated with an increased risk of renal replacement therapy (RRT) in CKD stages 3–5. These findings underscore that lipid abnormalities are not just a consequence of CKD but also play a role in disease progression.

In conclusion, this study reaffirms that CKD patients commonly exhibit significant dyslipidemia, especially elevated triglycerides, VLDL, and total cholesterol, and reduced HDL. These lipid abnormalities worsen with declining renal function, making lipid monitoring essential in CKD management. By focusing on early detection and targeted treatment of dyslipidemia, healthcare providers can reduce cardiovascular complications and slow CKD progression.

CONCLUSION

This study highlights the significant metabolic alterations, particularly dyslipidemia, in patients with chronic kidney disease (CKD), emphasizing the critical need for early detection and intervention. CKD patients demonstrated markedly altered lipid profiles, with elevated total cholesterol, triglycerides, LDL, and VLDL, alongside reduced HDL levels, contributing to an increased cardiovascular risk. The correlation between declining kidney function (as indicated by eGFR) and worsening lipid abnormalities further underscores the impact of renal impairment on lipid metabolism. Additionally, comorbid conditions such as hypertension and diabetes exacerbate these lipid derangements, particularly in patients undergoing maintenance hemodialysis. The findings stress the importance of regular lipid monitoring and aggressive management of dyslipidemia in CKD patients to reduce cardiovascular risks and improve overall prognosis. Early and comprehensive management of these parameters is crucial in improving patient outcomes and slowing the progression of CKD.

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