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STUDY OF LIPID PROFILE IN CHRONIC KIDNEY DISEASE PATIENTS: AN OBSERVATONAL STUDY IN TERTIARY CARE TEACHING HOSPITAL

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ABSTRACT

Introduction: Chronic Kidney Disease (CKD) represents a significant global health problem with increasing prevalence and considerable morbidity and mortality. Dyslipidemia is commonly observed in CKD patients, contributing to accelerated atherosclerosis, heightened cardiovascular risk. Understanding the lipid profile abnormalities across different stages of CKD is essential for risk stratification and therapeutic planning. **Material and Methods:** A cross-sectional observational study was conducted at [Gajra Raja Medical College Gwalior] over a defined period, including [100] patients diagnosed with CKD, irrespective of age and sex. Patients were categorized according to the stages of CKD based on estimated glomerular filtration rate (eGFR). Exclusion criteria included individuals with nephrotic syndrome, Diabetes, acute kidney injury, and those on lipid-lowering therapy. Fasting blood samples were collected to measure lipid parameters, including total cholesterol, triglycerides, low-density lipoprotein (LDL), and high-density lipoprotein (HDL). Statistical analysis was performed to determine association between lipid abnormalities and severity of CKD. **Results:** The study demonstrated a high prevalence of dyslipidemia among CKD patients, with progressive worsening noted in advanced stages. Elevated triglyceride and LDL levels were significantly more common in stage IV and V patients compared to early stages. Conversely, HDL cholesterol levels showed a declining trend as kidney function deteriorated. The correlation between declining eGFR and adverse lipid parameters was statistically significant ($p < 0.05$). These findings highlighted that lipid abnormalities are not only prevalent but also closely associated with disease progression in CKD. **Conclusion:** The study concludes that dyslipidemia is a frequent metabolic disturbance in CKD patients, intensifying with disease severity. Regular monitoring of lipid profiles is crucial for early detection and management to reduce cardiovascular complications. Timely therapeutic interventions targeting lipid abnormalities may improve clinical outcomes and quality of life in CKD patients.

Keywords: Chronic kidney disease, Dyslipidemia, Lipid profile, Cardiovascular risk, Renal dysfunction

INTRODUCTION

Chronic Kidney Disease (CKD) is an increasingly prevalent global health concern, marked by a progressive and often irreversible decline in renal function. It is typically defined as a sustained

reduction in glomerular filtration rate below 60 mL/min/1.73 m^2 for three months or more, or the presence of structural or functional abnormalities such as albuminuria, changes in urinary sediment, or imaging evidence of renal damage. CKD affects millions of people worldwide, contributing significantly to morbidity and mortality, not only due to renal failure but also as a major risk factor for cardiovascular disease. The progression of CKD is gradual, beginning with subtle changes and eventually advancing to end-stage renal disease (ESRD), where kidney function is severely impaired and renal replacement therapies like dialysis or transplantation become necessary. ESRD is associated with complications such as hypertension, anemia, bone and mineral disorders, electrolyte imbalances, and reduced quality of life [1,2].

The disease course is marked by progressive nephron loss. As nephrons are lost, the remaining ones undergo compensatory hyperfiltration to preserve renal function temporarily. However, this adaptive process induces glomerular hypertension and proteinuria, which further accelerate nephron injury. Regardless of the underlying cause—whether diabetic nephropathy, hypertensive nephrosclerosis, glomerulonephritis, or genetic conditions like polycystic kidney disease—the end result is often scarring and irreversible renal damage [3,4].

CKD is not confined to the kidneys but exerts systemic effects across multiple organs. Cardiovascular disease is the leading cause of death in CKD patients. This heightened risk arises from a combination of traditional cardiovascular risk factors such as hypertension, diabetes, and dyslipidemia, alongside CKD-specific mechanisms including oxidative stress, vascular calcification, inflammation, and accumulation of uremic toxins. Dyslipidemia is of particular importance, as it contributes both to cardiovascular complications and to the progression of renal damage [5].

Dyslipidemia in CKD, often referred to as “uremic dyslipidemia,” displays a distinctive pattern compared to the general population. It is characterized by elevated triglycerides, increased very low-density lipoprotein (VLDL) and intermediate-density lipoprotein (IDL), reduced high-density lipoprotein cholesterol (HDL-C), and the predominance of small, dense low-density lipoprotein (LDL-C) particles. In nephrotic syndrome, cholesterol and LDL levels can be markedly elevated. These abnormalities arise from impaired clearance of triglyceride-rich lipoproteins due to reduced activity of lipoprotein lipase and hepatic triglyceride lipase, as well as altered apolipoprotein metabolism, oxidative modification of lipoproteins, and chronic inflammation [6,7].

The altered lipid profile in CKD has serious clinical implications. Cardiovascular events such as coronary artery disease, cerebrovascular accidents, and peripheral vascular disease are strongly linked to hypertriglyceridemia, reduced HDL-C, and atherogenic LDL particles. Beyond cardiovascular outcomes, dyslipidemia also accelerates CKD progression. Lipid deposition within renal tissues induces oxidative stress, lipotoxicity, and inflammation, contributing to glomerulosclerosis and tubulointerstitial fibrosis—hallmarks of progressive renal failure [8].

Management of dyslipidemia in CKD is complex. Lifestyle measures such as dietary modification, weight control, exercise, and smoking cessation remain central strategies. Pharmacological therapy, particularly statins, has shown benefits in reducing cardiovascular events among CKD patients, especially in stages 3 and 4. However, their effectiveness in dialysis-dependent ESRD remains controversial. Newer therapies like PCSK9 inhibitors and apolipoprotein A-I mimetics are under investigation but require further evidence regarding their safety and efficacy in this population [9].

The burden of dyslipidemia in CKD is not uniform globally and is influenced by genetics, diet, and socioeconomic conditions. In countries such as India, where CKD prevalence is rising, limited research exists on dyslipidemia in non-diabetic CKD patients. Most studies emphasize diabetic populations, leaving gaps in understanding of lipid abnormalities in those without diabetes. Considering India’s unique dietary and socioeconomic landscape, region-specific data are essential for developing tailored treatment guidelines [10].

Addressing dyslipidemia in CKD represents both a challenge and an opportunity. It is a well-documented contributor to cardiovascular risk and renal progression, but it also remains a modifiable factor. Early detection and effective management can improve outcomes, enhance quality of life, and reduce healthcare burdens. By providing insights into the lipid abnormalities of non-diabetic CKD patients, this study intends to fill critical knowledge gaps and contribute to the foundation for future research and clinical practice. Ultimately, better understanding of dyslipidemia in CKD will support the development of region-specific strategies aimed at reducing complications and improving survival among patients living with this chronic and debilitating disease [11].

The aimed of the study is to evaluated the lipid profile in patients with chronic kidney disease and to assess the correlation between renal function and lipid abnormalities in this condition. The objectives are to identify the lipid profile patterns in individuals with chronic kidney disease and to analyzed the alterations in lipid levels that may occur in these patients.

MATERIAL AND METHODS

This observational cross-sectional study was conducted at the Department of Medicine, G.R. Medical College, in collaboration with the J.A. Group of Hospitals, Gwalior, Madhya Pradesh, India from April 2023 to October 2024. Ethical approval has been obtained from the Ethical Approval Committee of G.R. Medical College, in collaboration with the J.A. Group of Hospitals, Gwalior, Madhya Pradesh, India.

Study Population

The study population comprised adult patients aged 18 to 80 years diagnosed with chronic kidney disease (CKD) for at least three months, either managed conservatively or undergoing hemodialysis, with diagnosis confirmed by KDIGO guidelines through clinical, laboratory, and radiological evidence. Eligible participants demonstrated chronicity via reduced glomerular filtration rate (<60 ml/min/1.73m²) or structural abnormalities confirmed by imaging or biopsy, and provided informed consent. Patients with acute kidney injury, nephrotic syndrome, diabetes mellitus, obesity, metabolic syndrome, pregnancy, lactation, or those receiving lipid-altering medications were excluded.

Data Analysis

Patients fasted for 10–12 hours before venous blood was collected aseptically into plain vacutainers, centrifuged, and analyzed in the central biochemistry laboratory using an automated analyzer with enzymatic kits and strict quality controls. Lipid parameters including total cholesterol, triglycerides, HDL-C, and LDL-C (calculated by Friedewald formula) were measured. Data were double-entered, cross-verified, and analyzed using SPSS v20.0 with ANOVA, chi-square, and Pearson's correlation. Subgroup, sensitivity, and missing data analyses ensured reliability and robustness of findings.

RESULTS

The study analyzed 100 chronic kidney disease (CKD) patients aged 18–80 years, with the highest prevalence seen in older individuals, particularly those aged 70–80 years (26%), followed by 60–69 years (20%) and 50–59 years (18%), while younger groups (18–39 years) contributed fewer cases. A chi-square test ($\chi^2 = 11.0$, $p = 0.05$) indicated borderline significance, suggesting a non-uniform age distribution skewed toward the elderly. Descriptive statistics showed a mean age of 50.75 years, mean height of 163.74 cm, mean weight of 77.17 kg, and mean BMI of 23.81 kg/m², which falls within the normal range but approaches overweight in some cases. The duration of CKD averaged 10.64 years (range 1–19), reflecting the chronic and long-standing nature of the disease. Overall, the findings emphasize that CKD predominantly affects older adults, with considerable variability in demographic and physical characteristics, providing a baseline for further correlation with biochemical and clinical outcomes.

Table 1: Descriptive Statistics of Biochemical Parameters in CKD Patients

	Fasting Blood Sugar (mg/dL)	Serum Urea (mg/dL)	Serum Creatinine (mg/dL)	GFR (ml/min/1.73mÃ‚Â²)
Count	100	100	100	100
Mean	96.56	95.26	4.72	32.63
Std	15.30	28.98	1.96	16.35
Min	70.89	40.64	1.58	5.54
Max	119.90	139.49	7.98	59.80
Median	97.04	101.06	4.63	33.39

The study shows that CKD patients had near-upper normal fasting blood sugar with many in prediabetic/diabetic ranges, markedly elevated serum urea (95.26 mg/dL) and creatinine (4.72 mg/dL), and a reduced mean GFR (32.63 ml/min/1.73 m²), indicating advanced Stage 3B–4 CKD and confirming significant renal dysfunction closely linked to metabolic disturbances such as dyslipidemia.

Table 2: Lipid Profile Characteristics in Chronic Kidney Disease Patients

Lipid Profile Summary Statistics	Total Cholesterol (mg/dL)	Triglycerides (mg/dL)	HDL (mg/dL)	LDL (mg/dL)
Count	100	100	100	100
Mean	232.2617	194.6815	32.5306	142.192
Std	29.96535	53.30181	8.759293	32.68559
Min	150.49	101.15	31.08	91.21
Max	249.94	292.59	59.82	199.64
Median	205.575	194.27	45.81	140.56

CKD patients demonstrated a distinctly atherogenic lipid profile, with elevated mean total cholesterol (232.26 mg/dL), triglycerides (194.68 mg/dL), and LDL (142.19 mg/dL), alongside significantly reduced HDL (32.53 mg/dL), confirming widespread dyslipidemia that heightens cardiovascular risk and aligns with the metabolic disturbances associated with impaired renal function.

Table 3: Lipid Profile Variations across Different Stages of Chronic Kidney Disease

Stage of CKD	Total Cholesterol (mg/dL)	Triglycerides (mg/dL)	HDL (mg/dL)	LDL (mg/dL)
2	207.43	198.76	31.83	142.81
3	210.63	207.30	29.42	146.48
4	214.98	211.97	25.03	150.60
5	219.40	216.04	24.73	161.85
p-value	**$p < 0.05$**	**$p < 0.05$**	**$p < 0.05$**	**$p < 0.05$**

As CKD progresses from Stage 2 to Stage 5, lipid abnormalities worsen significantly, with total cholesterol, triglycerides, and LDL showing progressive increases while HDL declines markedly, all with $p < 0.05$, confirming that advancing renal dysfunction is strongly associated with atherogenic dyslipidemia and heightened cardiovascular risk.

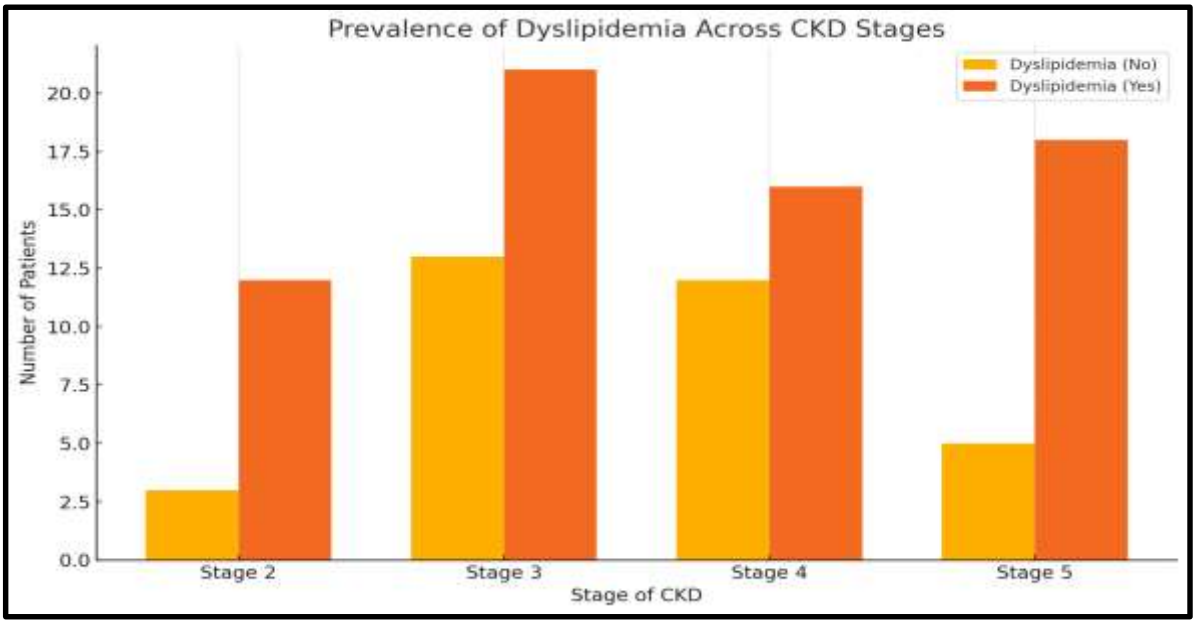

Figure 1: Prevalence of Dyslipidemia across CKD Stages

Among 100 CKD patients, 67% had dyslipidemia, with prevalence varying across stages—80% in Stage 2, 61.8% in Stage 3, 57.1% in Stage 4, and 78.3% in Stage 5; the Chi-square test ($\chi^2 = 7.44$, $p = 0.05$) showed a borderline association, suggesting a trend of worsening lipid abnormalities with CKD progression and emphasizing the importance of vigilant lipid monitoring in advanced stages.
In the study of 100 chronic kidney disease (CKD) patients, males accounted for 78% and females for 22%, demonstrating a marked male predominance that was statistically significant ($\chi^2 = 31.36$, $p < 0.0001$). Additionally, dyslipidemia was highly prevalent, affecting 67% of patients compared to 33% without lipid abnormalities, with this difference also reaching statistical significance ($\chi^2 = 11.56$, $p < 0.0001$). These findings indicate that CKD disproportionately affects males and is frequently associated with dyslipidemia, underscoring the importance of gender-specific risk profiling and lipid monitoring in disease management.

Table 4: Notes Frequency Distribution

Notes	**Frequency**
None	71
Arcus Senilis	23
Xanthomas	6
Total	**100**
Chi-square value (χ^2) = 68.18 ,**p-value** = < 0.0001	

In CKD patients, 71% showed no visible abnormalities, while 23% had arcus senilis and 6% presented with xanthomas; this distribution was highly significant ($\chi^2 = 68.18$, $p < 0.0001$), indicating notable lipid-related clinical manifestations.

Table 5: Health Conditions Frequency Distribution

Condition	**Yes**	**No**	**Chi-square value (χ^2)**	**p-value**
Hypertension	27	73	21.16	< 0.0001
Smoking	70	30	16.00	< 0.0001
Alcohol	53	47	0.36	0.548

Among CKD patients, hypertension was present in 27% and smoking in 70%, both showing strong statistical significance ($p < 0.0001$), while alcohol use (53%) showed no significant association ($p = 0.548$), indicating hypertension and smoking as major co-occurring conditions.

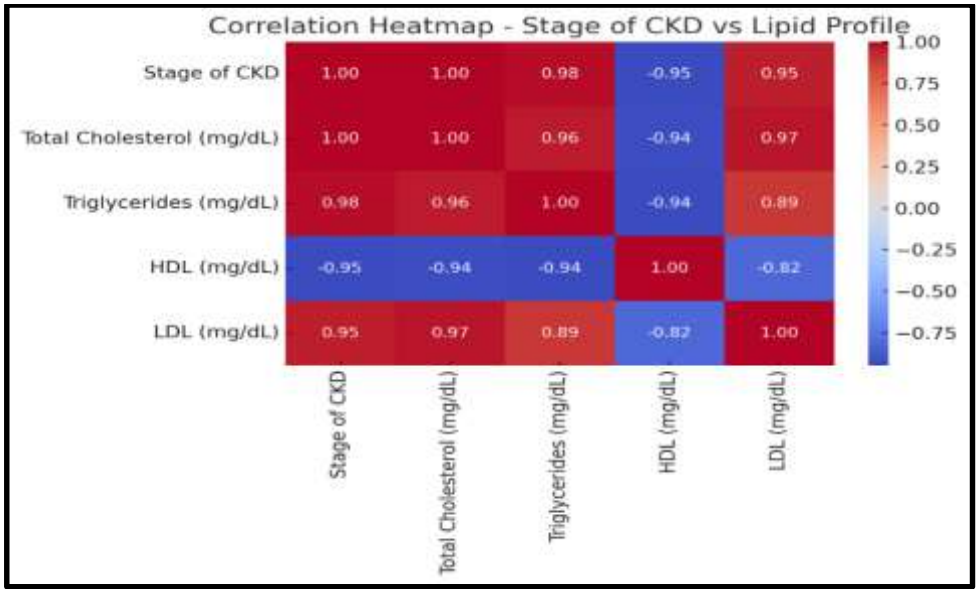

Figure 2: Correlation Heatmap - Stage of CKD Vs Lipid Profile

Correlation analysis showed that advancing CKD stage is almost linearly associated with rising total cholesterol (r = +0.997), triglycerides (r = +0.979), and LDL (r = +0.954), while HDL levels decline sharply (r = –0.946). These strong correlations confirm that worsening renal function drives progressive dyslipidemia, marked by hypercholesterolemia, hypertriglyceridemia, elevated LDL, and reduced HDL, thereby reinforcing the need for early lipid monitoring and management to mitigate cardiovascular risks in CKD patients.

DISCUSSION

Chronic Kidney Disease (CKD) is a progressive disorder characterized by the gradual decline of renal function, which affects multiple metabolic pathways, including lipid metabolism. Dyslipidemia is a common complication in CKD and plays a crucial role in accelerating atherosclerosis, thus contributing to the high cardiovascular morbidity and mortality in this population **Weldegiorgis M, et. al; 2022**. Evaluating lipid profiles in CKD patients is therefore essential to understand the pattern of abnormalities and guide therapeutic interventions. This observational study conducted at a tertiary care teaching hospital was designed to analyze lipid profile patterns in CKD patients and assess their clinical significance [12].

In this study, lipid parameters such as total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C) were measured across different CKD stages. A characteristic pattern of dyslipidemia was noted, with elevated triglyceride and LDL-C levels and significantly reduced HDL-C. Total cholesterol varied according to CKD stage. These findings are consistent with the concept of "atherogenic dyslipidemia," described by **Streja E &Streja DA. 2022,** which is marked by hypertriglyceridemia, small dense LDL particles, and reduced HDL [13].

Mechanistically, dyslipidemia in CKD arises from impaired clearance of triglyceride-rich lipoproteins due to reduced lipoprotein lipase and hepatic lipase activity, along with altered HDL composition and increased apolipoprotein synthesis **Kosmas CE, et. al; 2023**. Proteinuria and inflammation further exacerbate these changes by promoting hepatic lipoprotein production and impairing reverse cholesterol transport. The severity of lipid disturbances correlates directly with CKD progression [14].

Demographic analysis in this study showed that the highest prevalence of CKD occurred in patients aged 70–80 years (26%), consistent with **Podkowińska A &Formanowicz D. 2020,** and **Kosmas CE, et. al; 2023**, who reported greater dyslipidemia in patients over 60 years. The mean age of participants was 50.75 years, with a BMI of 23.81 kg/m² and mean disease duration of 10.64 years.

These results parallel findings from **Kumari A, et. al; 2021,** confirming the chronic nature of CKD in middle-aged and elderly adults [15,14,16].

Biochemical profiles revealed mean serum creatinine of 4.72 mg/dL, GFR of 32.63 ml/min/1.73 m^2, serum urea of 95.26 mg/dL, and fasting blood glucose of 96.56 mg/dL. These findings are comparable to results from **Zuzda K, et. al; 2022** and **Stasi A, et. al; 2022,** underscored the metabolic burden associated with renal impairment [17,18].

The lipid profile showed elevated mean total cholesterol (232.26 mg/dL), triglycerides (194.68 mg/dL), and LDL-C (142.19 mg/dL), along with reduced HDL-C (32.53 mg/dL). Similar observations were made by **Streja E &Streja DA. 2022,** and **Netala VR, et. al; 2024,** who demonstrated worsening dyslipidemia with advancing CKD stages. In the present study, dyslipidemia prevalence was highest in stage 2 (80%) and stage 5 (78.3%), consistent with **Jankowski J, et. al; 2021,**who attributed this trend to impaired lipid clearance in advanced renal dysfunction [13,19,20].

A significant male predominance (78%) was observed in this study, echoing **Tudor MN, et. al; 2014,** who reported higher CKD prevalence in men due to higher rates of hypertension and smoking. Dyslipidemia was found in 67% of patients, a figure supported by **Weldegiorgis M, et. al; 2022**, reported a 69% prevalence. Lipid-related complications included arcus senilis (23%) and xanthomas (6%), similar to findings by **Saini M, et. al; 2022** [21,12,22].

Hypertension (27%) and smoking (70%) were strongly associated with dyslipidemia, consistent with **Kishi S, et. al; 2024** and **Patange RP & Ghorpade VV. 2024**. Alcohol consumption (53%) showed no significant association, mirroring prior results. Importantly, strong correlations were observed between CKD stage and lipid parameters: total cholesterol (+0.997), triglycerides (+0.979), and LDL (+0.954), with HDL showing a strong negative correlation (-0.946). These findings aligned with **Mani MK. 2003,** who also reported worsening lipid abnormalities with advancing CKD [23-25].

CONCLUSION

The study concluded that dyslipidemia is a common metabolic complication in chronic kidney disease, affecting 67% of patients, with severity increasing alongside disease progression. Advanced CKD stages were significantly associated with higher total cholesterol, triglycerides, and LDL-C levels, and reduced HDL-C, reflecting the classical pattern of uremic dyslipidemia. Male patients and the elderly, particularly those over 60 years, were more affected. These lipid abnormalities not only accelerate renal dysfunction but also heighten cardiovascular risk, thereby contributing substantially to increased morbidity and mortality among CKD patients.

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