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Lipid Profile Variations Across CKD Stages and their Association with Cardiovascular Risk: A Cross-Sectional Study

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ABSTRACT

Background

Chronic kidney disease (CKD) is a major global health concern associated with significant cardiovascular morbidity and mortality. Dyslipidemia, a hallmark of CKD, plays a critical role in cardiovascular disease (CVD) progression. This study evaluates lipid profile alterations and their association with cardiovascular risk across CKD stages.

Methods

This cross-sectional study included 95 patients with CKD from SCB Medical College and Hospital, Odisha, India. Participants were classified according to CKD stages 1–5 based on eGFR. Lipid profiles, including total cholesterol (TC), low density lipoprotein (LDL), high density lipoprotein (HDL), triglycerides (TG), and very low density lipoprotein (VLDL) were assessed using fasting blood samples. Cardiovascular risk was evaluated using the Framingham risk score. Statistical analyses included the Kruskal-Wallis test, Pearson's correlation, and multivariate logistic regression. Survival probabilities were analyzed using Kaplan-Meier plots.

Results

HDL cholesterol declined significantly with CKD progression ($p = 0.011$), while total and LDL cholesterol levels were lower in Stage 5 ($p = 0.002$ and $p = 0.031$, respectively). Triglycerides and VLDL cholesterol showed positive correlations with cardiovascular risk ($p = 0.006$ and $p = 0.005$), whereas HDL cholesterol exhibited a negative correlation ($p = 0.002$). Multivariate regression identified low HDL cholesterol (OR: 0.88, $p = 0.003$) and elevated triglycerides (OR: 1.05, $p = 0.01$) as independent predictors of cardiovascular events. Kaplan-Meier analysis demonstrated declining survival rates with advancing CKD stages (log-rank $p < 0.05$).

Conclusion

Dyslipidemia significantly contributes to cardiovascular risk in patients with CKD. Targeted lipid management, particularly addressing HDL and triglycerides, may mitigate cardiovascular complications and improve outcomes in patients with CKD.

Keywords: Chronic Kidney Disease, Dyslipidemia, Cardiovascular Risk

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INTRODUCTION

Chronic kidney disease (CKD) is a condition characterized by prolonged damage to the kidneys, impairing both glomerular and tubular functions for over three months. This condition has emerged as a significant public health issue, with a global prevalence ranging from 8–16%, affecting more than 10% of adults in the United States (1). Despite the lack of a national registry in India, the prevalence is estimated at approximately 785 per million people(2). CKD often progresses to end-stage renal disease (ESRD), which is strongly associated with elevated rates of cardiovascular morbidity and mortality. Notably, patients with CKD are more likely to succumb to cardiovascular complications than to ESRD itself(3).

Recent studies have underscored that dyslipidemia in patients with CKD significantly contributes to cardiovascular disease (CVD) progression and the deterioration of renal function. CVD is the leading cause of death in patients with CKD, with even higher rates observed in those undergoing hemodialysis. Although dyslipidemia is a well-established risk factor for CVD in the general population, its role in the progression of CKD requires further exploration. (4)

The 2013 Kidney Disease: Improving Global Outcomes (KDIGO) guidelines recommend a conservative approach to lipid-lowering therapy and monitoring in Patients with CKD, primarily due to the lack of robust evidence specific to this population(5). Dyslipidemia in Patients with CKD differs significantly from that observed in the general population, underscoring the need for targeted research. Cardiovascular disease remains the leading cause of death in patients with chronic renal failure (CRF) and ESRD(6). Hypertension, in conjunction with lipid abnormalities prevalent in ESRD, impairs microcirculation and contributes to atherosclerotic coronary artery disease(7). Such abnormalities often include reduced high-density lipoprotein (HDL) cholesterol, increased plasma triglycerides, and defects in cholesterol transport. Reduced HDL synthesis and impaired reverse cholesterol transport exacerbate these issues(1).

Given the significant cardiovascular risks associated with dyslipidemia in CKD, this study aims to compare lipid profiles, across various CKD stages based on the estimated glomerular filtration rate (eGFR). Additionally, it seeks to analyze the association between lipid profile and cardiovascular risk in patients with CKD and identify potential lipid profile markers predictive of CKD progression.

Material and Methods

This cross-sectional study was conducted to analyze lipid profile variations in patients with CKD and explore their association with cardiovascular risk. The study included 95 patients diagnosed with CKD and receiving treatment at SCB Medical College and Hospital, Cuttack, Odisha, India. It was a collaborative effort involving the postgraduate department of Biochemistry, General Medicine, Nephrology, and Cardiology. CKD stages were classified based on the eGFR into stages 1–5.

Adults aged 18 years and older with a confirmed diagnosis of CKD at any stage (1–5) based on eGFR were included. Exclusion criteria included patients with acute kidney injury or other acute renal conditions, and individuals with severe comorbidities that affect lipid metabolism, such as severe liver disease or acute infections. Patients on medications like high-dose corticosteroids, immunosuppressants, pregnant or breastfeeding women and individuals with familial hypercholesterolemia or other genetic lipid disorders were also excluded.

The study was conducted over six months, from July 2023 to December 2023. A sample size of 95 patients with CKD was determined to be sufficient for statistical analysis based on power analysis and anticipated variability in lipid parameters. Ethical approval for the study was obtained from the Institutional Ethical Committee (IEC), with the registration number ECR/84/Inst/OR/2013/RR-20. The study was conducted in compliance with the principles of the Declaration of Helsinki, and written informed consent was obtained from all participants.

Data collection involved clinical assessments, including demographic details such as age, sex , body mass index (BMI), comorbidities like diabetes and hypertension, CKD stage determined by eGFR,

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blood pressure, history of cardiovascular events, and family history of CKD or CVD. Biochemical measurements included fasting blood samples for lipid profile analysis, measuring TC, TG, LDL, HDL, and VLDL. Serum creatinine and lipid profiles were analyzed using the TBA-120FR autoanalyzer at the Regional Diagnostic Centre (RDC), Biochemistry Department, SCB Medical College and Hospital. The eGFR was calculated using the MDRD equation, and cardiovascular risk was evaluated using the Framingham risk score(1,8).

Statistical analysis involved the use of descriptive statistics (mean ± standard deviation) for continuous variables. Differences in lipid profiles across CKD stages were assessed using the Kruskal-Wallis test for non-parametric data. Correlations between lipid parameters and cardiovascular risk were analyzed using Pearson's correlation coefficient. A multivariate logistic regression model was employed to identify independent lipid profile predictors of cardiovascular events and CKD progression. A p-value of less than 0.05 was considered statistically significant.

Results

The study analysed 95 patients with CKD distributed across stages 1 to 5 (Table 1).

Table 1: Demographic and Clinical Characteristics of Study Population

Characteristic	CKD Stage 1 (n=7)	CKD Stage 2 (n=11)	CKD Stage 3 (n=14)	CKD Stage 4 (n=21)	CKD Stage 5 (n=42)	p-value
Age (years)	58.67 ± 11.93	65 ± 4.72	45.45 ± 10.27	56 ± 19.80	47.28 ± 14.61	0.330
Sex (M/F)	5/2	8/3	9/4	15/6	33/9	0.103
BMI (kg/m²)	21.97 ± 2.61	24.00 ± 2.43	22.20 ± 1.66	23.00 ± 2.40	21.79 ± 2.17	0.284
Diabetes (%)	40%	60%	80%	90%	86.9%	0.019*
Hypertension (%)	60%	50%	100%	100%	84.4%	0.012*
On Lipid-Lowering Drugs (%)	100%	100%	100%	78%	85%	0.000*
Smoking History	80%	60%	70%	30%	45%	0.140
Family History	68%	76%	54.5%	83%	51.9%	0.242

The mean age varied significantly across CKD stages, with the highest age group observed in Stage 2 (65 ± 4.72 years) and the youngest in Stage 3 (45.45 ± 10.27 years). Male predominance was noted across all stages, particularly in Stage 5, where the male-to-female ratio was 33:9. The mean BMI remained relatively consistent, ranging from 21.79 ± 2.17 kg/m² in Stage 5 to 24.00 ± 2.43 kg/m² in Stage 2. Diabetes and hypertension prevalence increased with CKD severity, affecting over 80% of patients in Stages 3 to 5.Lipid profile analysis revealed significant alterations across CKD stages (Figure 1).

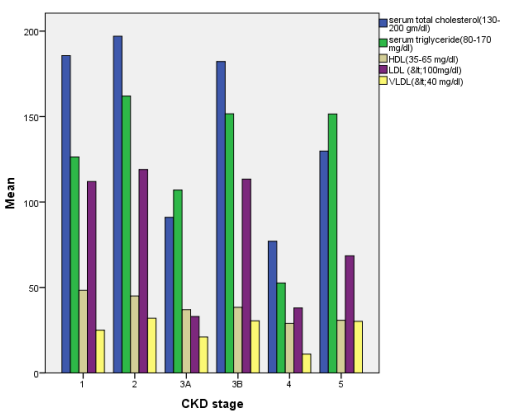

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Figure 1: Graphical Representation of Lipid Profile Across CKD Stages

Serum total cholesterol levels were significantly lower in Stage 5 compared to Stages 1 and 2 (p = 0.002). HDL cholesterol demonstrated a progressive decline with CKD advancement (p = 0.011), with the most pronounced reduction observed between Stages 1 and 5. LDL cholesterol levels were significantly lower in Stage 5 compared to Stages 1 and 2 (p = 0.031). However, across stages, no significant differences were observed for serum triglycerides (p = 0.216) or VLDL cholesterol (p = 0.193).In Table 2, cardiovascular risk, assessed using the Framingham risk score, increased with CKD severity, peaking in Stage 4 (20.7%) before declining slightly in Stage 5 (6.89 ± 7.18%). Cardiovascular events were most prevalent in Stage 5 (11%), with minimal occurrences in earlier stages

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Table 2: Cardiovascular Risk Assessment in Patients with CKD Using the Framingham Score

Risk Factor	CKD Stage 1 (n=7)	CKD Stage 2 (n=11)	CKD Stage 3 (n=14)	CKD Stage 4 (n=21)	CKD Stage 5 (n=42)
Framingham Risk Score (%)	1.47 ± 1.33	11.4 ± 0.38	0.96 ± 0.74	20.7 ± 0.24	6.89 ± 7.18
Previous Cardiovascular Events (%)	NA	NA	2%	5%	11%

Correlation analysis (Table 3) demonstrated that triglycerides (r = 0.282, p = 0.006) and VLDL cholesterol (r = 0.286, p = 0.005) positively correlated with cardiovascular risk, while HDL cholesterol exhibited a significant negative correlation (r = -0.319, p = 0.002). Total and LDL cholesterol did not show significant correlations with cardiovascular risk. The scatter plot (Figure 2) depicting the correlation between serum triglyceride levels and cardiovascular risk in the study population showed a positive linear relationship, with an R^2 value of 0.080, suggesting that triglyceride levels explained 8% of the variance in cardiovascular risk. In contrast, the scatterplot (Figure 3) for serum HDL cholesterol levels and cardiovascular risk revealed a negative linear correlation, with an R^2 value of 0.102, indicating that HDL cholesterol levels accounted for 10.2% of the variance in cardiovascular risk.

TABLE 3: Correlation Between Lipid Profiles and Framingham Risk Score (Total Subjects)

Parameter	Correlation Coefficient (r)	p-value
Serum Total Cholesterol	-0.046	0.655
Serum Triglycerides	0.282**	0.006*
HDL	-0.319**	0.002*
LDL	-0.070	0.502
VLDL	0.286**	0.005*

Figure 2: Scatter plot showing the correlation of serum triglyceride with cardiovascular risk in overall subjects

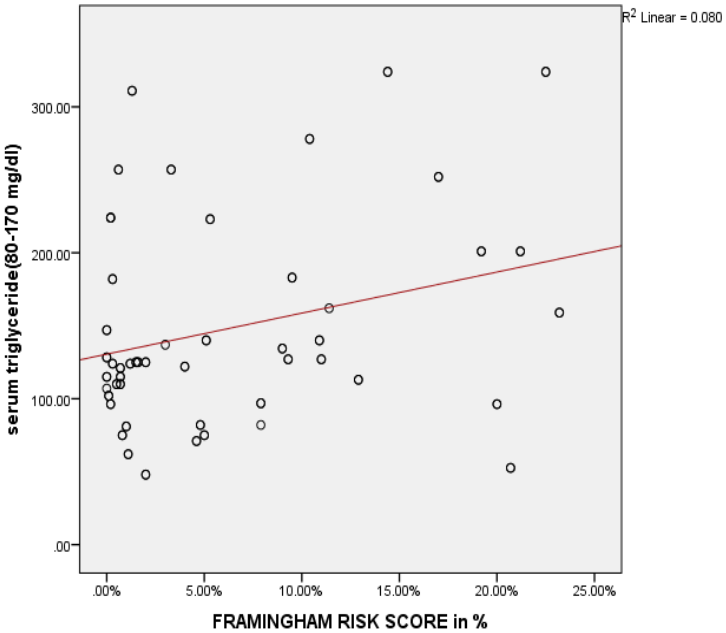
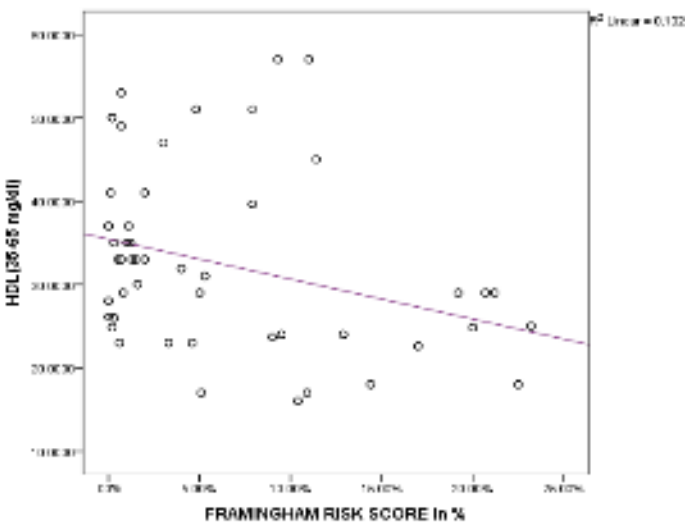


Figure 3: Scatter plot showing correlation of serum HDL with cardiovascular risk in overall subjects



Multivariate logistic regression (Table 4) identified low HDL cholesterol (OR: 0.88, p = 0.003) and elevated triglycerides (OR: 1.05, p = 0.01) as independent predictors of cardiovascular events, explaining 45% of the variance in cardiovascular outcomes (Nagelkerke R^2 = 0.45). The model demonstrated good fit (Hosmer-Lemeshow p = 0.25), emphasizing the critical role of dyslipidemia in cardiovascular risk among patients with CKD.Kaplan-Meier survival analysis (Figure 4) revealed declining survival probabilities with advancing CKD stages. While patients in Stages 1 and 2 had 100% survival with no cardiovascular events, survival rates progressively declined in later stages. Cardiovascular events occurred in 8 of 14 patients in Stage 3, 9 of 21 in Stage 4, and 21 of 42 in Stage 5. In Stage 5, nine patients experienced two episodes, and 12 experienced one episode, reflecting the highest cardiovascular burden. The median survival time decreased with CKD progression, with the steepest declines observed in Stages 4 and 5. A log-rank test confirmed significant differences in survival distributions across CKD stages ($p < 0.05$), underscoring the escalating cardiovascular risk associated with worsening renal function.

Table 4: Multivariate Logistic Regression Analysis for Predictors of Cardiovascular Events in Patients with CKD

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
HDL Cholesterol	0.88	0.80–0.95	0.003*
Triglycerides	1.05	1.01–1.10	0.01*
Model Summary			
Nagelkerke R^2	0.45		
Hosmer-Lemeshow Test (p-value)			0.25

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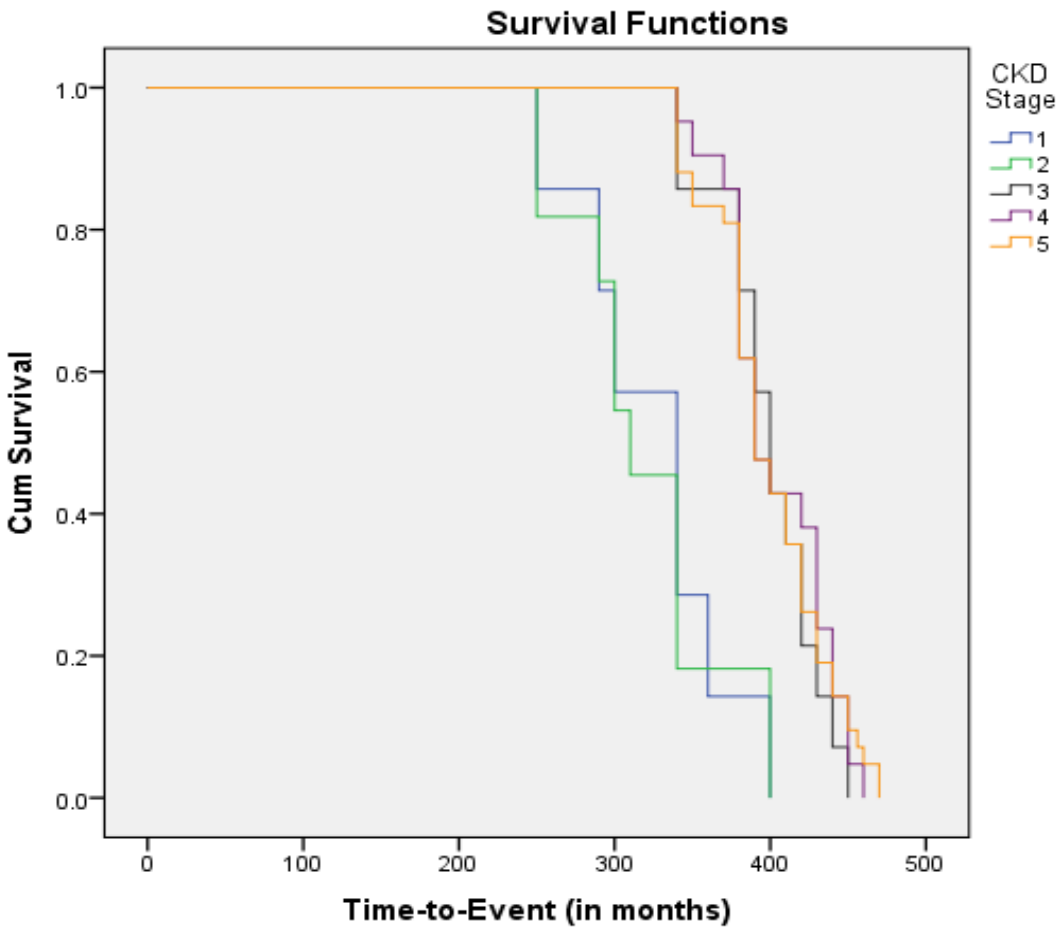
Figure 4: Kaplan-Meier Curve for Cardiovascular Events Stratified by CKD Stages



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REFERENCES

1. Saini M, Vamne A, Kumar V, et al. (January 23, 2022) The Study of Pattern of Lipid Profile in Chronic Kidney Disease Patients on Conservative Management and Hemodialysis: A Comparative Study. Cureus 14(1): e21506. DOI 10.7759/cureus.21506.
2. Gaitonde DY, Cook DL, Rivera IM. Chronic kidney disease: detection and evaluation. Am Fam Physician. 2017;96(12):776-783.
3. Talukdar R, Ajayan R, Gupta S, Biswas S, Parveen M, Sadhukhan D, Sinha AP, Parameswaran S. Chronic kidney disease prevalence in India: a systematic review and meta-analysis from community-based representative evidence between 2011 to 2023. Nephrology (Carlton). 2025 Jan;30(1):e14420. doi: 10.1111/nep.14420. PMID: 39763170.
4. Choudhary N. A study of lipid profile in chronic kidney disease in pre- dialysis patients. Int J Med Res Rev. 2019;7(3):150-156. Available From https://ijmrr.medresearch.in/index.php/ijmrr/article/ view/1051.
5. Lamb EJ, Levey AS, Stevens PE. The Kidney Disease Improving Global Outcomes (KDIGO) guideline update for chronic kidney disease: evolution not revolution. Clin Chem. 2013 Mar;59(3):462-5. doi: 10.1373/clinchem.2012.184259. PMID: 23449698.
6. Batra G, Ghukasyan Lakic T, Lindbäck J, et al. Interleukin 6 and Cardiovascular Outcomes in Patients With Chronic Kidney Disease and Chronic Coronary Syndrome. JAMA Cardiol. 2021;6(12):1440–1445. doi:10.1001/jamacardio.2021.3079.
7. Ponte B, James Glassock R, Pugliese G, Sheng CS, Tian J, Bloomgarden ZT, et al. CVD risk in non-albuminuric chronic kidney disease in hypertensive, non-diabetic subjects: A post-hoc analysis from SPRINT [Internet]. Available from: https://biolincc.nhlbi.nih.
8. Chen SC, Su HM, Tsai YC, Huang JC, Chang JM, Hwang SJ, Chen HC. Framingham risk score with cardiovascular events in chronic kidney disease. PLoS One. 2013;8(3):e60008. doi: 10.1371/journal.pone.0060008. Epub 2013 Mar 20. PMID: 23527293; PMCID: PMC3603980.
9. Tsai CW, Huang HC, Chiang HY, Chung CW, Chang SN, Chu PL, Kuo CC. Longitudinal lipid trends and adverse outcomes in patients with CKD: a 13-year observational cohort study. J Lipid Res. 2019 Mar;60(3):648–60. doi: 10.1194/jlr.P084590. PMID: 30642880; PMCID: PMC6399497.
10. Morales J, Handelsman Y. Cardiovascular outcomes in patients with diabetes and kidney disease: JACC review topic of the week. J Am Coll Cardiol. 2023 Jul;82(2):161–70. doi: 10.1016/j.jacc.2023.04.052.
11. Burnier M, Damianaki A. Hypertension as cardiovascular risk factor in chronic kidney disease. *Circ Res.* 2023 Apr 13;132(8). doi:10.1161/CIRCRESAHA.122.3217.
12. Pavanello C, Ossoli A. HDL and chronic kidney disease. Atheroscler Plus. 2023 Apr 18;52:9-17. doi: 10.1016/j.athplu.2023.04.001. PMID: 37193017; PMCID: PMC10182177.
13. Devine PA, Courtney AE, Maxwell AP. Cardiovascular risk in renal transplant recipients. J Nephrol. 2019 Jun;32(3):389-399. doi: 10.1007/s40620-018-0549-4. Epub 2018 Nov 7. PMID: 30406606; PMCID: PMC6482292.
14. Ren L, Cui H, Wang Y, Ju F, Cai Y, Gang X, Wang G. The role of lipotoxicity in kidney disease: From molecular mechanisms to therapeutic prospects. Biomed Pharmacother. 2023 May;161:114465. doi: 10.1016/j.biopha.2023.114465.