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Impact of Haemodialysis on Lipid Profile in Diabetic & Non-Diabetic Patients with End Stage Renal Disease

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HIGHLIGHTS

- ESRD causes dyslipidaemia
- Diabetics had poorer lipids
- Haemodialysis improved lipids
- Triglycerides decreased significantly
- Routine lipid monitoring essential

Key Words:
End-Stage Renal Disease
Haemodialysis
Dyslipidaemia
Diabetes Mellitus
Lipid Profile

ABSTRACT

Introduction: End-Stage Renal Disease (ESRD) is associated with dyslipidaemia, contributing to increased cardiovascular morbidity and mortality. Lipid abnormalities often persist despite haemodialysis and are more pronounced in diabetic ESRD patients, further elevating cardiovascular risk. **Aim & objective:** The present study aimed to evaluate the impact of haemodialysis on lipid profiles among diabetic and non-diabetic ESRD patients. **Material & Methods:** This prospective cohort study was conducted in the Department of General Medicine at IGESIC Hospital, Jhilmil, Delhi, from August 2023 to December 2024. A total of 180 ESRD patients undergoing haemodialysis were included, comprising 90 diabetic and 90 non-diabetic patients. Patients aged above 18 years and receiving haemodialysis for at least three months were enrolled. Lipid profile parameters including total cholesterol, LDL, HDL, and triglycerides were assessed before and after dialysis. Statistical analysis was performed using paired and independent t-tests, with $p<0.05$ considered statistically significant. **Results:** Diabetic patients demonstrated higher pre-dialysis lipid levels compared to non-diabetic patients. Following haemodialysis, both groups showed reductions in total cholesterol, LDL, and triglycerides, along with slight increases in HDL levels. In diabetic patients, total cholesterol reduced from 220 mg/dL to 200 mg/dL, while triglycerides decreased from 200 mg/dL to 170 mg/dL. Similar improvements were observed in non-diabetic patients. Statistical analysis confirmed significant differences between pre- and post-dialysis lipid profiles ($p<0.05$). **Conclusion:** Haemodialysis significantly improves lipid profile parameters in ESRD patients; however, diabetic patients continue to exhibit comparatively poorer lipid profiles than non-diabetic patients. Regular lipid monitoring and appropriate therapeutic interventions are essential to reduce cardiovascular complications in ESRD patients undergoing haemodialysis.

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INTRODUCTION

End-Stage Renal Disease (ESRD) represents the final stage of chronic kidney disease (CKD), where kidney function declines irreversibly, leading to the inability of the kidneys to maintain normal metabolic and physiological processes. CKD affects multiple organ systems and is associated with significant morbidity and mortality worldwide. One of the important complications observed in CKD and ESRD patients is dyslipidaemia, which is characterized by abnormal lipid metabolism, including elevated triglycerides, reduced high-density lipoprotein cholesterol (HDL-C), and altered low-density lipoprotein cholesterol (LDL-C). These lipid abnormalities contribute significantly to the development of cardiovascular diseases, which remain the leading cause of death among ESRD patients. Impaired lipid metabolism in CKD occurs due to reduced clearance of lipoproteins, oxidative stress, chronic inflammation, and hormonal imbalances, resulting in accelerated atherosclerosis and worsening renal function. Therefore, regular monitoring of lipid profiles, including total cholesterol, triglycerides, LDL, and HDL, is essential for reducing cardiovascular complications and improving patient outcomes [1,2].

Haemodialysis is the most used renal replacement therapy for patients with ESRD who are not eligible for kidney transplantation. This procedure functions by artificially removing waste products, excess fluids, and toxins from the blood through a dialysis machine, thereby mimicking the filtration process of healthy kidneys. Haemodialysis is generally performed three times per week and plays a vital role in maintaining electrolyte balance and improving survival in ESRD patients.

Although haemodialysis effectively manages fluid overload and metabolic waste accumulation, it does not completely correct the metabolic disturbances associated with ESRD, particularly dyslipidaemia. **Bhatti NK et al. (2016)** have shown that dialysis patients often continue to exhibit abnormal lipid profiles even after regular dialysis sessions, increasing their susceptibility to cardiovascular morbidity and mortality. Hence, lipid profile assessment remains an important aspect of clinical evaluation and management in haemodialysis patients [3-5].

Diabetes mellitus is one of the leading causes of ESRD globally and contributes significantly to the burden of chronic kidney disease through diabetic nephropathy. Persistent hyperglycaemia damages the glomerular filtration units of the kidneys, leading to structural and functional abnormalities such as glomerular basement membrane thickening, inflammation, and increased intraglomerular pressure. Over time, these pathological changes progress to irreversible kidney failure. Diabetic ESRD patients frequently exhibit more severe dyslipidaemia than non-diabetic patients, including elevated LDL & triglyceride levels and reduced HDL levels. These abnormalities further increase cardiovascular risk and complicate disease management. Additionally, declining renal function in diabetic patients disrupts glucose and lipid metabolism, making metabolic control more difficult. Effective management of blood glucose levels, renal function, and lipid abnormalities is therefore essential in delaying CKD progression and reducing complications associated with ESRD [6,7]. The comparison of lipid profiles between diabetic and non-diabetic ESRD patients undergoing haemodialysis is clinically important because diabetic patients tend to have more pronounced lipid abnormalities and a higher risk of cardiovascular disease.

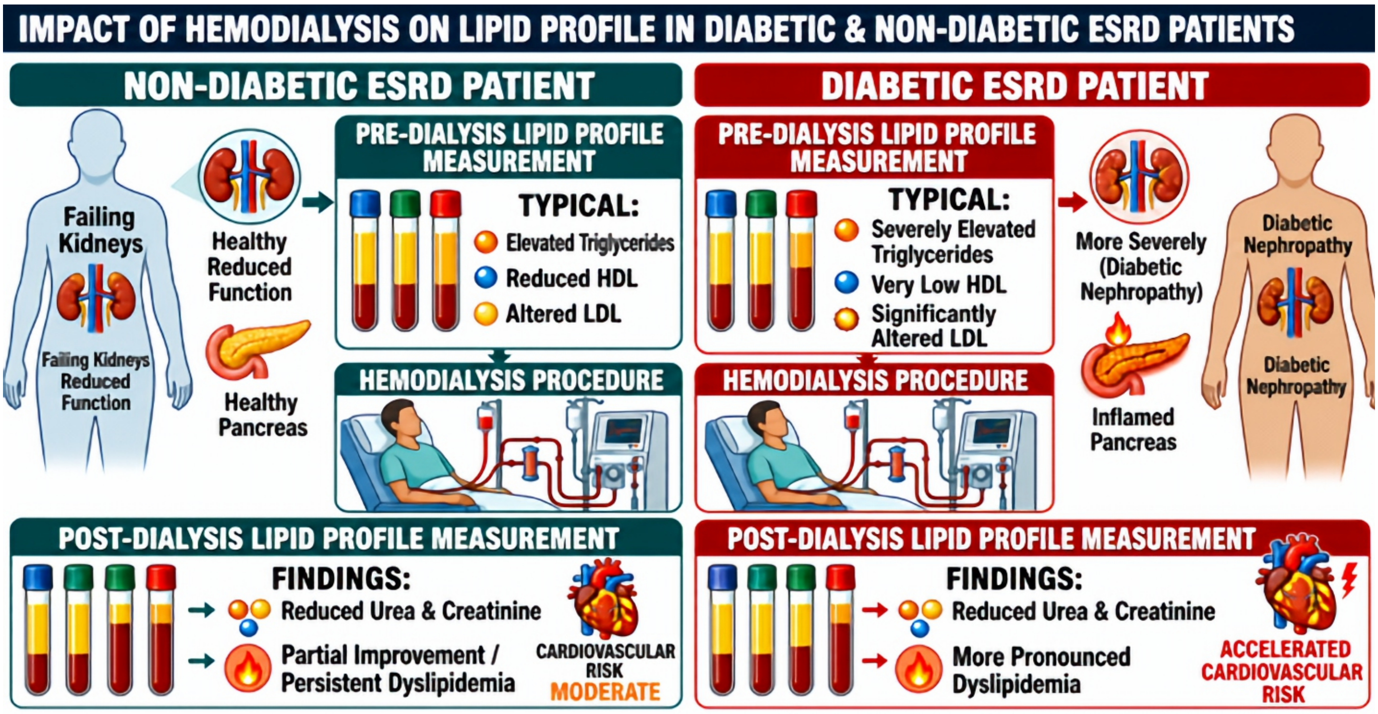

Figure 1: Schematic comparison of lipid profile changes following haemodialysis in diabetic and non-diabetic patients with end-stage renal disease (ESRD).

Understanding these differences can help healthcare professionals develop targeted therapeutic strategies for dyslipidaemia management in ESRD patients. Appropriate interventions, including dietary modifications, lipid-lowering medications, regular exercise, and strict glycaemic control, may improve cardiovascular health and overall quality of life in these patients. Furthermore, evaluating lipid profile changes before and after dialysis provides valuable insight into the effectiveness of haemodialysis on lipid metabolism and cardiovascular risk reduction. These findings can contribute to improved treatment planning, better patient monitoring, and enhanced long-term clinical outcomes for both diabetic and non-diabetic ESRD patients undergoing haemodialysis [8-10]. **Figure 1** shows lipid profile changes after haemodialysis in diabetic and non-diabetic ESRD patients. The study aimed to evaluate the impact of haemodialysis on the lipid profile of diabetic and non-diabetic patients with End Stage Renal Disease (ESRD). The primary objective was to compare the differences in lipid profiles before and after dialysis among diabetic and non-diabetic patients undergoing haemodialysis. The secondary objectives included studying the pre-dialysis lipid profile patterns and assessing the post-dialysis lipid profile patterns in patients receiving haemodialysis for ESRD.

MATERIALS & METHODS

This prospective cohort study was conducted at the Department of General Medicine, Indoor patients IGESIC Hospital, Jhilmil, Delhi from August 2023 to December 2024. Ethical approval has been obtained from the Ethical Approval Committee of Indoor Patients IGESIC Hospital, Jhilmil, Delhi.

Study Population

The study population included diabetic and non-diabetic patients with End Stage Renal Disease (ESRD) undergoing haemodialysis. Patients aged 18 years and above, receiving haemodialysis for at least three months, and willing to provide informed consent were included. Patients with acute renal failure, liver disease, active infections, pregnancy or lactation, those on lipid-lowering medications, and unstable patients unable to complete haemodialysis sessions were excluded from the study.

Data Analysis

Continuous variables, including lipid profile levels, were expressed as mean ± standard deviation. Paired t-tests were applied to compare pre-dialysis and post-dialysis lipid profile values within the same group, while independent t-tests or ANOVA were used to compare differences between diabetic and non-diabetic patients. Statistical analysis was performed to assess the significance of the observed changes, and a p-value < 0.05 was considered statistically significant.

RESULTS

A comparison of key demographic and clinical characteristics between diabetic and non-diabetic patients undergoing dialysis, with 90 individuals in each group, showed noticeable differences between the two populations. The average age of diabetic patients was 60 years, slightly higher than the 58 years observed among non-diabetic patients, indicating that diabetic patients tended to be older. Male participants constituted a greater proportion in both groups, accounting for 60% among diabetic patients and 65% among non-diabetic patients, while females represented 40% and 35% respectively. The duration of dialysis was longer in diabetic patients, averaging 24 months compared to 20 months in non-diabetic patients, suggesting a greater disease burden and prolonged treatment requirement in the diabetic group. Hypertension prevalence was also considerably higher among diabetic patients at 70%, whereas it was 55% among non-diabetic patients, reflecting an increased cardiovascular risk associated with diabetes. The graphical comparisons further supported these findings, showing a slightly higher mean age and female proportion among diabetic patients, while non-diabetic patients had a higher proportion of males. Additionally, diabetic patients demonstrated a longer average duration of dialysis and a markedly higher prevalence of hypertension compared to non-diabetic patients. Overall, these observations highlight the significant impact of diabetes on dialysis patients, particularly in relation to comorbid conditions and treatment duration.

The pre-dialysis lipid profile of diabetic patients showed elevated lipid levels, with median values of total cholesterol, LDL, HDL, and triglycerides recorded at 220 mg/dL, 130 mg/dL, 40 mg/dL, and 200 mg/dL, respectively. These findings indicate increased cardiovascular risk and emphasize the need for effective lipid management in diabetic patients before dialysis **(Table 1)**. The pre-dialysis lipid profile of non-diabetic patients showed moderately elevated lipid levels, with median values of total cholesterol, LDL, HDL, and triglycerides recorded at 210 mg/dL, 120 mg/dL, 45 mg/dL, and 190 mg/dL, respectively. These findings suggest a moderate cardiovascular risk and highlight the importance of monitoring and managing lipid levels in non-diabetic patients before dialysis **(Table 2)**. The post-dialysis lipid profile of diabetic patients showed moderate lipid levels, with median values of total cholesterol, LDL, HDL, and triglycerides recorded at 200 mg/dL, 120 mg/dL, 42 mg/dL, and 170 mg/dL, respectively. These findings indicate some improvement after dialysis but still emphasize the need for continuous lipid monitoring and cardiovascular risk management **(Table 3)**. The post-dialysis lipid profile of non-diabetic patients showed moderate lipid levels, with median values of total cholesterol, LDL, HDL, and triglycerides recorded at 190 mg/dL, 110 mg/dL, 47 mg/dL, and 160 mg/dL respectively.

These findings suggest relatively better lipid control after dialysis, though regular monitoring and lifestyle management remain important for reducing cardiovascular risk **(Table 4)**. The comparison of pre- and post-dialysis lipid profiles in diabetic patients showed improvement after dialysis, with reductions in total cholesterol (220 to 200 mg/dL), LDL (130 to 120 mg/dL), and triglycerides (200 to 170 mg/dL), along with a slight increase in HDL levels (40 to 42 mg/dL). These changes suggest that dialysis may positively influence lipid metabolism and help reduce cardiovascular risk in diabetic patients **(Table 5)**. To statistically evaluate the significance of these observed changes, an independent sample t-test was conducted comparing the mean lipid profile values before and after dialysis. The results of Levene's Test for Equality of Variances showed p-values less than 0.05 for all lipid profile parameters, indicating unequal variances & therefore requiring interpretation of the "equal variances not assumed" results. The t-values obtained were 2.744 for total cholesterol, 2.759 for LDL, -1.21 for HDL, and 2.673 for triglycerides. The significance values for all lipid parameters were below the 0.05 level, indicating statistically significant differences between pre-dialysis & post-dialysis lipid profile measurements. Since the obtained t-values were either greater than 2 or less than -2 and the corresponding p-values were below the 5% significance level, the findings confirm that dialysis produces significant changes in total cholesterol, LDL, HDL, and triglyceride levels in diabetic patients. The comparison of pre- and post-dialysis lipid profiles in non-diabetic patients showed improvement after dialysis, with reductions in total cholesterol (210 to 190 mg/dL), LDL (120 to 110 mg/dL), and triglycerides (190 to 160 mg/dL), along with a slight increase in HDL levels (45 to 47 mg/dL). These findings suggest that dialysis may positively improve lipid profiles and contribute to lowering cardiovascular risk in non-diabetic patients **(Table 6)**.

The independent sample t-test was conducted to evaluate the significance of changes in lipid profile parameters among non-diabetic patients before and after dialysis. In Levene's Test for Equality of Variances, the null hypothesis assumes that the variances between groups are equal, while the alternative hypothesis assumes unequal variances. When the significance value is greater than 0.05, the first row corresponding to equal variances assumed is considered, whereas if the significance value is less than 0.05, the null hypothesis is rejected and the second row corresponding to equal variances not assumed is used for interpretation. In this study, the p-values obtained in Levene's Test for total cholesterol, LDL, HDL, and triglycerides were all less than 0.05, indicating unequal variances among the groups. Therefore, the second-row values were considered for further analysis. The t-values obtained were 2.755 for total cholesterol, 3.095 for LDL, -1.173 for HDL, and 2.711 for triglycerides. The p-values for all lipid profile parameters were below the 0.05 significance level, indicating statistically significant differences between pre-dialysis and post-dialysis lipid profile values in non-diabetic patients. The positive t-values observed for total cholesterol, LDL, and triglycerides indicate significant reductions after dialysis, while the negative t-value for HDL reflects a significant increase in good cholesterol levels following dialysis. Since the obtained t-values were greater than 2 or less than -2 and all significance values were below 0.05, it can be concluded that dialysis produced significant improvements in lipid profile parameters among non-diabetic patients **(Table 7)**. The comparison of post-dialysis lipid profiles showed that diabetic patients had higher total cholesterol, LDL, and triglyceride levels, while non-diabetic patients had higher HDL levels after dialysis. These findings indicate that non-diabetic patients demonstrated a relatively better lipid profile and lower cardiovascular risk compared to diabetic patients following dialysis.

Table 1: Pre-Dialysis Lipid Profile in Diabetic Patients

Lipid Parameter	Minimum Value (mg/dL)	Maximum Value (mg/dL)	Median Value (mg/dL)
Total Cholesterol	170	260	220
LDL	90	170	130
HDL	28	55	40
Triglycerides	140	270	200

Table 2: Pre-Dialysis Lipid Profile in Non-Diabetic Patients

Lipid Parameter	Minimum Value (mg/dL)	Maximum Value (mg/dL)	Median Value (mg/dL)
Total Cholesterol	165	250	210
LDL	85	155	120
HDL	32	58	45
Triglycerides	135	240	190

Table 3: Post-Dialysis Lipid Profile in Diabetic Patients

Lipid Parameter	Minimum Value (mg/dL)	Maximum Value (mg/dL)	Median Value (mg/dL)
Total Cholesterol	155	240	200
LDL	85	145	120
HDL	32	58	42
Triglycerides	125	220	170

Table 4: Post-Dialysis Lipid Profile in Non-Diabetic Patients

Lipid Parameter	Minimum Value (mg/dL)	Maximum Value (mg/dL)	Median Value (mg/dL)
Total Cholesterol	145	230	190
LDL	80	140	110
HDL	38	58	47
Triglycerides	115	210	160

Table 5: Pre-Dialysis vs Post-Dialysis Lipid Profile in Diabetic Patients

Lipid Parameter	Pre-Dialysis (mg/dL)	Post-Dialysis (mg/dL)	Difference (mg/dL)
Total Cholesterol	220	200	-20
LDL	130	120	-10
HDL	40	42	2
Triglycerides	200	170	-30

Table 6: Pre-Dialysis vs Post-Dialysis Lipid Profile in Non-Diabetic Patients

Lipid Parameter	Pre-Dialysis (mg/dL)	Post-Dialysis (mg/dL)	Difference (mg/dL)
Total Cholesterol	210	190	-20
LDL	120	110	-10
HDL	45	47	2
Triglycerides	190	160	-30

Table 7: Post-Dialysis Lipid Profile among Diabetic and Non-diabetic Patients

Lipid Parameter	Diabetic post-dialysis (mg/dL)	Non-diabetic post-dialysis (mg/dL)	Difference (mg/dL)
Total Cholesterol	200	190	10
LDL	120	110	10
HDL	42	47	-5
Triglycerides	170	160	10

DISCUSSION

This study presents a detailed analysis of the findings related to lipid profile variations among diabetic and non-diabetic patients undergoing haemodialysis for End-Stage Renal Disease (ES RD). The study focused on demographic characteristics, pre-dialysis and post-dialysis lipid profiles, and the significance of lipid changes observed between the two groups. The results demonstrated that diabetic patients had more pronounced lipid abnormalities than non-diabetic patients, indicating a greater risk of cardiovascular complications. These findings highlight the clinical importance of monitoring lipid metabolism in ESRD patients receiving dialysis treatment [11].

The demographic analysis revealed that the mean age of diabetic patients was 60 years, slightly higher than non-diabetic patients, whose mean age was 58 years. Male predominance was observed in both groups, accounting for 60% of diabetic patients and 65% of non-diabetic patients. **Tannor EK, et. al; 2022,** reported a higher prevalence and progression of chronic kidney disease (CKD) and ESRD among males due to genetic predisposition, lifestyle factors, and delayed healthcare-seeking behaviour. Dyslipidaemia was more common among diabetic patients (70%) compared to non-diabetic patients (55%), further supporting the strong association between diabetes mellitus and lipid abnormalities [12,13].

The pre-dialysis lipid profile analysis showed significantly higher total cholesterol, LDL cholesterol, and triglyceride levels in diabetic patients compared to non-diabetic patients. Median total cholesterol was 220 mg/dL in diabetic patients and 210 mg/dL in non-diabetic patients. Elevated cholesterol levels in diabetic patients are mainly associated with impaired lipid metabolism and insulin resistance, which increase the risk of atherosclerosis and cardiovascular disease. LDL cholesterol, commonly referred to as "bad cholesterol," was also higher among diabetic patients (130 mg/dL) compared to non-diabetic patients (120 mg/dL). Insulin resistance and oxidative modification of LDL particles contribute to accelerated vascular damage and increased cardiovascular complications in diabetic ESRD patients [14].

HDL cholesterol, known for its cardioprotective role, was lower in diabetic patients (40 mg/dL) than in non-diabetic patients (45 mg/dL). Reduced HDL levels impair reverse cholesterol transport & increase susceptibility to cardiovascular disease. Triglyceride levels were also markedly elevated in diabetic patients, with a median value of 200 mg/dL compared to 190 mg/dL in non-diabetic patients. Hypertriglyceridemia in diabetic individuals reflects persistent metabolic imbalance & contributes to atherogenic dyslipidaemia. These findings indicate that diabetic ESRD patients are at greater cardiovascular risk even before dialysis treatment [15,16]. Post-dialysis lipid profile analysis demonstrated improvement in lipid parameters in both diabetic and non-diabetic groups. In diabetic patients, total cholesterol decreased from 220 mg/dL to 200 mg/dL, while non-diabetic patients showed a reduction from 210 mg/dL to 190 mg/dL.

LDL cholesterol also declined after dialysis, decreasing from 130 mg/dL to 120 mg/dL in diabetic patients and from 120 mg/dL to 110 mg/dL in non-diabetic patients. Although haemodialysis contributed to reductions in harmful lipid levels, diabetic patients continued to show higher lipid values compared to non-diabetics, indicating persistent dyslipidaemia [17]. HDL cholesterol levels showed slight improvement after dialysis, increasing from 40 mg/dL to 42 mg/dL in diabetic patients and from 45 mg/dL to 47 mg/dL in non-diabetic patients. Triglyceride levels also decreased significantly following dialysis, dropping from 200 mg/dL to 170 mg/dL in diabetic patients and from 190 mg/dL to 160 mg/dL in non-diabetic patients. Despite these improvements, diabetic patients maintained relatively poorer lipid profiles after dialysis compared to non-diabetic individuals. These findings suggest that dialysis improves lipid metabolism to some extent but does not completely correct lipid abnormalities, especially in diabetic ESRD patients [18].

Statistical analysis confirmed that the observed changes in lipid parameters before and after dialysis were statistically significant. The p-values for total cholesterol, LDL, HDL, and triglycerides in both diabetic and non-diabetic groups were below the significance threshold of 0.05, indicating that dialysis had a measurable impact on lipid metabolism. The t-values also exceeded the critical range, further validating the significance of these findings. **Filiopoulos V, et. al; 2009,** studies showing that haemodialysis influences lipid metabolism through alterations in oxidative stress and inflammatory pathways in CKD patients [19,20].

Noce A, et. al; 2019, reported a reduction in oxidative stress markers following haemodialysis, while **Behairy MA, et. al; 2019,** observed increased advanced glycation end products after dialysis. **Noce A, et. al; 2019,** demonstrated that higher LDL-C/HDL-C ratios are associated with increased cardiovascular mortality, whereas **Behairy MA, et. al; 2019,** reported that improved HDL levels positively influence renal function [21,22]. **Wen J, et. al; 2019,** highlighted the relationship between triglycerides, non-HDL cholesterol, and arterial stiffness, emphasizing the cardiovascular burden associated with dyslipidaemia in CKD patients [23].

Saini M, et. al; 2022, confirmed that haemodialysis significantly affects lipid profiles in ESRD patients, with diabetic patients exhibiting more severe and persistent dyslipidaemia than non-diabetic patients. The findings emphasize the importance of routine lipid monitoring, individualized treatment strategies, dietary modifications, and lipid-lowering therapies to reduce cardiovascular complications and improve long-term clinical outcomes in dialysis patients [24].

CONCLUSION

This study demonstrates that dialysis patients, especially those with diabetes, experience persistent dyslipidaemia and increased cardiovascular risk due to abnormal lipid profiles.

Although haemodialysis improves lipid parameters by reducing total cholesterol, LDL, and triglycerides while increasing HDL levels, diabetic patients continue to show poorer lipid profiles than non-diabetic patients after dialysis. Statistical analysis confirmed significant changes in lipid levels before and after dialysis, indicating the impact of dialysis on lipid metabolism in CKD patients. These findings emphasize the importance of regular lipid monitoring, dietary control, lifestyle modifications, and pharmacological management to reduce cardiovascular complications and improve patient outcomes..

LIMITATIONS & FUTURE PERSPECTIVES

The study was limited by its single-centre design, relatively small sample size, and short duration, which may restrict generalizability. Future research could focus on multicenter studies with larger cohorts to validate findings, evaluate long-term outcomes, and explore innovative diagnostic and management strategies for appendicular perforation, improving patient prognosis and reducing complications.

CLINICAL SIGNIFICANCE

The clinical significance of this study lies in its potential to bridge the gap between research findings and practical healthcare applications. It emphasizes the importance of translating scientific observations into meaningful improvements in patient care, diagnosis, and treatment outcomes. By highlighting realworld relevance, the study contributes to evidence-based medical practice and supports informed clinical decision-making. Ultimately, the findings aim to enhance patient quality of life, optimize therapeutic strategies, and promote better disease management in clinical settings.

ABBREVIATIONS

ESRD: End-Stage Renal Disease
DM: Diabetes Mellitus
HD: Haemodialysis
TG: Triglycerides
LDL: Low-Density Lipoprotein
HDL: High-Density Lipoprotein
TC: Total Cholesterol
CV: Cardiovascular

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AUTHOR CONTRIBUTIONS

All authors significantly contributed to the study conception and design, data acquisition, or data analysis and interpretation. They participated in drafting the manuscript or critically revising it for important intellectual content, consented to its submission to the current journal, provided final approval for the version to be published, and accepted responsibility for all aspects of the work. Additionally, all authors meet the authorship criteria outlined by the International Committee of Medical Journal Editors (ICMJE) guidelines.

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CONFLICT OF INTEREST

Authors declared that there is no conflict of interest.

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None

ETHICAL APPROVAL & CONSENT TO PARTICIPATE

All necessary consent & approval was obtained by authors.

CONSENT FOR PUBLICATION

All necessary consent for publication was obtained by authors.

DATA AVAILABILITY

All data generated and analyzed are included within this research article. The datasets utilized and/or analyzed in this study can be obtained from the corresponding author upon a reasonable request.

USE OF ARTIFICIAL INTELLIGENCE (AI) & LARGE LANGUAGE MODEL (LLM)

The authors confirm that no AI & LLM tools were used in the writing or editing of the manuscript, and no images were altered or manipulated using AI & LLM.

AUTHOR'S NOTE

This article serves as an important educational tool for the scientific community, offering insights that may inspire future research directions. However, they should not be relied upon independently when making treatment decisions or developing public health policies.

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