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Biochemical Disturbances and Profile of Lipid in Chronic Renal Failure Patients on Maintenance Hemodialysis

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Abstract

This study was conducted in AL-Hakeem Hospital in Al Najaf Al Ashraf City between January and March of 2026. 77 people, 53 men and 24 women, aged 21 to 65, were enrolled in order to assess the serum lipid profile, albumin, and hemoglobin in patients with renal failure receiving hemodialysis. The patient was diagnosed with renal failure for both sexes based on the patient's medical history, clinical examination, and renal function test findings. Medical professionals and family members who showed no signs of diabetes mellitus, hypertension, lipid issues, or renal sickness comprised the 50 control groups. There were twenty women and thirty men, ages ranging from 22 to 66. The samples of blood were obtained from the patients (8-12) hr. after night fasting. The study's discoveries include a significant alteration in the majority of variables (Lipid profile, Liver enzymes, Albumin, Urea, Uric acid, Hb, and PCV), with the exception of HDL, which was not significant. Additionally, the following changes (urea and uric acid) seem to be significantly correlated with the length of CRF disease, although the other parameters remain unchanged (TC, LDLc, HDLc, VLDLc, TG, Hb, PCV, GOT, GPT, and Albumin). On the other hand, the anova analysis of statistical analysis reveals the following: PCV vs Uric acid, PCV vs Albumin, PCV vs Hb%, GOT vs Uric acid, VLDL vs TG, Hb% vs TG, Hb% vs VLDL, LDL vs HDL), According to the current study, patients with chronic renal failure often have high TG and aberrant haematological markers.

Introduction

Renal failure, a condition in which the kidneys no longer function correctly, can be caused by a number of conditions, including infections, autoimmune diseases, diabetes and other endocrine disorders, cancer, and toxic substances (Mohsen et al., 2023; Romagnani et al., 2017; Stavropoulou et al., 2021). It can be identified by a reduction in the excretory and regulatory functions of the kidney (Meyer & Hostetter, 2007). According to research, people with chronic renal failure (CRF) are living longer thanks to advancements in conservative treatment and dialysis (OKE et al., 2026; Peters & Orinate, 2026; Gao et al., 2026). There is growing evidence that accelerated atherosclerosis may continue to be a significant unresolved issue endangering the lifespan of CRF patients as patient survival has decreased over the past century (Linder et al., 1994). According to studies, chronic renal failure (CRF) is defined as either long-term, permanent damage to kidney tissue or a substantial and persistent decrease in glomerular filtration rate (Dewardener, 1986; Koper et al., 2026; Młynarska et al., 2024). It is characterized by several clinical symptoms and indicators as well as a broad range of metabolic disruptions (Mathenge et al., 2003; Casazza et al., 2026; Jerzak et al., 2026). In addition to the fact that

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conditions where renal function is compromised can be fatal, adequate renal function is crucial for homeostasis.

In many nations across the world, kidney diseases rank among the leading causes of mortality and disability (Bijlani, 2004; Francis et al., 2024; Khandelwal & Gupta, 2023). However, the changes include osteodystrophy, impaired sexual function, neurologic disorders, gastrointestinal disorders, cardiovascular issues, haematologic abnormalities, and skin disorders (Maronkola, 2006). The author explains how various hematopoietic alterations are linked to renal disorders. Failure of renal erythropoietin secretion is the primary cause of anemia, which is correlated with the severity of renal impairment. Further variables include hemolysis, bone marrow suppression from retained uremic components, and chronic blood loss (Suresh et al., 2012; Ula & Basim, 2024). As a result, RBC survival in uremic patients is decreased in proportion to blood urea nitrogen level, and it significantly improves following intensive hemodialysis (Alsayb et al., 2026; Red blood cells' outer cell surface phosphatidylserine expression is elevated by uremic plasma. This makes it easier for macrophages to identify damaged red blood cells, which causes them to be destroyed and have a lower chance of surviving (Michael et al., 2004; Ali et al., 2025).

Conversely, most patients with renal insufficiency have altered lipoprotein metabolism. Early on in renal failure, dyslipidemia develops. A marked dyslipidemia is caused by the difference in lipoprotein synthesis and breakdown in long-term renal failure (Nzere et al., 2012; Hashim & Ali, 2026). Researchers discovered that dyslipidemias are a common consequence of chronic renal failure (CRF) (Norrie, 2025; Hamouz & Aljalal, 2026; Stabouli et al., 2026). Even in the early stages of CRF, abnormalities in lipoprotein metabolism are noticeable, and they often have a declining trajectory that corresponds with the decline in renal function. According to recently released research, dyslipidemias in these patients may actively contribute to both the decline in renal function and the pathophysiology of cardiovascular disease (CVD). The common lipid abnormalities seen in CRF patients include elevated triglycerides, normal or lowered total cholesterol (TC), decreased HDL, and normal LDL. Progressive CRF is associated with higher mortality and cardiovascular infection in addition to end-stage renal disease (ESRD). Actually, CRF patients are significantly more likely to die from dyslipidemias than to develop end-stage renal disease (Dipika et al., 2013; Almohanna et al., 2025).

Methods

This cross-sectional study was conducted at Al-Hakeem General Hospital, Al-Najaf Al-Ashraf, Iraq, between January and March 2026.

Seventy-seven patients with chronic renal failure (CRF) who were receiving maintenance hemodialysis were included in the study (53 men and 24 females, ages 21–65). Renal function testing, clinical examination, and medical history all supported the diagnosis. Fifty age- and sex-matched healthy controls (20 females and 30 men; ages 22–66) who had no history of ischemic heart disease, diabetes mellitus, hypertension, dyslipidemia, or renal illness were chosen among hospital employees and family members. Diabetes mellitus, hypertension, and ischemic heart disease were among the exclusion criteria.

Sample Collection

Five milliliters of venous blood were drawn from patients and controls into plain tubes after they had fasted for eight to twelve hours. Serum was extracted for biochemical examination

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after samples were centrifuged for 10 minutes at 3000 rpm and allowed to clot for 30 minutes at room temperature.

Laboratory Measurements

An automated Beckman Coulter analyzer was used to measure the hematological parameters (Hb) and (PCV). Total cholesterol (TC), triglycerides (TG), HDL-cholesterol (HDL-C), albumin, aspartate aminotransferase (GOT), alanine aminotransferase (GPT), urea, and uric acid were among the serum biochemical parameters that were colorimetrically measured using commercial kits on a fully automated clinical chemistry analyzer. Friedewald's formula was used to determine LDL-cholesterol (LDL-C) and very low-density lipoprotein cholesterol (VLDL-C) (Friedewald et al., 1972; Ali et al., 2021).

Statistical analysis

Statistical software (SPSS) was used to perform statistical calculations on the data collected following biochemical examination. The F-distribution test, mean, and standard deviation of the mean were acquired. Additionally, use Microsoft Excel (2016). A critical value or test of probability less than 0.05 ($p<0.05$) was considered significant (Auda et al., 2021; Ali et al., 2020).

Results and Discussion

The distribution of the registered patients followed clear clinical and demographic tendencies, according to an analysis of the study data. Patients were specifically classified by sex (males, Table 2; females, Table 3), and a one-way ANOVA revealed a significant gender difference (Table 8). Furthermore, patients were categorized based on the length of their illness and the number of dialysis sessions they had received; a one-way ANOVA revealed statistically significant differences between these factors (Table 5 and Table 7, respectively).

The study's findings indicate that patients with CRF had significantly higher levels of cholesterol, GPT, and LDLC conc. when compared to their control groups. Additionally, the same table indicates that patients with CRF had significantly higher levels of TG, albumin, urea, uric acid, and VLDLC in comparison to their control groups. However, compared to their comparison groups, patients with CRF had much lower levels of Hb% and PCV, according to table (1). The HDLc levels in patients with CRF did not significantly differ from those in their control individuals, according to the results in tables 1, 2, & 3.

Table 1. showed the biochemical parameters in hemodialysis patients with CRF and control.

P value	Control =50 SD	Control =50 Mean	Patient =77 SD	Patient =77 Mean	parameter
0.004*	23.24	103.12	42.87	120.42	cholesterol mg/dl
0.137	11.62	43.42	18.43	39.427	HDL (mg/dl)
0.0003**	21.51	103.24	57.15	130.53	TG (mg/dl)
0.0003**	0.79	5.56	1.59	6.36	Uric acid
0.0001**	6.85	33.71	40.22	71.08	Urea (mg/dl)
0.0001**	0.44	4.33	0.56	4.01	Albumin (g/dl)
0.0001**	0.4	12.750	1.59	11.96	Hb
0.0001**	4.66	44.20	5.93	40.19	PCV
0.0004**	4.51	24.30	6.15	27.75	G OT (U/L)

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0.0027*	6.7	24.2	8.03	28.23	GPT (U/L)
0.0002**	4.3	20.65	11.43	26.10	VLDL
0.0017*	21.52	41.56	41.8	59.73	LDL

Patients with CRF had significantly greater levels of cholesterol, TG, GOT, GPT, VLDL, LDL, and albumin than their control groups, according to Table 2's results, which include 53 male patients and 30 male control groups. In addition, urea and uric acid levels were significantly higher than in the control groups. When compared to the usual group, the same table showed a highly significant drop in PCV levels and a considerable drop in Hb%.

Table 2. shows the biochemical parameters of male hemodialysis patients with CRF and controls.

P value	Control = 30 SD	Control = 30 Mean	Patient = 53 SD	Patient = 53 Mean	Parameter
0.0053*	24.98	95.7	37.38	115.42	cholesterol mg/dl
0.5	13.32	42.45	20.6	39.93	HDL (mg/dl)
0.0346*	22.31	112.57	64.88	133.68	TG (mg/dl)
0.0001**	0.91	5.55	1.59	6.82	Uric acid
0.0001**	4.98	31.46	39.08	75.25	Urea (mg/dl)
0.0059*	0.43	4.36	0.55	4.05	Albumin (g/dl)
0.0429*	0.09	12.53	1.61	12.07	Hb
0.0001**	3.48	46.6	5.04	41.44	PCV
0.017*	3.55	25.33	6.58	28.04	G OT (U/L)
0.017*	6.43	24.93	9.05	29.11	GPT (U/L)
0.031*	4.22	22.46	12.98	26.75	VLDL
0.014*	24.24	38.41	38.75	55.82	LDL

The results in Table 3, which includes 24 female patients and 20 female control groups, indicate that patients with CRF had significantly higher levels of cholesterol, urea, GOT, GPT, LDL, and albumin when compared to the control groups. Furthermore, there was a significant increase in the levels of TG and VLDLc when compared with the control groups. In the same table, the CRF patients showed significantly lower levels of Hb% and PCV when compared to the standard group.

Table 3. shows the biochemical parameters of female hemodialysis patients with CRF and controls**.**

P value	Control = 20 SD	Control = 20 Mean	Patient = 24 SD	Patient = 24 Mean	Parameter
0.053*	14.22	108.90	52.24	131.46	cholesterol mg/dl
0.059	8.93	44.67	12.69	38.33	HDL (mg/dl)
0.0001**	13.74	89.65	34.71	123.58	TG (mg/dl)
0.876	0.68	5.38	1.01	5.34	Uric acid
0.012*	5.86	38.30	42.00	61.88	Urea (mg/dl)
0.013*	0.43	4.33	0.59	3.93	Albumin (g/dl)
0.0002*	0.37	13.13	1.54	11.71	Hb
0.049*	3.22	40.65	6.86	37.43	PCV
0.021*	5.51	23.25	5.12	27.13	G OT (U/L)

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0.033*	6.27	22.50	4.73	26.29	GPT (U/L)
0.0001**	2.75	17.93	6.94	24.72	VLDL
0.042*	16.09	46.3	47.61	68.38	LDL

Patient frequency for each time period is displayed in Table 3, by sex and total.

Table 4. The study sample was distributed by Duration of the CRF.

Duration	Period interval/ Month	Male no.	Female no.	Total
Period 1	>36	16	4	20
Period 2	24-35	12	6	18
Period 3	13-23	13	6	19
Period 4	1-12	12	8	20

Using Tukey simultaneous comparison (one-way ANOVA), the results in Table 5 showed no significant change in all biochemical variations in patients with CRF, with the exception of a highly significant increase in urea level and a subsequent significant increase in uric acid concentration.

Table 5. the biochemical parameters according to the duration of hemodialysis for CRF patients.

P value	F	Duration 4 SD	Duration 4 Mean	Duration 3 SD	Duration 3 Mean	Duration 2 SD	Duration 2 Mean	Duration 1 SD	Duration 1 Mean	variation
0.22	0.22	52	124	42	121.4	41.4	121.7	33.5	113.4	cholesterol mg/dl
0.52	0.77	15.8	36.8	19.7	37.3	24	45.1	14.9	40.2	HDL (mg/dl)
0.9	0.25	52.2	135.5	58.2	126.9	49.7	121.7	70.7	135.6	TG (mg/dl)
0.019*	3.53	1.3	5.7	1.7	6.45	1.5	6.24	1.6	7.23	Uric acid
0.0001**	5.75	4.6	33.9	7.24	52.5	10.8	79.8	25.54	132.4	Urea (mg/dl)
0.61	0.62	0.5	4.01	0.54	4.6	0.63	3.96	0.6	3.9	Albumin (g/dl)
0.75	0.41	1.3	11.8	1.51	11.9	1.66	12.3	1.8	11.9	Hb
0.3	1.24	5.9	40.2	6.1	40.5	6.3	37.9	6.27	41.7	PCV
0.44	0.92	4.92	26.2	6.05	29.05	8.62	28.6	5.06	27.7	G OT (U/L)
0.46	0.88	5.03	26.5	13.19	30.4	6.95	28.75	4.18	27.8	GPT (U/L)
0.86	0.25	10.45	27.1	11.64	25.39	9.93	24.34	14.14	27.1	VLDL
0.84	0.28	47.5	62.14	44.16	63.2	36.6	60.7	38.16	51.7	LDL

Patient frequency for all dialysis sessions is displayed in Table (6) as male and female numbers as well as the total for each dialysis stage.

Table 6. The study sample was distributed based on the number of CRF patients receiving dialysis.

Dialysis	Dialysis no.	Male no.	Female no.	Total no.
1	More than 6	13	6	19
2	4-5	15	5	20
3	3	13	9	22
4	1-2	8	8	16

Tukey simultaneous comparison (anova one way) was used to complete the results in table (7), which revealed a significant increase in TG and VLDL levels, a considerable drop in PCV levels and a highly significant drop in Hb% in CRF patients; the remaining variance in CRF patients did not alter significantly.

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Table 7. revealed the biochemical parameters based on the number of CRF patients receiving dialysis.

P value	F	Step 4 SD	Step 4 Mean	Step 3 SD	Step 3 Mean	Step 2 SD	Step 2 MEAN	Step 1 SD	Step 1 Mean	variation
0.22	1.52	58.63	137.44	42.8	113.5	24.81	109.7	39.2	124.6	cholesterol mg/dl
0.62	0.59	10.5	38.6	24.95	43.5	19.2	36.14	13.8	38.3	HDL (mg/dl)
0.003*	5.1	59.2	170.3	60.2	135.5	44.96	118.9	45.03	103.4	TG (mg/dl)
0.22	1.5	1.6	6.15	1.86	6.2	1.32	6.013	1.4	6.99	Uric acid
0.63	0.58	34.5	60.3	34	70.22	49.15	77	43.35	75.35	Urea (mg/dl)
0.65	0.55	0.53	3.99	0.72	3.9	0.5	4.06	0.4	4.12	Albumin (g/dl)
0.0001**	8.6	0.8	13.9	0.22	12.47	0.37	11.44	0.87	9.73	Hb
0.003*	5.06	5.9	43.4	3.099	41.75	4.96	37.7	7.46	38.003	PCV
0.25	0.86	9.53	28.3	5.89	28	4.42	26.7	4.51	28	G OT (U/L)
0.46	0.87	5.25	28.25	5.82	26.9	13.38	30.8	5.3	27.45	GPT (U/L)
0.0029*	5.1	11.8	34.1	12.04	27.1	8.99	23.8	9	20.68	VLDL
0.67	0.52	52.26	65.38	40.9	56.5	32.7	51.5	42.7	66.1	LDL

Table 8 of this study's simultaneous comparison between the two genders showed no significant differences in any of the parameters, with the exception of a highly significant difference in uric acid level and a significant difference between male and female patients with CRF.

Table 8. displays the metabolic characteristics of CRF patients receiving hemodialysis by gender.

P value	F	Female = 24 SD	Female = 24 Mean	Male = 53 SD	Male = 53 Mean	variation
0.13	2.36	52.24	131.5	37.38	115.4	cholesterol mg/dl
0.7	0.12	12.69	38.33	20.6	39.93	HDL (mg/dl)
0.48	0.51	34.7	123.58	64.88	133.68	TG (mg/dl)
0.0001**	17.4	1.002	5.34	1.59	6.82	Uric acid
0.18	1.85	42.003	61.875	39.08	75.25	Urea (mg/dl)
0.399	0.72	0.59	3.93	0.55	4.05	Albumin (g/dl)
0.355	0.87	1.5	11.71	1.61	12.07	Hb
0.0053*	8.26	6.86	37.43	5.04	41.44	PCV
0.55	0.36	5.12	27.13	6.58	28.04	G OT (U/L)
0.155	2.07	4.73	26.29	9.05	29.1	GPT (U/L)
0.48	0.5	6.9	24.7	12.98	26.74	VLDL
0.22	1.5	47.61	68.38	38.75	55.82	LDL

The statistical analysis shows that the following parameters are positively correlated (Urea & Uric acid, PCV & Uric acid, PCV & Albumin, PCV & Hb%, GOT & Uric acid, VLDL & TG) and negatively correlated (Hb% & TG, Hb% & VLDL, LDL & HDL); the remaining parameters are not correlated

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Table 9. demonstrates the relationship between markers in hemodialysis patients with CRF.

r P-value	cholesterol	HDLc	TG	Uric acid	Urea	Albumin	Hb	PCV	G OT	GPT	VLDLc
HDLc	**0.079-**										
	0.493										
TG	0.151	0.191									
	0.19	0.096									
Uric acid	-0.008	0.145	-0.030								
	0.944	0.208	0.798								
Urea	-0.141	0.127	0.005	0.305							
	0.220	0.270	0.963	0.007*							
Albumin	0.150	0.126	-0.117	0.181	-0.094						
	0.192	0.275	0.310	0.116	0.415						
Hb	-0.101	-0.005	-0.454	0.107	0.159	0.006					
	0.384	0.967	0.000*	0.353	0.166	0.958					
PCV	0.046	0.062	-0.093	0.303	0.085	0.323	0.396				
	0.688	0.590	0.422	0.007*	0.463	0.004*	0.000*				
G OT	-0.077	0.025	0.034	0.248	0.082	-0.081	-0.003	0.139			
	0.503	0.831	0.770	0.030*	0.480	0.484	0.976	0.227			
GPT	-0.055	-0.155	-0.069	0.007	0.006	0.128	-0.011	0.031	0.064		
	0.636	0.180	0.550	0.953	0.957	0.269	0.927	0.791	0.581		
VLDLc	0.151	0.191	1.000	-0.030	0.005	-0.117	-0.454	-0.093	0.034	-0.069	
	0.190	0.096	*	0.798	0.963	0.310	0.000*	0.422	0.770	0.550	
LDLc	0.904	-0.362	-0.072	-0.054	-0.149	0.092	-0.014	-0.017	-0.103	-0.001	-0.072
	0.000	0.001*	0.531	0.640	0.197	0.426	0.901	0.881	0.371	0.993	0.531

The biochemical parameters of 50 age and sex-matched controls and 77 patients with chronic renal failure were compared. The PCV and Hb% levels in chronic renal failures have been found to be lower in the current investigation, as Table 1 illustrates. This result is consistent with the findings of Suresh M. et al., who state that decreased erythropoietin synthesis and other variables that damage marrow erythropoiesis and shorten red cell life are the main causes of decreased PCV and Hb% levels in chronic renal failure (Suresh et al., 2012; Risan & Ali, 2024). RBC survival increases dramatically during intensive hemodialysis and decreases in uremic patients in proportion to blood urea concentration. Red blood cells with uremic plasma have more phosphatidylserine on their outer surface. This makes it easier for macrophages to identify broken red blood cells, which damages them and reduces their chances of survival. This study supports our current findings, which show a significant drop in Hb and PCV levels in Table 1. Additionally, Table 7's statistical analysis reveals a significant alteration in Hb and PCV percent. The outcomes refer to a decrease in Hb and PCV levels whenever hemodialysis is increased Michael et al., 2004; Al-Zurfi et al., 2016). In general, the hematocrit and hemoglobin concentration accurately reflect the degree of reduction in the mass of circulating

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red blood cells. Reduced erythropoietin secretion and increased red blood cell destruction in chronic renal disease result in a decrease in RBCs, which lowers PCV & Hb. Even patients with mild to moderate renal insufficiency show a drop in hematocrit (Emmanuel et al., 2004). anemia of chronic illness has historically included any long-standing inflammatory, infectious, or neoplastic disease. Chronic renal failure, rheumatoid arthritis, severe trauma, heart disease, and diabetes mellitus are all included in the current criteria. Reduced iron availability, comparatively lower erythropoietin levels, and a slight reduction in RBC lifespan to 70–80 days (usually 120 days) are the main effects of these conditions (Besarab et al., 2006). The recent study supports all of these investigations.

The metabolism of lipoprotein is primarily impacted by chronic renal failure (Vaziri & Moradi, 2006; Ali et al., 2020). This is linked to higher rates of cardiovascular morbidity and mortality as well as early atherosclerosis. In patients with CRF, atherogenesis and cardiovascular disease are caused by a number of variables, most notably dyslipidemias. Tables 1, 2, 3, and 7 display the typical dyslipidemias seen in CRF patients receiving hemodialysis in this study. Dr. Dipika (2013) also shows that long-term hemodialysis is unable to address dyslipidemias caused by CRF in patients receiving intermittent dialysis. The current study is different from that of some writers who discovered that dialysis did not seem to have an impact on the lipid and lipoprotein compositions of CRF patients (Senti et al., 1992; Ponticelli et al., 1978). The lipid profile values of male and female patients are compared statistically. Tables 1, 2, 3, and 8 demonstrate that dyslipidemias of CRF affected both male and female patients similarly. Similarly, Amin et al. (2006) described (Amin et al., 2006). Therefore, decreased catabolism of TG lipoprotein is an early essential disruption in the kidney. TG and TG-rich lipoproteins (VLDL and LDL-C) were found to be considerably higher in CRF together male and female. This implies that the digestion of TG, VLDLc, and LDLc is impacted by renal dysfunction (CRF), which puts the patient at risk for cardiovascular disease (Nzere et al., 2012). The same findings from the current investigation are shown in tables 1, 2, 3, and 8.

Conclusion

Patients with chronic renal failure have abnormal hematological parameters, according to the current study. It has been proposed that hematuria and gastrointestinal blood loss in chronic renal failure cause a decrease in red blood cell count, hemoglobin percentage, and hematocrit. TG is frequently elevated in CRF patients. Increased plasma levels and impaired clearance of VLDL, total cholesterol, and LDL-c are common outcomes of heavy proteinuria, either by itself or in combination with chronic renal insufficiency.

Recommendations

Routine changes may gradually raise HDL levels; more prospective research with long-term monitoring is advised.

Exercise can help avoid certain serious illnesses, including CHD and CRF.

Diets tailored to each person's body type and age group

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