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Blood Indicators and Hemoglobin Analysis Among Dialysis Patients in Basrah City, Iraq

Nidham Mohammed Jamalludeen[1]*, Lujain Mohammed Hashim[2], Zainab Ali Mohammed[2] and Baneen Naseer Jaber[2]

[1]Department of Microbiology, College of Medicine, University of Basrah, Basrah, Iraq.
[2]Department of Medical Laboratory Technology, College of Health and Medical Technology, Southeast Technical University, Basrah, Iraq.
*Corresponding Author E-mail: njovc@yahoo.com

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Individuals diagnosed with chronic kidney disease (CKD) often experience various complications, one of the most prominent of which is anemia. Additionally, elevated levels of creatinine, urea, ferritin, and C-reactive protein (CRP) and low red blood cell counts are often observed. This study focused on examining blood markers in individuals with CKD undergoing dialysis and comparing them with those of a healthy control group. Samples were randomly collected from patients and control groups. One hundred and two (102) samples were collected from a group of 77 CKD patients, including 39 males and 38 females. The age group was divided into three categories: 20 to 39, 40 to 59, and 60 years and older, of which 25 were from the control group. Significant decreases were observed in red blood cell (RBC) count, hematocrit (HCT), hemoglobin (HGB), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) in dialysis patients compared to the control group. There was no significant difference in mean corpuscular volume (MCV), white blood cell (WBC), and platelet count (PLT). Dialysis patients showed significantly higher creatinine, urea, ferritin, and C-reactive protein levels compared to the control group. The highest mean MCV was recorded in the 20-39 age group, followed by the 40-59 and the =60 age groups. Creatinine levels peaked in the 40-59 age group, with declining levels in the other age groups. Urea, ferritin, and C-reactive protein levels did not show significant age-related variation. Male dialysis patients had higher mean urea levels than females. Females showed lower creatinine levels compared to males. Ferritin and C-reactive protein levels did not differ significantly by sex. In conclusion, the study highlighted significant changes in blood parameters and kidney function indices in dialysis patients compared to healthy controls. The study also identified age- and sex-related differences, emphasizing the importance of monitoring and personalized management for chronic kidney failure patients undergoing dialysis. Individuals diagnosed with chronic kidney disease (CKD) often experience various complications, one of the most prominent of which is anemia. Additionally, elevated levels of creatinine, urea, ferritin, and C-reactive protein (CRP) and low red blood cell counts are often observed. This study focused on examining blood markers in individuals with CKD undergoing dialysis and comparing them with those of a healthy control group. Samples were randomly collected from patients and control groups. One hundred and two (102) samples were collected from a group of 77 CKD patients, including 39 males and 38 females. The age group was divided into three categories: 20 to 39, 40 to 59, and 60 years and older, of which 25 were from the control group. Significant decreases were observed in red blood cell (RBC) count, hematocrit (HCT), hemoglobin (HGB), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) in dialysis patients compared to the control group. There was no significant difference in mean corpuscular volume (MCV), white blood cell (WBC), and platelet count (PLT). Dialysis patients showed significantly higher creatinine, urea, ferritin, and C-reactive protein levels compared to the control group. The highest mean MCV was recorded in the 20-39 age group, followed by the 40-59 and the =60 age groups. Creatinine levels peaked in the 40-59 age group, with declining levels in the other age groups. Urea, ferritin, and C-reactive protein levels did not

show significant age-related variation. Male dialysis patients had higher mean urea levels than females. Females showed lower creatinine levels compared to males. Ferritin and C-reactive protein levels did not differ significantly by sex. In conclusion, the study highlighted significant changes in blood parameters and kidney function indices in dialysis patients compared to healthy controls. The study also identified age- and sex-related differences, emphasizing the importance of monitoring and personalized management for chronic kidney failure patients undergoing dialysis.

Keywords: Basrah; Blood Indicators; Dialysis; Hemoglobin Analysis; Kidney Failure.

Kidney failure is the inability of the kidneys to perform their function, which leads to retention of nitrogenous waste from the blood, and then the kidneys fail to maintain the balance of chemicals in the body. The pathophysiological spectrum of kidney disease is broad and there are two general aspects, namely acute kidney disease (AKD) and chronic kidney disease. [1] Acute kidney disease is a disorder where the kidneys become damaged and lose their ability to filter blood effectively. It is characterized by a rapid decline in kidney function over days to weeks, often marked by a decrease in glomerular filtration rate (GFR), elevated serum creatinine levels, or oliguria. [2] AkD encompasses a variety of conditions and is classified based on its stage and underlying cause. This type of renal injury affects approximately 20% of hospitalized patients and is associated with significant complications, including volume overload, electrolyte imbalances, uremic symptoms, and drug-induced toxicity. However, recent clinical guidelines from the Kidney Disease Improving Outcomes Global Organization (KDIGO) define acute renal failure as a subset of acute kidney disease. [3,4] Whereas Chronic kidney disease (CKD) is a long-term condition that involves gradual deterioration in kidney structure and function due to multiple underlying factors. It is commonly identified by a persistent decline in renal function, indicated by an estimated glomerular filtration rate (eGFR) below 60 mL/min/1.73 m², or by the presence of markers of kidney damage—such as albumin in the urine (albuminuria), blood in the urine (haematuria), or other laboratory or imaging abnormalities—lasting for a minimum of three months. [5, 6, 7] Chronic kidney disease is frequently referred to as the "silent killer" in medicine, as symptoms rarely appear until the glomerular filtration rate (GFR) has significantly declined. It refers to a broad group of diverse disorders that impair the structure and function of the kidneys.[8] Chronic kidney disease can be identified through standard laboratory tests. Early intervention and appropriate treatments may help prevent its onset, slow its progression, mitigate complications associated with a reduced glomerular filtration rate, lower the risk of cardiovascular diseases, and enhance both survival and quality of life. Consequently, blood and urine analyses are routinely conducted. Medical care plays a fundamental role in managing the condition. [9]

The estimation of glomerular filtration rate (eGFR) primarily relies on serum biomarkers filtered by the kidneys, with serum creatinine (SCr) being the typically observed utilized. Although SCr levels reflect the glomerular filtration rate (GFR), they are also influenced by factors such as muscle mass, tubular secretion of creatinine, and, to a lesser extent, dietary intake of cooked lean meat. Additionally, the relationship between SCr and GFR is inverse. Creatinine-based equations used to estimate GFR often incorporate variables including sex, race, and age to improve accuracy. [8,10]

It is very common that about 15% of adults in the United States are likely to have chronic kidney disease. [11] While in Canada it is 1.0%. [12]

In Asian countries, there is an increasing prevalence of chronic kidney disease (CKD), with an estimated 2.3% of adults suffering from CKD in Singapore in 2018, 12.5% in Indonesia, 12% in Taiwan, 17.5% in Thailand, 13.3% in northern India

(Delhi), 13% in China (Beijing), and 13% in Japan. [13,14] In Vietnam, an estimated six million people suffer from CKD, representing approximately 5% of the total Vietnamese population in 2017. [15] In Iraq, the prevalence and incidence of CKD in the southern governorates of Basrah were 98.5 pmp, Maysan 78.8 pmp, and Dhi Qar 61.3 pmp. [16] In North Africa, the prevalence (percentage points) was Tunisia 734, Egypt 650, Algeria 475, Libya 323, and Morocco 300. [17]

Several blood indicators must be examined among dialysis patients to determine the disease, including kidney function tests, serum ferritin tests, complete blood counts, and C-reactive protein as well. [18,19] Therefore, this research aimed to study some blood and hemoglobin indicators in dialysis patients.

Table 1. Blood indices between Dialysis and Control Groups

Index	Group	N	Mean	Std. Deviation	P value
RBC	Dialysis group	25	3.94	0.91	0.01**
	Control group	25	4.58	0.45	
HCT	Dialysis group	25	32.74	4.79	0.01**
	Control group	25	39.88	2.10	
HGB	Dialysis group	25	9.95	1.50	0.03*
	Control group	25	13.15	0.77	
MCV	Dialysis group	25	83.86	9.71	0.07N.S.
	Control group	25	79.99	3.76	
MCH	Dialysis group	25	25.48	2.91	0.01**
	Control group	25	27.69	1.23	
MCHC	Dialysis group	25	30.41	1.45	0.01**
	Control group	25	33.51	1.26	
WBC	Dialysis group	25	6.07	2.18	0.08N.S.
	Control group	25	7.14	1.95	
PLT	Dialysis group	25	179.16	59.10	0.92N.S.
	Control group	25	200.12	70.08	

RBC count: The dialysis group has a significantly lower mean RBC count in comparison with the control categories (3.94 vs. 4.58, $p < 0.01$). That indicates that dialysis patients have a lower number of red blood cells in their blood compared to healthy individuals.

HCT: The dialysis group has a significantly lower mean hematocrit level in comparison with the control categories (32.74 v s. 39.88, $p < 0.01$). Hematocrit represents the proportion of blood volume that is occupied by red blood cells, and a lower value indicates anemia. The results suggest that dialysis patients are more likely to be anemic than healthy individuals.

HGB: The dialysis group has a significantly lower mean hemoglobin level in comparison with the control categories (9.95 vs. 13.15, $p < 0.03$). Hemoglobin is the protein in red blood cells that carries oxygen throughout the body. A lower hemoglobin level indicates anemia, and the results suggest that dialysis patients are more likely to be anemic than healthy individuals.

MCV: Although the mean MCV values for the dialysis and control groups are not significantly different (83.86 vs. 79.99, $p=0.07$), the dialysis group's values are higher, indicating that their red blood cells are larger in size.

MCH and MCHC: The dialysis group has significantly lower meaning MCH (25.48 vs. 27.69, $p<0.01$) and MCHC (30.41 vs. 33.51, $p<0.01$) values in comparison with the control categories. These measurements represent, respectively, the average quantity and concentration of hemoglobin within individual red blood cells. The results suggest that dialysis patients have lower levels of hemoglobin in each red blood cell compared to healthy individuals.

WBC and PLT: The mean values of WBC and PLT in both the dialysis and control groups were comparable ($p>0.05$), suggesting that dialysis patients have similar white blood cell and platelet count as healthy individuals.

MATERIALS AND METHODS

Sample Collection

A volume of (5 ml) of blood was obtained from each participant through venipuncture from twenty-five dialysis patients admitted to Basrah General Hospital (Basrah, Iraq) between the period from January 2022 to March 2023, and twenty-five healthy people were selected as a control group. Ethical approval was obtained from the Iraqi Health and Higher Education Commission Council before beginning sample collection. A questionnaire was also filled out for a total of 25 patients and 25 control people involved in this study. The five milliliter blood samples were split into two portions: the first portion (3 ml) was transferred into a regular tube, allowed to clot for 30 minutes at room temperature, and subsequently separated by centrifuge at (3000Xg) for (10 minutes). The resulting serum was divided into two parts: (1 ml) was kept in an Eppendorf tube, which is used to analyze kidney function tests (creatinine and blood urea). Two milliliters of serum were stored in an Eppendorf tube, which was immediately transferred to the freezer at a temperature of (-20 C°) for later analysis (ferritin). The second portion of blood (2 ml) was placed in an EDTA tube, mixed gently, and placed on a shaker for measurements of RBC, PCV, Hb, MCV, MCH, MCHC, WBC, and PLT.

Reagents

Urea kit Randox (UK), Creatinine Kit Cromatest (Spain), Ferritin Kit Roche (France), and C-reactive protein kit (CRP) (Jordan) were the kits used at the laboratory to study the parameters of renal function test (urea and creatinine), complete blood picture indices, serum ferritin test, and C-reactive protein test.

Statistics

Data analysis was performed by IBM SPSS Statistics 26 For Blood indices, KFT, and CRP between dialysis and control group: The statistical analysis was conducted using the T-test at a significance level of 0.05. Results were interpreted as follows: $P < 0.01$ indicated a highly significant difference (**), $P < 0.05$ indicated a statistically significant difference (*), and $P > 0.05$ indicated no statistical significance (N.S.). For comparisons of blood indices, kidney function tests (KFT), and C-reactive protein (CRP) levels

Table 2. Creatinine, Urea, Ferritin and CRP between Dialysis and Control groups

Index	Group	N	Mean	Std. Deviation	P value
Creatinine	Dialysis group	25	10.01	2.15	0.01**
	Control group	25	0.82	0.22	
Urea	Dialysis group	25	143.48	35.36	0.01**
	Control group	25	27.76	8.50	
Ferritin	Dialysis group	25	430.34	470.08	0.02*
	Control group	25	115.58	92.38	
CRP	Dialysis group	25	20.16	16.51	0.01**
	Control group	25	2.26	1.96	

Creatinine and Urea: The dialysis group has significantly higher mean levels of creatinine (10.01 vs. 0.82, $p<0.01$) and urea (143.48 vs. 27.76, $p <0.01$) in comparison with the control categories. Creatinine, along with urea, are waste products that are normally excreted from the body through urine, but in dialysis patients, these products build up in the blood due to reduced kidney function.

Ferritin: The dialysis group has a significantly higher mean ferritin level in comparison with the control categories (430.34 vs. 115.58, $p <0.02$). Ferritin is a protein that stores iron in the body, and high levels may indicate iron overload in dialysis patients.

CRP: The dialysis group has a significantly higher mean CRP level in comparison with the control categories (20.16 vs. 2.26, $p <0.01$). CRP is a protein produced by the liver in response to inflammation, and high levels may indicate infection or inflammation in dialysis patients.

Overall, the results of the study suggest that dialysis patients in Basrah city have a higher likelihood of anaemia, elevated levels of creatinine, urea, ferritin, and CRP, and reduced levels of red blood cell indices compared to healthy.

across different age groups, the ANOVA test was employed under the same significance criteria. Similarly, differences in blood indices, KFT, and CRP levels between genders were assessed using the T-test, maintaining the significance threshold at 0.05.

RESULTS AND DISCUSSION

The results showed significant differences between the dialysis group and the control group in various hematological parameters. Age was also found to have a significant effect on MCV and

Table 3. Blood indices between age Groups

Index	Age group	Mean	Std. deviation	P value
RBC	20-39yrs	3.61	0.71	0.08N.S.
	40-59yrs	3.73	0.54	
	>=60yrs	4.06	0.88	
HCT	20-39yrs	30.25	5.89	0.57N.S.
	40-59yrs	30.88	4.97	
	>=60yrs	31.89	5.99	
HGB	20-39yrs	9.37	1.81	0.36N.S.
	40-59yrs	9.48	1.62	
	>=60yrs	10.04	1.89	
MCV	20-39yrs	85.75	7.85	0.01**
	40-59yrs	81.55	10.78	
	>=60yrs	74.60	18.47	
MCH	20-39yrs	26.87	3.29	0.15N.S.
	40-59yrs	25.60	2.83	
	>=60yrs	25.33	2.94	
MCHC	20-39yrs	31.04	1.92	0.46N.S.
	40-59yrs	30.98	1.79	
	>=60yrs	31.60	2.08	
WBC	20-39yrs	6.40	2.76	0.57N.S.
	40-59yrs	5.76	1.82	
	>=60yrs	6.25	2.13	
PLT	20-39yrs	191.65	78.12	0.55N.S.
	40-59yrs	175.04	87.43	
	>=60yrs	198.92	73.88	

RBC count: The mean RBC count did not show a significant variation across the various age categories ($p > 0.05$).
HCT: The mean hematocrit level did not show a significant variation across the various age categories ($p > 0.05$).
HGB: The mean hemoglobin level did not show a significant variation across the various age categories ($p > 0.05$).
MCV: A significant difference in mean MCV values was identified across the various age categories ($p < 0.01$). The highest mean MCV was recorded in the 20–39 age group (85.75), then the 40–59 age group (81.55), and the e"60 age group (74.60). These results indicate that younger dialysis patients generally exhibit larger red blood cells compared to older patients.
MCH and MCHC: There is no significant difference in the mean MCH and MCHC values across the various age categories ($p>0.05$).
WBC and PLT: The mean WBC and PLT values do not show any significant variations across the various age categories ($p>0.05$).
Overall, the results suggest that age does not have a significant impact on most blood indices among dialysis patients in Basrah city. However, younger patients tend to have larger red blood cells compared to older patients, as indicated by the higher MCV values observed in the 20-39 age group.

Table 4. Creatinine, Urea, Ferritin ad CRP between age groups

Index	Age group	Mean	Std. deviation	P value
CRP	20-39yrs	18.24	20.23	0.53N.S.
	40-59yrs	12.92	13.96	
	>=60yrs	16.32	16.92	
Creatinine	20-39yrs	10.87	3.40	0.01**
	40-59yrs	11.82	4.19	
	>=60yrs	8.49	2.74	
Ferritin	20-39yrs	361.49	455.31	0.52N.S.
	40-59yrs	239.48	295.65	
	>=60yrs	324.82	406.78	
Urea	20-39yrs	131.77	36.10	0.33N.S.
	40-59yrs	149.36	40.60	
	>=60yrs	147.29	58.34	

CRP: No statistically significant variation was found in mean CRP levels across the various age categories ($p>0.05$).
Creatinine: The mean creatinine levels showed a significant variation across the various age categories ($p<0.01$). The highest mean creatinine value was recorded in the 40–59 age group (11.82), then the 20–39 age category (10.87), and the e”60 age category (8.49). These findings suggest that younger dialysis patients tend to exhibit higher creatinine levels compared to older individuals.
Ferritin: : The mean ferritin level did not show a significant variation across the various age categories ($p > 0.05$).
Urea: The mean urea level did not show a significant variation across the various age categories ($p > 0.05$).
Overall, the results suggest that age does not have a significant impact on most blood indicators among dialysis patients in Basrah city, except for creatinine levels, which tend to be higher in younger patients.

Table 5. Blood indices between genders

Index	Gender	N	Mean	Std. deviation	P value
RBC	Female	38	3.77	0.65	0.99N.S.
	Male	39	3.77	0.85	
HCT	Female	38	30.97	6.62	0.77N.S.
	Male	39	30.55	6.26	
HGB	Female	38	11.64	11.10	0.23N.S.
	Male	39	9.49	2.01	
MCV	Female	38	82.31	15.17	0.71N.S.
	Male	39	81.29	8.32	
MCH	Female	38	26.21	2.87	0.24N.S.
	Male	39	25.46	2.73	
MCHC	Female	38	31.03	2.09	0.86N.S.
	Male	39	31.12	2.71	
WBC	Female	38	6.14	2.44	0.93N.S.
	Male	39	6.10	2.10	
PLT	Female	38	202.29	87.28	0.19N.S.
	Male	39	178.13	73.79	

The overall results observation for table 5 suggest that gender does not have a significant impact on most blood indices among dialysis patients in Basrah city.

Table 6. Creatinine, Urea, Ferritin ad CRP between genders

Index	Group	N	Mean	Std. Deviation	P value
Creatinine	Female	38	9.52	2.71	0.03*
	Male	39	11.31	4.39	
CRP	Female	38	15.79	17.44	0.74N.S.
	Male	39	14.53	16.06	
Ferritin	Female	38	317.57	420.86	0.82N.S.
	Male	39	297.80	359.11	
Urea	Female	38	127.67	43.21	0.01**
	Male	39	158.12	44.15	

Creatinine: The mean creatinine level is significantly different between genders ($p<0.03$), with female dialysis patients having a lower mean creatinine level (9.52) than male dialysis patients (11.31).
CRP: The mean CRP levels did not differ significantly between males and females ($p>0.05$).
Ferritin: The mean ferritin levels showed no significant variation between males and females ($p>0.05$).
Urea: The mean urea level is significantly different between genders ($p<0.01$), with male dialysis patients having a higher mean urea level (158.12) than female dialysis patients (127.67).
Overall, the results suggest that gender may have a significant impact on some blood indicators among dialysis patients in Basrah city, with male patients having higher levels of creatinine and urea compared to female patients. However, the mean CRP and ferritin levels showed no significant variation between males and females.

creatinine levels, while gender affected creatinine and urea levels. Anemia, which is indicated by low red blood cell count, HCT and hemoglobin levels, has been found to be more prevalent in dialysis patients than in healthy individuals. These findings are consistent with previous studies that have reported an increased prevalence of anemia in individuals diagnosed with end-stage renal disease (ESRD) receiving dialysis treatment. [20] The development of anemia in dialysis patients can be linked to multiple factors, including decreased erythropoietin (EPO) production, primarily caused by renal failure, along with iron deficiency resulting from blood loss during dialysis, chronic inflammation that increases hepcidin levels (which inhibits iron utilization), and nutritional deficiencies such as low vitamin B12 and folic acid. These factors affect red blood cell production and contribute to the high prevalence of anemia in patients with chronic renal failure. Reduced renal erythropoietin production, iron deficiency, and persistent inflammation are also common. [21,22,23,24] Furthermore, the study revealed that dialysis patients had lower MCH and MCHC values, indicating that their red blood cells contain lower levels of hemoglobin than healthy individuals. This finding further supports the prevalence of anemia in the dialysis population. In addition, the dialysis group exhibited higher levels of creatinine, urea, ferritin, and CRP compared to the control group. Elevated creatinine and urea levels are expected in dialysis patients due to impaired kidney function, which hinders the proper excretion of these waste products. [25] Higher ferritin levels in dialysis patients may be indicative of iron overload or a response to inflammation, as ferritin serves as an acute-phase reactant. [26] The increased CRP levels in the dialysis group suggest a higher prevalence of infection or inflammation in this population. [27] Chronic inflammation is a common feature of ESRD and has been linked to poor clinical outcomes in dialysis patients, such as cardiovascular events and mortality. [28]

Age-related differences in MCV and creatinine levels were observed in dialysis patients. Younger patients had 39% larger red blood cells, as evidenced by higher MCV values in the 20-39 age group. The clinical significance of this observation

warrants further investigation. The study also found that younger dialysis patients had higher creatinine levels than older patients.The age-related differences in creatinine levels might be due to the varying muscle mass among different age groups, as creatinine is produced from the breakdown of creatine phosphate in muscle tissue. [29] Gender differences were noted in creatinine and urea levels among dialysis patients. Male patients had higher creatinine levels than female patients, which could be attributed to the generally higher muscle mass in men. [29] Additionally, male patients exhibited higher urea levels compared to female patients, possibly due to differences in dietary protein intake and body size between genders. [30]

CONCLUSION

The present study demonstrates that dialysis patients in Basrah City exhibit a higher prevalence of anemia, elevated levels of creatinine, urea, ferritin, and CRP, and reduced levels of red blood cell indices compared to healthy individuals. Age-related differences were observed in MCV and creatinine levels, while gender differences were observed in creatinine and urea levels. These findings highlight the need for comprehensive and individualized management of dialysis patients, considering the patient's age and gender, to optimize clinical outcomes. Interventions aimed at addressing anemia, iron management, and inflammation may improve the overall health and quality of life of dialysis patients.

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Conflict of Interest

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This statement does not apply to this article.

Ethics Statement

This research did not involve human participants, animal subjects, or any material that requires ethical approval.

Informed Consent Statement

This study did not involve human participants, and therefore, informed consent was not required.

Clinical Trial Registration

This research does not involve any clinical trials

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Not applicable.

Authors' Contribution

Nidham Jamalludeen: Visualization, Supervision, Review & Editing, Project Administration; Lujain M. Hashim: Conceptualization, Methodology, Writing – Original Draft, Editing, Data Collection, Analysis; Zainab A. Mohammed: Methodology, Data Collection, Analysis; Baneen N. Jaber: Methodology, Writing – Original Draft.

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