Original

Assessment of haematological parameters in patients with chronic kidney disease in Sokoto, Northern Nigeria

[1]Imoru Momodu, [2]Zainab Ibrahim Ishaq, [3]Hamidu Muhammad Liman

[1]Department of Medical Laboratory Science, Federal University Wukari, Taraba State, Nigeria
[2]Haematology Department, School of Medical Laboratory Science, Usmanu Danfodiyo University, Sokoto, Nigeria
[3]Institute of Urology and Nephrology, Department of Medicine, Usmanu Danfodiyo University, Sokoto, Nigeria.

Corresponding author: Imoru Momodu, Department of Medical Laboratory Science, Federal University Wukari, Taraba State, Nigeria*: imorumomodu67@yahoo.com; +234-8033174997*

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Abstract

Background: Chronic kidney disease (CKD) is a major health problem globally that is associated with alteration of haematological parameters. The study assessed some haematological parameters of patients with chronic kidney disease in Sokoto, Northern Nigeria.

Materials and methods: A cross-sectional study was carried out on 122 male CKD patients, aged 20-84 years, recruited from Usmanu Danfodiyo University Teaching Hospital, Sokoto and Specialist Hospital Sokoto, and 50, age- and sex-matched apparently healthy subjects recruited from Sokoto metropolis between October 2019 and September, 2020. The values of haematocrit, total white blood cell and platelet count were determined using Mythic 18 haematology analyser.

Results: The values of haematocrit and lymphocyte count were significantly lower while the total white blood cell count and neutrophil count were significantly higher in CKD patients compared to the control subjects (P<0.001), however, there was no significant difference in the platelet counts of CKD patients and the control group (P=0.406). Age had no significant effect on the values of haematocrit, total white blood cell count, neutrophil count and lymphocyte count (P>0.05) while platelet count fluctuated significantly with age (P=0.02). However, lymphocyte count reduced significantly with increasing stage of CKD (P=0.004) while haematocrit, total white blood cell count, neutrophil count and platelet count showed no significant differences with stages of CKD (P>0.05).

Conclusion: CKD is associated with significantly lower values of haematocrit and lymphocyte count, and significantly higher values of total white blood cell count and neutrophil count with little or no effect of age and stage of CKD.

Keywords: Assessment, haematological parameters, chronic kidney disease.

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Introduction

CKD has been described as the presence of structural or functional abnormalities of the kidney with or without an accompanying reduction in glomerular filtration rate (GFR). The CKD patients are associated with pathological abnormalities, markers of kidney damage as revealed by imaging abnormalities in serum or urine (proteinuria or albuminuria and abnormal urinary sediment) or GFR of less than 60ml per minute per 1.73m^2 for at least three months.[1]

Albuminuria is the presence of more than 30mg of albumin in the 24-hour urine or more than 30mg/g of albumin in an isolated urine sample adjusted by urinary creatinine.[2]

Glomerulonephritis was one of the leading causes of kidney disease in the past, especially in many low-income countries such as Asian and Sub-Saharan Africa [3] but currently, hypertension and diabetes have been implicated as the 2 major causes of kidney disease worldwide.[4,5] Diabetes and hypertension are common in all high-income, middle-income and low-income countries.[6]

There has been increasing incidence and prevalence of chronic kidney disease (CKD) in recent years in both developed and developing countries, and this has been consuming a higher proportion of health care finances in developed countries apart from contributing to higher morbidity and mortality coupled with decreased life expectancy in developing nations.[7,8]

The CKD burden is expected to increase internationally due to rising prevalence of diabetes, which is the leading cause of CKD globally.[9] However, the prevalence of CKD across the globe has been estimated to be 8-16% [10] while in Nigeria the CKD prevalence had a range of 6-12%.[11]

CKD is classified based on abnormal urinalysis and/ or renal structure and estimated glomerular filtration rate (eGFR) [9] but the stages were defined according to National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (KDOQI) as follows:
Stage 1: estimated glomerular filtration rate (eGFR) ≥90ml/min/1.73m^2, stage 2: eGFR of 60-89ml/min/1.73m^2, stage 3: eGFR of 30-59ml/min/1.73m^2, stage 4: eGFR of 15-29ml/min/1.73m^2 and stage 5: eGFR less than 15ml/min/1.73m^2.[12]
At advanced stages of CKD (stages 4 and 5), clinical symptoms such as fatigue, itching of the skin, bone or joint pain, muscle cramps and swollen ankles, feet or hands become evident.[13]

CKD can be managed through the treatment of its risk factors such as hypertension and diabetes mellitus [14] while a small proportion of the patients with CKD progress to end-stage renal disease (ESRD), requiring renal replacement therapy with dialysis and/or kidney transplantation. [15]

Renal diseases have been associated with haematological changes; however, anaemia has been `the predominant feature. Pathogenesis of anaemia in CKD patients has been linked primarily to deficiency of erythropoietin (EPO) while other causes include haemolysis and shortened red cell survival, iron deficiency, vitamin B12 and folate deficiency among others.[16]

The paucity of information on the changes of haematological parameters in Nigerian CKD patients necessitated the study on the assessment of haematocrit, white blood cell and platelet counts, and the effects of age and CKD stage on these parameters in patients with CKD in Sokoto, North-west Nigeria.

Materials and methods

Setting

The study was conducted at Usmanu Danfodiyo University Teaching Hospital, Sokoto and Specialist Hospital Sokoto.

Study design

A cross-sectional study was carried out on recruited CKD patients from Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto and Specialist Hospital Sokoto (SHS) to assess haematological parameters in patients with chronic kidney disease in Sokoto between October 2019 and September 2020.

Population

One-hundred and twenty-two (122) male CKD patients, aged 20-84 years, and 50 age- and sex-matched apparently healthy control subjects recruited from Sokoto metropolis were studied.

Inclusion criteria

1. Diagnosed and consented patients with CKD.
2. Ages considered were ≥ 20 years.

Exclusion criteria

1. Non-consenting CKD patients.

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2. Patients diagnosed with diseases other than CKD such as haemoglobinopathies, cancer, HIV, acute or chronic inflammatory condition, infection.
3. CKD patients on erythropoiesis stimulating agents.

Ethical approval
Ethical approval was granted by the ethics and research committees of Specialist Hospital, Sokoto with reference letter SHS/SUB/122/VOL 1 and Usmanu Danfodiyo University Teaching Hospital, Sokoto with reference letter UDUTH/HREC/2019/NO. 877.

Informed Consent
Informed consent was obtained from every participant for the study.

Blood collection and processing
Two milliliters (2ml) of venous blood was collected from every participant and dispensed into EDTA bottle to make final concentration of 1.5mg/ml of blood. The whole blood was analysed for haematocrit (HCT), white blood cell count (WBC) and differential, and platelet count using a quality controlled and calibrated 3- part differentiation Mythic 18 haematology analyser manufactured in Geneva Switzerland.

Data analysis
Data were analysed using SPSS, version 22 (Chicago IL USA) and presented as means ± standard deviation. Student's t-test and one-way analysis of variance with Tukey post-hoc test were used to compare the groups and a P-value of less than 0.05 was considered as statistically significant.

Results
Table 1 shows haematological values in patients with CKD. The different values of haematocrit (HCT), white blood cell count (WBC), neutrophil count and lymphocyte count of 30.03 ± 16.21%, 8.86 ± 4.67 $\times 10^9$/L, 62.74 ± 13.24% and 25.12 ± 11.14% observed in CKD patients compared to 46.74 ± 4.54%, 4.91 ±1.03 × 10^9/L, 47.15 ± 6.79% and 42.22 ± 6.62% in control subjects were statistically significant (P<0.0001)while the platelet counts in CKD patients and control group showed no statistically significant difference (P=0.406).
Effect of age on haematological parameters in patients with CKD is revealed in Table 2. The values of HCT, WBC, neutrophil and lymphocyte counts of 29.81 ± 16.13%, 9.40 ± 5.54 × 10^9/L, 58.6 ± 14.94% and 28.29 ± 13.32%, respectively for CKD patients of 21-40 years; 28.23 ± 13.72%, 9.08 ± 4.43 × 10^9/L, 63.77 ± 12.61% and 25.04 ± 10.12%, respectively for CKD patients of 41-60 years; 33.66 ± 20.82%, 8.36 ± 4.38 × 10^9/L, 65.75 ± 11.07% and 21.61 ± 8.65%, respectively for patients of 61-80 years; and 27.91 ± 7.87%, 7.0 ± 2.83 × 10^9/L, 62.24 ± 15.58% and 25.83 ± 13.99%, respectively for CKD patients of 81-100 years showed no statistically significant differences (P>0.05). However, platelet counts for CKD patients of 250.94 ± 132.30 × 10^9/L, 211.16 ± 76.78 × 10^9/L, 298.9 ± 181.04 × 10^9/L and 195.43 ± 97.25 × 10^9/L for the age groups of 21-40 years, 61-80 years, and 81-100 years, respectively showed statistically significant differences (P<0.020).

Assessment of haematological parameters according to stages of CKD is shown in Table 3. Stage 1, stage 2, stage 3, stage 4 and stage 5 showed values 40.9 ± 28.94%, 30.54 ± 8.31%, 28.34 ± 14.86%, 26.5 ± 9.25% and 33.3 ±20.74%, respectively for HCT; 6.0 ±0.98 × 10^9/L, 6.5 ± 1.99 × 10^9/L, 6.5 ± 1.99 × 10^9/L, 9.44 ± 4.48 × 10^9/L, 9.19 ± 5.1 × 10^9/L, and 8.86 ± 4.78 × 10^9/L, respectively for WBC; 58.6 ± 10.84%, 51.21 ± 11.78%, 63.73 ± 16.68%, 62.65 ± 10.93% and 64.48 ± 13.08%, respectively for neutrophil count; and 248.75 ± 143.23 × 10^9/L, 240.14 ± 63.77 × 10^9/L, 242.12 ± 133.07 × 10^9/L, 220.36 ± 122.07 × 10^9/L and 266.81 ± 144.95× 10^9/L, respectively for platelet count. The values for HCT, WBC, neutrophil count and platelet count with stages showed no statistically significant differences (P>0.05). However, the lymphocyte counts of 32.43 ± 8.85%, 38.89 ± 9.7%, 22.63 ± 12.16%, 25.46 ± 8.21% and 23.35 ± 11.89% for stage 1, stage 2, stage 3, stage 4, and stage 5, respectively showed statistically significant differences (P<0.004).

Table 1. Haematological parameters of patients with CKD and controls

Parameter	Control (n = 50) Mean ± SD	CKD Patients (n = 122) Mean ± SD	P-value
HCT (%)	46.76 ± 4.54	30.03 ± 16.21	0.0001
WBC ($\times 10^9$/L)	4.91 ± 1.03	8.86 ± 4.67	0.0001
Neutrophil count (%)	47.15 ± 6.79	62.74 ± 13.24	0.0001
Lymphocyte count (%)	42.22 ± 6.62	25.12 ± 11.14	0.0001
Platelet count (%)	227.78 ± 48.51	243.64 ± 130.86	0.4060

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Table 2: Effect of age on haematological parameters in patients with CKD

Parameter - Mean ± SD	Age in years				P-value
	21 – 40 (n = 34)	41 – 60 (n = 50)	61 – 80 (n = 31)	81 – 100 (n = 7)	
HCT (%)	29.81 ± 16.13	28.23 ± 13.72	33.66 ± 20.82	27.91 ± 7.87	0.518
WBC ($\times 10^9$/L)	9.40 ± 5.54	9.08 ± 4.43	8.36 ± 4.38	7.0 ± 2.83	0.573
Neutrophil count (%)	58.60 ± 14.94	63.77 ± 12.61	65.75 ± 11.07	62.24 ± 15.58	0.155
Lymphocyte count (%)	28.29 ± 13.32	25.04 ± 10.12	21.61 ± 8.65	25.83 ± 13.99	0.775
Platelet count (%)	250.94 ± 132.30	211.16 ± 76.78	298.9 ± 181.04	195.43 ± 97.25	0.020*

*: P<0.05, platelet count in age group 41-60 years versus age group 61-80 years.

Table 3. Assessment of haematological parameters according to stages of CKD

Parameter - Mean ± SD	**CKD Stages**					**P-value**
	1 (n = 4)	**2 (n = 7)**	**3 (n = 25)**	**4 (n = 42)**	**5 (n = 44)**	
HCT (%)	40.9 ± 28.94	30.54 ± 8.31	28.34 ± 14.86	26.5 ± 9.27	33.3 ± 20.74	0.209
WBC ($\times 10^9$/L)	6.0 ± 0.98	6.5 ± 1.99	9.44 ± 4.48	9.19 ± 5.1	8.86 ± 4.78	0.426
Neutrophil (%)	58.6 ± 10.84	51.21 ± 11.78	63.73 ± 16.68	62.65 ±10.93	64.48 ± 13.02	0.158
Lymphocyte (%)	32.43 ± 8.85	38.89 ± 9.7	**22.63 ± 12.16	*25.46 ± 8.21	**23.35 ± 11.89	0.004
Platelet (%)	248.75 ± 143.23	240.14 ± 63.77	242.12 ± 133.07	220.36 ± 122.07	266.81 ± 144.95	0.612

*: P<0.05, lymphocyte count in stage 2 versus stage 4
**: P<0.01, lymphocyte count in stage 2 versus stage 3 and stage 5.

Discussion

The study has revealed significantly lower value of haematocrit and higher values of total white blood cell count and absolute neutrophil count in CKD patients compared to control group. However, CKD stage and age had little or no effects on haematological values.

The significantly lower haematocrit value compared to the control group in this study is consistent with the earlier reports.[17,18] However, anaemia in chronic kidney disease has been primarily associated with impaired erythropoietin (EPO) production and shortened red cell survival, due to the effect of uremic plasma which increases the expression of phosphatidyserine on outer leaflet of red cell membrane and hence, increases the destruction of red cells by macrophages.[19]

The study further revealed that age and stage of CKD patients no influence on the haematocrit value, however, haematocrit value reduced insignificantly with increasing stage of CKD. These findings tend to agree with the earlier report which concluded that anaemia worsens with the stage of the disease.[19]At advanced stages of CKD, anaemia can be caused due to reduced production of red cells as a result of deficiency of erythropoietin and iron. [20,21]

Divergent views have been expressed by previous authors on the total white blood cell count in CKD patients. Significantly higher total white blood cell counts in CKD patients compared to control subjects has been observed by previous researchers [17, 18, 22] while Suresh et al. [23] showed no significant difference in the WBC count between CKD patients and apparently healthy subjects. However, this study revealed significantly higher total white blood cell count in CKD patients compared to the control group. The high total white blood cell count in CKD patients has been attributed to underlying process of chronic inflammation and more activation of immune system.[24]

The study further showed that total white blood cell counts in CKD patients decreased insignificantly with increasing age, however, the stage of CKD had no effect on total white blood cell count. This is consistent with the earlier study that showed that white blood cell count had no significant association with CKD severity. [25]

It has been revealed in this study that neutrophil count is significantly higher in CKD patients compared to control subjects. This is in line with the previous studies [17,18] but in contrary to the report of Agarwal and Light [26] which showed no significant difference in the neutrophil count between CKD patients and non-CKD subjects. The conflicting reports could be associated with different sample sizes considered by the researchers, severity and cause of CKD. [27] However, elevated white cell count and granulocyte count have been linked to rapid progression to end-stage renal disease (ESRD), cardiovascular morbidity and mortality[28-30] while the high ratio of neutrophil and lymphocyte level in CKD has been associated with inflammatory state. [31]

This study further revealed that age and stage of CKD had no significant effects on neutrophil counts. This is in line with the previous report which showed that neutrophil count had no significant relationship with CKD severity. [25]

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Our study has demonstrated significantly lower lymphocyte count in CKD patients compared to the control group. This finding is consistent with the earlier reports.[26,32,33] However, progressive decrease in renal function has been linked to the activation and selective loss of T cells and $CD4^+$ cells with a marked increase in $CD8^+$ cells.[34]

This study has further shown that there was no significant difference in the platelet count of CKD patients compared to control group. This is in support of earlier study but in disagreement with other reports that showed significantly lower platelet count in CKD patients [23,35] and significantly higher platelet count in CKD patients.[22] Platelet count variation observed by researchers could be attributed to sample sizes, severity and causes of CKD considered for the studies. [27] However, thrombocytopenia has been reported to be associated with the effects of heparin, dialyzer membrane and extracorporeal circulation on platelet during haemodialysis.[36]

It has been revealed in this study that stage of CKD had no effect on platelet count. This agrees with the study of Kaze et al. [37] that showed no association between platelet count and stage of CKD. However, platelet count fluctuated significantly with age in this study.

Strengths and limitations of the study

The study was not limited to CKD patients with end-stage renal disease requiring haemodialysis but included non-dialysis patients.

The study was conducted in Sokoto metropolis on 122 CKD patients, which therefore makes the report not to be representative of the entire Sokoto State.

The selection of the CKD patients was not through random sampling because of the few patients available.

This study did not consider the demographic characteristics of the CKD patients.

Implications of the findings of the study

The decreased haematocrit level and increased white blood cell count in CKD patients with little or no effects of age and CKD stage would serve as guide to the physicians in this locality and thereby improving the treatment of the CKD patients and ultimately reducing morbidity and mortality rates.

Conclusion

Alteration in haematological parameters in chronic kidney disease was associated with significantly lower values of haematocrit and lymphocyte count, and significantly higher values of total white blood cell count and neutrophil count with little or no effect of age and stage of CKD. However, CKD had no significant effect on platelet count.

It is therefore recommended that full blood count be included among the routine laboratory investigations for CKD patients to provide information that could be helpful in the management of the patients.

Declarations

Ethical considerations: Ethical approval was granted by the ethics and research committees of Specialist Hospital, Sokoto and Usnanu Danfodiyo University Teaching Hospital, Sokoto through letters SHS/SUB/122/VOL 1 and UDUTH/HREC/2019/NO. 877, respectively.

Authors' contributions: IM and IZI conceived the study design, IZI collected the data while IM, IZI and LHM analysed the data. IM and LHM wrote the manuscript while all authors reviewed and approved the final manuscript for publication.

Conflict of interest: None

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