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Original Research Article

Comparative analysis of renal impairment in HIV-positive and HIV-negative individuals at Kono government hospital, Sierra Leone

Arthur B. C. Garber[1]*, Saidu Bangura[1], Angie Pinto[2], Sahr Kanawa[3], Atiba Adeniran Samuel[1], Isatta Wurie[1]

[1]College of Medicine and Allied Health Sciences, University of Sierra Leone, Sierra Leone
[2]Partners in Health Sierra Leone, Freetown, Sierra Leone
[3]Kono Government Hospital, Eastern Province, Sierra Leone

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***Correspondence:**
Arthur B. C. Garber,
E-mail: garberarthur23@gmail.com

ABSTRACT

Background: Non-communicable disease is of major concern affecting a significant portion of the global population. It is a serious and gradual condition marked by the progressive deterioration of kidney function. In recent years, Renal impairment has emerged as a clinically relevant and significant issue. The aim of this study was to compare analysis of renal impairment in individual with HIV, diabetes, and hypertension.
Methods: This was a cross-section quantitative study. It was conducted from June to September 2024. A total of 275 participants were selected. Serum creatine and CD4 counts were measured in HIV-Positive individuals, and the eGFR was calculated using the CKD-Epi 2021 formula. Data analysis was done using SPSS Version 16.
Results: Among the study population, 158 participants (57.5%) were HIV-Positive, while 62 (22.5%) and 55(20%) were HIV-Negative individuals diagnosed with hypertension and diabetes, respectively. The overall prevalence of renal impairment was found to be 34.2% among HIV-Positive, 30.6% among hypertensive participants, and 38.2% among those with diabetes. Participants aged 31-40 years demonstrated a significant higher likelihood of renal impairment (AOR=5.37, 95% CI: 2.414-12.489), and for those over 50 years (AOR=4.93; 95% CI:1.491-16.351). Among diabetic participants, older age was also significantly associated with renal impairment (OR=6.379; 95% CI: 1.129-36.060). Furthermore, hypertensive females were identified as having an increased risk of developing renal impairment.
Conclusions: The study highlights a concerning prevalence of renal impairment among participants, with age and gender as significant risk factors. These findings underscore the importance of monitoring renal function in at-risk populations.

Keywords: HIV, Renal impairment, Diabetes, Hypertension and prevalence

INTRODUCTION

Non-communicable disease is of major concern, affecting a significant portion of the global population. Also, Renal impairment is of great concern and has affected so many lives. It is a serious and gradual condition marked by the progressive deterioration of kidney function.[1] In recent years, Renal impairment has emerged as a clinically relevant and significant issue.[2] The consequences of renal impairment can include acute kidney injury (AKI), chronic kidney disease (CKD), end-stage renal disease (ESRD), or death.[3] A sudden loss of excretory kidney function defines AKI. AKI is part of a range of conditions summarized as acute kidney diseases and disorders, in which slow deterioration of kidney function or persistent kidney dysfunction is associated with an irreversible loss

of Kidney cells and nephrons, which can lead to CKD.[4] CKD is a progressive condition characterized by the gradual loss of kidney function over time. CKD is a global health issue that affects millions of people worldwide.[5] Impaired renal function in sub-Saharan Africa has been linked to both infectious and non-infectious risk factors. Furthermore, individuals living with HIV (Human immunodeficiency virus), diabetes, and hypertension face a compounded burden of kidney disease due to unique risk factors and comorbidities associated with these conditions and their treatments.[6] Globally, the estimated prevalence of renal function impairment among adults living with HIV, using the chronic kidney disease epidemiology collaboration formula (CKD-EPI) equation, was 4.8%. The magnitude of the phenomenon was found to be 6.5% in North America and 2.7% in Europe.[7] In Sub-Saharan Africa, individuals living with HIV have a high prevalence of renal function impairment, ranging from 25-77%.[8] There have been several studies linking the use of Tenofovir Disoproxil Fumarate with acute kidney injury and chronic kidney disease.[9] Still, no previous studies have been conducted on its effects in our setting, as TDF is one of the first-line treatments for HIV in Sierra Leone.[10]

Diabetes mellitus is a long-term disorder caused by high blood sugar levels due to defects in insulin secretion, insulin action, or both. It has become a global epidemic, with an estimated 537 million adults worldwide living with diabetes by 2024.[11] Among the various complications associated with diabetes, renal impairment is a significant and debilitating complication, which significantly impacts patients' quality of life and increases mortality rates.[12] This study aimed to compare renal impairment among individuals with HIV, diabetes, and hypertension to understand how each condition affects kidney function differently.

METHODS

Study design

A comparative cross-sectional study was conducted on patients at Kono Government Hospital who were sent to perform their routine laboratory testing at the Koidu Government Hospital Laboratory.

Population and sampling

A consecutive sampling technique was employed. All eligible adults (≥18 years) attending the HIV Clinic and Non-Communicable Disease Clinic at Koidu Government Hospital during the study period (July–September 2024) who met the inclusion criteria were recruited consecutively until the required sample size was achieved. The study population target was adults ≥18 years as enrolled at the HIV Clinic and Non-Communicable Disease Clinic at the Koidu Government Hospital, Kono, from July 2024 to September 2024. Participants were either HIV-Positive confirmed through serological testing or medical records, and on Treatment, or HIV-Negative diagnosed with diabetes mellitus and hypertension, and were recruited. The study does not include pregnant women, individuals undergoing dialysis, those with missing or incomplete clinical, laboratory, or demographic data, or patients with other comorbidities.

Sample size

Two hundred and Seventy-Five (275) samples were used in the study, which was determined using the Unmatched cross-sectional study (exposed and unexposed). The calculation was done using EPI INFO software version 7, with a 95% confidence level, a desired margin of error of 5%, a statistical power of 80%, and a Risk factor of 2. The percentage outcomes of exposed and unexposed groups are 30% and 15%, respectively.

Data analysis

Data were entered and analyzed using IBM SPSS Statistics version 16.0. Descriptive statistics were used to summarize the data, and appropriate inferential statistical tests were applied where necessary.

Blood sample collection and handling

About 3 ml and 2 ml was respectively collected inside plain and EDTA specimen bottles. Subsequently they were used for analysis of serum creatinine and CD4 count respectively. The sample was collected following proper procedures to avoid hemolysis and to ensure the safety of the participants. The sample collected in the Plain top tube tube was promptly transported to the Biochemistry Department, where it was centrifuged at 3500 rpm for 10 minutes to facilitate serum separation. The resulting serum was immediately used for biochemical analyses. In contrast, the sample collected in the EDTA tube was not centrifuged, as whole blood is required for CD4 analysis using the Pima™ CD4 Analyzer.

Ethical clearance

Ethical clearance was obtained for the commencement of this research through the Ethics Review Board of the College of Medicine and Allied Health Sciences (COMAHS), University of Sierra Leone (USL).

RESULTS

It focuses on key outcomes, particularly estimated glomerular filtration rate (eGFR) levels, and explores the patterns and severity of renal impairment in each group. Figure 1 indicates the different age groups and sex distribution present in this study. The largest number of participants are females and adults aged 18-30 years, followed by adults aged above 50 years. The majority of the study participants were HIV-positive 158 (57.5%), followed by 117 (42.5%) HIV-Negative individuals, which consisted of 55 (20.0%) Diabetic patients and

62(22.5%) Hypertensive patients (Table 1). The mean age of HIV-positive, hypertensive, and diabetic patients was 34.1, 53.8, and 46.1 years, respectively. Hypertensive patients have the highest mean, followed by diabetes (Table 1).

Table 1: Characteristics of HIV-positive and HIV-negative individuals attending ART clinic and NCD clinic respectively at Kono government hospital, Koidu town, Sierra Leone (n=275).

Characteristics	HIV-positive (%) (n=158)	HIV-negative (hypertension) (%) (n=62)	HIV-negative (diabetes) (%) (n=55)
Age (in years); mean(median)	34.1 (32)	53.8 (55)	46.05 (50)
Ages (years)			
18-30	75 (47.5)	3 (4.8)	10 (18.2)
31-40	44 (27.8)	7 (11.3)	8 (14.5)
41-50	24 (15.2)	15 (24.2)	11 (20)
>50	15 (9.5)	37 (59.7)	15 (27.3)
Sex			
Male	44 (27.8)	21 (33.9)	22 (40)
Female	114 (72.2)	41 (66.1)	33 (60)
CD4 count			
<200	23 (14.6)		
200-500	60 (38.0)		
>500	75 (47.4)		

Table 2: Comparison of eGFR of the study participants for HIV-positive and HIV-negative individuals.

Characteristics	HIV-positive (n=158)	HIV-negative (hypertension) (n=62)	HIV-negative (diabetes) (n=55)
eGFR (ml/min/1.73m^2), mean	75.7	71.5	66.6
EGFR categories (ml/min/1.73m^2 N (%)			
Normal (90-135)	50 (31.7)	20 (32.3)	16 (29.1)
Mildly decreased (60-89)	58 (36.7)	24 (38.7)	17 (30.9)
Mildly to moderately decreased (45-59)	34 (21.5)	3 (4.8)	7 (12.7)
Moderately to severely decreased (30-44)	11 (7.0)	7 (11.3)	9 (16.4)
Severely decreased (15-29)	4 (2.5)	6 (9.7)	3 (5.5)
Kidney failure (<15)	1 (0.6)	2 (3.2)	3 (5.5)

Table 3: Renal impairment status among the three conditions.

Characteristics	HIV-positive renal impairment		Hypertension renal impairment		Diabetes renal impairment	
	Yes (%)	**No (%)**	**Yes (%)**	**No (%)**	**Yes (%)**	**No (%)**
Total	54 (34.2)	104 (65.8)	19 (30.6)	43 (69.4)	21 (38.2)	34 (61.8)
Sex						
Female	38 (24.1)	76 (48.1)	16 (25.8)	25 (40.3)	12 (21.8)	21 (38.2)
Male	16 (10.1)	28 (17.7)	3 (4.8)	18 (29.0)	9 (16.4)	13 (23.6)
Age (years)						
18-30	15 (9.5)	61 (38.6)	2 (3.2)	1 (1.6)	2 (3.6)	9 (16.4
31-40	24 (15.2)	19 (12.0)	4 (6.5)	3 (4.8)	1 (1.9)	6 (10.9)
41-50	7 (4.4)	17 (10.7)	5 (8.1)	10 (16.1)	3 (5.5)	8 (14.5)
>50	8 (5.1)	7 (4.4)	8 (12.9)	29 (46.8)	15 (27.3)	11 (20)
CD4 count						
<200	8 (5.1)	15 (9.5)				

Continued.

Characteristics	HIV-positive renal impairment		Hypertension renal impairment		Diabetes renal impairment	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
200-500	20 (12.7)	39 (24.7)				
>500	26 (16.5)	50 (31.6)				

Table 4: Bivariable and multivariable to determine the association between renal impairment and covariates in HIV-positive and HIV-negative adults.

Characteristics of HIV-positive adults	Renal impairment		COR (95% CI)	P value	AOR (95% CI)	P value
	Yes	No				
Sex						
Female	38	76	1			
Male	16	28	1.143 (0.552-2.365)	0.719	0.859 (0.370-1.995)	0.723
Age (years)						
18-30	15	61	1		1	
31-40	24	19	5.137 (2.250-11.727)	<0.001	5.376 (2.314 -12.489)	<0.001
41-50	7	17	1.675 (0.588-4.765)	0.334	1.765 (0.596-5.228)	0.305
>50	8	7	4.648 (1.455-14.841)	0.009	4.938 (1.491-16.351)	0.009
CD4						
<200	8	15	1		1	
200-500	20	39	0.962 (0.349-2.649)	0.940	0.731 (0.239-2.229)	0.581
>500	26	50	0.975 (0.366-2.598)	0.960	0.737 (0.245-2.215)	0.587
Characteristics of hyper tensive adults						
Sex						
Male	3	18	1		1	
Female	16	25	3.840 (0.972-15.171)	0.055	4.406 (1.023-18.958)	0.046
Age (years)						
18-30	2	1	1		1	
31-40	4	3	0.667 (0.039-11.285)	0.779	0.586 (0.029-11.824)	0.727
41-50	5	10	0.250 (0.018-3.467)	0.301	0.234 (0.014-3.826)	0.308
>50	8	29	0.138 (0.011-1.723)	0.124	0.111 (0.007-1.655)	0.111
Characteristics of diabetes adults						
Sex						
Female	12	21	1		1	
Male	9	13	1.212 (0.400-3.665)	0.734	1.442 (0.421-4.942)	0.560
Age (years)						
18-30	2	9	1		1	
31-40	1	6	0.750 (0.055-10.233)	0.829	0.718 (0.052-9.891)	0.804
41-50	3	8	1.687 (0.222-12.809)	0.613	1.812 (0.234-14.053)	0.569
>50	15	11	6.136 (1.101-34.214)	0.039	6.379 (1.129-36.060)	0.036

Table 2. shows the mean eGFR was highest (75.5 ml/min/1.73 m^2) in HIV-Positive adults followed by 71.5 ml/min/1.73 m^2 in HIV-Negative (Hypertension) and Lowest (66.6 ml/min/1.73 m^2) in HIV-Negative (Diabetes adults). Diabetes adults have a larger proportion (16.4%) of participants with moderate to severely impaired renal function, followed by Hypertension (11.3%), and then HIV-Positive adults have the least proportion of moderate to severely impaired renal function (7.0%). However, HIV-positive adults have the highest proportion of mildly to moderately impaired renal function at 21.5% followed by Diabetes Adults. HIV-Negative (Hypertension) adults have the highest proportion (9.7%) of severely decreased renal function followed by Diabetes adults (5.5%), and HIV-Positive adults (2.5%).

Kidney failure occurred highly in adults suffering from Diabetes (5.5%), (3.2%) in Hypertension adults, and (0.6%) in HIV-positive adults. Prevalence of Renal Impairment in HIV-positive and HIV-negative (Diabetes and Hypertension) (eGFR <60 ml/min/1.73 m^2 is Regarded as Renal Impaired).

Table 3 shows that out of the 275 participants, 94 (34.2%) had renal impairment, of which there were 66 (24%) females and 28 (10.2%) males. There was renal impairment in 54 (34.2%) of HIV-positive adults, with females (24.1%) having the highest proportion of renal impairment in this population. Hypertension and diabetes also report females having the highest proportion, 25.8% and 21.8%, respectively.

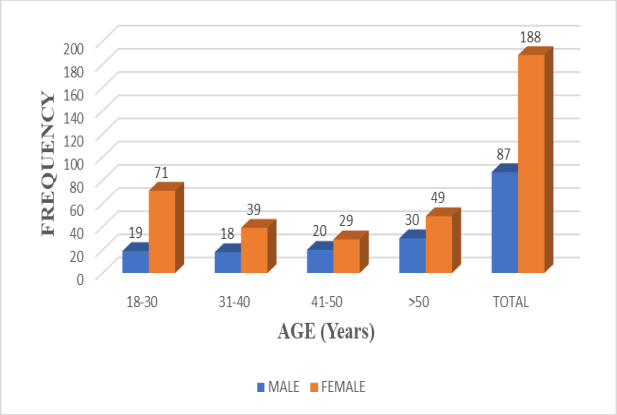

Figure 1: The age-sex distribution.

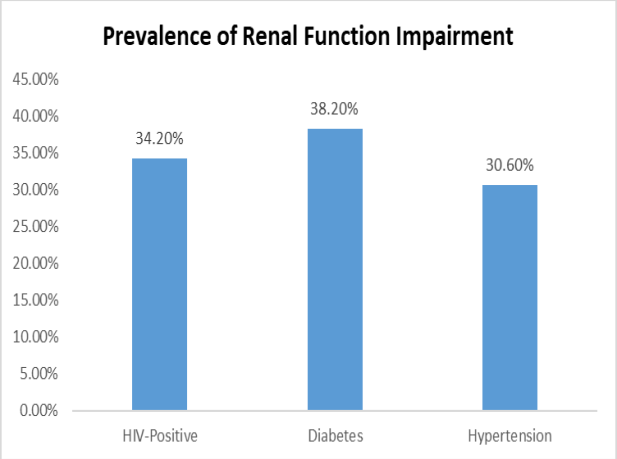

Figure 2: The prevalence of renal impairment.

Figure 2 shows that HIV-Negative (Diabetes) Adults have the highest prevalence of Impaired renal function (eGFR <60 ml/min/1.73m^2) at 38.2%, followed by HIV-Positive Adults (34.2%), and finally HIV-Negative (Hypertension) Adults with (30.6%). Factors associated with renal Impairment in HIV-positive and HIV-negative (Diabetic and Hypertensive) Adults. To determine the association between renal impairment and covariates within the population, bivariable and multivariable binary logistic regression analyses were performed.

In HIV-Positive Adults, Males were 14% less likely (AOR=0.86; 95% CI:0.37-1.99) to have renal impairment than females. The odd ratios indicate that sex does not significantly impact renal impairment among HIV-positive adults, as shown by the high p-value (0.719), suggesting no significant association between sex and renal impairment (Table 4.). Adults within the age limit (31-40) were 5.3 times more likely (AOR=5.37; 95% CI: 2.31-12.48), age ranged (41-50) were 1.7 times more likely (AOR=1.76; 95% CI: 0.59 to 5.22), and age >50 years were 4.9 times more likely (AOR=4.93; 95% CI: 1.49-16.25) to have renal impairment than Adults HIV-Positive within 18-30 years.

Age groups show a marked association with renal impairment. 31-40 years shows a high AOR and COR with significant CI with a p-value <0.001. This suggests that individuals in this age have a significantly higher risk of renal impairment compared to the 18-30 age group. >50 years also shows increased odds (AOR and COR) with significant CIs and a p-value of 0.009, indicating an elevated risk for renal impairment (Table 4). The study also indicates that CD4 > 500 is 30% less likely (AOR=0.73; 95% CI: 0.24-2.22) to have renal impairment compared to CD4 <200. It does not show a significant association with renal impairment. Both the AOR and COR for CD4 counts between 200-500 and >500 is below 1, with high p values (0.940 and 0.96), indicating no significant difference in renal impairment risk based on CD4 levels (Table 4).

The odds ratios for females (AOR:4.405; and COR:3.840) suggest that hypertensive females are 4.4 times more likely to develop renal impairment than hypertensive males, and show a strong statistical significance (p=0.046) (Table 4). Age does not appear to significantly impact the risk of renal impairment among hypertensive adults, as indicated by the AOR; 31-40 years: AOR of 0.586 (0.029-11.824) p=0.779, 41-50 years; AOR of 0.234 (0.014-3.836), p=0.301, and >50 years; AOR of 0.111 (0.007-1.655), with p=0.124. None of these age-related associations show statistical significance, indicating that age alone may not be a determining factor for renal impairment risk among hypertensive individuals in this sample (Table 4). In Diabetic Adults, Males have higher odds (AOR=1.442) of renal impairment than females, but this association is not statistically significant (p>0.05). Therefore, sex is not a significant predictor in this model. Individuals aged over 50 have significantly higher odds (AOR=6.379) of renal impairment compared to the 18 - 30 age group, with a statistically significant p-value (p<0.05) (Table 4). This suggests that age >50 is a significant predictor of renal impairment in diabetic adults. The age group (31-40 and 41-50) shows a non-significant reduction and increase in odds of renal impairment compared to the 18-30 age group respectively

DISCUSSION

The findings of this study indicate a notable prevalence of renal function impairment among the HIV-positive population, with an estimated glomerular filtration rate (eGFR) of 34.2% calculated using the CKD EPI 2021 equation.[13] This prevalence is significantly higher compared to reports from other regions, such as South-West Ethiopia (20.7%), South-West Nigeria (23.7%) (Umeizudike et al, South Nigeria (24.3%) and rural Tanzania (15.7%) (Umeizudike et al.[14,16] However, the prevalence of renal function impairment in this study is lower than in studies from (Kefeni, Hajito, and Getnet 2021). This variation may be due to participant differences among studies and the use of different methods to estimate GFR (Kefeni, Hajito, and Getnet

2021). A modified diet of renal disease formula was used to estimate GFR in Ghana, the Cockcroft-Gault method in north-west- and south-west Ethiopia, which might also contribute to the variation in the prevalence since CKD EPI 2021 formula was used in this study.[19] In individuals with diabetes, the prevalence of renal impairment was observed to be 38.2%, which aligns closely with findings from a study in the Western region of China (41.3%).[20]

Conversely, other studies reported significantly higher rates, such as Tanzania (83.7%), while lower prevalence figures were noted in Ghana (16.1%) and Sierra Leone (11.4%).[21,22] This variation underscores the complexity of renal health in populations with diabetes and suggests that regional factors may influence outcomes. Among hypertensive patients, the study reported a prevalence rate of 30.6%, exceeding the 26.3% rate documented in Ghana and the 11.4% recorded in Nigeria; however, a strikingly higher rate of 52% was reported among hypertensive individuals in Sierra Leone.[23] The differing rates indicate that while hypertension remains a significant risk factor for renal impairment, the extent of its impact may vary across geographical and demographic contexts.[24] This research highlights that diabetes elevates the risk of renal impairment, followed by HIV-positive status and hypertension. These findings challenge the notion presented in previous studies conducted in Ethiopia, which positioned hypertension as the primary contributor to renal impairment.[25,26] Instead, our results resonate with the body of evidence supporting diabetes as a leading cause of renal complications, potentially attributed to diabetic nephropathy, a common consequence of the disease that adversely affects glomerular filtration rates.[27] Additionally, the study observed that older age, particularly those aged 31 years and above, was significantly associated with increased risk of renal impairment in HIV-positive participants. This correlation is further illustrated by consistent findings from previous research conducted in Ethiopia, South Africa, Ghana, and Nigeria, establishing older age as a critical factor in renal health for this population.[29-31]

Limitations

This study evaluated the extent of renal function impairment and its associated factors among adult HIV-positive patients attending an ART clinic, as well as HIV-negative patients with diabetes and hypertension, in Koidu Town, Kono, Sierra Leone. The study has several limitations. Firstly, creatinine levels were measured only at a single point in time, which may have captured short-term, reversible causes of renal impairment, potentially leading to an overestimation of renal dysfunction. Secondly, the study did not include an assessment for proteinuria. Thirdly, its cross-sectional design limited our ability to identify the underlying causes of renal impairment. Also, conducting the study in a laboratory setting restricted our ability to gather comprehensive characteristics of the studied population. Lastly, the study did not use the gold standard for measuring GFR, which is the Inulin Clearance.

CONCLUSION

This study found a high prevalence of renal function impairment among adult patients, with the highest rates observed in diabetic individuals, followed by HIV-positive patients, and then those with hypertension. Older age (31 years and above) was significantly associated with renal impairment among HIV-positive participants, while age over 50 was a key risk factor among diabetic patients. Additionally, hypertensive females were found to be at greater risk for renal impairment.

Recommendations

These findings highlight the need for routine renal function screening, particularly among HIV-positive individuals receiving antiretroviral therapy (ART), to enable early detection and effective management. Similarly, regular monitoring of kidney function is recommended for diabetic and hypertensive patients to prevent progression of renal complications. Further research is also recommended to deepen the understanding of renal impairment patterns among HIV-positive, hypertensive, and diabetic adults, and to guide the development of targeted interventions.

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