





Research Article

Impaired Renal Function and Associated Factors Among HIV-Infected Individuals Who Are on Follow-Up in Two Tertiary Hospitals' Art Clinic, Addis Ababa, Ethiopia

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Abstract

Background: It has been four decades since the Human Immunodeficiency Virus (HIV) became a global public health issue; much has changed about the disease since then. The occurrence of renal impairment in HIV-infected individuals is associated with both increased morbidity and mortality. **Objective:** The goal of this study was to assess the incidence of renal dysfunction and the variables associated with it in HIV-positive patients undergoing treatment at the ART clinics of Zewuditu Memorial Hospital (ZMH) and St. Paul's Millennium Medical College (SPHMMC) between April and August of 2021. **Methodology:** A cross-sectional study was conducted to assess the association between impaired renal function and different factors among HIV-infected individuals. Data was collected from the medical charts of the patients in the anti-retroviral therapy (ART) clinic of respective hospitals. Variables with a p-value of <0.25 on bivariate analysis were taken to Multivariable logistic regression to see the statistical significance and at <0.05 statistical significance was declared. **Result:** The total number of samples was 405, and all of them were included in the analysis. The magnitude of the renal dysfunction revealed in this study was 8.4% (95% Confidence Interval: 5.51 to 11.4). Multivariable logistic regression showed that being female (Adjusted Odds Ratio = 4.5; 95%CI: 1.94, 10.36), Baseline CD4 count less than 200, (AOR = 3.4; 95% CI:1.34, 8.70), and a history of opportunistic infection (AOR = 2.7; 95% CI: 1.02, 7.39) were significantly associated with the impaired renal function. **Conclusion:** Routine monitoring of renal function, especially in patients with risk factors like female gender, low CD4 count, and history of opportunistic infections, is crucial. Promoting ART regimens containing TDF, early detection and prevention of opportunistic infections, and educating patients about regular CD4 count monitoring and timely treatment are essential for maintaining renal health.

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Keywords

Impaired Renal Function, HIV Infection, ART Clinic, Addis Ababa, Ethiopia

1. Background

Renal impairment is the inability of the kidneys to perform their excretory function, which includes filtering or getting rid of toxins and waste products, the removal or metabolism of drugs, maintaining the balance of body fluids and electrolytes, and the release of hormones that act on different parts of the body. Renal impairment can be classified as acute kidney injury (AKI) or chronic kidney disease (CKD) based on the duration and reversibility of the disease. This is usually characterized by a reduced glomerular filtration rate (GFR), with or without a decrease in urine output [1].

HIV-infected individuals are at risk of both AKI and CKD, just like any other people. Moreover, they are at an increased risk of renal impairment compared to the general population, due to the virus, opportunistic infections, and the polypharmacy they are undergoing [2].

A relatively high prevalence of renal dysfunction has been reported throughout the world, most importantly in several African countries among ART-naïve HIV-positive people. Low body mass index (BMI), low CD4 count, high viral load (VL), concomitant hepatitis C virus (HCV) infection, and advanced stage of the disease have been identified as risk factors for the development of renal impairment in ART-naïve HIV-positive people, in addition to the traditional risk factors for kidney diseases in the general population [3].

HIV/AIDS continues to have devastating health effects globally, with over 39 million HIV/AIDS-related deaths to date and more than 38 million people currently living with HIV. Despite great advancements in ART and worldwide progress towards the implementation of treatment-as-prevention programs, approximately 2.2 million people become newly infected with HIV every year [4]. Sub-Saharan Africa (SSA) is more heavily affected by HIV and AIDS than any other region of the world. An estimated 22.9 million people are living with HIV in the region, accounting for two-thirds of the globally infected population [5].

The first description of severe proteinuria with a rapid loss of kidney function in HIV-infected patients with AIDS was published in 1984. The histopathological pattern corresponded to collapsing focal segmental glomerulosclerosis (FSGS), a condition later known as HIV-associated nephropathy (HIVAN), that usually presents. Although HIVAN is the best-known example of HIV-associated kidney disease, a broad spectrum of kidney syndromes is now known to occur in HIV-infected patients [6]. Obviously, due to the introduction of ART, the classic HIVAN has become less common while other kidney diseases have concomitantly increased. It

has been shown that people with a high viral load, low CD4 count, and advanced disease are the major risk factors for HIVAN. With the introduction of ART, these risk factors have significantly reduced, while other risk factors have become more prominent, like lifelong exposure to ART [2].

Early initiation of ART improves renal function, despite which HIV-infected patients are still at a higher risk for both AKI and CKD, which are interconnected syndromes responsible for a heavy burden of mortality among HIV-infected individuals [6]. Since 2016, WHO has recommended the initiation of ART regardless of clinical stage and CD4 count, which may further reduce the incidence of HIVAN, but the overall risk-benefit for kidney health is unknown [2]. Renal impairment in HIV-infected persons manifests in a variety of ways, including AKI, HIV-associated kidney disease, comorbid CKD, and treatment-related kidney toxicity. The burden of CKD and end-stage renal disease (ESRD) remains high in the HIV-infected population [7].

The coexistence of kidney disease and HIV/AIDS significantly increases the mortality of affected individuals [8]. ART improves renal survival even when started after renal disease has ensued. As a result, there is an increasing prevalence of CKD, now found in 2.4–47.6% of HIV-infected patients, across variable geographic areas and ethnicities [9]. However, to the best knowledge of the investigator, studies conducted regarding renal dysfunction among HIV patients in Ethiopia are limited. This study aimed to generate evidence on the prevalence of renal function impairment and associated factors including duration of ART, regimen of ART, age, the presence of other traditional risk factors of renal impairment, CD4 count, viral load, WHO clinical stage, and the disease characteristics and demographics of HIV which in turn would indicate possible mitigation strategies. To the scope of the researcher, no similar study was done in the study area among people living with HIV/AIDS. Therefore, this study was aimed at assessing the prevalence and factors associated with renal dysfunction among people living with HIV and attending the ART clinic at Zewuditu Memorial Hospital and Saint Paul's Hospital Millennium Medical College.

2. Methods and Materials

2.1. Study Area

Zewuditu Memorial Hospital was one of the sites where

the study was conducted. It is located in the capital city, Addis Ababa. It was built, owned, and operated by a Seventh-day Adventist church, but was nationalized during the Derg regime in about 1976. The hospital is named after Empress Zewuditu, the cousin and predecessor on the throne of Emperor Haile Selassie. Today, the Zewuditu Hospital is operated by the Ministry of Health. Zewuditu Hospital is Ethiopia's leading hospital in the treatment of ART and currently treats over 7000 people each month. It is also one of the few government-owned dialysis centers in the town. The center has 2 nephrologists and 28 other supporting staff.

SPHMMC ART clinic was the other site where this study was conducted. SPHMMC is also located in Addis Ababa, Ethiopia, and it's one of the largest tertiary referral hospitals in the capital under the Federal Ministry of Health. It was built by Emperor Haile Selassie in 1961 to provide health services to those unable to afford care. It has a catchment population of more than 5 million population. Medical college was added in 2007 and currently, there are over 13 departments. One of them is the Department of Internal Medicine, under the department there are several subspecialties. ART clinic is one of the several outpatient departments in SPHMMC. Saint Paul's renal unit has different centers under it like the dialysis center, transplant center, and outpatient department kidney disease follow-up. It is the only transplant center in the country since 2016. It has also a nephrology subspecialty program.

2.2. Study Period

This study was conducted from July 01 2021 to August 30, 2021.

2.3. Study Design

This study used a cross-sectional study design.

2.4. Population

2.4.1. Source Population

The source population was all HIV-infected individuals who had follow-ups in the ART clinic at SPHMMC and ZMH.

2.4.2. Study Population

The study populations were all patients who had follow-ups at the ART clinic at SPHMMC and ZMH in the last five years and those who fulfilled the inclusion criteria.

2.5. Inclusion and Exclusion Criteria

2.5.1. Inclusion Criteria

All patients who had follow-ups at ART clinics of SPHMMC and ZMH in the past 5 years and those who had

complete laboratory and clinical data regarding their renal status during the study period. This study included all adults aged 18 and above only.

2.5.2. Exclusion Criteria

Those patients with a solitary kidney, with a diagnosis of obstructive uropathy at any time in their follow-up period and those with incomplete investigation results, and pregnant women at the time of renal impairment assessment.

2.6. Sample Size and Sampling Technique

The sample size was calculated using the single population proportion formula:

$$n = \frac{Z^2 p(1-p)}{d^2}$$

Where:

n is the required sample size,

Z is the confidence level at 95% (standard value of 1.96),

d is the margin of error (5%),

P is the estimated prevalence of renal impairment of patients in ART clinics, which is not known in Ethiopia, so 50% is taken as a proportion of the population to give the maximum sample size.

Substituting the values into the formula, we get:

$$n = \frac{(1.96)^2 * 0.5 * 0.5}{(0.05)^2} = 384$$

Since the study population is less than 10,000, there is a need to use the population correction formula, which is:

$$n = \frac{n_i * N}{N + n_i}$$

Where:

n_i is the initial sample size (368),

N is the study population (9000),

N is the total number of HIV-infected individuals at ZMH and SPHMMC who were followed up.

Because the source population is less than 10,000, the final sample size was determined as follows:

$$nf = \frac{n}{1 + \frac{n}{N}}$$

Substituting the values into the formula, we get:

$$nf = \frac{384}{1 + \frac{384}{9000}} = 368$$

The final sample size, after adding a 10% contingency, was 405.

2.7. Study Variables

2.7.1. Dependent Variables

Renal impairment

2.7.2. Independent Variables

Sociodemographic data

1) Age

2) Sex

Comorbidities: DM, HTN, CLD, Cardiac illness, presence of UTI

Disease-related factors: weight, presence of anemia, BMI, duration of HIV infection, history of ARV treatment failure, ART regimen, Opportunistic infection, drug adherence, Duration of ART, Baseline CD4, Baseline Viral load, and WHO clinical staging during diagnosis.

2.8. Operational Definitions

Renal Function Impairment: A patient diagnosed with either CKD or AKI is characterized by a disturbed renal function that is indicated by raised SCr at a certain point in time.

AKI: An increase in SCr by 50% within 7 days, or an increase in SCr by 0.3 mg/dl (26.5 μ mol/l) within 2 days, or oliguria, or GFR < 60 ml/min/1.73 m² for less than 3 months, or a decrease in GFR by \geq 35%, or an increase in SCr by more than 50% for less than 3 months, or kidney damage for less than 3 months [8].

CKD: GFR < 60 ml/min/1.73 m² for more than 3 months, or kidney damage for more than 3 months, and bilateral shrinkage on ultrasound [8].

Hypertension: A patient with a value greater than 140/90 mmHg will be considered hypertensive [10].

Systolic Hypertension: A patient with a blood pressure greater than 140 mmHg will be considered to have systolic hypertension [10].

Nutritional Assessment: The BMI cut-off value, according to the WHO classification (in Kg/m³), will be: less than 18.5 (underweight), 18.5-24.99 (normal), 25-29.99 (overweight), and greater than 30 (obese) [10].

Electrolytes: Patients' electrolytes will be reported as low, high, or within the normal range depending on the reference ranges of:

Potassium: 3.5–5.0 mEq/l

Calcium: 4.5–5.5 mEq/l

Phosphate: 0.97–1.45 mEq/l

Sodium: 136-145 mEq/l

Magnesium: 1.5-2.5 mEq/l

Chloride: 97-107 mEq/l [11].

Diabetes Mellitus: DM is defined as a fasting blood sugar level greater than 125 mg/dl or HbA1c greater than 6.5%, symptoms of hyperglycemia, and a random blood sugar level greater than 200 mg/dl or a two-hour oral glucose tolerance test result greater than 200 mg/dl [12].

1c: Zidovudine/Lamivudine/Nevirapine

1e: Tenofovir/Lamivudine/Efavirenz

1 j: Tenofovir/Lamivudine/Dolutegravir

2 h: Tenofovir/Lamivudine/Lopinavir/Ritonavir

2 f: Atazanavir/Ritonavir/Lamivudine/Zidovudine

1 g: Abacavir/Lamivudine/Efavirenz

2.9. Data Collection, Analysis & Quality Control

The study used a questionnaire adapted from various pieces of literature. The questionnaire consists of information on socio-demographic and economic status, adapted from EDHS.

The data collection process was carried out by ten data collectors and was supervised by two supervisors, with the principal investigator also playing a supervisory role. The data were collected through a document review by nurses and physicians working in the Antiretroviral Therapy (ART) clinic. Medical records were reviewed to collect data on the socio-demographic and clinical characteristics of the study participants, including the outcome variable.

To ensure data quality, data collectors were trained for one day by the principal investigator on the study's objective, relevance, confidentiality of information, and how to collect the specific data needed for the study. A pretest was conducted on 5% of the total sample size at St. Paul's Hospital Millennium Medical College (SPHMMC) before actual data collection. The questionnaire was assessed for clarity, length, and completeness, and necessary corrections were made accordingly.

The data were entered into EpiData 3.1 and exported to IBM SPSS Statistics version 20 for cleaning and analysis. Descriptive statistics were used to determine the proportion, mean, and standard deviation. Bivariate and multivariable logistic regression analyses were performed to examine the association between explanatory variables and the outcome variable. Variables with a p-value < 0.25 in bivariate analysis were included in multivariate analysis.

Before multivariate analysis, possible collinearity between explanatory variables was tested, and a Variance Inflation Factor (VIF) > 5 was used to screen for collinearity. The Hosmer-Lemeshow goodness-of-fit model was used for multivariate fitness, with > 0.05 as the cut-off point to assure good fitness. In multivariate analysis, an Adjusted Odds Ratio with a 95% Confidence Interval (CI) at a P-value less than 0.05 was used to declare the statistical significance of associations.

2.10. Ethical Consideration

Ethical clearance was obtained from the Research Ethics Committee of St Paul's Hospital Millennium Medical College, Zewuditu Hospital, ART clinics, and renal clinics of Zewuditu Hospital and St. Paul's Millennium Medical College.

The information obtained was kept confidential Throughout the data collection and other activities related to the study appropriate COVID-19 prevention protocol was followed.

3. Result

3.1. Socio-Demographic Characteristics

The total number of samples was 405, all of which were included in the analysis. The majority of the study participants were female, accounting for 250 (61.7%). The mean age of the study participants was 36.72 with a standard deviation of 5.45. The majority, 229 (56.5%), of the study participants were in the age group of 30 to 44.

Table 1. Shows the socio-demographic characteristics of participants.

Variables	Frequency	Percent (%)
Sex		
Male	155	38.3
Female	250	61.7
Total	405	100
Age		
≤25	45	11.1
25-29	41	10.1
30-34	60	14.8
35-39	107	26.4
40-44	62	15.3
45-49	56	13.8
≥50	34	8.4
Total	405	100

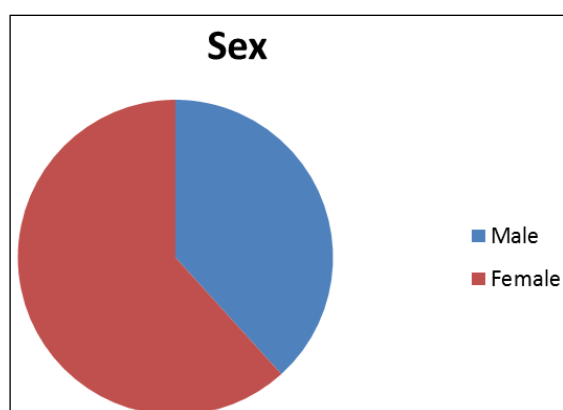


Figure 1. Frequency of sex in patients with impaired renal functions in study area & period.

3.2. Clinical Factors

3.2.1. Subsection of the Clinical Factors

The majority, 403 (99.5%), of the participants' BMI was in the range of 18.5 to 24.99. Thirteen (3.5%) had a history of medical illnesses, and 10 of these patients took medication for their medical illnesses. Ten of the study participants were diagnosed with Hypertension, and 8 were diagnosed with DM.

Table 2. Showing the clinical factors for impaired renal function.

Variables	Frequency	Percent (%)
BMI		
≤18.49	2	0.5
18.5-24.99	403	99.5
Total	405	100
History of medical illnesses		
Yes	13	3.5
No	392	96.5
Total	405	100
On treatment for their chronic medical condition		
Yes	10	76.9
No	3	23.1
Total	13	100
Type of Medical Illness		
DM	8	1.98
HTN	10	2.5
Cardiac illness	1	0.2

3.2.2. Subsection of the Clinical Factors

Regarding the duration of ART treatment, 197 (48.7%) were in treatment for 13 to 36 months. The majority, 284 (70.1%), of the study participants started their ART with an initial Regimen 1E. Additionally, 308 (76%) of the participants were at the 1st or 2nd WHO clinical stage during their initiation, according to the charts reviewed.

Table 3. Shows other clinical factors related to HIV/AIDS and Impaired renal function.

Variables	Frequency	Percent (%)
Duration of ART treatment		
≤12	49	12.1

Variables	Frequency	Percent (%)	Variables	Frequency	Percent (%)
13-24	97	24.0	Experienced	405	100
25-36	100	24.7	Baseline CD4 count		
37-48	75	18.5	> 200	294	72.6
49-60	84	20.7	<200	54	13.3
Total	405	100	Total	405	100
Patient's Initial Regimens			> 200	294	72.6
1E	284	70.1	Recent		
1J	116	28.6	> 200	319	78.8
1C	3	0.7	<200	73	18.0
Others (ATV/DTG/3Tc)	2	0.4	Undermined	13	3.2
Total	405	100	History of Treatment Failure		
WHO clinical stage during initiation			Yes	23	5.7
Stage I and II	308	76	No	382	94.3
Stage III and IV	97	24	Total	405	100
Total	405	100	History of poor drug adherence		
The stage during the Renal insult			Yes	22	5.4
Stage I	376	92.8	No	383	94.6
Stage II	5	1.2	Total	405	100
Stage III	9	2.2	History Opportunistic infection		
Stage IV	15	3.7	Yes	176	43.5
Total	405	100	No	229	56.5
Viral Load during the renal insult			Total	405	100
Undetectable	363	89.6			
Detectable	30	7.4			
Undetermined	12	3.0			
Total	405	100			

3.2.3. Subsection of the Clinical Factors

One hundred seventy-six (43.5%) participants had a history of opportunistic infection. The majority, 206 (50.9%), of the study participants had a baseline CD4 count of > 200 during the Renal Insult. Additionally, 294 (72.6%) of the study participants had the most recent CD4 count of > 200. All the participants had experienced HAART.

Table 4. Shows other clinical factors related to HIV/AIDS and Impairment of Renal function.

Variables	Frequency	Percent (%)
Status of HAART		

3.3. Outcome Variable

The magnitude of the impaired renal function revealed from this study was 8.4% (95% CI: 5.51 to 11.4).

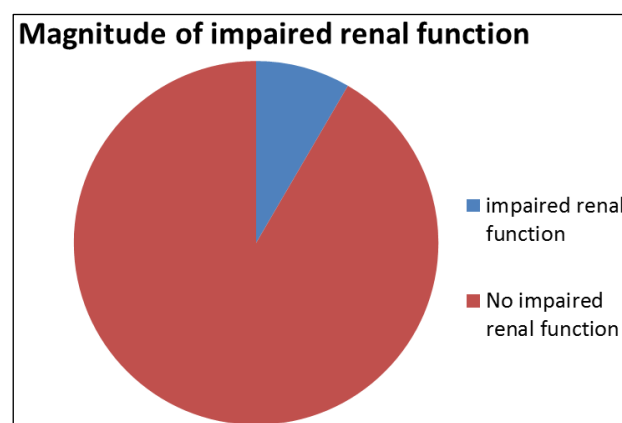


Figure 2. Showing the magnitude of the impaired renal function.

Subsection of the Outcome Variables

From the total impaired, renal function majority of the patients were AKI, 23 (67.6%). The stages of CKD indicated were stages II and III.

Table 5. Showing the types of impaired renal functions and stages of CKD.

Variables	Frequency	Percent (%)
Type of Renal dysfunction		
AKI	23	67.6
Deranged renal function	7	20.6
CKD	4	11.8
Stages of CKD		
Total	34	100
Stage II	2	50
Stage III	2	50
Total	4	100

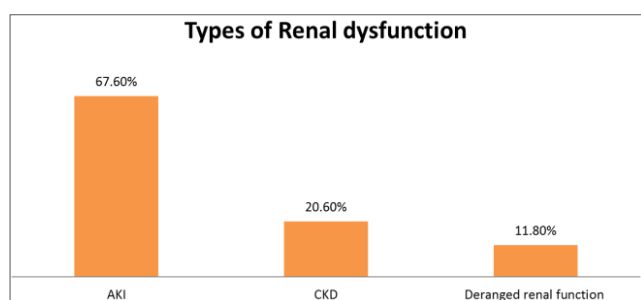


Figure 3. Types of Renal dysfunction in the study population.

3.4. Laboratory Results

Of the 34 patients with renal impairment, 9 (26.5%) had anemia ($\text{hgb} < 13$), compared with 17 (4%) out of 405. MCV at the time of renal impairment revealed that the majority, 29 (85.3%), were normal. RDW at the time of renal impairment indicated that the majority, 28 (82.4%), were normal.

Table 6. Showing the laboratory results of patients with impaired renal function.

Variables	Frequency	Percent (%)
Hemoglobin at the time of Renal Impairment		
≤ 13	9	26.5
13-16	25	73.5

Variables	Frequency	Percent (%)
Total	34	100
MCV at the time of renal impairment		
Normal	29	85.3
Low	2	8.8
High	3	5.9
Total	34	100
RDW at the time of renal impairment		
Normal	28	82.4
High	6	17.6
Total	34	100
Presence of UriAn/casts		
Yes	3	0.7
No	31	97.0
Serum creatinine		
Creatinine ≥ 1.2	34	100
2+ Urine protein		
Positive	5	14.7
Negative	29	85.3
Total	34	100
Creatinine ≥ 1.2	34	100
Ultra-sound renal size		
Normal	31	91.2
Shrunk	1	2.9
Not done	2	5.9
Total	34	100

3.5. Bivariable and Multivariable Logistic Regression Analysis for Renal Impairment

To identify the factors associated with Impaired Renal Function among patients a logistic model was fitted with Impaired Renal Function (dichotomous) being the dependent variable and the selected independent variables. The Variables with a p-value > 0.25 were excluded from the multivariable analysis. Those variables include BMI, history of medical illness, WHO clinical stage, and viral load. The variables with a p-value < 0.25 in the bivariable analysis were taken to multivariable logistic regression analysis to see whether they have a true association or not. Those variables include gender, age, Duration of ART treatment, Patients' initial and current regimens, History of treatment failure, history of poor treatment adherence, history of opportunistic infections,

and Baseline CD4.

In the multivariable logistic regression, gender, patient's initial regimen, history of opportunistic infections and Baseline CD4 count have p-values <0.05, hence they were significantly associated with impaired renal function.

The chance of female Patients with HIV having impaired renal functions was 4.48 times higher likelihood of suffering from impaired renal function when compared with their male counterparts. The chance of patients with HIV taking an initial regimen of 1E and 1J had 95% less likelihood of having

renal impairment when compared with patients taking another type of initial regimen. Those patients with HIV infection had opportunistic infections had a 2.74 times higher chance of having impaired renal function when compared with those patients without opportunistic infections. Those patients with a baseline CD4 count of less than 200 had a 2.74 times higher chance of having impaired renal function when compared with patients with a CD4 count of greater than or equal to 200.

Table 7. Bivariable logistic regression for all the independent Variables.

Variables	Impaired renal function		COR (95% CI)	P-value
	Yes	No		
Gender				
male	24	131	1	0.000
Female	10	240	4.4(2.04, 9.48)	
Age				
< 50	32	339	1	0.221
> 50	2	32	1.51(0.35, 6.60)	
BMI				
17-18.49	0	2	1	0.999 *
18.5- 24.99	34	369	Very large number	
Duration of ART treatment				
< 24 months	7	139	1	0.122
25-36	10	90	0.45(0.17, 1.23)	
37-48	7	68	0.49 (0.17, 1.45)	
49-60	10	74	0.37 (0.14, 1.02)	
Hx of medical illnesses				
No	21	371	Very Large number	0.998 *
Yes	13	0	1	
Viral load during renal insult				
Undetectable	24	338	1	0.999 *
Detectable	10	20	open-ended	
Undetermined	0	12	open-ended	
WHO clinical stage				
Not advanced	25	296	1	0.39 *
Advanced	9	75	0.71(0.32, 1.57)	
Patients' initial regimen				
1E	25	259	1	0.223
1J	6	110	1.77(0.71, 4.43)	

Variables	Impaired renal function		COR (95% CI)	P-value
	Yes	No		
Others	3	2	0.06(0.01, 0.40)	0.003
Patients' current regimen				
1J	28	333	1	0.191
Others	6	38	0.53(0.21, 1.37)	
History of Opportunistic Infections				0.007
No	25	204	1	
Yes	9	167	1.94(, 4.18)	0.100
History of poor drug adherence				
No	30	353	1	0.120
Yes	4	18	2.61(0.83, 8.22)	
History of treatment failure				0.009
No	30	352	1	
Yes	4	19	0.41(0.13, 1.27)	
Baseline CD4				0.009
< 200	8	178	3.0(1.32, 6.79)	
> 200	26	193	1	

*Variables removed from multivariable logistic regression, due to their p-values being greater than 0.25.

Table 8. Multivariable Logistic Regression Analysis for variables of P-value of <0.25.

Variables	Impaired renal function		COR (95% CI)	P-value	AOR (95% CI)	P-Value
	Yes	No				
Gender						
Male	24	131	1	0.000	1	0.000
Female	10	240	4.4(2.04, 9.48)		4.48(1.94,10.34)	
Age						
< 50	32	339	1	0.221	1	
> 50	2	32	1.51(0.35, 6.60)		1.28(0.25, 6.53)	
Duration of ART treatment						
< 24 months	7	139	1	0.122	1	
25-36	10	90	0.45(0.17, 1.23)		0.44(0.12, 1.62)	
37-48	7	68	0.49 (0.17, 1.45)		0.41(0.10, 1.79)	
49-60	10	74	0.37 (0.14, 1.02)		0.35(0.09, 1.34)	
Patients' initial regimen						
1E	25	259	1		1	

Variables	Impaired renal function		COR (95% CI)	P-value	AOR (95% CI)	P-Value
	Yes	No				
1J	6	110	1.77(0.71, 4.43)	0.223	0.94(0.25, 3.52)	
Others	3	2	0.06(0.01, 0.40)	0.003	0.05(0.01, 0.48)	0.01
Patients' current regimen						
1J	28	333	1	0.191	1	
others	6	38	0.53(0.21, 1.37)		0.67(0.18, 2.55)	
History of Opportunistic Infections						
No	25	204	1	0.007	1	
Yes	9	167	1.94(, 4.18)		2.74(1.02, 739)	0.043
History of poor drug adherence						
No	30	353	1	0.100	1	
Yes	4	18	2.61(0.83, 8.22)		0.38(0.10, 1.49)	
History of treatment failure						
No	30	352	1	0.120	1	
Yes	4	19	0.41(0.13, 1.27)		0.30(0.06,1.43)	
Baseline CD4						
< 200	8	178	3.0(1.32, 6.79)	0.009	3.42(1.34, 8.70)	0.01
> 200	26	193	1		1	

4. Discussion

The overall prevalence of renal function impairment in this study aligned with a cross-sectional study conducted among Chinese hospitalized HIV-positive patients, which showed a prevalence of 5.56% [13].

This study's results were lower compared to a study done in Uganda. The Ugandan study, a hospital-based cross-sectional study conducted among newly diagnosed HIV-positive individuals in Northern Uganda, revealed the prevalence of impaired renal function to be 14.4% [14]. The results were also lower compared to another study conducted in Mwanza, Tanzania, to determine renal dysfunction among HIV-infected patients starting antiretroviral therapy, which revealed a prevalence of 63.7%. This supports the idea that the 'Test and Treat' approach is of paramount importance in reducing renal impairment [15].

However, the prevalence of impaired renal function in this study was higher compared to a cross-sectional study done in Kampala, Uganda, in 2018. That study assessed the prevalence of renal dysfunction among HIV-infected patients receiving Tenofovir and showed a prevalence of 2.52%. This discrepancy could be because the Ugandan study included

only those on a proven effective Tenofovir-based regimen [16]. Variations in the population, sample size, and the definition used to classify impaired renal function could account for these differences.

Several factors were associated with renal function impairment in this study, including gender, the patient's initial regimen, history of opportunistic infections, and baseline CD4 count. A lower CD4 count (< 200) was shown to be associated with renal function impairment in a study done in South Africa [17]. Another cross-sectional study conducted in Tanzania to determine renal dysfunction among HIV-infected patients starting antiretroviral therapy found that a CD4 count (<200 cells/mm³) was independently associated with renal dysfunction [14]. A hospital-based prospective cross-sectional study done in Ethiopia revealed that a baseline CD4 count of less than 200 cells/mm³ was associated with renal function impairment [18].

In a cross-sectional study conducted in Tanzania to determine renal dysfunction among HIV-infected patients starting antiretroviral therapy, the female gender was independently associated with renal dysfunction [15]. Another retrospective cross-sectional study conducted in Togo, Lomé which aimed to identify risk factors for renal failure, found that female gender was significantly associated with impaired renal func-

tion [19]. This might be due to the higher proportion of women who make up the majority of the total number of people living with HIV/AIDS in Ethiopia and this study.

In this study, there was an association between the presence of opportunistic infections and renal function impairment among patients with HIV. This finding is supported by established evidence from the United States of America [20] and the United Kingdom [21] that renal function impairment is associated with the presence of opportunistic infections. This could be because opportunistic infections directly affect renal function or facilitate the damage imposed by the HIV infection on renal function.

5. Strength and Limitation of the Study

5.1. Strength

It was relatively quick and inexpensive to conduct. Since this study used a cross-sectional study design, it was important to identify multiple exposures to an outcome variable at the same time.

Multi-center study would make it more representative.

5.2. Limitations

It used secondary data, and some of the variables were not recorded then we were forced to remove some variables from the questionnaire and then from the analysis.

6. Conclusion and Recommendation

Routine monitoring of renal function in HIV patients, especially those with risk factors such as female gender, low CD4 count, and history of opportunistic infections, is crucial. Health institutions should encourage the use of ART regimens containing TDF as their backbone, as they are associated with a lower risk of renal impairment despite concerns about TDF's renal toxicity. Additionally, early detection and prevention of opportunistic infections should be a focus to reduce the risk of renal impairment. Educating patients, particularly females, about the importance of regular CD4 count monitoring and seeking timely treatment for opportunistic infections is essential to maintaining renal health.

Abbreviations

ABC	Abacavir
AIDS	Acquired Immune Deficiency Syndrome
AKI	Acute Kidney Injury
ARC	Annualized Rate of Change
ART	Anti-Retroviral Therapy
ATV	Atazanavir
BMI	Body Mass Index
CDC	Centers for Disease Control

CKD	Chronic Kidney Disease
Ddi	Didanosine
DTG	Dolutegravir
D4T	Stavudine
eGFR	Estimated Glomerular Filtration Rate
ESRD	End-Stage Renal Disease
FSGS	Focal Segmental Glomerular Sclerosis
GC	Gregorian Calendar
HCV	Hepatitis C Virus
HIVAN	HIV Associated Nephropathy
HIVICK	HIV Associated Immune Complex Kidney Disease
HIV	Human Immunodeficiency Virus
NVP	Nevirapine
PI	Protease Inhibitors
PLHIV	People Living With HIV
Scr	Serum Creatinine
SSA	Sub-Saharan Africa
SPMMC	Saint Paul's Millennium Medical College
TDF	TenofovirDiproxil Fumarate
VL	Viral Load
WHO	World Health Organization
ZMH	Zewuditu Memorial Hospital
3TC	Lamivudine

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Institutional Review Board Statement

The study was conducted according to the guidelines of the Declaration of Helsinki (2013 version) and was approved by the Ethical Committee of SPHMMC and Zewuditu Hospital.

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Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] Kulohoma, B. W. (2018). H3Africa: Crucial importance of knowledge on human demographic history in strategies for data exploitation—an analysis of the Luhya in Webuye, Kenya population from the 1000 Genomes Project. *Wellcome Open Research*, 3.
- [2] Swanepoel, C. R., Atta, M. G., D'Agati, V. D., Estrella, M. M., Fogo, A. B., Naicker, S., ... Winkelmayer, W. C. (2018). Kidney disease in the setting of HIV infection: Conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference. *Kidney International*, 93(3), 545–559.
- [3] Yilma, D., Abdissa, A., Kästel, P., Tesfaye, M., Olsen, M. F., Girma, T., et al. (2020). Renal function in Ethiopian HIV-positive adults on antiretroviral treatment with and without tenofovir. *BMC Infectious Diseases*, 20(1), 1–11.
- [4] Pandey, A., & Galvani, A. P. (2019). The global burden of HIV and prospects for control. *The Lancet HIV*, 6(12), e809–e11.
- [5] Eneyew, K., Seifu, D., Amogne, W., & Menon, M. (2016). Assessment of renal function among HIV-Infected patients on combination antiretroviral therapy at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. *Technology and Investment*, 7(3), 107–22.
- [6] Campos, P., Ortiz, A., & Soto, K. (2016, December 1). HIV and kidney diseases: 35 years of history and consequences. *Clinical Kidney Journal*.
- [7] Wyatt, C. M. (2017). Kidney disease and HIV infection. *Topics in Antiviral Medicine*, 25(1), 13.
- [8] Barry, R., & James, M. T. (2015). Guidelines for Classification of Acute Kidney Diseases and Disorders. *Nephron*, 131(4), 221–6.
- [9] Hou, J., & Nast, C. C. (2018). Changing concepts of HIV infection and renal disease. *Current Opinion in Nephrology and Hypertension*, 27(3), 144–52.
- [10] Kent, S., Fusco, F., Gray, A., Jebb, S. A., Cairns, B. J., & Mihaylova, B. (2017). Body mass index and healthcare costs: a systematic literature review of individual participant data studies. *Obesity Reviews*, 18(8), 869–79.
- [11] Hoorn, E., Tuut, M., Hoorntje, S., van Saase, J., Zietse, R., & Geers, A. (2013). Dutch guideline for the management of electrolyte disorders-2012 revision. *Neth J Med*, 71(3), 153–65.
- [12] Association, A. D. (2020). 9. Pharmacologic approaches to glycemic treatment: Standards of Medical Care in Diabetes—2020. *Diabetes care*, 43(Supplement 1), S98–S110.
- [13] Sun, C., Wen, Y., Liu, S., Cui, W., Zhou, Y., Deng, B., et al. (2018). Prevalence of renal impairment among HIV-positive patients hospitalized in the first hospital of China Medical University. *INTERNATIONAL JOURNAL OF CLINICAL AND EXPERIMENTAL MEDICINE*, 11(8), 8622–7.
- [14] Odongo, P., Wanyama, R., Obol, J. H., Apiyo, P., & Byakika-Kibwika, P. (2015). Impaired renal function and associated risk factors in newly diagnosed HIV-infected adults in Gulu Hospital, Northern Uganda. *BMC nephrology*, 16(1), 1–7.
- [15] Mwemezi, O., Ruggajo, P., Mngumi, J., & Furia, F. F. (2020). Renal Dysfunction among HIV-Infected Patients on Antiretroviral Therapy in Dar es Salaam, Tanzania: A Cross-Sectional Study. *International Journal of Nephrology*, 2020.
- [16] Nyende, L., Kalyesubula, R., Sekasanvu, E., & Byakika-Kibwika, P. (2020). Prevalence of renal dysfunction among HIV infected patients receiving Tenofovir at Mulago: a cross-sectional study. *BMC nephrology*, 21(1), 1–6.
- [17] Assaram, S., Magula, N. P., Kinoo, S. M., & Mashamba-Thompson, T. P. (2017). Renal manifestations of HIV during the antiretroviral era in South Africa: a systematic scoping review. *Systematic reviews*, 6(1), 1–11.
- [18] Yazie, T. S., Orjino, T. A., & Degu, W. A. (2019). Reduced kidney function in tenofovir disoproxil fumarate based regimen and associated factors: a hospital-based prospective observational study in Ethiopian patients. *International journal of nephrology*, 2019.
- [19] Amekoudi, E. Y. M., Sabi, K. A., Dolaama, B., Tona, K. G., Noto-Kadou-Kaza, B., Kola, E., et al. (2019). Risk Factors of Renal Failure in HIV Patients at Initiation of ARV Treatment: Retrospective Study of 3118 Patients Followed in Infectious Diseases Department at Lomé University Hospital. *Open Journal of Nephrology*, 9(03), 55.
- [20] Li, Y., Shlipak, M. G., Grunfeld, C., & Choi, A. I. (2012). Incidence and risk factors for acute kidney injury in HIV Infection. *American journal of nephrology*, 35(4), 327–34.
- [21] Roe, J., Campbell, L. J., Ibrahim, F., Hendry, B. M., & Post, F. A. (2008). HIV care and the incidence of acute renal failure. *Clinical Infectious Diseases*, 47(2), 242–9.