

Burden and Determinants of Renal Dysfunction among HIV Patients on ART in India: A Tertiary Care Experience



Mohammed Mufeeth¹, Abhishek Agarwal², Deepak Muraleedharan³, Jayadevan R⁴, Neethu E⁵

Received: 03 June 2025; Accepted: 25 February 2026

ABSTRACT

Background: HIV infection, primarily caused by human immunodeficiency virus type-1 (HIV-1), has become a chronic condition with the advent of multidrug antiretroviral therapy (ART). ART can lead to adverse effects, including renal dysfunction, especially in patients receiving tenofovir-based regimens.

Objectives: To find out the associations between renal function and serum parameters, and analyze the relationship between renal function and CD4 count in patients on tenofovir-based ART.

Materials and methods: A cross-sectional observational study was conducted at the ART clinic of SMS Medical College, Jaipur, from March 2023 to January 2024. The study included 300 HIV patients on tenofovir-based ART for at least 6 months. Demographic, clinical, and biochemical data, including renal function, serum parameters, and CD4 counts, were collected using a prevalidated and pretested structured questionnaire through convenience sampling. Data analysis by SPSS v. 25.

Results: Among 300 HIV patients on tenofovir-based ART for ≥ 6 months, 45% had mildly decreased renal function, while 0.3% experienced kidney failure. Mean age was 37.97 years (SD 11.15), with age showing a significant association with renal function ($p < 0.001$); younger participants predominantly had normal renal function, whereas older age groups had higher impairment rates. Serum potassium (mean 4.5 mmol/L) and albumin (mean 3.8 gm/dL) levels were also significantly associated with renal dysfunction ($p < 0.001$). Additionally, 87% of patients had undetectable viral loads, primarily among those with normal or mildly decreased renal function.

Conclusion: Age, body weight, serum potassium, and albumin levels are significant predictors of renal function in HIV patients on Tenofovir-based ART. These findings highlight the need for targeted monitoring to preserve renal health in this population.

Journal of The Association of Physicians of India (2026); 10.59556/japi.74.1486

INTRODUCTION

Human immunodeficiency virus (HIV) infection remains a major global health challenge, with over 39 million people living with HIV (PLHIV) worldwide.¹ The advent of antiretroviral therapy (ART) has significantly improved survival and quality of life among PLHIV, transforming HIV from a fatal disease into a manageable chronic condition.² Among the various ART regimens, tenofovir disoproxil fumarate (TDF)-based therapy is widely used due to its potent antiviral efficacy, high genetic barrier to resistance, and favorable safety profile.³ However, concerns regarding its long-term renal toxicity have been raised, as TDF is known to cause proximal tubular dysfunction, leading to renal impairment and altered serum biochemical parameters.⁴

Renal dysfunction in PLHIV is multifactorial, influenced by HIV-associated nephropathy (HIVAN), opportunistic infections, comorbidities such as diabetes and hypertension, and the nephrotoxic effects of ART.⁵ CD4+ T-cell count serves as a critical marker of immune function in HIV-infected individuals, and its relationship with

renal function remains a subject of ongoing investigation. Some studies suggest that lower CD4 counts may be associated with an increased risk of renal impairment, possibly due to heightened systemic inflammation and immune activation.⁶ However, the specific impact of CD4 count on renal function in patients receiving TDF-based ART has not been fully elucidated, warranting further research.

This study aims to examine the associations between renal function and key serum biochemical parameters in HIV-positive patients on TDF-based ART. Additionally, we seek to analyze the relationship between renal function and CD4 count to better understand the interplay between immune status and renal health in this population. The findings of this study could have important implications for optimizing ART regimens and monitoring strategies to mitigate renal complications in PLHIV.

MATERIALS AND METHODS

Before commencing the study, ethical approvals were obtained from the Institutional

Clinical Trial Screening Committee (CTSC), Institutional Ethical Committee (IEC), Rajasthan University of Health Sciences (RUHS), and relevant authorities at SMS Medical College, Jaipur. Participant identities were anonymized, and participation was voluntary.

This observational cross-sectional study was conducted from March 2023 to January 2024 at the ART center, focusing on HIV patients on tenofovir-based ART. A sample of 300 patients was determined, accounting for a 5% attrition rate, based on the prevalence of proteinuria in HIV patients on ART for 6 months or more. Inclusion criteria were HIV patients on tenofovir-based therapy for at least 6 months, aged 18–65 years, with normal renal function before treatment. Patients with preexisting kidney disease or chronic illnesses were excluded. Eligible patients were sampled until the target was reached.

Renal function was defined using the estimated glomerular filtration rate (eGFR), calculated through common formulas, with six stages of kidney function identified based on eGFR values. Key serum parameters monitored included serum sodium, chloride, potassium, albumin, urea, creatinine, random blood sugar, CD4 count, and HIV viral load, forming a comprehensive methodology to assess renal function and related parameters in HIV patients receiving tenofovir-based ART.

Statistical Analysis

The collected data were analyzed using appropriate statistical software. Descriptive

¹Department of Internal Medicine; ²Senior Professor, Department of Internal Medicine
³Department of Community Medicine; ⁴Junior Resident, Department of Community Medicine;
⁵Department of Community Medicine, SMS Medical College, Jaipur, Rajasthan, India;
*Corresponding Author

How to cite this article: Mufeeth M, Agarwal A, Muraleedharan D, et al. Burden and Determinants of Renal Dysfunction among HIV Patients on ART in India: A Tertiary Care Experience. *J Assoc Physicians India* 2026;74(5):24–27.

statistics were calculated for demographic and clinical characteristics, including means, medians, and standard deviations for continuous variables, and frequencies and percentages for categorical variables. The Chi-square test was used to examine

associations between categorical variables, and independent *t*-tests or Mann–Whitney *U* tests were used to compare continuous variables as appropriate. A *p*-value of less than 0.05 was considered statistically significant, and confidence intervals were calculated

to provide a measure of precision for the estimated prevalence rates.

RESULTS

The study population consists mainly of younger individuals, with 51% in the 18–37 age group and 42% in the 38–57 age group, while only 7% are aged 58–77 years. Males make up a significant majority (71%), whereas females account for 29%. Regarding body weight, most participants fall within the 45.13–65.13 kg range, with 42%. A smaller proportion (22%) falls within the 65.13–75.13 kg range (Table 1).

The association between viral load (copies/mL) and CD4 count among the study population. There is an observed increase in the number of individuals with viral loads >1000 copies/mL as CD4 counts decrease, suggesting a correlation between lower CD4 counts and higher viral loads (Fig. 1).

Table 2 shows that nearly half of the participants (45%) have mildly decreased renal function, while only 0.3% have kidney failure.

Distribution of renal function by viral load level among the study population. The data suggest that the majority of individuals with undetectable or low viral loads maintain normal or mildly decreased renal function, whereas severe renal impairment and kidney failure are rare across all viral load categories (Table 3).

Renal function in relation to the duration of tenofovir-based ART. The data do not show a clear trend over time, indicating varied renal function statuses across different ART durations. The mean study duration, based on the given data, is approximately 21.02 months (Fig. 2).

Serum potassium and albumin levels showed a significant association with renal function (*p* < 0.001), where lower serum albumin and higher serum potassium levels correlated with poorer renal function. However, serum sodium and chloride levels did not show significant associations. Regarding CD4 counts, patients with preserved renal function had higher counts, whereas those with impaired renal function had lower counts (Tables 4 and 5).

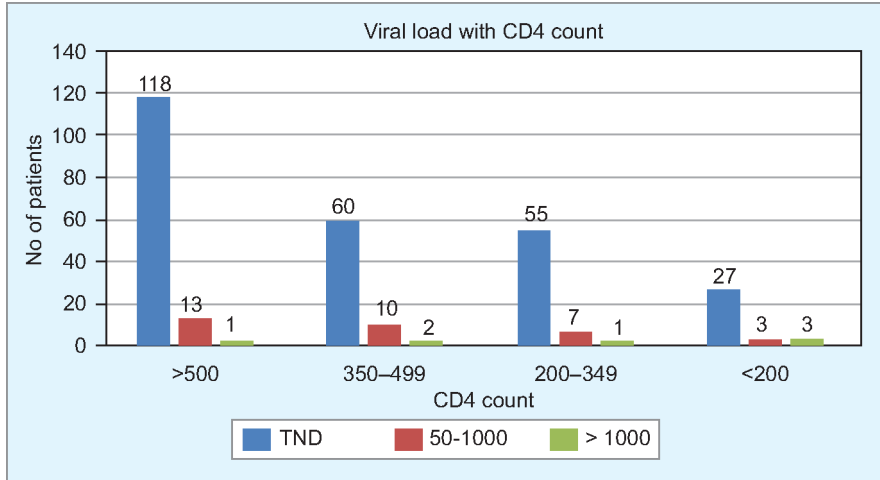


Fig. 1: Distribution of viral load with CD4 count among the study population

Table 1: Distribution of variables among the study population

Variables		Number (n = 300)	Percentage (%)
Age groups	18–37	153	51
	38–57	127	42
	58–77	20	7
Gender	Male	213	71
	Female	87	29
Body weight	45.13–55.13	126	42
	55.13–65.13	105	35
	65.13–75.13	65	22
	75.13–85.13	4	

Table 2: Distribution of renal functions among study population

Renal functions	eGFR (mL/min/1.73 m ²)	n = 300	Percentage (%)
Normal renal function	≥90	131	43.7
Mildly decreased renal function	60–89	135	45.0
Mildly to moderately decreased renal function	45–59	21	7.0
Moderately to severely decreased renal function	30–44	12	4.0
Severely decreased renal function	15–29	0	0
Kidney failure	<15	1	0.3
Total		300	100.0

Table 3: Distribution of renal functions with viral load among study population

Viral load	Total n (%)	Normal renal function	Mildly decreased renal function	Mildly to moderately decreased renal function	Moderately to severely decreased renal function	Kidney failure
TND	260 (87%)	113	121	16	9	1
50–1000	35 (11%)	14	13	5	3	0
> 1000	5 (2%)	4	1	0	0	0

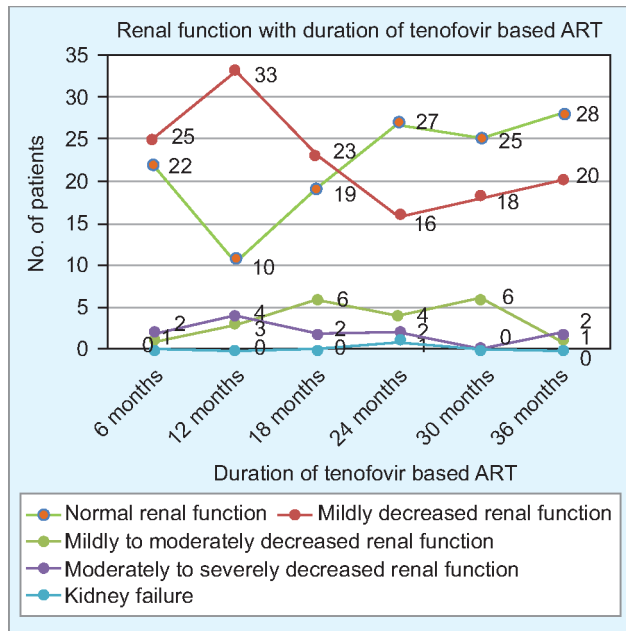


Fig. 2: Distribution of renal dysfunctions with duration of tenofovir-based ART among the study population

Table 4: Distribution of renal functions with S. potassium among study population

Renal function	Grand total (n)	K ⁺ (mean ± SD)	p-value
Normal renal function	131	4.04 ± 0.28	ANOVA test F = 70.17; p < 0.001*
Mildly decreased renal function	135	4.03 ± 0.27	
Mildly to moderately decreased renal function	21	4.05 ± 0.27	
Moderately to severely decreased renal function	12	4.42 ± 0.43	
Kidney failure	1	5.3 ± 0	
Grand total	300	4.06 ± 0.30	

*signifies the p-value is statistically significant

Table 5: Association of renal functions with serum albumin among study population

Renal functions	Grand total (n = 300)	S. albumin	One-way analysis of variance (ANOVA)
Normal renal function	131	4.48 ± 0.05	F = 61.56; p < 0.001*
Mildly decreased renal function	135	4.14 ± 0.27	
Mildly to moderately decreased renal function	21	4.03 ± 0.49	
Moderately to severely decreased renal function	12	3.78 ± 0.64	
Kidney failure	1	3 ± 0	

*Statistically significant values, p-value < 0.05

Table 6: Association of Renal Functions with Post-ART CD4 count among study population

Renal functions	Grand total (n = 300)	Post-ART CD4 count	One-way analysis of variance (ANOVA)
Kidney failure	1	24 ± 0	F = 10.46; p-value = 0.225
Mildly decreased renal function	135	518 ± 48	
Mildly to moderately decreased renal function	21	541.95 ± 380.55	
Moderately to severely decreased renal function	12	383.83 ± 193.53	
Normal renal function	131	626.02 ± 766.26	

The post-ART CD4 counts across different renal function stages. The mean post-ART CD4 counts vary across the groups, with the highest mean count in the normal renal

function category. The one-way ANOVA test shows that these differences are not statistically significant (F = 1.46, p = 0.225) (Table 6).

Multiple logistic regression analysis reveals that S. K⁺ and S. albumin have a significant impact on the odds of the outcome occurring. However, S. Na⁺ and S. Cl⁻ do not have a significant effect on the outcome (Table 7).

DISCUSSION

Renal Function and Serum Parameters

Our study found that 45% of participants had mildly decreased renal function, with only 0.3% experiencing kidney failure. This aligns with Mwemezi et al.,⁷ who reported a significant association between age and renal function. Serum albumin levels were significantly correlated with renal function, highlighting the role of nutrition.⁸ Unlike Brennan et al.,⁹ who reported higher renal dysfunction rates, our findings suggest a lower prevalence of severe impairment.^{10,11}

Body Weight and Renal Function

Higher body weight correlated with better renal function. This contrasts with Nyende et al.,¹² who found no such association, but aligns with studies linking malnutrition to impaired renal function.

Duration of Tenofovir-based ART and Renal Function

No significant trend was found between renal function and prolonged tenofovir-based ART use, consistent with Msango et al.¹³ This contradicts studies suggesting a progressive renal decline with extended ART use.

CD4 Count and Renal Function

No significant correlation was observed between renal function and CD4 count. This differs from Kumarasamy et al.,¹⁴ who linked renal dysfunction to age and baseline eGFR. Other factors, such as body weight and serum albumin levels, may have a greater influence.

Comparison with Other Studies

Compared with Debeb et al.,¹⁵ our study found a higher prevalence of renal dysfunction, possibly due to population differences. Our body weight findings (p < 0.001) contrast with Nyende et al.¹⁶ The link between renal function and serum albumin aligns with Gayatri et al.,¹⁷ emphasizing the importance of nutritional assessment.

Table 7: Multiple logistic regression among serum electrolytes and albumin

Multiple logistic regression	S. E	OR	p-value	95% CI	
				Lower	Upper
S. K ⁺	0.625	3.402	0.050	0.999	11.583
S. albumin	2.302	0.001	0.001	0.001	0.001

CONCLUSION

The study concludes that older age is associated with poorer kidney function, while higher body weight may protect against it. Serum potassium and albumin levels are key indicators of kidney health. No major gender differences were found, and better kidney function was associated with improved HIV treatment outcomes.

DECLARATIONS

Conflict of Interest

None.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was performed in accordance with the ethical standards of the Institutional Ethics Committee of Sawai Man Singh Medical College, Jaipur. Ethical clearance has been obtained from the Institutional Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent was obtained from all participants where applicable. IEC Approval Number: 1023 MC/EC/2023. Date of Approval: August 18, 2023.

AUTHENTICATION STATEMENT

The manuscript is free from plagiarism. All data, images, and figures used in the manuscript are original or properly cited. This article has not been submitted to any other journal for simultaneous consideration.

ACKNOWLEDGMENTS

The authors would like to thank all the residents and faculty members of the department.

Source of Funding

None.

AUTHOR'S CONTRIBUTIONS

MM, AA and DM conceptualized the study; MM and NE designed the methodology and applied the statistical analyses; MM and JR conducted the data collection, DM and JR data analysis and wrote the main manuscript; DM and NE (guide/other authors name) provided supervision. All the authors reviewed the final manuscript.

ORCID

Muhammed Mufeeth <https://orcid.org/0009-0003-9979-4137>

Deepak Muraleedharan <https://orcid.org/0009-0004-3761-7992>

REFERENCES

- UNAIDS. (2023). Global HIV and AIDS statistics—fact sheet. [online] Available from www.unaids.org [Last accessed April, 2026].
- Deeks SG, Lewin SR, Havlir DV. The end of AIDS: HIV infection as a chronic disease. *Lancet* 2013;382(9903):1525–1533.
- Sax PE, Wohl D, Yin MT, et al. Tenofovir alafenamide versus tenofovir disoproxil fumarate for HIV-1 therapy. *N Engl J Med* 2015;373(23):2113–2126.
- Hall AM, Hendry BM, Nitsch D, et al. Tenofovir-associated kidney toxicity in HIV-infected

patients: a review of the evidence. *Am J Kidney Dis* 2021;57(5):773–780.

- Wyatt CM, Kopp JB. HIV-associated nephropathy in the era of antiretroviral therapy. *Nat Rev Nephrol* 2022;18(3):173–184.
- Lucas GM, Ross MJ, Stock PG, et al. Clinical practice guideline for the management of chronic kidney disease in patients infected with HIV: 2018 update by the HIV Medicine Association of the Infectious Diseases Society of America. *Clin Infect Dis* 2019;68(6):e1–e73.
- Mwemezi O, Ruggajo P, Mngumi J, et al. Renal dysfunction among HIV-infected patients on antiretroviral therapy in Dar es Salaam, Tanzania: a cross-sectional study. *Int J Nephrol* 2020;2020(3):8378947
- Cheng T, Wang X, Han Y, et al. The level of serum albumin is associated with renal prognosis and renal function decline in patients with chronic kidney disease. *BMC Nephrol* 2023;24(1):57.
- Brennan A, Evans D, Maskew M, et al. Relationship between renal dysfunction, nephrotoxicity and death among HIV adults on tenofovir. *AIDS* 2011;25(13):1603–1609.
- Ortiz A, Lees JS, Torra R, et al. The updated global burden of chronic kidney disease: one death every 20 seconds. *Nephrol Dial Transplant* 2026.
- Singh AK, Farag YM, Mittal BV, et al. Epidemiology and risk factors of chronic kidney disease in India: results from the SEEK (Screening and Early Evaluation of Kidney Disease) study. *BMC Nephrol* 2013;14:114.
- Nyende L, Kalyesubula R, Sekasanu E, et al. Prevalence of renal dysfunction among HIV infected patients receiving Tenofovir at Mulago: a cross-sectional study. *BMC Nephrol* 2020;21:232.
- Msango L, Downs JA, Kalluvya SE, et al. Renal dysfunction among HIV-infected patients starting antiretroviral therapy. *AIDS* 2011;25(11):1421–1425.
- Kumarasamy N, Sundaram S, Poongulali S, et al. Prevalence and factors associated with renal dysfunction in patients on tenofovir disoproxil fumarate-based antiretroviral regimens for HIV infection in Southern India. *J Virus Erad* 2018;4(1):37–40
- Debeb SG, Muche AA, Kifle ZD, et al. Tenofovir Disoproxil Fumarate-Associated Renal Dysfunction Among Adult People Living with HIV at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia, 2019: A Comparative Retrospective Cohort Study. *HIV AIDS (Auckl)* 2021;13:491–503.
- Omer K, Clemens K, Zhu Y, et al. Nonpharmacologic and nonsurgical weight management interventions for patients with advanced CKD: a scoping review of the medical literature. *Kidney Med* 2025;7.
- Gayatri L, Manpang NN, Nobing D, et al. A study of renal dysfunction among HIV-infected patients on tenofovir based ART regimen in the Northeast part of India. *Int J Adv Med* 2020;7(8):1227–1231.