Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Prevalence and Clinical Characteristics of Renal Disease in Hiv Patients at a Tertiary Care Hospital

Varun Jain

bhuvna.ahuja1983@gmail.com

JSS Medical College and Hospital

Faraz Ahmad

JSS Medical College and Hospital

Manjunath S Shetty

JSS Medical College and Hospital

kiran Krishnamurthy kelur

JSS Medical College and Hospital

Research Article

Keywords: HIV, Renal disease, CD4 + count, Hypertension, Antiretroviral therapy, Chronic kidney disease

Posted Date: November 3rd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11006314/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

Renal disease is a significant comorbidity among people living with HIV (PLHIV), contributing to morbidity and mortality despite antiretroviral therapy (ART). Limited data exist regarding the prevalence and clinical characteristics of renal disease in HIV-positive patients in India.

Objectives

To determine the prevalence of renal disease among HIV-positive patients at a tertiary care hospital and to identify risk factors associated with renal involvement, including the correlation between CD4 + count and renal dysfunction.

Materials and Methods

This prospective cross-sectional study was conducted at JSS Medical College and Hospital, Mysuru, from September 2023 to March 2025. A total of 147 HIV-positive patients aged 18–70 years were enrolled. Renal disease was defined as serum creatinine > 1.3 mg/dL or urine albumin ≥ 2 + on dipstick. Data collected included demographics, clinical parameters, CD4 + count, ART regimen, comorbidities, and renal function tests. Statistical analysis included chi-square test, correlation analysis, and multivariate logistic regression.

Results

The mean age was 45.7 ± 12.8 years with male predominance (65.3%). The overall prevalence of renal disease was 21.1% (95% CI: 14.6–28.6%). Among affected patients, 48.4% had elevated creatinine only, 32.3% had significant albuminuria only, and 19.4% had both. Hypertension was significantly associated with renal disease (OR 2.76, p = 0.031). CD4 + count showed a significant inverse relationship with renal disease (p = 0.032). Multivariate analysis identified hypertension (adjusted OR 3.12, p = 0.022) and CD4 + count per 100 cells/μL decrease (adjusted OR 1.28, p = 0.041) as independent predictors.

Conclusion

Renal disease affects approximately one in five HIV-positive patients. Hypertension and low CD4 + count are significant independent risk factors, underscoring the importance of systematic renal screening, blood pressure management, and early ART initiation.

INTRODUCTION

Human Immunodeficiency Virus (HIV) infection remains one of the most significant global public health challenges. According to UNAIDS estimates for 2022, approximately 39 million people worldwide were living with HIV, with 1.3 million new infections and 630,000 AIDS-related deaths occurring during that year [1]. The advent of combination antiretroviral therapy (cART) in the mid-1990s revolutionized HIV management, transforming what was once an invariably fatal disease into a chronic, manageable condition with significantly improved life expectancy [2]. However, as PLHIV survive longer due to effective ART, a new spectrum of long-term complications has emerged, among which renal disease occupies a position of particular clinical importance.

The kidney remains a major target organ in HIV infection, with renal manifestations ranging from acute kidney injury (AKI) to chronic kidney disease (CKD) and various glomerulopathies specific to HIV. The relationship between HIV and renal disease is complex and multifactorial, involving direct viral effects on renal tissue, immune-mediated mechanisms, co-infections, comorbid conditions, and the nephrotoxic potential of certain antiretroviral medications [3]. HIV-associated nephropathy (HIVAN), characterized by collapsing focal segmental glomerulosclerosis, was once the most common and severe renal manifestation in HIV-positive individuals. While the introduction of cART significantly reduced HIVAN incidence, the overall burden of kidney disease in PLHIV remains elevated, with studies indicating a four-fold increased risk of CKD among HIV-infected individuals compared to the general population [4].

The pathogenesis of renal disease in HIV patients encompasses several distinct mechanisms. Direct viral cytopathic effects occur when HIV infects renal epithelial cells, particularly podocytes and tubular epithelial cells, leading to cellular injury and dysfunction. Immune-mediated injury results from the deposition of immune complexes in the glomeruli and the dysregulation of immune responses. Additionally, the chronic inflammatory state associated with HIV infection contributes to endothelial dysfunction and accelerated atherosclerosis, which can impair renal perfusion [5]. Antiretroviral medications, particularly tenofovir disoproxil fumarate (TDF), have been associated with proximal tubular dysfunction, Fanconi syndrome, and decreased glomerular filtration rate in susceptible individuals [6].

The epidemiology of renal disease in HIV patients varies considerably across geographic regions and populations. In developed countries where cART is widely available, the spectrum has shifted from classical HIVAN to other forms of kidney disease including diabetic nephropathy, hypertensive nephrosclerosis, and medication-related kidney injury [7]. CKD prevalence estimates in HIV-positive populations range from 2–12% depending on definitions, geographic location, and study era, with generally higher prevalence in populations of African descent reflecting genetic susceptibility factors related to APOL1 gene variants [3, 4].

India presents a unique epidemiological context in the global HIV landscape. Despite a relatively low national HIV prevalence of approximately 0.22%, the country's large population translates into approximately 2.4 million people living with HIV, making India the country with the third-highest HIV burden globally [8]. The epidemic in India exhibits considerable heterogeneity, with higher prevalence in

southern states including Karnataka, Andhra Pradesh, and Maharashtra [8]. Limited data exist regarding the prevalence and characteristics of renal disease among HIV-infected individuals in India. A pilot study from North India reported renal involvement in 17.3% of HIV-positive patients, with higher prevalence among treatment-naïve individuals compared to those on ART [9]. A cross-sectional study from Kolkata similarly found renal involvement in 22.9% of treatment-naïve and 13.8% of ART-treated patients [10]. The clinical spectrum of renal disease in hospitalized Indian HIV patients has also been described, with electrolyte disorders in 71% of patients, acute renal failure in 15.8%, and CKD in 13% [11].

Several risk factors have been identified for kidney disease in HIV patients globally, including low CD4 count, high viral load, diabetes mellitus, hypertension, hepatitis C co-infection, and nephrotoxic medications [4, 7]. The D:A:D study, one of the largest international HIV cohort collaborations, developed a validated risk score incorporating age, sex, baseline eGFR, CD4 nadir, hypertension, diabetes, cardiovascular disease, hepatitis C, and specific ART exposures to predict CKD development [12]. Clinical practice guidelines from the HIV Medicine Association recommend systematic screening through serum creatinine with eGFR calculation and urinalysis at baseline and periodically during follow-up [13].

Despite the availability of effective ART and growing awareness of kidney disease as a complication of HIV, significant gaps remain in understanding the epidemiology, risk factors, and optimal management strategies in resource-limited settings like India. This study aims to address this knowledge gap by systematically evaluating the prevalence and clinical characteristics of renal disease among HIV-positive patients at a tertiary care hospital in South India.

AIMS AND OBJECTIVES

Primary Objective

To determine the prevalence of renal disease among HIV-positive patients, either treatment-naïve or receiving antiretroviral therapy, at a tertiary care hospital in Mysuru.

Secondary Objectives

(1) To identify the risk factors associated with renal dysfunction in HIV patients. (2) To analyze the correlation between CD4 + count and renal dysfunction in this population.

MATERIALS AND METHODS

Study Design and Setting

This prospective cross-sectional study was conducted at JSS Medical College and Hospital, Mysuru, a tertiary care referral center serving a large patient population from Mysore district and surrounding regions of Karnataka state, India. The study was conducted from September 2023 to March 2025.

Sample Size Calculation

Based on the reported incidence of acute renal failure of 15.8% in HIV patients by Verma et al. [11], using a 95% confidence interval and 6% relative precision, the required sample size was calculated using the formula: $N = Z^2 \times P \times (1 - P) / E^2$, where $Z = 1.96$, $P = 15.8\%$, and $E = 6\%$. This yielded a minimum requirement of 147 participants.

Sampling Technique

A convenience sampling technique was employed. All eligible HIV-positive patients attending the Department of Nephrology and ART center at JSS Hospital during the study period were approached. Those meeting inclusion criteria who provided informed consent were enrolled consecutively until the required sample size was achieved.

Inclusion Criteria

HIV-positive individuals aged 18–70 years with documented confirmed HIV-reactive status, either treatment-naïve or on ART, including those with lifestyle-related comorbid conditions (diabetes mellitus, hypertension), who provided informed consent were included.

Exclusion Criteria

Excluded were HIV-negative individuals, those with co-infection with hepatitis B or hepatitis C, pregnant women (due to confounding effects on renal function), and individuals with severe cognitive or communication impairments that hindered their ability to provide informed consent.

Data Collection

Demographic data (age, sex, BMI), HIV-related history (date of diagnosis, ART regimen, duration and adherence), clinical history (symptoms of renal disease, comorbidities), medication history (with particular attention to nephrotoxic drugs including NSAIDs, aminoglycosides, tenofovir-containing regimens, and trimethoprim-sulfamethoxazole prophylaxis), and personal history (smoking, alcohol consumption) were systematically collected through a structured proforma. Clinical examination included vital signs, assessment for pedal edema, and systematic examination of cardiovascular, respiratory, abdominal, and central nervous systems.

Laboratory investigations included complete blood count, renal function tests (blood urea, serum creatinine, electrolytes, calcium, phosphorus, uric acid), liver function tests, lipid profile, CD4 + T-lymphocyte count, and HIV viral load. Estimated glomerular filtration rate (eGFR) was calculated using

the CKD-EPI equation. Urine samples were analyzed for routine and microscopic examination including albumin, red blood cells, white blood cells, and casts.

Definition of Renal Disease

Renal disease was defined as serum creatinine > 1.3 mg/dL OR urine albumin ≥ 2 + on dipstick examination.

Imaging Protocol

Renal ultrasonography was performed for all participants using a standard ultrasound machine with a 3–5 MHz convex probe. Two-dimensional echocardiography was performed when clinically indicated.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 26 (Licensed to JSSAHER). Descriptive statistics were used for summarization. Risk factor analysis included univariate followed by multivariate logistic regression. Correlation analysis was performed using Pearson's or Spearman's coefficients. Chi-square or Fisher's exact test was used for categorical variables; Student's t-test or Mann-Whitney U test for continuous variables. A p-value < 0.05 was considered statistically significant.

RESULTS

Demographic and Baseline Characteristics

The study enrolled 147 HIV-positive patients with a mean age of 45.7 ± 12.8 years (range: 18–76 years) and median age of 45.0 years (IQR: 37.0–55.0). The largest proportion of patients belonged to the 41–50 years age group (n = 44, 29.9%), followed by 31–40 years (n = 33, 22.4%), 51–60 years (n = 30, 20.4%), 18–30 years (n = 21, 14.3%), and > 60 years (n = 19, 12.9%). Males constituted 65.3% (n = 96) with a male-to-female ratio of 1.88:1. Among patients with available data, 78.0% were married, and 60.7% were outpatients. The majority (92.5%) were receiving ART while 11 patients (7.5%) were treatment-naïve (Table 1).

Table 1
Demographic and Baseline Characteristics (N = 147)

Parameter	Value
Mean age ± SD (years)	45.7 ± 12.8
Median age (IQR)	45.0 (37.0–55.0)
Male, n (%)	96 (65.3)
Female, n (%)	51 (34.7)
Married, n (%) (of 82)	64 (78.0)
Outpatient, n (%) (of 122)	74 (60.7)
History of renal disease, n (%)	27 (18.4)
On ART, n (%)	136 (92.5)
Treatment-naïve, n (%)	11 (7.5)

Prevalence and Classification of Renal Disease

The overall prevalence of renal disease was 21.1% (n = 31; 95% CI: 14.6–28.6%). Among the 31 patients with renal disease, 15 (48.4%) had elevated serum creatinine only, 10 (32.3%) had significant albuminuria only, and 6 (19.4%) met both criteria (Table 2). The prevalence was higher among treatment-naïve patients (36.4%, 4/11) compared to those on ART (19.9%, 27/136), though this difference did not reach statistical significance (p = 0.183).

Table 2
Prevalence and Classification of Renal Disease

Parameter	n (%)
Renal disease present	31 (21.1)
Renal disease absent	116 (78.9)
Among patients with renal disease (n = 31):	
Elevated creatinine only (> 1.3 mg/dL)	15 (48.4)
Significant albuminuria only (≥ 2+)	10 (32.3)
Both criteria met	6 (19.4)

Association of Comorbidities with Renal Disease

Renal disease prevalence increased progressively with age: 9.5% in 18–30 years, 15.2% in 31–40 years, 22.7% in 41–50 years, 26.7% in 51–60 years, and 31.6% in > 60 years (p = 0.285 for trend). Males had slightly higher prevalence (22.9%) than females (17.6%, p = 0.445). Hypertension was the only

comorbidity significantly associated with renal disease (37.5% vs. 17.9%, p = 0.031, OR 2.76, 95% CI: 1.09–6.97). Diabetes showed a numerical trend (31.3% vs. 19.8%, OR 1.83, p = 0.293) without statistical significance (Table 3).

Table 3
Association of Comorbidities with Renal Disease

Comorbidity	Renal Disease n (%)	No Renal Disease n (%)	OR (95% CI)	p-value
Hypertension (n = 24)	9 (37.5)	15 (62.5)	2.76 (1.09–6.97)	0.031*
No hypertension (n = 123)	22 (17.9)	101 (82.1)	Ref	—
Diabetes (n = 16)	5 (31.3)	11 (68.8)	1.83 (0.59–5.64)	0.293
No diabetes (n = 131)	26 (19.8)	105 (80.2)	Ref	—
CAD (n = 5)	2 (40.0)	3 (60.0)	2.59 (0.44–15.35)	0.288
CVA (n = 11)	3 (27.3)	8 (72.7)	1.44 (0.37–5.66)	0.595

*Statistically significant at p < 0.05

CD4 + Count and Renal Disease

A significant inverse relationship was observed between CD4 + count categories and renal disease prevalence: 29.2% (14/48) in CD4 + < 200 cells/μL, 23.8% (10/42) in 200–350, 14.3% (4/28) in 351–500, and 10.3% (3/29) in > 500 cells/μL (p = 0.032; Table 4). Mean CD4 + count was significantly lower in patients with renal disease (241 ± 208 vs. 333 ± 239 cells/μL, p = 0.048). Correlation analysis showed significant associations between CD4 + count and serum creatinine (r = − 0.187, p = 0.023), eGFR (r = 0.224, p = 0.009), and urine albumin grade (r = − 0.163, p = 0.048).

Table 4
CD4 + Count Categories and Renal Disease

CD4+ (cells/μL)	n	Renal Disease n (%)	Mean Creatinine ± SD	Mean eGFR ± SD
< 200	48	14 (29.2)	1.29 ± 0.89	77.4 ± 33.2
200–350	42	10 (23.8)	1.10 ± 0.58	85.1 ± 28.9
351–500	28	4 (14.3)	1.01 ± 0.52	91.5 ± 25.7
> 500	29	3 (10.3)	0.96 ± 0.43	95.8 ± 27.1
p-value (trend)	—	0.032*	—	—

*Statistically significant at p < 0.05

Renal Function Parameters and eGFR Distribution

The mean serum creatinine was 1.13 ± 0.72 mg/dL (median 0.98; range: 0.35–5.76), mean eGFR was 85.2 ± 30.2 mL/min/1.73m² (median 88.1; range: 10.1–147), and mean serum albumin was 3.24 ± 0.50 g/dL. Regarding eGFR distribution, 44.3% had normal/high eGFR (≥ 90, G1 stage), 35.0% had mild reduction (60–89, G2), 11.4% had mild-moderate CKD (45–59, G3a), 5.7% had moderate-severe CKD (30–44, G3b), 2.1% had severe CKD (15–29, G4), and 1.4% had kidney failure (< 15, G5). Overall, 20.7% (n = 29) had eGFR < 60 mL/min/1.73m² (Table 5).

Table 5
Distribution of eGFR Categories (N = 140)

eGFR (mL/min/1.73m²)	CKD Stage	n (%)
≥ 90	G1	62 (44.3)
60–89	G2	49 (35.0)
45–59	G3a	16 (11.4)
30–44	G3b	8 (5.7)
15–29	G4	3 (2.1)
< 15	G5	2 (1.4)

Multivariate Logistic Regression

Multivariate analysis identified two independent predictors of renal disease: hypertension (adjusted OR 3.12, 95% CI: 1.18–8.26, p = 0.022) and CD4 + count per 100 cells/μL decrease (adjusted OR 1.28, 95% CI: 1.01–1.62, p = 0.041). Age, sex, diabetes, ART status, and septran use were not statistically significant in the adjusted model, though ART showed a protective trend (adjusted OR 0.38, 95% CI: 0.10–1.45, p = 0.157; Table 6).

Table 6
Multivariate Logistic Regression – Independent Predictors of Renal Disease

Variable	Adjusted OR	95% CI	p-value
Hypertension	3.12	1.18–8.26	0.022*
CD4 + count (per 100 cells/μL decrease)	1.28	1.01–1.62	0.041*
Age (per year)	1.02	0.99–1.05	0.156
Male sex	1.21	0.45–3.24	0.708
Diabetes mellitus	1.64	0.47–5.71	0.436
ART status (on ART)	0.38	0.10–1.45	0.157
Septran use	1.09	0.46–2.59	0.846

*Statistically significant at $p < 0.05$

DISCUSSION

This prospective cross-sectional study reveals important findings regarding the burden of kidney disease in PLHIV in the Indian context. The overall prevalence of renal disease of 21.1% (95% CI: 14.6–28.6%) indicates that approximately one in five HIV-positive patients attending this tertiary care hospital had evidence of renal involvement. This finding aligns with reported rates from Indian studies. Gupta et al. reported renal involvement in 17.3% of HIV-positive patients from North India, with significantly higher prevalence among treatment-naïve individuals (18.9%) compared to those on ART (12.7%) [9]. A study from Kolkata documented renal involvement in 22.9% of ART-naïve patients and 13.8% of those on treatment [10]. Verma and Singh reported acute renal failure in 15.8% and CKD in 13% of hospitalized HIV patients, with dipstick proteinuria ≥ 1 + in 29% of patients [11]. Our slightly higher overall prevalence likely reflects the inclusion of both outpatients and inpatients in our cohort.

The heterogeneous pattern of renal disease in our study, with approximately half of affected patients having isolated elevated creatinine and one-third having isolated albuminuria, suggests diverse underlying pathophysiological mechanisms rather than a single predominant entity. Rosenberg et al. described this evolving spectrum of HIV-associated kidney diseases, noting the decline in classical HIVAN following widespread ART implementation and the increasing recognition of immune complex glomerulonephritis, AKI, and CKD from traditional causes [3]. The relative infrequency of classical HIVAN in Indian populations may reflect lower prevalence of APOL1 risk variants compared to populations of African ancestry, as described by Kopp et al. [5].

Hypertension emerged as the most significant predictor of renal disease in both univariate (OR 2.76, $p = 0.031$) and multivariate analysis (adjusted OR 3.12, $p = 0.022$). After controlling for age, sex, diabetes, CD4 + count, and ART status, hypertensive patients had more than three times the odds of having renal disease. This is consistent with the D:A:D study by Mocroft et al., which demonstrated a 1.4-fold

increased CKD risk among hypertensive HIV patients [12]. Lucas et al. in their clinical practice guidelines similarly identified hypertension as a major risk factor for CKD and recommended target blood pressure < 130/80 mmHg [13]. The mechanisms linking hypertension to kidney disease in HIV patients are multifactorial, involving direct nephrotoxic effects of elevated blood pressure, endothelial dysfunction, and interactions with HIV-related inflammatory processes.

CD4 + count demonstrated a highly significant inverse relationship with renal disease. The prevalence showed a striking gradient from 29.2% in patients with CD4 + < 200 cells/μL to 10.3% in those with > 500 cells/μL ($p = 0.032$), representing nearly three-fold higher prevalence in the most immunosuppressed group. Mean CD4 + count was significantly lower in the renal disease group (241 ± 208 vs. 333 ± 239 cells/μL, $p = 0.048$). In multivariate analysis, each 100 cells/μL decrease in CD4 + count independently increased renal disease odds by 28% (adjusted OR 1.28, $p = 0.041$). This translates to approximately 2.1-fold increased odds for a patient with CD4 + of 100 cells/μL compared to 400 cells/μL. Doshi et al. similarly found that CD4 + count < 200 cells/μL was associated with 1.52-fold increased risk of incident renal disease [14]. The D:A:D study incorporated CD4 + nadir < 200 cells/μL in their risk score with a 1.8-fold increased CKD risk [12].

The protective trend observed with ART use (adjusted OR 0.38, $p = 0.157$) is clinically meaningful despite not reaching statistical significance, likely due to the small number of treatment-naïve patients (n = 11). Every measured renal and immunological parameter showed trends favoring ART-treated patients. Wyatt and Klotman documented dramatic reductions of 50–80% in HIVAN incidence following widespread ART implementation [4]. Campos et al. in their comprehensive 35-year review emphasized that ART represents the most important intervention for HIV-associated kidney diseases [15].

Regarding specific ART regimens, TLD (tenofovir/lamivudine/dolutegravir) was the predominant regimen (85.0%) and showed 19.2% renal disease prevalence, with no significant differences across regimen types ($p = 0.442$). Gupta et al. identified risk factors for tenofovir-associated Fanconi syndrome including lower body weight, older age, reduced baseline eGFR, and concurrent protease inhibitor use [6]. The absence of significant renal disease differences across ART types in our study may reflect that patients with pre-existing renal impairment were preferentially prescribed alternative regimens.

The distribution of CKD stages revealed that while the majority (79.3%) maintained eGFR > 60 mL/min/1.73m², a concerning 20.7% had moderate to severe CKD (eGFR < 60), with 3.6% having advanced disease (stages 4–5). Serum albumin was significantly lower in the renal disease group (3.08 ± 0.58 vs. 3.29 ± 0.47 g/dL, $p = 0.033$), reflecting proteinuria, malnutrition, or chronic inflammation. Hemoglobin was also lower (11.7 ± 2.3 vs. 12.5 ± 2.0 g/dL, $p = 0.057$), consistent with the anemia of chronic kidney disease. Septran prophylaxis showed no significant association with renal disease (OR 1.09, $p = 0.846$), providing reassurance regarding its renal safety.

Strengths and Limitations

Strengths of this study include its prospective design, standardized data collection, inclusion of both outpatients and inpatients, comprehensive assessment of multiple risk factors, and multivariate statistical analysis. Limitations include the relatively small number of treatment-naïve patients limiting statistical power, absence of systematic viral load data, lack of kidney biopsies for histopathological characterization, cross-sectional design preventing establishment of causality, and single-center setting potentially limiting generalizability.

CONCLUSION

This study demonstrates that renal disease affects approximately one in five HIV-positive patients (21.1%) at a tertiary care hospital in South India. Hypertension and low CD4 + count emerge as independent modifiable risk factors, with hypertensive patients having more than three-fold increased odds and each 100 cells/μL decrease in CD4 + count increasing odds by 28%. The heterogeneous pattern of renal involvement suggests diverse underlying pathophysiological mechanisms. These findings underscore the critical importance of systematic renal screening in all HIV patients, aggressive blood pressure management with target control and use of nephroprotective agents, maintenance of immune function through early ART initiation and excellent adherence, and close monitoring of high-risk individuals. As HIV-infected individuals survive longer on effective ART, CKD will likely emerge as an increasingly important cause of morbidity. Comprehensive HIV care must integrate regular renal assessment, judicious ART selection considering renal safety, and timely nephrology referral. Future longitudinal studies with kidney biopsies and larger treatment-naïve samples are warranted to further characterize renal disease patterns in Indian HIV populations.

Declarations

Ethics approval and consent to participate

The study protocol was reviewed and approved by the Institutional Ethical Committee of JSS Medical College, JSS Academy of Higher Education and Research, Mysuru, at its meeting held on 27 October 2023 (Ref. No. JSS/MC/PG/4564/2023-24, dated 09 November 2023). The study was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent was obtained from all participants prior to enrolment.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Funding

The authors received no specific funding for this study.

Author Contribution

M.S.S. conceived and designed the study and provided overall supervision. He mentored the full research work. K.K.K checked and analyzed the data .V.J. and A.F. contributed to patient recruitment, data collection, and clinical assessment. V.J. and A.F. contributed to data organization and analysis. M.S.S., K.K.K., V.J., and A.F. contributed to interpretation of the results and preparation of the manuscript. M.S.S. and K.K.K. critically revised the manuscript for important intellectual content. All authors reviewed and approved the final manuscript and agree to be accountable for all aspects of the work.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

References

1. Joint United Nations Programme on HIV/AIDS. Global HIV & AIDS statistics — Fact sheet 2023. Geneva: UNAIDS; 2023.
2. Palella FJ Jr, Delaney KM, Moorman AC, Loveless MO, Fuhrer J, Satten GA, et al. Declining morbidity and mortality among patients with advanced human immunodeficiency virus infection. N Engl J Med. 1998;338(13):853–60.
3. Rosenberg AZ, Naicker S, Winkler CA, Kopp JB. HIV-associated nephropathies: epidemiology, pathology, mechanisms and treatment. Nat Rev Nephrol. 2015;11(3):150–60.
4. Wyatt CM, Klotman PE. HIV-associated nephropathy in the era of antiretroviral therapy. Am J Med. 2007;120(6):488–92.
5. Kopp JB, Nelson GW, Sampath K, Johnson RC, Genovese G, An P, et al. APOL1 genetic variants in focal segmental glomerulosclerosis and HIV-associated nephropathy. J Am Soc Nephrol. 2011;22(11):2129–37.
6. Gupta SK, Anderson AM, Ebrahimi R, Fralich T, Graham H, Scharen-Guivel V, et al. Fanconi syndrome accompanied by renal function decline with tenofovir disoproxil fumarate: a prospective, case-control study of predictors and resolution in HIV-infected patients. PLoS ONE. 2014;9(3):e92717.

7. Naicker S, Rahmanian S, Kopp JB. HIV and chronic kidney disease. Clin Nephrol. 2015;83(7 Suppl 1):32–8.
8. National AIDS Control Organisation, India HIVE. 2021: Technical Brief. New Delhi: NACO, Ministry of Health and Family Welfare, Government of India; 2021.
9. Gupta V, Gupta S, Sinha S, Sharma SK, Dinda AK, Agarwal SK, et al. HIV associated renal disease: A pilot study from north India. Indian J Med Res. 2013;137(5):950–6.
10. Mukherjee A, Saha MK, Chawla AS, Goswami RP. A cross-sectional study on renal involvement among HIV-infected patients attending a tertiary care hospital in Kolkata. Indian J Nephrol. 2018;28(4):281–6.
11. Verma B, Singh A. Clinical spectrum of renal disease in hospitalized HIV/AIDS patients: A teaching hospital experience. J Fam Med Prim Care. 2019;8(3):886–91.
12. Mocroft A, Lundgren JD, Ross M, Law M, Reiss P, Kirk O, et al. Development and validation of a risk score for chronic kidney disease in HIV infection using prospective cohort data from the D:A:D study. PLoS Med. 2015;12(3):e1001809.
13. Lucas GM, Ross MJ, Stock PG, Shlipak MG, Wyatt CM, Gupta SK, et al. Clinical practice guideline for the management of chronic kidney disease in patients infected with HIV: 2014 update by the HIV Medicine Association of the Infectious Diseases Society of America. Clin Infect Dis. 2014;59(9):e96–138.
14. Doshi S, Ucanda M, Hart R, Hou Q, Terzian AS, Subramanian T, et al. Incidence and Risk Factors for Renal Disease in an Outpatient Cohort of HIV-Infected Patients on Antiretroviral Therapy. Kidney Int Rep. 2019;4(8):1075–84.
15. Campos P, Ortiz A, Soto K. HIV and kidney diseases: 35 years of history and consequences. Clin Kidney J. 2016;9(6):772–81.