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Impact of estimated glomerular filtration rate (eGFR) on in-hospital mortality: an age- and HIV status-specific retrospective cohort study in Uganda

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Abstract

Background Limited studies have explored the relationship between estimated Glomerular Filtration Rate(eGFR) and in-hospital mortality(IHM) in low-income sub-Saharan African countries. This study aimed to explores this association, offering insights into its impact in resource-limited settings.

Methods and results We retrospectively included 226 patients(age 45.35 ± 18.85yrs, 54.4% women) admitted to Naguru-referral hospital between January 1st and June 30th, 2024. Baseline demographics and clinical variables, including eGFR, were recorded at admission. Patients were followed from date of admission to discharge and primary outcome was IHM.

Multivariable Hazard *regression* analysis assessed the association between eGFR and IHM, respectively. During follow-up, 45(19.9%) of patients died. Per-standard deviation(SD) increase in eGFR(48.60 mL/min/1.73m^2) was associated with Hazard Ratio(HR) of 0.46[95%CI: 0.282–0.759, $p = 0.002$, β = -0.77] for IHM in fully adjusted models. When stratified by eGFR quartiles, using highest quartile(≥ 120 mL/min/1.73m^2) as reference, HR was 1.08[95%CI: 0.276–4.226, $p = 0.912$, β = + 0.08] for 99.0–120 mL/min/1.73m^2; 4.08[95%CI: 1.284–12.954, $p = 0.017$, β = + 1.41] for 66.8–99.0 mL/min/1.73m^2, and 4.08[95%CI: 1.284–12.954, $p = 0.037$, β = + 1.25] for < 66.8 mL/min/1.73m^2. Among age stratification-subgroups: age < 40yrs: 0.93[95%CI: 0.89–0.97, $p < 0.001$, β = -0.07]; 40-60yrs: 0.98[95%CI: 0.966–0.999, $p = 0.039$, β = -0.02]; ≥ 60yrs, $p < 0.005$ with p-value$_{\text{-interaction}}$ for age = 0.046; and HIV-positive: 0.94[95%CI: 0.905–0.974, $p < 0.001$, β = -0.06] with p-value$_{\text{-interaction}} = 0.021$. Significant Pearsons-correlation(r) was observed only in: [< 40yrs, HIV(-)] with $p = 0.016$, $r = -0.275$; [40-60yrs, HIV(+)] with $p = 0.020$, $r = -0.397$; and [≥ 60yrs,HIV(+)] with $p = 0.003$, $r = -0.997$.

Conclusions We report that eGFR was associated with in-hospital mortality, with a stronger association observed in HIV-negative patients(< 40yrs) and HIV-positive patients (aged ≥ 60yrs yrs). Further research is warranted to validate these findings.

Keywords EGFR, In-hospital mortality, HIV-positive, Low-income countries, Africa

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Introduction

The estimated glomerular filtration rate(eGFR) is a widely utilized measure of renal function, offering a reliable estimate of kidney filtration capacity [1–3]. Beyond evaluating kidney health, eGFR also reflects a patient's overall physiological status, particularly in-hospital settings where multiple organ systems interact [2]. Influenced by factors such as age, gender, muscle mass, and systemic health, eGFR serves as a dynamic marker providing insight into broader clinical outcomes, including in-hospital mortality(IHM) [3, 4]. While extensive research in Europe, United States, and Asia has demonstrated eGFR's strength as mortality predictor [3–5], data from developing Sub-Saharan African countries, especially East Africa, remain limited.

In populations with chronic infections like Human Immune virus(HIV) [6], cardiovascular disease(CVD), and more recently COVID-19 [7], eGFR emerges as a critical biomarker for assessing disease severity, treatment response, and IHM risk [8]. In resource-limited settings, where healthcare capacity may be constrained, understanding the relationship between eGFR and IHM can enhance clinical decision-making and identify high-risk patients. However, data on the role of eGFR in developing countries is limited, particularly where the young and HIV-positive individuals constitute a significant portion of hospitalized patients [9].

HIV-positive individuals, while benefiting from antiretroviral therapy(ART) and living longer [6, 9], face increased risks of renal dysfunction due to HIV-associated nephropathy, inflammation [6], and the nephrotoxic effects of certain ART medications [9]. These factors can diminish eGFR even in young patients who might not exhibit traditional risk factors for kidney disease. Therefore, monitoring eGFR in this population offers essential insights into how well the kidneys are managing both the infection and its treatment.

However, the relationship between eGFR and IHM, especially among high-risk groups such as HIV-positive and patients < 60yrs in low-income countries, has not been explored. Therefore, it remains unclear whether eGFR can predict IHM in settings like Uganda. This study aims to examine the impact of eGFR on IHM in the general population and among high-risk subgroups.

Methods

Study design and population

This was a single-center, retrospective observational cohort study that used data from patients admitted to the Internal Medicine Ward at Naguru Referral Hospital (NRH) in Uganda between January 1st and June 30th, 2024, as recorded in the hospital's information system. Patients' HIV status was classified as either HIV-positive or HIV-negative and further stratified into three age groups: < 40 years (Young adults), 40–60 years (Middle-aged adults), and ≥ 60 years (Elderly adults).

Patient selection and sample size

Of the 510 patients aged > 18 years admitted during the study period, 67 were excluded due to being referred to other facilities for further management, and 217 were excluded because of missing clinical, demographic, or discharge outcome data. As a result, the final analysis included 226 patients with complete data (Fig. 1). The quality and risk of bias in the data extraction were assessed using the Newcastle–Ottawa Scale (NOS)(Supplementary Table 1).

Study variables

The outcome variable studied was IHM as an adverse event. IHM was assessed for hospitalized patients in the internal medicine ward, based on death certificates issued to confirm deaths that occurred within a specified period. For patients without death certificates, confirmation was obtained through the hospital's death register.

Patient clinical assessment

Information on characteristics that might confound our outcome was obtained from hospital records from January to July 2024. These characteristics included age, gender, smoking status, and alcohol consumption, the latter of which was self-reported. The duration of hospital stays was calculated from the date of admission to discharge in days. Alcohol use disorders referred to patients being treated for alcohol intoxication. Systolic blood pressure(SBP) and diastolic blood pressure(DBP) were measured using a sphygmomanometer, with average recorded after three separate measurements [10]. Septicemia was identified by elevated lactate and/or C-reactive protein(CRP) levels, along with symptoms such as fever, tachycardia, hypotension, organ dysfunction, or positive blood cultures indicating pathogens in the bloodstream [11]. Pneumonia, characterized by clinical symptoms(fever, cough, shortness of breath), physical examination findings(crackles, abnormal breath sounds), chest imaging(X-ray showing consolidation), and laboratory tests (complete blood count, sputum culture, and inflammatory markers) [12]. Malaria was diagnosed by detecting Plasmodium parasites in blood via microscopy, rapid diagnostic tests(RDTs), and blood slides(B/S), with symptoms including fever and/or chills [13]. HIV was identified through self-reporting, being on antiretroviral(ARV) medication, and/or detecting HIV antibodies and/or antigens in blood tests, such as ELISA or rapid tests followed by confirmatory PCR testing [14]. eGFR was calculated using serum creatinine levels, age,

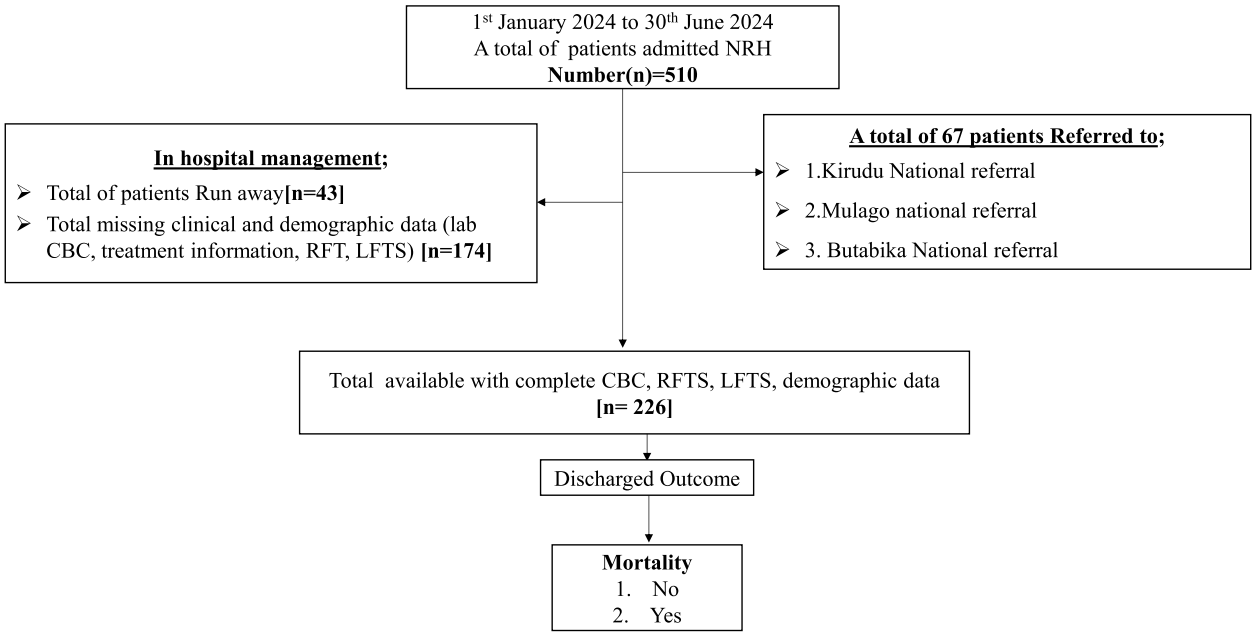

Fig. 1 Flow diagram of patient recruitment and final study sample at NRH. Abbreviations: CBC Cell blood count, RFTs Renal function tests, LFTs Liver function tests, NRH Naguru referral hospital

sex, and race, according to the CKD-EPI formula, which adjusts creatinine levels to estimate kidney function [15]. Diabetes mellitus(DM) was defined by fasting blood glucose levels ≥ 126 mg/dL, non-fasting blood glucose levels ≥ 200 mg/dL, use of antidiabetic medications, and/or self-reported physician diagnosis of diabetes mellitus [16]. Hypertension(HTN) was characterized by systolic blood pressure ≥ 140 mmHg and diastolic blood pressure ≥ 90 mmHg, and/or use of blood pressure medication in the past two weeks [17]. Serum creatinine(Cr) was graded using an appropriate kinetic Jaffe technique [18].

The diagnoses of the above conditions were made by qualified physicians or doctors, typically in consultation with experienced doctors or the head of the department. In some cases, resident doctors may also have been involved in the process under the guidance and supervision of senior medical professionals.

Statistical analysis

Statistical analyses were performed using SPSS version 25.0 (IBM, Armonk, New York).

To assess kidney function, we utilized the SPSS quartiles function to stratify eGFR values into four groups based on decreasing kidney function. This approach divides the population into quartiles, with Q1 representing the lowest kidney function and Q4 representing the highest. Stratifying by quartiles provides a natural distribution of kidney function, enabling the identification of patterns and outcomes associated with varying levels of kidney function, without relying on arbitrary thresholds. Participant characteristics were categorized based on eGFR into the following groups: < 66.8, 66.8–99.0, 99.0–120, and ≥ 120 mL/min/1.73m^2. Hazard ratios (HRs) and 95% confidence intervals (95%CIs) for HIM were then estimated for each of these groups.

Normally distributed continuous clinical characteristics were presented as mean ± standard deviation, continuous variables that are not normally distributed, expressed as median (IQR), while non-continuous variables are represented as mean ± standard deviation, unless otherwise indicated, while categorical variables were displayed as absolute values and percentages. The correlation between eGFR, hospital duration, and IHM was assessed using Pearson's correlation test. Multivariable Hazard regression models were employed with eGFR modeled as a continuous dependent variable. Three models were constructed to control for confounding variables and evaluate the independent association between eGFR and IHM. Model-1 was adjusted for age and gender. Model-2 included the variables from Model-1 plus smoking and alcohol consumption. And model-3, fully adjusted model for variables from model-2 as well as systolic blood pressure (SBP), diastolic blood pressure (DBP), creatinine, alcohol withdrawal, hypertension (HTN), diabetes mellitus (DM), malaria, HIV, and white blood cell count (WBC). There were no missing values for the variables in the main model. Additionally, subgroup analysis was conducted to identify high-risk subgroups for IHM. All

p-values were two-sided, with p-values < 0.05 and 95%CIs considered statistically significant.

Results

Characteristics of the study population

A total of 226 participants were recruited, with a mean age of 45.35 ± 18.85 yrs, and 54.4% were women, mean hospital stay was 6.07 ± 6.64 days, during follow-up, 19.9% of patients died. The stratification of study participants across eGFR categories as follows: 24.8% in Q1 group(eGFR < 66.8 mL/min/1.73 m^2), 26.5% in Q2 group(eGFR = 66.8–99.0 mL/min/1.73 m^2), 24.3% in Q3 group(eGFR = 99.0–120 mL/min/1.73 m^2), and 24.3% in Q4 group(eGFR ≥ 120 mL/min/1.73 m^2). In Q1 group(eGFR < 66.8 mL/min/1.73 m^2) (Table 1).

Estimated glomerular filtration rate, inhospital mortality, and hospital stay

Pearson's correlation was used to estimated the relationship between IHM, hospital stay duration, and eGFR. IHM was significantly correlated with eGFR ($r = -0.294$, $p < 0.001$) and with hospital stay ($r = 0.108$, $p = 0.105$) (Table 2).

Estimated glomerular filtration rate and inhospital mortality

The prevalence of IHM increased as eGFR levels decreased across the quartiles. Using the group with eGFR ≥ 120 mL/min/1.73 m^2 as the reference, HR[95% CI] for mortality were as follows: 1.08 [0.276–4.226, $p = 0.912$, $\beta = +0.08$] for the eGFR 99.0–120 mL/min/1.73 m^2 group, 4.079 [1.284–12.954, $p = 0.017$, $\beta = +1.41$] for the eGFR 66.8–99.0 mL/min/1.73 m^2 group, and 4.08 [1.284–12.954, $p = 0.037$, $\beta = +1.25$] for the eGFR < 66.8 mL/min/1.73 m^2 group. Further, standard deviation increases of 48.60 mL/min/1.73 m^2 in eGFR, the HR[95% CI] for in-hospital mortality was 0.46 [0.282–0.759, $p = 0.002$, $\beta = -0.77$] (Table 3, Fig. 2).

Estimated glomerular filtration rate and in-hospital mortality in high-risk groups

The impact of eGFR on IHM in high-risk subgroups was as follows: women had a higher mortality risk than men (P for interaction by gender = 0.055). In the age subgroup, P for interaction by age = 0.046). And, HIV-status had P for interaction = 0.021.

Furthermore, subgroups: age < 40 years: 0.93 [95% CI: 0.89–0.97, $p < 0.001$, $\beta = -0.07$]; 40–60 years: 0.98 [95% CI: 0.966–0.999, $p = 0.039$, $\beta = -0.02$]; ≥ 60 years, $p < 0.005$; and HIV-positive: 0.94 [95% CI: 0.905–0.974, $p < 0.001$, $\beta = -0.06$] (Table 4).

A significant correlation was reported in the following groups: [< 40yrs, HIV(-)], with $p = 0.016$ and $r = -0.275$; [40-60yrs, HIV(+)], with $p = 0.020$ and $r = -0.397$; and [≥ 60yrs, HIV(+)], with $p = 0.003$ and $r = -0.997$. However, no significant correlation was found in the groups [< 40yrs, HIV(+)], with $p = 0.320$ and $r = -0.138$; [40–60 years, HIV(-)], with $p = 0.333$ and $r = -0.153$; and [≥ 60yrs, HIV(-)], with $p = 0.062$ and $r = -0.477$ (Supplementary Table 2).

Discussion

The present study reports several key findings. First, lower eGFR levels were associated with a significantly higher risk of IHM, while higher eGFR levels were linked to a reduced risk. Second, a significant interaction between eGFR and both age and HIV status was observed in relation to IHM in this cohort. Specifically, IHM was notably higher among patients with lower eGFR, particularly in younger patients who were HIV-negative and in HIV-positive individuals aged ≥ 60yrs. Finally, the association remained significant after full adjustment for potential confounders. To our knowledge, this is the first study to examine the relationship between eGFR and IHM in a low-income setting. The study, conducted at NRH, included 226 patients admitted to the internal medicine ward during the first half of 2024 in Uganda.

Patients with lower eGFR levels had a significantly higher risk of IHM, whereas those with higher eGFR levels demonstrated a reduced risk. This finding supports the established association between impaired renal function and adverse outcomes, including mortality [19–21]. Low eGFR, which indicates decreased kidney function [22], was associated with physiological disturbances such as fluid overload, electrolyte imbalances [23], and toxin accumulation, all of which may contribute to worse clinical outcomes [24]. IHM was notably higher among patients with lower eGFR who were younger or HIV-positive((≥ 60yrs). The interaction between age and HIV status suggests that young individuals and those with HIV are disproportionately affected by reduced eGFR and comorbidities. This is consistent with literature highlighting the compounding effects of renal dysfunction on morbidity and mortality, particularly in vulnerable populations [19, 22, 25]. A significant negative correlation was observed between low eGFR and specific subgroups. Younger, HIV-negative patients (< 40 years) showed a modest correlation ($p = 0.016$, $r = -0.275$), which was stronger in middle-aged HIV-positive patients (40–60yrs; $p = 0.020$, $r = -0.397$) and most pronounced in older HIV-positive individuals (≥ 60yrs; $p = 0.003$, $r = -0.997$). These results suggest that these subgroups are particularly vulnerable to renal impairment, underscoring the need for targeted monitoring and management.

Table 1 Demographic and clinical characteristics of study participants

Variables on admission		Stratified eGFR/ML/min/1.73 m^2 subgroups				
		Q1 = [< 66.8] 56 (24.8)	**Q2 = [66.8–99.0] 60(26.5)**	**Q3 = [99.0–120] 55 (24.3)**	**Q4 = [≥ 120] 55 (24.3)**	***P* values**
Demographics	**Overall = 226**					
Age, yrs [Median(IQR)]	43.0(25.3)	53.0(28.0)	50.5(31.0)	39.0(20.0)	32.0(17.0)	**< 0.001**
Gender, n(%)						0.440
Male	103 (45.6)	28 (27.2)	22 (21.4)	26 (25.2)	27 (26.2)	
Female	123 (54.4)	28 (22.8)	38 (30.9)	29 (23.6)	28 (22.8)	
Smoking, n (%)	31 (13.7)	10 (32.3)	10 (32.3)	4 (12.9)	7 (22.6)	0.358
Alcohol, n (%)	98 (43.4)	27 (27.6)	25 (25.5)	22 (22.4)	24 (24.5)	0.835
Clinical characteristics						
Mortality, n (%)	45 (19.9)	21 (46.7)	14(31.1)	4(8.9)	6(13.3)	**< 0.001**
Hospital stays, days	4.0(5.0)	6.07 ± 6.64	4.98 ± 4.00	5.56 ± 5.65	6.42 ± 7.47	0.588
Comorbidities						
Anemia, n(%)	105(46.5)	30(28.6)	27(25.7)	26(24.8)	22(21.0)	0.546
vAlcohol use disorders, n(%)	21(9.3)	4(19.0)	3(14.3)	6(28.6)	8(38.1)	0.309
Septicemia, n(%)	40(17.7)	16(40.0)	7(17.5)	9(22.5)	8(20.0)	0.090
Hypertension, n(%)	67(29.6)	30(44.8)	23(34.3)	13(19.4)	1(1.5)	**< 0.001**
Pneumonia, n(%)	28(12.4)	5(17.9)	9(32.1)	8(28.6)	6(21.4)	0.719
DM, n(%)	52(23.0)	26(50.0)	16(30.8)	6(11.5)	4(7.7)	**< 0.001**
Malaria, n(%)	39(17.3)	7(17.9)	5(12.8)	11(28.2)	16(41.0)	**0.019**
HIV, n(%)	54(23.9)	11(20.4)	14(25.9)	15(27.8)	14(25.9)	0.805
SBP, mmHg [Median(IQR)]	123.0(31.5)	125.0(66.3)	123(43.8)	124.0(24.0)	122.0(23)	**0.016**
DSP, mmHg [Median(IQR)]	74.0(23.5)	76.0(46.8)	75.0(25.8)	74.0(14.0)	71.0(18.0)	**0.022**
Laboratories values						
Cr, mg/dl [Median(IQR)]	71.0(37.3)	144.5(316.2)	76.0(21.0)	66.0(16.0)	47(26.0)	**< 0.001**
eGFR, min/1.73 m2 [Median(IQR)]	99.0(53.3)	28.5(46.0)	87(16.5)	111.0(8.0)	131(20.0)	**< 0.001**
RBS, mmol/L [Median(IQR)]	7.0(2.0)	7.2(4.9)	7.0(3.0)	7.0(2.0)	6.7(1.0)	0.288
HG, g/dl [Median(IQR)]	11.5(5.3)	10.6(5.6)	11.4(5.4)	11.7(4.7)	12.3(5.3)	0.916
WBC, 10^9/L [Median(IQR)]	7.7(7.3)	9.0(9.9)	8.0(7.5)	7.0(7.40)	7.3(4.7)	0.104
Treatment medications						
Diuretics, n(%)	34(15.0)	16(47.1)	10(29.4)	4(11.8)	4(11.8)	**< 0.001**
Anti-HTN medic, n(%)	61(27.0)	28(45.9)	20(32.8)	11(18.0)	2(3.3)	**< 0.001**
Anti-DM medic, n(%)	52(23.0)	26(50.0)	16(30.8)	6(11.5)	4(7.7)	**< 0.001**
Blood transfusion, n(%)	48(21.2)	9(18.8)	14(29.2)	11(22.9)	14(29.2)	0.640
PPI, n(%)	103(45.6)	20(19.4)	24(23.3)	35(34.0)	24(23.3)	**0.016**
Anti-malaria, n(%)	40(17.7)	7(17.5)	6(15.0)	55(24.3)	55(24.3)	**0.035**

This table highlights the clinical and demographic characteristics of study participants stratified by eGFR, identifying statistically significant variables that should be adjusted for in subsequent analyses to better understand their impact on study outcomes. Data are presented as continuous variables that are not normally distributed, expressed as median (IQR), while non-continuous variables are represented as number (percentage)

The characteristics of the study population ($n = 226$) are based on hospitalised patient at internal medical department stratified into quartiles(Q) of eGFR

Abbreviations: *SBP* Systolic blood pressure, *DBP* Diastolic blood pressure, *HG* Hemoglobin, *WBC* White blood cells, *eGFR* Estimated glomerular filtration rate, *IQR* Interquartile range, *RBS* Random blood sugar, *HTN* Hypertension, *DM* Diabetes mellitus, *HIV* Human immunodeficiency virus, *HIV* Human acquired Virus, *Hb* Hemoglobin, *PPI* Proton pump inhibitor, *RBS* Random blood sugar. *Bold, statistically significant*

Previous investigations have largely focused on eGFR's role in stratifying mortality in populations from Europe, Asia, and the United States [26]. There was a notable lack of data on this association in low-income countries within sub-Saharan Africa, particularly Uganda. Our study addresses this gap by providing data on this association in a low-income, sub-Saharan African context, contributing valuable insights into the unique healthcare challenges faced by these populations. One key finding was the significant inverse correlation between eGFR and IHM, as demonstrated by hazard ratios(HRs) across different eGFR quartiles. Patients

Table 2 Correlation between eGFR level and risk of in-hospital mortality and duration of hospital stay

eGFR/ML/min/1.73 m2	Total (*n*) = 226	Duration of Hospital stay	inhospital mortality
	r	+0.108	−0.294
	P value	0.105	< 0.001

This table highlights the correlation between eGFR, in-hospital mortality, and length of hospital stay. Pearson Correlation (*r*): Values range from −1 to 1. Other abbreviation as in Table 1

r = 1: Perfect positive correlation

r = −1: Perfect negative correlation

r = 0: No correlation

Bold, statistically significant

in the Q1 group (eGFR < 66.8 mL/min/1.73 m^2) had the highest mortality risk, with a hazard ratio of 4.08 (95% CI: 1.284–12.954, $p = 0.037$), compared to the reference group (eGFR ≥ 120 mL/min/1.73 m^2). Similarly, participants in the Q2 group (eGFR = 66.8–99.0 mL/min/1.73 m^2) showed a significantly elevated mortality risk (HR = 4.079, 95% CI: 1.284–12.954, $p = 0.017$). This highlights the graded relationship between declining renal function and mortality, with even moderate reductions in eGFR contributing to a marked increase in risk. Notably, an increase of 48.60 mL/min/1.73 m^2 in eGFR was associated with a 54% reduction in IHM risk (HR = 0.46, 95% CI: 0.282–0.759, $p = 0.002$), highlighting the protective effect of preserved renal function. These results are consistent with previous studies that have established chronic kidney disease(CKD) as a potent independent risk factor for mortality [26–29]. Possibles explanation was that impaired renal function could possibly lead to the accumulation of uremic toxins, electrolyte imbalances, and volume overload, which contribute to cardiovascular dysfunction and increased risk of adverse outcomes during acute hospitalization [23].

The present study also analyzed the interaction between eGFR and high-risk subgroups, shedding light on how age and HIV status influence the relationship between renal function and IHM. Significant interactions between age and HIV status were observed, aligning with previous findings [30–32]. Notably, participants under 60yrs old had a higher risk of mortality compared to older participants (P for interaction = 0.046), potentially due to aggressive or rapidly progressing conditions, such as severe infections or advanced HIV [30, 33]. HIV status emerged as a key predictor of mortality, with HIV-positive individuals aged 40-60yrs and ≥ 60yrs demonstrating significantly higher mortality compared to their HIV-negative counterparts (P for interaction = 0.021). The CKD progression in HIV-positive individuals has been linked to the virus's nephrotoxic effects, opportunistic infections, and antiretroviral therapy-related nephropathy [34]. Compounded risks like chronic inflammation, immune dysfunction, and cardiovascular comorbidities further contribute to poor outcomes in hospitalized HIV-positive patients [6, 34].

Interestingly, among patients (< 40yrs), HIV-positive status was not significantly associated with IHM. Instead, it was associated with HIV-negative status, and a possible explanation for worsened kidney function in this group, possibly due to lifestyle factors such as alcohol abuse and drug use. This pattern suggests that the impact of HIV

Table 3 Association of eGFR level and risk of in-hospital mortality

eGFR/ML/min/1.73 m^2 Quartile (Q) groups	Model[a]			Model 2[b]			Model 3[c]		
	HR(95%CI)	*P* value	β	HR (95%CI)	*P* value	β	HR (95%CI)	*P* value	β
[≥ 120]	Reference = 1			Reference = 1			Reference = 1		
[99.0–120]	0.88(0.244–3.164)	0.842	−0.13	0.87(0.240–3.137)	0.830	−0.14	1.08(0.276–4.226)	0.912	+0.08
[66.8–99.0]	3.09(1.099–8.715)	**0.033**	**+1.13**	3.06(1.08–8.658)	**0.035**	**+1.12**	4.079(1.284–12.954)	**0.017**	+1.41
[< 66.8]	3.55(1.363–9.228)	**0.009**	**+1.27**	3.56(1.368–9.260)	**0.009**	**+1.27**	4.08(1.284–12.954)	**0.037**	+1.25
Per-SD elevation 0.48.60/eGFR/ML/min/1	0.496(0.363–0.679)	**< 0.001**	**−0.70**	0.52(0.376–0.727)	**< 0.001**	**−0.65**	0.46(0.282–0.759)	**0.002**	**−0.77**

This table shows that dropping eGFR level, after adjusting for covariates, was independently associated with in-hospital mortality. These findings highlight eGFR as a critical indicator of patient outcomes, emphasizing the need for early kidney function assessment in clinical decision-making. HR indicates, hazard ratio; β, Beta coefficient; CI, confidence interval

Other abbreviation as in Table 1. *Bold, statistically significant*. Per-SD elevation, implies Per standard deviation (SD) elevation refers to the increase in the variable by one standard deviation, which is used for clinical applicability

[a] Adjusted for age and gender

[b] Adjusted for age, gender, smoking, and drinking

[c] Adjusted for age, gender, smoking cigarette, drinking, SBP, DBP, creatinine, alcohol withdraw, HTN, DM, Malaria, HIV, and WBC

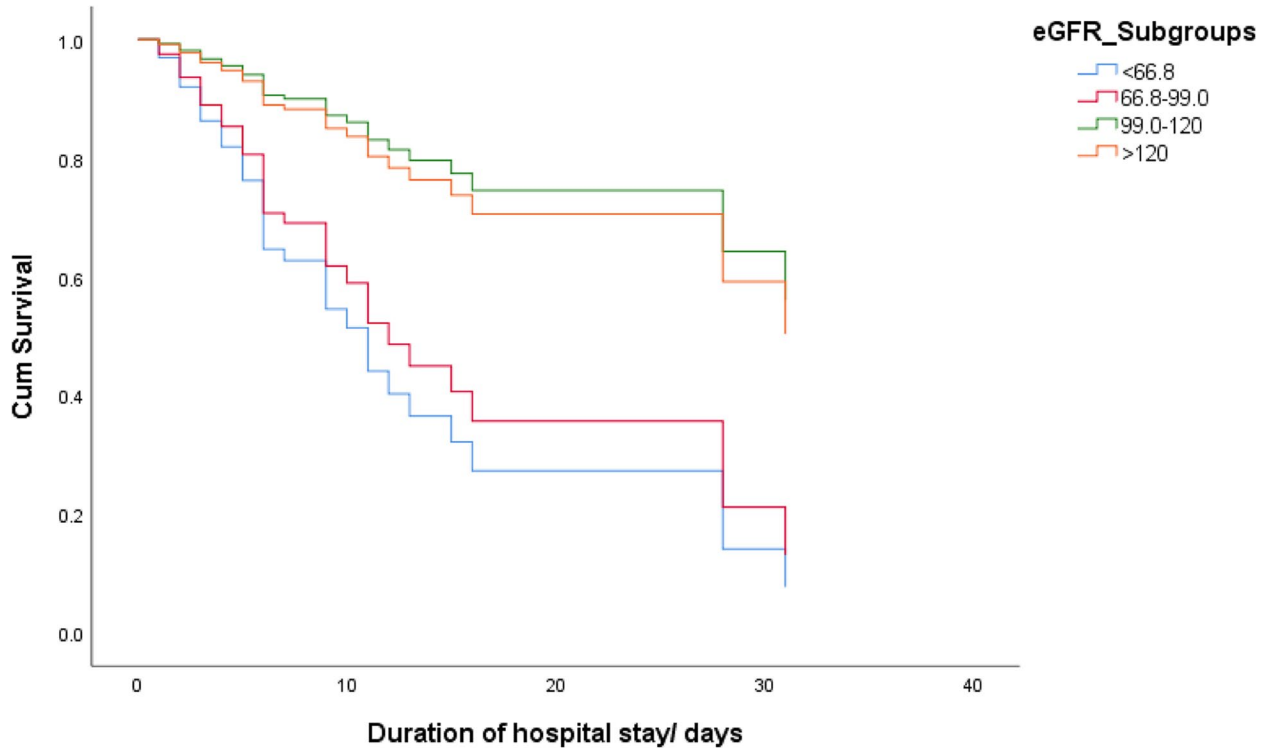

Fig. 2 Cumulative survival plots of in-hospital mortality across study subgroups stratified by eGFR: eGFR, estimated glomerular filtration rate

on IHM may be mediated through different mechanisms depending on age [30, 34].

These findings highlight the critical need for early risk stratification and proactive management of eGFR levels, particularly in resource-limited settings in sub-Saharan Africa particularly Uganda where optimal care is often challenging. Clinicians should prioritize targeted strategies for high-risk groups, including younger patients and individuals with HIV, to enhance outcomes. Recommendations include regular eGFR monitoring, early intervention for declining levels, and tailored management plans addressing both age and HIV status. Emphasizing preventive care and timely treatment adjustments is essential for improved prognosis [6, 28].

Study limitations

Despite the significant findings, this study has several limitations that must be acknowledged. The retrospective cohort design inherently carries the risk of selection bias, which could affect the internal validity of the findings and limit their applicability to broader populations beyond the specific cohort studied. Furthermore, the small sample size and the short study period reduce the statistical power and may limit the ability to detect subtle or long-term effects, potentially skewing the results. Another significant limitation is that this was a single-center study, which restricts the diversity of the sample and raises concerns about external validity. Multi-center studies with larger and more heterogeneous populations, as well as extended follow-up periods, are necessary to confirm and generalize these findings. Additionally, while eGFR is a widely used and accepted surrogate marker for renal function, it may not comprehensively reflect kidney health in certain patient groups. For instance, in patients experiencing acute kidney injury or fluctuating renal function, eGFR may fail to capture dynamic changes or nuanced aspects of renal impairment. Lastly, potential confounding variables and unmeasured factors, such as some comorbid conditions, medication use, or lifestyle factors, were not fully accounted for, which could further influence the study outcomes. Addressing these limitations in future research is essential to validate and strengthen the findings.

Conclusion

In this study, lower eGFR was significantly associated with in-hospital mortality, particularly among younger patients and those living with HIV. The association was most pronounced in HIV-negative patients younger than 40 years and HIV-positive patients aged

Table 4 Association of eGFR level and risk of in-hospital in high-risk groups

High-risk Subgroup	Number of participants	Number of events	HR(95%CI)	*β coefficient*	*P value*	*P for interaction*
Gender						0.055
Male	103	24	0.99(0.97–1.00)	−0.01	0.070	
Female	114	21	0.97(0.943–0.988)	−0.04	0.003	
Age, yrs						**0.046**
< 40	99	15	0.93(0.89–0.97)	−0.07	< 0.001	
40–60	70	17	0.98(0.966–0.999)	−0.02	0.039	
≥ 60	46	13	0.98(0.950–1.006)	−0.03	0.113	
Alcohol drinkers						0.203
Never	127	23	0.97(0.954–0.991)	−0.03	0.004	
Current or ever	98	22	0.99(0.965–9.992)	−0.02	0.041	
Cigarette smokers						0.251
Never	194	36	0.98(0.968–0.991)	−0.02	< 0.001	
Current or ever	31	9	0.99(0.994–1.015)	−0.01	0.595	
Alcohol use disorders						0.315
Yes	21	8	0.92(0.758–1.126)	−0.08	0.434	
No	204	37	0.99(0.974–0.995)	−0.02	0.006	
Hypertension						0.882
Yes	67	14	1.04(0.999–1.092)	+ 0.04	0.057	
No	158	31	0.97(0.955–0.982)	−0.03	< 0.001	
Diabetes mellitus						0.921
Yes	52	12	0.99(0.964–1.017)	−0.01	0.469	
No	173	33	0.98(0.969–0.993)	−0.02	< 0.001	
Malaria						0.175
Yes	24	7	0.92(0.112–7.589)	−0.08	0.939	
No	187	38	0.98(0.967–0.990)	−0.02	< 0.001	
HIV						**0.021**
Yes	53	19	0.94(0.905–0.974)	−0.06	< 0.001	
No	171	26	0.99(0.979–1.002)	−0.01	0.098	
Anemia						0.705
Yes	104	31	0.98(0.921–0.994)	−0.02	0.004	
No	121	14	0.98(0.946–1.017)	−0.02	0.292	
Blood transfusion						0.167
Yes	37	9	0.88(0.225–3.416)	−0.132	0.849	
No	177	36	0.98(0.967–0.991)	−0.02	< 0.001	

This table shows that eGFR, after adjusting for covariates, was associated with in-hospital mortality in subgroup analyses. Significant interactions ($P < 0.05$) between eGFR and age, as well as eGFR and HIV status, influence mortality

Fully adjusted for age(excluded in age subgroup comparison), gender(excluded in gender subgroup comparison), smoking cigarette(excluded in smoking subgroup comparison), Drinking(excluded in alcohol subgroup comparison), SBP, DBP, creatinine, alcohol withdraw(excluded in alcohol withdraw subgroup comparison), HTN(excluded in HTN subgroup comparison), DM(excluded in DM subgroup comparison), Malaria(excluded in malaria subgroup comparison), HIV(excluded in HIV subgroup comparison), and WBC

Other abbreviation as in Table 1. *Bold, statistically significant P value for interactions*

40–60 years and older than 60 years. These findings underscore the critical impact of kidney function on outcomes in hospitalized patients in low-income settings such as Uganda. Further large-scale, multicenter studies are warranted to validate the findings of this study.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12882-025-03976-w.

Supplementary Material 1.

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Authors' contributions
Julius Kabbali Kuule: Conceptualization, Data Curation, and Writing Original Draft. Wang Yanmei: Methodology, Writing, Review and Editing Doreen Mary Nanyunja: Data Curation, and Writing – Review and Editing. Makabayi Emmanuel Yeko: Writing Review and Editing. Odong Christopher: Supervision, Data analysis, Study design, Validation, Writing, Review and Editing.

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Data availability
The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study used anonymized secondary data and did not involve direct interaction with participants. Therefore, by national regulations, the Institutional Review Board (IRB) of Naguru Referral Hospital determined that informed consent was not required. The study protocol was approved by the IRB of Naguru Referral Hospital in collaboration with the Ministry of Health of Uganda and the Uganda National Council for Science and Technology (Registration No: ADM/N/353/27/11/24).

Competing interests
The authors declare no competing interests.

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