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Survival and Predictors of Mortality among Chronic Hemodialysis Patients in Burundi: A Retrospective Cohort Study

Joseph Nyandwi[1,2,3]*, Moise Manirambona[3,4], Roméo Irankunda[1,3], Elysée Baransaka[3,4]

[1]Hemodialysis Unit, Kamenge University Teaching Hospital, Bujumbura, Burundi
[2]National Institute of Public Health, Ministry of Public Health, Bujumbura, Burundi
[3]Faculty of Medicine, University of Burundi, Bujumbura, Burundi
[4]Department of Internal Medicine, Kamenge University Teaching Hospital, Bujumbura, Burundi
Email: *nyandwijo@yahoo.fr

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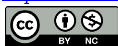
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Abstract

Introduction: End-stage renal disease (ESRD) represents a growing public health challenge in sub-Saharan Africa, with limited access to renal replacement therapy and high mortality rates. This study aimed to assess the survival of chronic hemodialysis patients in Burundi and to identify factors associated with mortality. **Methods:** We conducted a retrospective cohort study including all patients undergoing hemodialysis during the study period (n = 367). Socio-demographic, clinical, and therapeutic data were collected. Survival probabilities were estimated using the Kaplan-Meier method and compared across groups. Factors associated with mortality were identified using logistic regression and Cox proportional hazards models. **Results:** The mean age of patients was 51.46 ± 14.45 years, with a male predominance (73.57%). Hypertension (97.55%) and diabetes (51.23%) were the most common comorbidities. Only 11.44% of patients received at least three dialysis sessions per week. The median survival was 684 days. Death was the main outcome (86.55%), with infections (35.80%) and cardiovascular diseases (32.92%) as the leading causes. In multivariate analysis, fewer than three dialysis sessions per week (aOR = 2.81; p = 0.003), hypertension (aOR = 2.34; p = 0.033), and diabetes (aOR = 1.70; p = 0.027) were significantly associated with mortality. In the Cox model, diabetes was an independent predictor of death (HR = 2.21; 95% CI [1.70 - 2.87]; p < 0.001). **Conclusion:** Mortality among hemodialysis patients in Burundi remains high, with limited survival. Diabetes and inadequate dialysis frequency are major determinants of poor outcomes. Improving access to adequate dialysis and better management of comorbidities are critical to enhancing patient survival in low-resource settings.

Keywords

Hemodialysis, Survival Analysis, Chronic Kidney Disease, Mortality, Diabetes Mellitus, Burundi

1. Introduction

End-stage renal disease (ESRD) represents a major global public health issue due to its increasing prevalence, high mortality, and the substantial costs associated with its management. Over time, chronic kidney disease (CKD) has been recognized as an increasing burden on society. According to the study by Xie K. *et al.* [1], the average annual percentage change in CKD prevalence and mortality rates over the period from 1990 to 2021 was 0.92 and 2.66, respectively. A significant increase in disability-adjusted life years (DALYs) and DALY rates related to CKD has also been observed. Furthermore, age-standardized prevalence and mortality rates of CKD are projected to rise to 8773.85 and 21.26 per 100,000 individuals, respectively, by 2032. CKD leads to a substantial increase in public health expenditures, particularly in its advanced stages, which require intensive management such as dialysis or kidney transplantation. This financial burden is even more pronounced in low-resource settings [2].

In many African countries, mortality related to CKD remains high due to limited material, financial, and human resources. Renal replacement therapies (RRT) are often scarce, expensive, and concentrated in major urban centers [3] [4].

In Burundi, hemodialysis was introduced in 2014 and remains the only available RRT to date. A study conducted in 2019 among chronic hemodialysis patients between 2014 and 2017 reported a mortality rate of 77.7% [5]. Identifying factors associated with this high mortality is crucial to improving patient survival. Therefore, the aim of this study was to assess mortality and the factors influencing survival among patients undergoing chronic hemodialysis in Burundi.

2. Materials and Methods

2.1. Study Setting

The study was conducted in hospitals in Burundi with dialysis units, including Prince Regent Charles Hospital, Kamenge University Hospital, Kamenge Military Hospital, Burundi National Police Hospital, NATWE TURASHOBOYE Hospital in Karusi, Kira Hospital, and Tanganyika Hospital. These centers represent the main referral hubs for the management of chronic kidney disease nationwide.

2.2. Study Design and Period

This was a retrospective analytical cohort study with descriptive and explanatory objectives, focusing on the survival of patients undergoing chronic hemodialysis in the seven dialysis centers in Burundi from January 2020 to December 2024.

2.3. Study Population

The study population comprised all adult patients receiving chronic hemodialysis in the selected centers. Inclusion criteria were: patients with chronic kidney disease on hemodialysis for at least 30 days during the study period and having a complete medical record (paper or electronic). Patients with incomplete records for key variables were excluded.

2.4. Sampling Method

A comprehensive sampling approach was used, including all eligible patients during the study period to maximize statistical power and minimize selection bias. In total, 452 patients underwent chronic hemodialysis during the study period; 367 patients met the inclusion criteria, while 85 were excluded due to incomplete medical records.

2.5. Study Variables

2.5.1. Dependent Variable

- Patient survival, defined by vital status (Death: Yes/No)
- Survival time in months

2.5.2. Independent Variables

- Sociodemographic: age, sex
- Socioeconomic: health coverage (mutual insurance, private insurance, social assistance, self-payment)
- Clinical: comorbidities (hypertension, diabetes, HIV, hepatitis B and C, heart disease), complications (catheter-related infections, intradialytic hypotension)
- Therapeutic: number of hemodialysis sessions per week

2.6. Data Collection

Data were extracted from archived medical records and electronic databases (OpenClinic). A standardized questionnaire was used, pre-tested on 10 records to assess clarity and reproducibility, and adjusted accordingly. For each dialysis unit, a trained investigator collected data using the questionnaire.

Data were entered into Microsoft Excel 2013 and KoboCollect, then exported to Epi Info version 7.2.5.0 for statistical analysis. Quality control procedures included verification of completeness, detection of outliers, and validation of internal consistency. No missing or aberrant values were noted for the studied variables.

2.7. Statistical Analysis

Descriptive analyses were conducted to summarize demographic, clinical, therapeutic characteristics, and health coverage. Categorical variables were presented as absolute frequencies and percentages, while continuous variables were described using the mean, standard deviation, and median.

To assess factors associated with mortality, bivariate analysis was performed to

examine associations between each factor and death using odds ratios (OR) for categorical variables, with Chi-square or Fisher's exact tests as appropriate. Variables with $p < 0.20$ in the bivariate analysis were included in a multivariate logistic regression model to identify independent predictors of mortality, with adjusted odds ratios (aOR) and 95% confidence intervals (CI) reported.

For survival analysis, the Kaplan-Meier method was used to estimate overall survival probability as well as survival according to specific comorbidities (diabetes, hypertension). Differences in survival between groups were assessed using the log-rank and Wilcoxon tests.

Independent predictors of mortality were identified using a multivariate Cox regression model, with calculation of adjusted hazard ratios (aHR), 95% CI, and corresponding p-values. A p-value < 0.05 was considered statistically significant. All analyses were performed using Epi Info version 7.2.5.0.

3. Resultats

3.1. Sociodemographic Characteristics of Patients

A total of 367 patients were included in the study, with a mean age of 51.46 ± 14.45 years and a predominance of male population (73.57%). The most represented age group was 55 - 64 years (27.52%). Overall, 64.58% of patients had some form of health insurance coverage, while 35.42% had no insurance, as noted in **Table 1**.

Table 1. Sociodemographic and health insurance coverage.

Variable	N	Estimate % (95% CI)
Sociodemographic factors		
Male sex	270	73.57% (69.06 - 78.08)
<25 years	14	3.81% (1.85 - 5.77)
25 - 34 years	33	8.99% (6.06 - 11.92)
35 - 44 years	67	18.26% (14.30 - 22.22)
45 - 54 years	84	22.89% (18.60 - 27.18)
55 - 64 years	101	27.52% (22.95 - 32.09)
≥65 years	68	18.53% (14.56 - 22.50)
Health insurance coverage		
Any health coverage	237	64.58% (59.69 - 69.47)
Public health coverage (PHC)	70	19.07% (15.05 - 23.09)
PHC + supplementary insurance	70	19.07% (15.05 - 23.09)
Social assistance	83	22.26% (18.34 - 26.90)
Private insurance	14	3.81% (1.85 - 5.77)
No health insurance	130	35.42% (30.53 - 40.31)

3.2. Clinical Characteristics of Patients

Diabetes and hypertension were considered both as comorbidities and as primary

causes of ESRD. Hypertension (97.55%) and diabetes (51.23%) were the most common comorbidities (Table 2). Catheter-related infections were frequent (42.23%). Diabetes and hypertension were also the leading causes of end-stage renal disease, accounting for 51.23% and 41.96% of cases, respectively. Only 11.44% of patients received at least three hemodialysis sessions per week.

Table 2. Clinical factors and etiology of end-stage renal disease.

Variable	N	Estimate % (95% CI)
Clinical factors		
Hypertension	358	97.55% (95.97 - 99.13)
Diabetes	188	51.23% (46.12 - 56.34)
Hepatitis B	6	1.63% (0.34 - 2.92)
Hepatitis C	15	4.09% (2.07 - 6.11)
HIV	11	3.00% (1.26 - 4.74)
Cancer	10	2.72% (1.05 - 4.39)
Heart disease	55	14.99% (11.34 - 18.64)
Catheter-related infection	155	42.23% (37.17 - 47.29)
Intradialytic hypotension	41	11.17% (7.96 - 14.38)
Etiology of end-stage renal disease		
Diabetes	188	51.23% (46.12 - 56.34)
Hypertension	154	41.96% (36.92 - 47.06)
Chronic glomerulonephritis	9	2.45% (0.87 - 4.03)
Liver cirrhosis	5	1.36% (0.01 - 2.54)
Polycystic kidney disease	2	0.54% (0.01 - 1.30)
Unknown cause	12	3.27% (1.45 - 5.09)
Therapeutic factors		
≥3 hemodialysis sessions per week	42	11.44% (8.18 - 14.70)

3.3. Patients' Outcomes

Among the 367 patients included in the study, 243 deaths were recorded, yielding an overall mortality rate of 62.1%. The mean survival time was 684 ± 76 days. Data from Table 3 noted that the majority of patients discontinued hemodialysis due to death (86.55%). The leading causes of death were infections (35.80%) and cardiovascular diseases (32.92%), followed by cerebrovascular events (11.93%), while 16.80% of deaths had unknown causes.

3.4. Risk Factors for Mortality

3.4.1. Bivariate Analysis

In Table 4 of the bivariate analysis, receiving fewer than three hemodialysis ses-

sions per week (OR = 2.89; 95% CI: 1.50 - 5.55; p = 0.001), presence of comorbidity (OR = 3.57; 95% CI: 0.84 - 15.21; p = 0.047), hypertension (OR = 2.58; 95% CI: 1.31 - 5.09; p = 0.004), and diabetes (OR = 1.86; 95% CI: 1.19 - 2.91; p = 0.003) were significantly associated with mortality.

Table 3. Patient outcomes and causes of death.

Variable	N	Estimate % (95% CI)
Reasons for discontinuation of hemodialysis		
Death	238	86.55% (82.53 - 90.57)
Left the country	22	8.00% (4.79 - 11.21)
Lost to follow-up	7	2.55% (0.69 - 4.41)
Kidney transplantation	4	1.45% (0.00 - 2.86)
Financial constraints	3	1.09% (0.00 - 2.32)
Personal decision	1	0.36% (0.00 - 1.07)
Causes of death		
Infection	87	35.80% (29.19 - 41.81)
Cardiovascular	80	32.92% (27.92 - 38.82)
Cerebrovascular	29	11.93% (7.85 - 16.01)
Cancer	3	1.23% (0.00 - 2.62)
Unknown	44	18.10% (13.27 - 23.95)

Table 4. Bivariate analysis of factors associated with mortality.

Variable	Category	cOR (95% CI)	χ^2	p-value
Sex	Male	0.72 (0.43 - 1.21)	1.55	0.108
Age	≥65 years	0.83 (0.47 - 1.46)	0.42	0.259
Health coverage	Present	1.25 (0.79 - 1.97)	0.91	0.171
Hemodialysis sessions per week	<3	2.89 (1.50 - 5.55)	10.74	0.001
Comorbidity	Present	3.57 (0.84 - 15.21)	3.36	0.047
Hypertension	Yes	2.58 (1.31 - 5.09)	7.85	0.004
Diabetes	Yes	1.86 (1.19 - 2.91)	7.45	0.003
Hepatitis B	Yes	2.44 (0.28 - 21.00)	0.70	0.366
Hepatitis C	Yes	1.34 (0.42 - 4.30)	0.24	0.428
HIV infection	Yes	2.21 (0.47 - 10.40)	1.06	0.164
Heart disease	Yes	0.72 (0.40 - 1.31)	1.18	0.142
Known cancer	Yes	0.47 (0.13 - 1.66)	1.44	0.129
Catheter-related infection	Yes	0.89 (0.57 - 1.39)	0.28	0.303
Intradialytic hypotension	Yes	1.19 (0.58 - 2.42)	0.22	0.327

3.4.2. Multivariate Analysis

In multivariate logistic regression analysis (Table 5), receiving fewer than three hemodialysis sessions per week (aOR = 2.81; 95% CI: 1.43 - 5.54; p = 0.003), hypertension (aOR = 2.34; 95% CI: 1.07 - 5.11; p = 0.033), and diabetes (aOR = 1.70; 95% CI: 1.06 - 2.70; p = 0.027) were independently associated with increased odds of mortality.

Table 5. Multivariate logistic regression analysis of factors associated with mortality.

Variable	Category	aOR	95% CI	p-value
Sex	Male	0.69	0.40 - 1.20	0.186
Health coverage	Present	1.28	0.79 - 2.07	0.312
Hemodialysis sessions per week	<3	2.81	1.43 - 5.54	0.003
Comorbidity	Present	2.02	0.38 - 10.75	0.409
Hypertension	Yes	2.34	1.07 - 5.11	0.033
Diabetes	Yes	1.70	1.06 - 2.70	0.027
HIV infection	Yes	1.80	0.37 - 8.72	0.464
Heart disease	Yes	0.76	0.41 - 1.42	0.391
Known cancer	Yes	0.50	0.14 - 1.83	0.293

3.5. Survival Analysis

3.5.1. Global Survival Probability

The Kaplan-Meier survival curve of global survival (Figure 1) showed a progressive decline in survival over time, with a marked decrease between 25 and 35

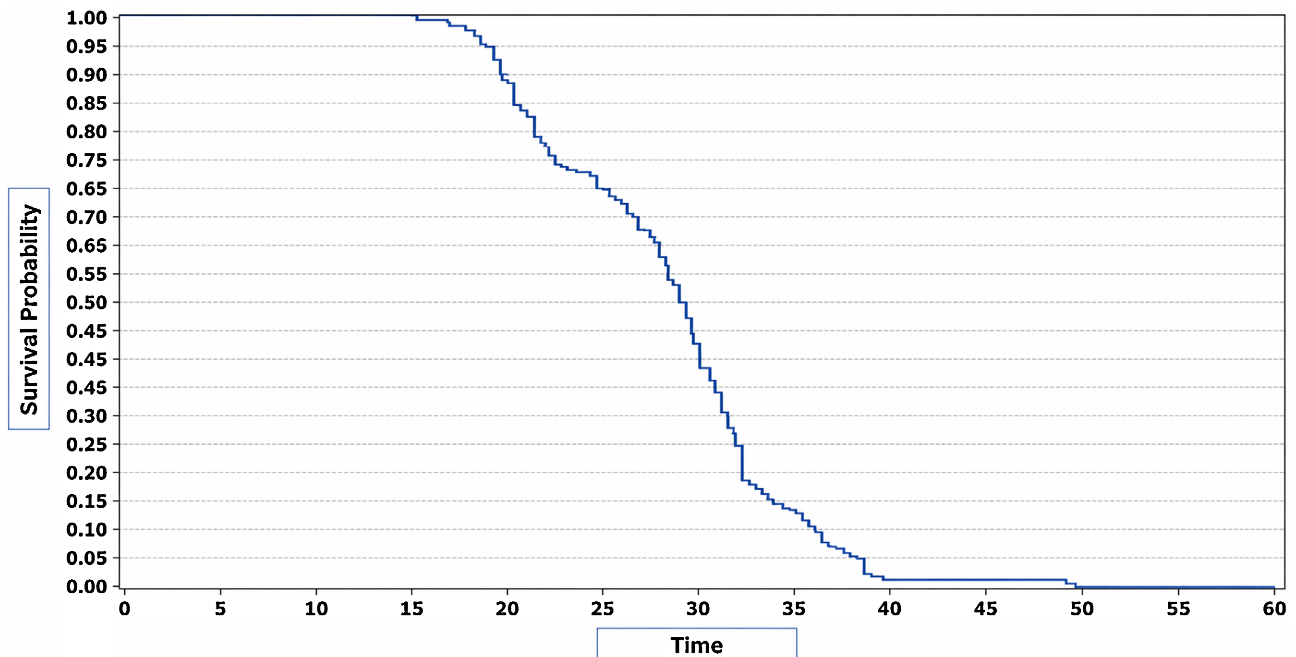

Figure 1. Kaplan-Meier global survival curve.

months. The median survival time was approximately 30 months. By 40 months of follow-up, the probability of survival had dropped below 10%, indicating a very high cumulative mortality.

3.5.2. Association between Hypertension and Survival: Kaplan-Meier Analysis

The Kaplan-Meier curves for patients with and without hypertension (**Figure 2**) were nearly superimposed, with a slight crossing around 30 months, suggesting a weak and time-varying effect. The log-rank test (p = 0.469) and the Wilcoxon test (p = 0.845) both confirm the absence of a statistically significant difference: hypertension does not appear to influence survival in our cohort.

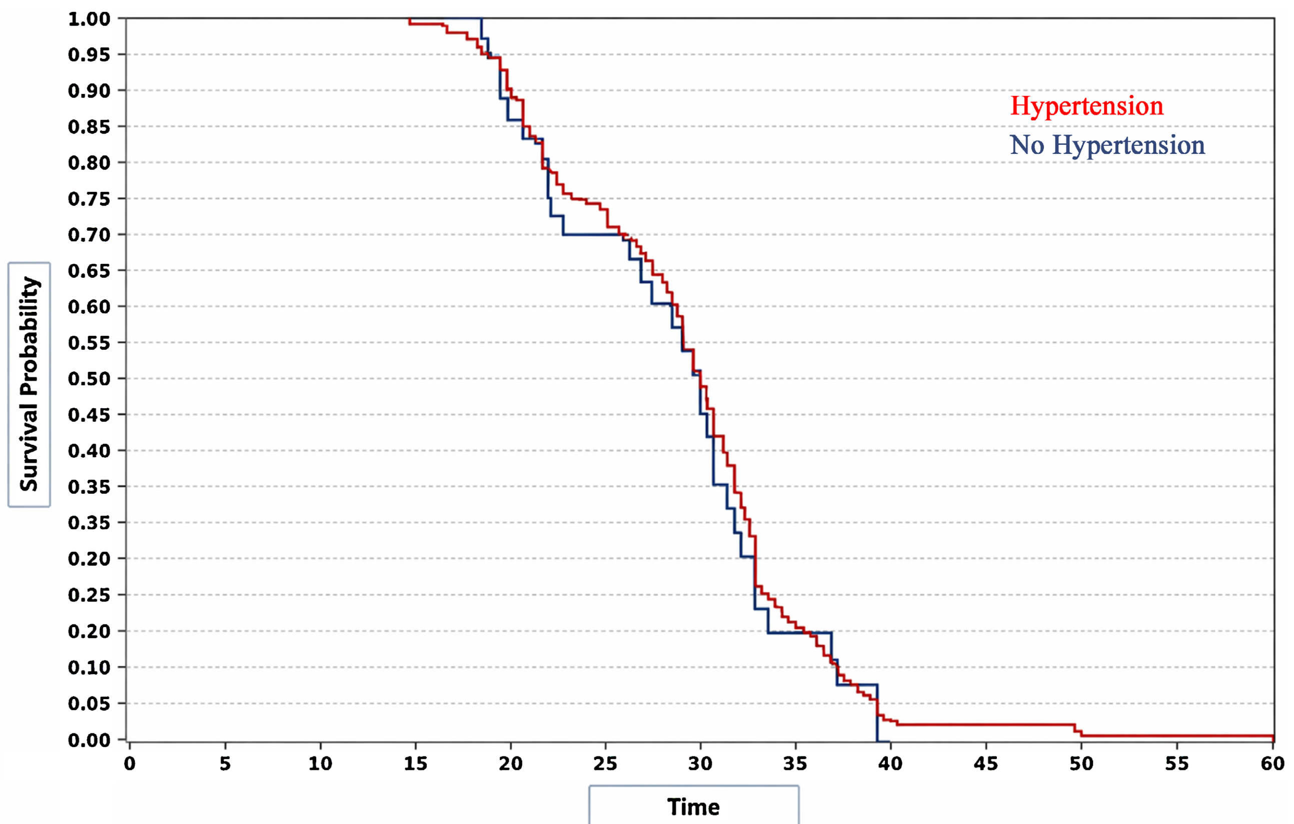

Figure 2. Kaplan-Meier survival curves stratified by hypertension status.

3.5.3. Association between Diabetes and Survival: Kaplan-Meier Analysis

According to **Figure 3**, the survival probability of diabetic patients is already significantly lower from 20 - 25 months onward, and declines earlier. For diabetic patients, the median survival is 28 months and is approximately 34 months for non-diabetic patients. Overall, diabetic patients live on average 6 to 8 months less than non-diabetic patients in our cohort.

The two curves show a clear separation between patients with and without diabetes. Diabetic patients exhibit a much steeper decline in survival probability, indicating substantially poorer survival compared to non-diabetic patients. The

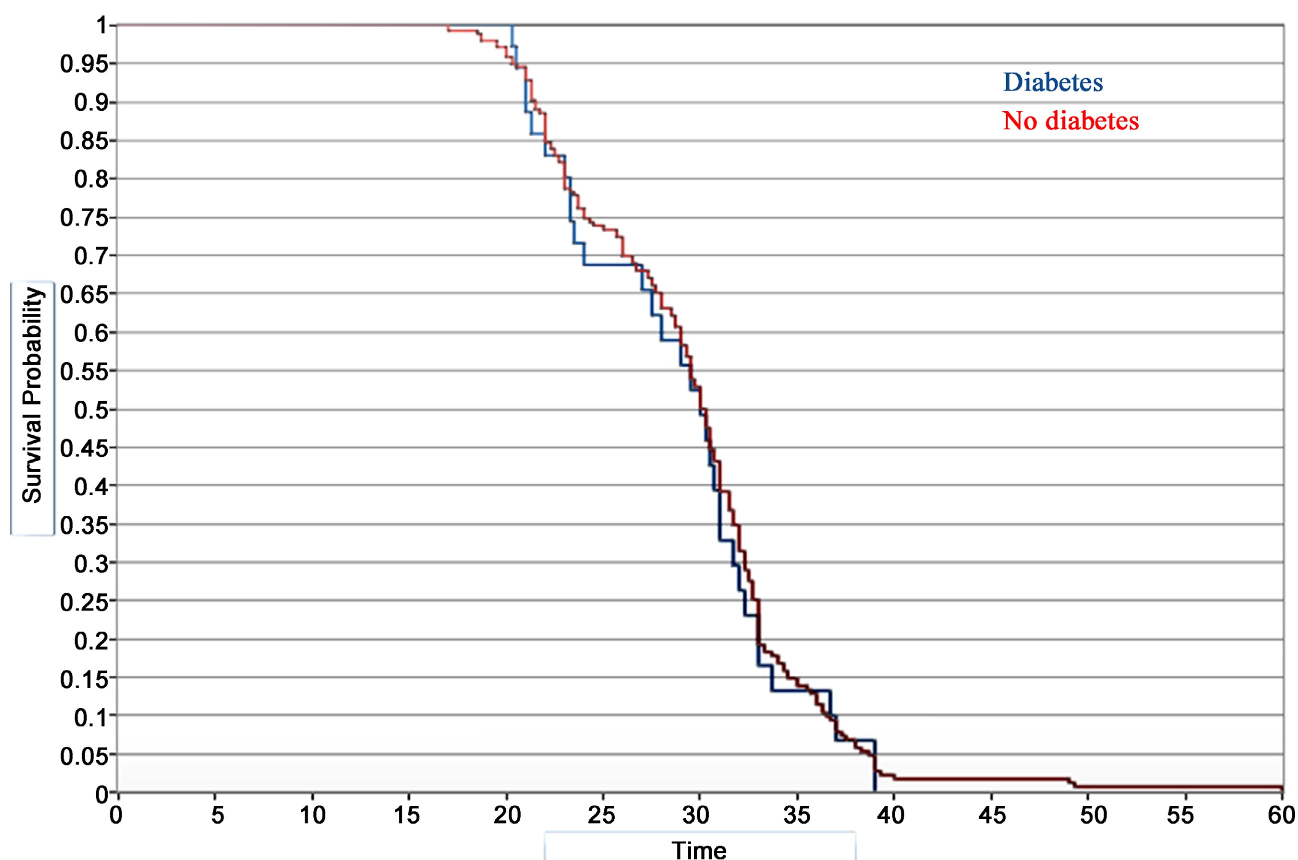

Figure 3. Kaplan-Meier survival curves stratified by diabetes status.

Log-rank test ($p < 0.001$) and Wilcoxon test ($p < 0.001$) demonstrate a highly significant difference between the two groups. Therefore, the presence of diabetes is significantly associated with an increased risk of mortality.

3.6. Factors Associated with Mortality

In Table 6, diabetes was the only independent predictor of mortality (aHR = 2.08; 95% CI: 1.60 - 2.71; $p < 0.001$). No significant associations were observed for sex, health insurance coverage, frequency of hemodialysis sessions, or hypertension. The overall model was statistically significant (Likelihood ratio test, $p < 0.001$).

Table 6. Independent predictors of mortality: A multivariate Cox regression analysis.

Factor	Category	aHR	95% CI	p-value
Sex	Male	0.9194	0.693 - 1.2190	0.559
Age	≥65 years	0.0000	0.000 - >1.0E12	0.973
Health insurance	Present	1.1110	0.849 - 1.454	0.443
Hemodialysis sessions per week	<3	0.6545	0.407 - 1.053	0.080
Diabetes	Yes	2.0837	1.599 - 2.716	<0.001
Hypertension	Yes	0.8562	0.587 - 1.249	0.420

4. Discussion

This study provides a comprehensive overview of the characteristics, outcomes, and determinants of mortality among patients undergoing chronic hemodialysis in Burundi. The findings highlight a relatively young patient population, a high burden of comorbidities, limited access to optimal dialysis, and markedly high mortality, with diabetes emerging as the most consistent predictor of poor survival.

The mean age of patients in this study (51.46 ± 14.45 years) reflects the young population of Burundi and is considerably lower than that reported in high-income countries, where the average age of patients on dialysis often exceeds 60 years [6]-[8]. This pattern is consistent with previous studies from sub-Saharan Africa and reflects the earlier onset and faster progression of chronic kidney disease (CKD), often due to delayed diagnosis and suboptimal management of risk factors such as hypertension and diabetes.

A marked male predominance (73.57%) was observed, in line with findings from other African cohorts. While biological differences may partly explain this trend, disparities in access to healthcare and financial resources likely play a major role, with men more likely to receive costly treatments such as hemodialysis [9].

Although 64.58% of patients had some form of health insurance, more than one-third remained uninsured, underscoring persistent financial barriers to care. In low- and middle-income countries (LMICs), out-of-pocket expenditure remains a major obstacle to accessing RRT and is associated with delayed initiation and reduced treatment adherence [10].

Hypertension (97.55%) and diabetes (51.23%) were the most prevalent comorbidities and the leading causes of ESRD in this cohort. These findings are consistent with global epidemiological trends, where these two conditions account for the majority of ESRD cases [11]. However, the higher prevalence of hypertension suggests poor control and late-stage presentation, which is a common issue in sub-Saharan Africa due to limited screening and treatment resources [12].

The high frequency of catheter-related bloodstream infections (42.23%) is particularly concerning. This rate is substantially higher than that observed in high-income settings, where arteriovenous fistulas are more commonly used and are associated with lower infection risk [13]. The reliance on central venous catheters in resource-limited settings has been identified as a major contributor to infection-related morbidity and mortality [14].

Only 11.44% of patients received the recommended minimum of three hemodialysis sessions per week. This reflects significant structural and financial constraints and has important clinical implications. Inadequate dialysis has been strongly associated with poor toxin clearance, fluid overload, and increased mortality [15].

The mortality rate of 62.1% observed in this study is markedly high and underscores the substantial challenges facing hemodialysis care in Burundi and, more broadly, in sub-Saharan Africa. This finding is consistent with previous studies from the region reporting poor survival outcomes, largely driven by late diagnosis,

limited resources, and restricted access to specialized care [16]. In view of the high mortality associated with chronic dialysis in sub-Saharan Africa, kidney transplantation represents a more effective long-term therapeutic option. However, only a limited number of African countries have developed sustainable transplantation programs [17] [18]. Similarly, the median survival time of approximately 30 months is shorter than the 3 - 5 years commonly reported in high-income settings [19]. Patients receiving chronic dialysis in sub-Saharan Africa generally experience poor median survival, with reports of 345 days in a multicenter survey across three hospitals in Ethiopia in 2021 [20], and 17 months in the Congo [21]. These findings highlight the substantial gap in outcomes between high-resource and low-resource environments.

Infections (35.80%) and cardiovascular diseases (32.92%) were the leading causes of death. This pattern is consistent with global data indicating that cardiovascular disease is the primary cause of death among dialysis patients, while infections remain a major contributor, particularly in LMICs [22]. The high burden of infection-related mortality in this study is likely linked to frequent catheter use and suboptimal infection control practices. The notable proportion of deaths attributed to cerebrovascular events further reflects the impact of poorly controlled cardiovascular risk factors. Meanwhile, the relatively high percentage of deaths with unknown causes suggests limitations in diagnostic capacity and medical record documentation.

The analysis of risk factors revealed that inadequate dialysis frequency, hypertension, and diabetes were significantly associated with mortality in multivariate logistic regression. The association between receiving fewer than three dialysis sessions per week and increased mortality (aOR = 2.81) is well established. According to the National Kidney Foundation KDOQI guidelines, thrice-weekly dialysis is the standard of care for adequate treatment [23]. Reduced dialysis frequency, often driven by financial constraints, has been consistently associated with worse outcomes in LMICs [10].

Hypertension was also independently associated with mortality in logistic regression. However, this association was not confirmed in survival analysis, where Kaplan-Meier curves showed no significant difference between hypertensive and non-hypertensive patients. This apparent discrepancy may reflect the complex relationship between blood pressure and mortality in dialysis populations, including the phenomenon of reverse epidemiology, where lower blood pressure may paradoxically be associated with higher mortality [24].

Diabetes emerged as a consistent and robust predictor of mortality across all analytical approaches. In logistic regression, diabetic patients had significantly higher odds of death (aOR = 1.70), while survival analysis demonstrated a clear separation of Kaplan-Meier curves, with a significantly shorter median survival (28 vs. 34 months). In the Cox proportional hazards model, diabetes remained the only independent predictor of mortality (aHR = 2.08), indicating more than a twofold increased risk of death over time.

These findings are consistent with extensive literature showing that diabetes is a major determinant of poor outcomes in ESRD patients. Diabetic patients are more prone to cardiovascular complications, infections, and accelerated disease progression, all of which contribute to increased mortality [25] [26].

This study has several limitations. First, its retrospective design may be subject to information bias and limit the ability to establish causal relationships. Second, although an exhaustive sampling approach was used, the exclusion of patients with incomplete records may have introduced selection bias. Third, some potentially important variables—such as biological parameters, dialysis adequacy measures (e.g., Kt/V), nutritional status, and medication adherence—were not available, leading to possible residual confounding. In addition, the relatively small sample size for certain subgroups may have reduced the statistical power to detect significant associations. Despite these limitations, the study provides valuable insights into the determinants of mortality among hemodialysis patients in a resource-limited context.

5. Conclusion

This study reveals a high mortality burden among chronic hemodialysis patients in Burundi, with limited survival and infections and cardiovascular diseases as leading causes of death. Diabetes emerged as the strongest independent predictor of mortality, while inadequate dialysis frequency and hypertension also contributed to poorer outcomes. These findings highlight the urgent need to improve access to adequate dialysis, strengthen the management of diabetes and hypertension, and enhance infection prevention strategies. A comprehensive approach addressing both clinical care and health system barriers is essential to improve survival in this population.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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