

Influence of Infections on the 36-Week Survival of Chronic Hemodialysis Patients at the Hemodialysis Unit of the General Hospital of Douala, Cameroon

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Abstract

Background: The absence of local data on the survival of hemodialysis patients complicates the optimization of their care in Cameroon, a country characterized by a high prevalence of chronic kidney disease (CKD). This study, conducted at the hemodialysis unit of the General Hospital of Douala (GHGD), aimed to address this gap by assessing the 36-week survival of hemodialysis patients with CKD, thus providing essential data to enhance clinical practices and inform public health decisions. **Methods:** We conducted a prospective study at GHGD over a period of 9 months, monitoring 262 hemodialysis patients. Sociodemographic data, comorbidities, the presence of infections, adherence to regular hemodialysis sessions, and the week of death were collected using a structured survey form. The Kaplan-Meier estimator and Cox regression model were used to analyze patient survival. **Results:** The mean age of the patients was 49 ± 14 years. Adherence to hemodialysis sessions ($HR = 0.19$, $p < 0.001$) was associated with improved survival, while the presence of infections at the vascular access site ($HR = 2.23$, $p = 0.05$) and diabetes ($HR = 3.31$, $p = 0.005$) increased the risk of mortality. The probability of survival was significantly lower for patients with catheter infections ($p < 0.001$), particularly when the infecting agent was *Burkholderia cepacia* ($p = 0.006$), and for those who were divorced ($p = 0.001$). **Conclusion:** Strengthening infection prevention and providing psychosocial support for patients with CKD are crucial measures to improve patient care and develop public health strategies tailored to local needs.

Keywords

Survival, CKD, Hemodialysis, Kaplan-Meier Estimator, Cox Model

1. Introduction

Chronic kidney disease (CKD) is defined as a progressive and irreversible decline in kidney function, characterized by a glomerular filtration rate (GFR) below 60 ml/min/1.73m² for at least three months, with or without signs of kidney damage (Kidney Disease: Improving Global Outcomes [KDIGO], 2012) [1]. This condition is associated with severe metabolic complications and increased mortality, particularly in advanced stages requiring renal replacement therapy such as hemodialysis [2]. Due to its slow progression and subtle symptoms in the early stages, CKD remains a major cause of morbidity and mortality globally.

Epidemiologically, CKD affects approximately 10% of the global population, equating to over 850 million people, and is the 12th leading cause of death worldwide (International Society of Nephrology, 2023) [3]. In Africa, prevalence is estimated between 10% and 20%, with high mortality attributed to limited access to dialysis and late diagnoses [4]. In Cameroon, although precise data are scarce, local studies indicate a concerning rise in CKD, particularly in urban areas such as Douala, driven by the increasing prevalence of risk factors such as hypertension and diabetes [5].

Infections play a significant role in the progression of CKD and influence the survival of hemodialysis patients. In many African countries, infectious diseases remain highly prevalent, contributing to acute and chronic kidney complications [6]. In Cameroon, infections, particularly catheter-related bloodstream infections, are a leading cause of morbidity and mortality among hemodialysis patients [7].

However, survival data for hemodialysis patients in sub-Saharan Africa, particularly in Cameroon, remain extremely limited. Most survival studies on dialysis patients originate from developed countries, where infrastructure and access to care are significantly more favorable [6]. These gaps make it challenging to accurately assess the needs of African patients and formulate recommendations to improve their care.

This study, conducted at the General Hospital of Douala, is essential for generating local data. It aims to provide valuable insights into the survival of hemodialysis patients, identify associated risk factors, and guide health policies to improve hemodialysis care in Cameroon. This work also contributes to enriching national and regional CKD databases and could serve as a guide for clinical decision-making and resource allocation in the Cameroonian context.

2. Materials and Methods

2.1. Study Design, Period, and Location

We conducted a prospective study over a period of 9 months, from January to

September 2024, in the hemodialysis department of the General Hospital of Douala. The General Hospital of Douala is one of the most important healthcare facilities in Cameroon, located in the economic capital, Douala. It plays a central role in managing various diseases, including chronic conditions such as chronic kidney disease (CKD). Built to provide high-level care, it is equipped with specialized services, including the hemodialysis department, which stands out as one of the main centers for treating patients with kidney failure in the region.

The hemodialysis department of the General Hospital of Douala has significant capacity, with many modern dialysis units, and is one of the best-equipped facilities in Cameroon to meet the growing demand for CKD management. The department accommodates, on average, a hundred new patients each semester, with infrastructure and equipment that support dialysis treatments in line with current medical standards. Among its strengths, the department benefits from qualified staff, including nephrologists, specialised dialysis nurses, and technical personnel to maintain the sophisticated dialysis equipment. Furthermore, the hospital regularly conducts training and refreshers to ensure that the staff stays up-to-date with advances in nephrology, making it a reference centre for kidney diseases in Cameroon. This expertise, combined with the available equipment, enhances the quality of care for patients with kidney failure, thus contributing to improved survival and quality of life for patients undergoing haemodialysis.

2.2. Study Population

We included in our study patients of both genders, diagnosed with chronic kidney disease, confirmed by a nephrologist, who were undergoing haemodialysis sessions at the haemodialysis department of the General Hospital of Douala. These patients provided informed and voluntary consent to participate in the study and for their personal and medical data to be used throughout the study.

2.3. Sample Size Calculation

The sample size was calculated using the Lorentz formula: $n = Z^2 \cdot p(1 - P) / E^2$ where:

n = sample size;

Z = Z score corresponding to the desired confidence level (for example, for a 95% confidence level, Z is approximately 1.96);

p = estimated prevalence of the event (for example, the proportion of patients with erectile dysfunction);

E = acceptable margin of error (for example, 0.05 for 5%).

We considered the prevalence of 13.7% found by Tchouanguep *et al.* (2020) [8] to calculate the sample size. By applying the Lorentz formula, we determined a minimum sample size of 174 patients.

2.4. Data Collection

A structured questionnaire and patient records were used for data collection,

with the questionnaire validated through an extensive literature review, expert consultations, and a pilot study involving 15 non-participating patients. The reliability of the questionnaire was confirmed with a Cronbach's alpha coefficient of 0.82. Administered in 10 - 15 minutes interviews, the questionnaire gathered sociodemographic data, comorbidities (diabetes, hypertension), vascular access infections, and weekly patient outcomes (deceased or alive). Participants were selected based on inclusion criteria—aged 18 years or older, undergoing hemodialysis at the General Hospital of Douala, and providing informed consent. Exclusion criteria included incomplete medical records, peritoneal dialysis, or previous kidney transplants. Recruitment was conducted systematically from a list of eligible patients, ensuring representation across age groups, genders, and treatment durations, to provide a comprehensive view of the hemodialysis population.

2.5. Diagnosis of Vascular Access Infections

The evaluation of vascular access infections was carried out in 5 stages:

1) Initial Clinical Assessment: Local and systemic clinical signs were considered as the first indicators of suspected vascular access infections during our study. The clinical assessment began with an examination of the vascular access site (arteriovenous fistula or catheter) to look for local infection signs, such as redness, warmth, swelling, pain, and purulent discharge at the puncture site, according to the recommendations of Maki *et al.* (2006) [9]. Systemic symptoms, such as fever, chills, and hypotension, were also noted, as they may indicate bacteremia associated with vascular access infections, according to the Infectious Diseases Society of America (IDSA, 2009) [10].

2) Diagnostic Criteria: The diagnostic criteria were based on standardised guidelines. Vascular catheter infections were suspected in the presence of a combination of local infection signs and systemic symptoms, with or without fever. For arteriovenous fistulas, we used criteria defining the presence of local signs associated with intense pain and purulent discharge at the access site, as outlined by Lok & Mokrzycki (2011) [11].

3) Microbiological Sampling and Analysis: Blood samples were collected to confirm the presence of bacteria. Two blood cultures, one drawn peripherally and another from the suspected access site, were performed following the KDOQI 2006 recommendations [12]. The presence of the same bacteria in both samples, with a higher concentration in the access site culture, confirmed the infection (Tepel *et al.*, 2013) [13].

4) Biological Markers: Laboratory tests were conducted to evaluate inflammatory markers, such as white blood cell count and C-reactive protein (CRP) (Horch *et al.*, 2015) [14]. An elevation in these markers, along with clinical signs, strengthened the suspicion of infection. In some patients, more specific tests, such as procalcitonin, were carried out to differentiate bacterial infections from non-infectious inflammatory responses (Saxena & Panhotra, 2010) [15].

5) Infection Confirmation: Infection was confirmed by isolating a specific pathogen in blood cultures or cultures from the insertion site, with or without concomitant bacteremia (Khan *et al.*, 2007) [16]. For patients with a confirmed infection, a treatment plan was established, including the removal of the catheter in some cases, and antibiotic therapy tailored to the results of the antibiogram (Jaber, 2005) [17].

2.6. Statistical Analysis

Data were entered into an Excel spreadsheet (Microsoft Office, USA) and imported into R software version 4.4.2 for Professional Windows. Categorical variables were presented as frequencies (N, n) and percentages (%). Continuous variables were presented as mean \pm standard deviation. The Shapiro-Wilk normality test was performed on continuous variables, and the non-parametric Mann-Whitney test was used to compare the mean ages between deceased and non-deceased individuals. Fisher's and Pearson's chi-square tests of independence were used to study the dependence between categorical variables. The Kaplan-Meier estimator was used to plot survival curves. The Cox model was applied to identify factors increasing the risk of mortality. For these tests, the null hypothesis (H_0) confidence interval was set at 95%, and the margin of error was set at 5% (H_0 rejected if $p < 0.05$).

3. Results

3.1. Sociodemographic Factors

The average age of patients with chronic kidney disease (CKD) in our study was 49 ± 14 years, with extreme values ranging from 17 to 78 years. The average age of deceased patients was 55 ± 14 years, while that of living patients was 49 ± 14 years. A significant difference was found between these ages ($p = 0.007$). Patients aged between 25 and 50 years were the most represented (49%), had a secondary level of education (89%), were married (63%), mostly resided in Douala (88%), worked in the informal sector (41%), and were predominantly male (60%). Mortality was found to depend on education level ($p = 0.05$) and marital status ($p = 0.01$) (Table 1).

3.2. Survival Probability Based on the Presence of Vascular Access Infections

The survival probability of haemodialysis patients who had a vascular access infection was significantly lower than that of patients without an infection ($p < 0.001$) (Figure 1).

3.3. Survival Probability Based on the Type of Infection

Patients with chronic kidney disease who had a catheter infection had a significantly lower survival probability compared to those with other types of infections, such as urinary tract infections or arteriovenous fistula infections ($p < 0.001$).

(Figure 2).

Table 1. Sociodemographic factors distributed according to patient outcomes (deceased or not).

Sociodemographics factors	Patient deaths			p-value
	Overall (N = 262)	No (N = 228)	Yes (N = 34)	
Age (years)	49 ± 14 [17 - 78]	49 ± 14 [17 - 78]	55 ± 14 [29 - 73]	0.007
Sex				0.3
Male	157 (60%)	140 (53%)	17 (6.5%)	
Female	105 (40%)	88 (34%)	17 (6.5%)	
Age groups				0.2
25 - 50 years	128 (49%)	114 (44%)	14 (5.3%)	
>50 years	123 (47%)	103 (39%)	20 (7.6%)	
17 - 25 years	11 (4.2%)	11 (4.2%)	0 (0%)	
Level of education				0.051
Secondary	233 (89%)	206 (79%)	27 (10%)	
University	18 (6.9%)	15 (5.7%)	3 (1.1%)	
Primary	11 (4.2%)	7 (2.7%)	4 (1.5%)	
Marital status				0.019
Married	148 (63%)	128 (54%)	20 (8.5%)	
Single	67 (29%)	60 (26%)	7 (3.0%)	
Widowed	18 (7.7%)	11 (4.7%)	7 (3.0%)	
Divorced	2 (0.9%)	2 (0.9%)	0 (0%)	
Residence				0.2
Douala	148 (88%)	124 (73%)	24 (14%)	
Mbanga	4 (2.4%)	4 (2.4%)	0 (0%)	
Bafoussam	3 (1.8%)	1 (0.6%)	2 (1.2%)	
Foumban	2 (1.2%)	2 (1.2%)	0 (0%)	
Nkongsamba	2 (1.2%)	2 (1.2%)	0 (0%)	
Batouri	1 (0.6%)	0 (0%)	1 (0.6%)	
Kribi	1 (0.6%)	0 (0%)	1 (0.6%)	
Kribi	1 (0.6%)	1 (0.6%)	0 (0%)	
Mbanga	1 (0.6%)	1 (0.6%)	0 (0%)	

Continued

Mbouda	1 (0.6%)	1 (0.6%)	0 (0%)
Ndobo	1 (0.6%)	1 (0.6%)	0 (0%)
Njombe	1 (0.6%)	1 (0.6%)	0 (0%)
Nkongsamba	1 (0.6%)	1 (0.6%)	0 (0%)
Souza	1 (0.6%)	1 (0.6%)	0 (0%)
YaoundÉ	1 (0.6%)	1 (0.6%)	0 (0%)
Occupations			0.5
Informal sector	88 (41%)	72 (34%)	16 (7.5%)
Liberal sector	43 (20%)	38 (18%)	5 (2.3%)
Retired	29 (14%)	22 (10%)	7 (3.3%)
Public sector	15 (7.0%)	14 (6.5%)	1 (0.5%)
Student	14 (6.5%)	14 (6.5%)	0 (0%)
Without profession	14 (6.5%)	11 (5.1%)	3 (1.4%)
Private sector	10 (4.7%)	8 (3.7%)	2 (0.9%)
No profession	1 (0.5%)	1 (0.5%)	0 (0%)

Data are presented as mean \pm standard deviation (SD), frequency (N), and percentage (%). P-value: the non-parametric Mann-Whitney test was performed to compare the mean age between deceased and surviving patients, while Pearson's chi-square test for independence was conducted to compare the proportions of various sociodemographic factors between these groups. For these tests, the confidence interval for the null hypothesis was set at 95%, with a margin of error of 5% (p significant if $p < 0.05$).

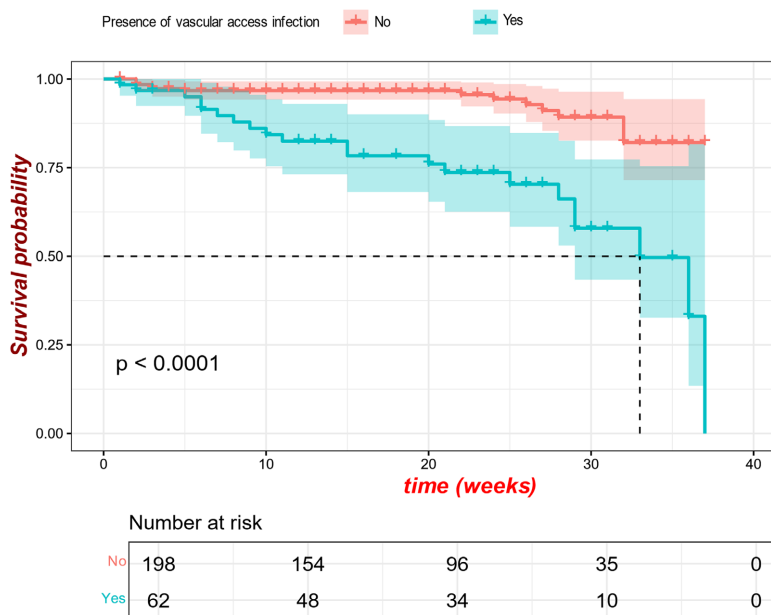


Figure 1. Kaplan-Meier survival curve illustrating the probability of survival among chronically haemodialysed patients based on the presence of vascular access infection over a 36-week period.

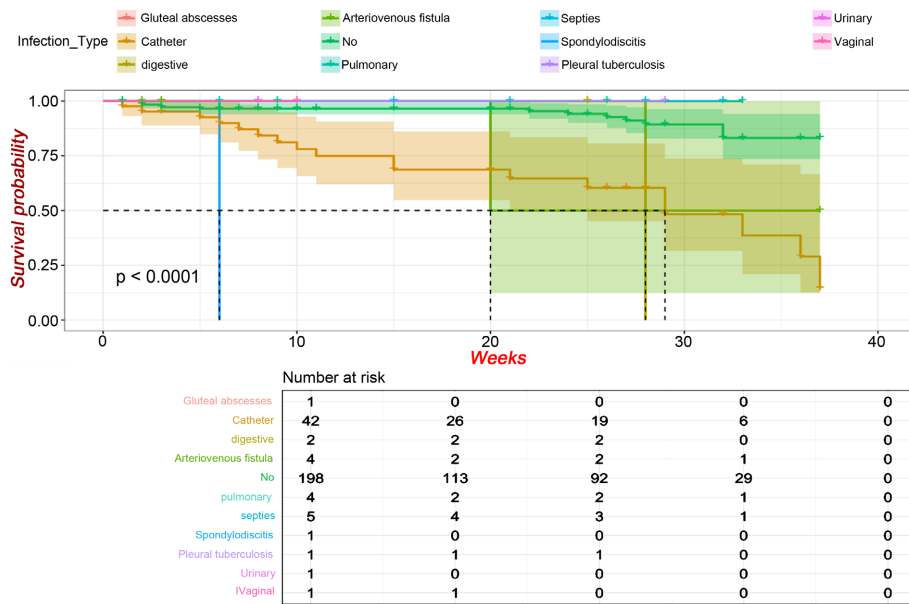


Figure 2. Kaplan-Meier survival curve illustrating the probability of survival among chronically haemodialysed patients based on the type of infection over a 36-week period.

3.4. Survival Probability Based on the Type of Infectious Agent

Patients with chronic kidney disease whose infections were caused by *B. cepacia* or whose infectious agents were unidentified had a significantly lower survival probability compared to patients whose infections were caused by other types of infectious agents ($p = 0.006$) (Figure 3).

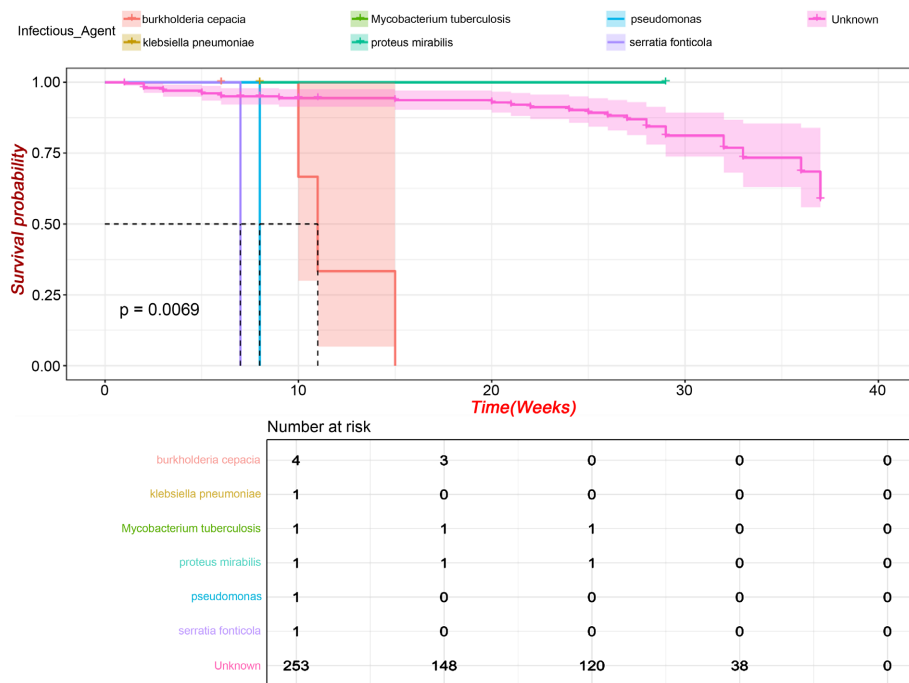


Figure 3. Kaplan-Meier survival curve illustrating the probability of survival among chronically haemodialysed patients based on the type of infectious agent over a 36-week period.

3.5. Survival Based on Adherence to Haemodialysis Sessions

Patients who did not adhere to their haemodialysis sessions had a significantly lower survival probability compared to those who adhered to their sessions ($p < 0.001$) (Figure 4).

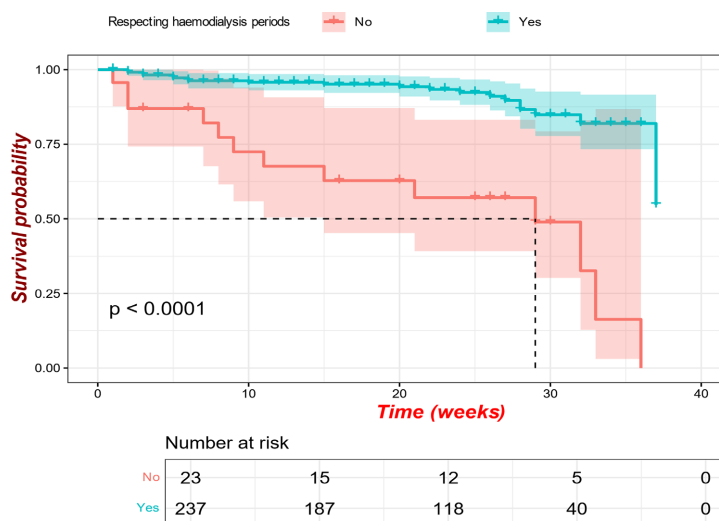


Figure 4. Kaplan-Meier survival curve illustrating the probability of survival among chronically haemodialysed patients based on adherence to haemodialysis sessions over a 36-week period.

3.6. Survival Probability of Patients with Chronic Kidney Disease and Diabetes

The survival probability of patients with chronic kidney disease and diabetes was significantly lower compared to those with chronic kidney disease but without diabetes ($p < 0.001$) (Figure 5).

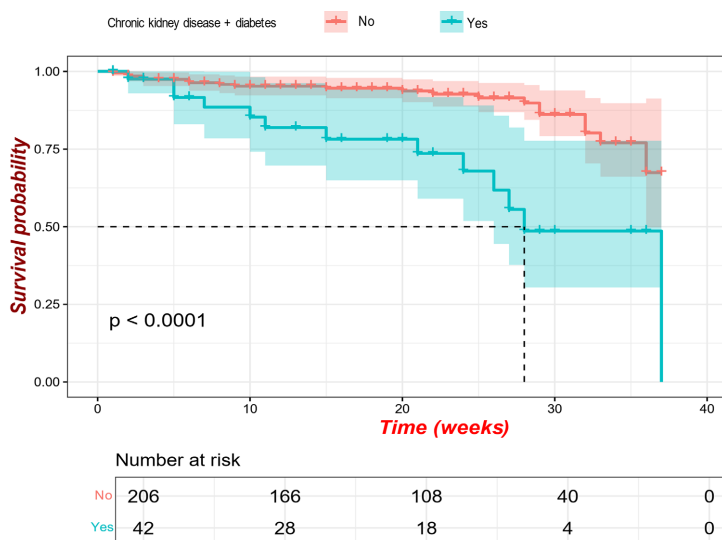


Figure 5. Kaplan-Meier survival curve illustrating the probability of survival among chronically haemodialysed diabetic patients over a 36-week period.

3.7. Survival Probability of Patients with Chronic Kidney Disease and Hypertension

No difference in survival probability was found between hypertensive CKD patients and those without hypertension ($p = 0.6$) (Figure 6).

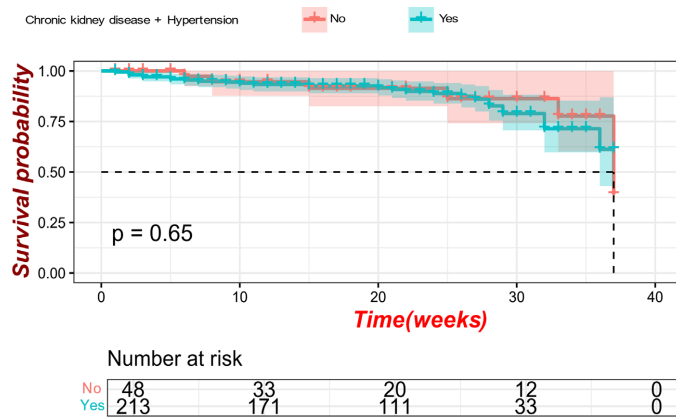


Figure 6. Kaplan-Meier survival curve illustrating the probability of survival among chronically haemodialysed hypertensive patients over a 36-week period.

3.8. Survival Probability Based on Marital Status

The survival probability of CKD patients who were widowed was significantly lower than that of those who were divorced, single, or married ($p = 0.001$) (Figure 7).

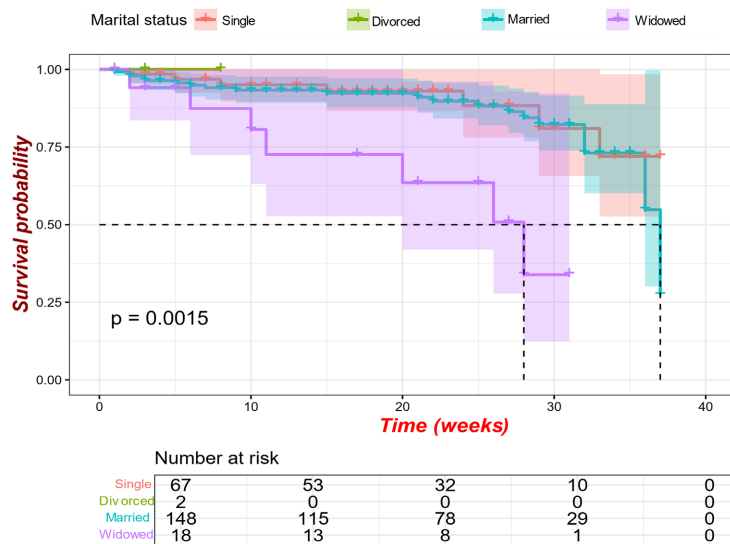


Figure 7. Kaplan-Meier survival curve illustrating the probability of survival among chronically haemodialysed patients based on marital status over a 36-week period.

3.9. Mortality Risk Estimation

Factors that increased the risk of mortality included the presence of a vascular access infection (HR = 2.23, $p = 0.05$) and the presence of diabetes (HR = 3.31, $p = 0.005$). Factors that improved survival included adherence to haemodialysis

sessions (HR = 0.19, $p < 0.001$) (Figure 8).

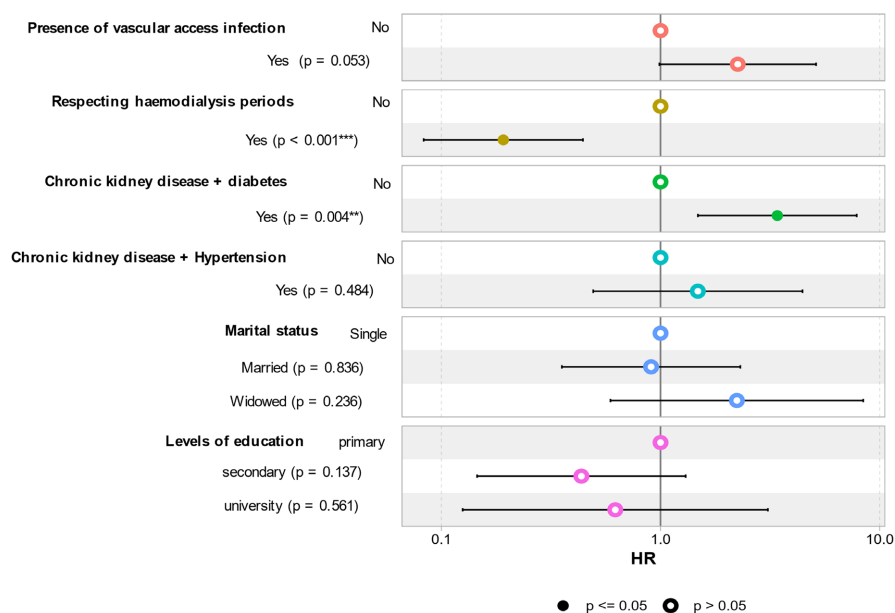


Figure 8. Cox model estimating the risk of mortality among patients with chronic kidney disease.

4. Discussion

Chronic kidney disease (CKD) represents a major public health issue in Cameroon, where the increasing prevalence of chronic diseases such as hypertension and diabetes contributes to a higher risk of kidney failure. However, local documentation regarding the survival of CKD patients on haemodialysis remains limited, hindering the optimisation of care and the implementation of targeted prevention strategies. The absence of specific follow-up data for Cameroon, particularly on survival during haemodialysis, complicates evidence-based clinical decision-making and makes it difficult to design public health programmes tailored to local realities. The Douala General Hospital, being one of the largest haemodialysis referral centres in the country, provides an ideal setting for this study. It serves a diverse range of patients from various regions of Cameroon and is equipped to deliver high-quality dialysis care. However, patients at this centre face unique challenges, including irregular access to dialysis sessions, limited resources, and high rates of comorbidities such as diabetes and infections. These factors make this centre a conducive environment for studying the factors influencing patient survival and identifying specific care needs. This study, by providing local data on the survival of patients on haemodialysis, addresses a critical need. It helps identify risk factors associated with mortality, highlights gaps in care, and guides public health decisions to improve the quality of life and survival rates for patients.

The results of our study regarding the age, education level, and marital status of CKD patients on haemodialysis contribute valuable insights to the existing

literature, particularly in the African and Cameroonian contexts, where research on the survival of haemodialysis patients remains limited.

The average age of 49 years for the entire cohort in our study, with higher mortality among older patients (mean age of deceased patients: 55 years), reflects similar trends observed in other studies. For instance, a study conducted in West Africa by Agyei-Mensah *et al.* (2019) reported that advanced age was associated with greater vulnerability to dialysis, due to often-associated comorbidities such as diabetes and hypertension [18]. Similarly, in Cameroon, Tchokonte *et al.* (2021) found that older dialysis patients had an increased risk of mortality, a finding that aligns with our results and confirms the importance of age as a risk factor for survival in haemodialysis patients [19].

Education level, significantly associated with survival in our study, shows that patients with secondary education are better able to adhere to care, likely due to a better understanding of their disease and required treatments. In a study conducted in Egypt, Ismail *et al.* (2020) also found that patients with higher education levels received better dialysis care, which improved their survival [20]. Our findings highlight the need to strengthen health education in populations with lower education levels to improve adherence to haemodialysis care.

Marital status, which was significantly associated with mortality in our study, with married patients having better survival, is in line with studies conducted in Asia and North America. A study by Lee *et al.* (2018) in South Korea showed that social support offered by marriage positively contributes to healthcare adherence and survival during haemodialysis [21]. This association may be explained by the fact that spousal support not only helps manage the stress of chronic illness but also encourages adherence to treatment.

Our study fills a gap in the literature on the survival of patients on haemodialysis in Cameroon by providing valuable sociodemographic data for improving clinical practices. It highlights the importance of age, education level, and social support in patient survival, which should inform public health strategies for these populations. Our findings suggest that paying particular attention to sociodemographic factors in managing CKD patients could improve survival outcomes in Africa and beyond.

The results of our study highlight several factors influencing survival in CKD patients on haemodialysis in Cameroon, particularly adherence to dialysis sessions, the presence of vascular access infections, and diabetes. These observations are consistent with similar studies conducted worldwide, although they present nuances specific to the Cameroonian context.

Adherence to haemodialysis sessions is associated with better survival in our cohort (HR = 0.19, $p < 0.001$), a result similar to that observed by Lacson *et al.* (2019) in the United States, where the regularity of dialysis sessions was linked to reduced mortality [22]. This link is also observed in Africa, where a study conducted in Nigeria by Okaka *et al.* (2020) showed that patient survival is strongly influenced by treatment adherence and the frequency of dialysis sessions [23].

However, economic and logistical challenges make regular dialysis sessions particularly complex in Cameroon, where the cost and availability of haemodialysis care may pose significant barriers for patients.

The presence of vascular access infections (HR = 2.23, $p = 0.05$), especially caused by *Burkholderia cepacia* ($p = 0.006$), constitutes a significant risk factor for mortality. Our results align with those reported by Nguyen *et al.* (2018) in Australia, where vascular access infections are a major risk factor for patients on dialysis [24]. The increased vulnerability to *B. cepacia* infections in Central Africa may be due to limited hygiene standards and insufficient resources for infection control, which is less of an issue in countries with more robust healthcare infrastructure.

Diabetes, identified as a risk factor for mortality in our study (HR = 3.31, $p = 0.005$), is well-documented in the literature. A study by Jha *et al.* (2020) in India demonstrated that diabetes significantly increases the risk of mortality in patients on haemodialysis [25]. However, diabetes management remains a challenge in Cameroon, where limited access to treatments and patient health education complicate the management of this comorbidity. Finally, marital status, associated with mortality in our study ($p = 0.001$), underscores the importance of social support, as also observed by Kimmel *et al.* (2019) in the United States. However, the socio-economic situation of divorced or isolated patients in Cameroon may be more precarious, which exacerbates their vulnerability.

Although these studies have made significant progress, their direct applicability to Cameroon is limited by significant cultural, economic, and healthcare differences. International studies often rely on patient cohorts with more regular care and advanced technologies that are not accessible in developing countries. In Africa, studies are often sparse and lack consistency due to the diversity of local contexts. Our study, therefore, provides a crucial contribution by providing specific sociodemographic and clinical data for Cameroon. It identifies risk factors in the unique context of Douala General Hospital, offering directly applicable information for clinicians and public health decision-makers in Cameroon. These results also highlight the need to improve dialysis infrastructure and infection prevention strategies, while considering the sociodemographic characteristics of patients to optimise their care.

5. Conclusion

The results of our study highlight key factors influencing the survival of CKD patients on haemodialysis in the Cameroonian context. We found that adherence to haemodialysis sessions was associated with better survival, while the presence of vascular access infections, particularly *Burkholderia cepacia* infections, and diabetes significantly increased the risk of mortality. Marital status also played a crucial role, with reduced survival for divorced patients. These results emphasise the importance of rigorous and personalised management of haemodialysis patients and reveal specific needs for follow-up and support based on patients' risk profiles.

6. Limitation

This study has some limitations. First, the relatively short follow-up period (36 weeks) limits our ability to observe long-term survival and identify broader mortality trends. Second, the sample was restricted to patients at Douala General Hospital, which may limit the generalisability of the results to other dialysis centres in Cameroon or other regions with different sociodemographic characteristics. Finally, some variables, such as individual hygiene practices or the patients' economic situation, were not considered, although they may influence adherence to care and infection risks.

7. Future Directions

To further and complement these results, multicentric studies at the national level would be beneficial in examining the survival of haemodialysis patients in Cameroon in varied contexts over a longer period. Furthermore, research integrating socio-economic and environmental factors would help better understand the specific barriers faced by dialysis patients, particularly regarding access to care and infection prevention. The implementation of training programmes for healthcare staff and awareness campaigns for patients on good hygiene practices could help reduce the risk of vascular access infections. Lastly, the development of psychological and social follow-up programmes for patients, particularly those without marital support, could also improve their treatment adherence and survival outcomes.

Ethical Approval and Consent to Participate

Studies involving human participants were reviewed and approved by the Institutional Ethics Committee for Human Health Research of the University of Yaoundé. Written informed consent to participate in this study was provided by the legal guardian/next of kin of the participants.

Availability of Data and Equipment

The original data supporting the conclusions of this article will be made available by the authors without undue reservation.

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The authors state that the research was conducted in the absence of any external funding.

Authors' contributions

ENLPJ designed the experimental approach and the writing plan. ENLPJ and NNE recruited the participants and carried out the laboratory analyses. ENLPJ and FH carried out the statistical analysis. ENLPJ drew all the figures. ENLPJ wrote the draft. ANLPJ, NNA and FH reviewed the manuscript. All the authors

mentioned made a substantial, direct and intellectual contribution to the work and approved it for publication.

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Conflicts of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationship that could be construed as a potential conflict of interest.

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