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Factors Associated with Mortality in Chronic Haemodialysis Patients in Semi-Rural Areas: The Experience of the Franceville Haemodialysis Centre (Gabon)

Alda Marcelle Ngoubadjambo[1,2], Martial Hervé Ekomy[3], Edmery Mpouho Ntsounga[4], Herman Begouabe[5], Joefred Mbogho Abogo[5], Cédric Sima Obiang[5,6]

[1]Centre d'Hémodialyse de Franceville, Centre Hospitalier Universitaire Amissa Bongo (CHUAB), Franceville, Gabon
[2]Département de Médecine et des Spécialités Médicales, Libreville, Gabon
[3]Département de Santé au Travail, Polyclinique du Haut-Ogooué, Franceville, Gabon
[4]Département de Santé Publique, Amissa Bongo University Hospital, Franceville, Gabon
[5]Laboratoire de Recherche en Biochimie, Université des Sciences et Techniques de Masuku, USTM, Gabon, Franceville
[6]Département de Biologie, Polyclinique du Haut-Ogooué, Franceville, Gabon
Email: naldamarcelle@yahoo.fr

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Abstract

Introduction: The mortality rate remains high among chronic haemodialysis patients. Several factors may explain this in semi-rural Gabon. This study was conducted to identify these factors at the Franceville haemodialysis centre in Gabon. **Patients and Methods:** This cross-sectional, descriptive and analytical study was conducted at the Franceville haemodialysis centre from 1 October 2021 to 30 September 2024. It involved the records of chronic haemodialysis patients who had been on dialysis for more than three months and were being treated at the Franceville haemodialysis centre. Sampling was exhaustive. Socio-professional, clinical, and biological data were collected. Statistical analysis was performed using Epi Info 7.2.6. software. Logistic regression was used to identify associated factors ($p < 5\%$). **Results:** A total of 99 chronic haemodialysis patients were included in the study, 66.67% of whom were male. The average age was 50.1 years (±12.1). The mortality rate was 39.39%. The most common comorbidities were hypertension (56.41%), diabetes (23.07%), and alcoholism (23.07%). The most common initial nephropathies were vascular (66.67%) and diabetic (25.64%). The main reasons for haemodialysis were acute pulmonary oedema (51.28%) and uraemic encephalopathy (23.07%). Multivariate analysis identified two factors associated with mortality in chronic haemodialysis patients: duration of treatment 0 - 180 days (OR 3.17 [1.33 - 3.47], $p = 0.02$) and retired (OR 3.25 [1.18 - 4.84], $p = 0.01$). **Conclusion:** Our results

reveal a high mortality rate among chronic haemodialysis patients at the Franceville haemodialysis centre. It is therefore crucial to implement strategies that raise awareness of kidney disease and its risk factors, and that facilitate screening for them.

Keywords

Franceville, Chronic Haemodialysis Patients, Mortality, Factors

1. Introduction

The estimated number of people with chronic kidney disease (CKD) worldwide is approximately 844 million [1]. The global prevalence of CKD across all age groups has increased by 29.3% over the last three decades [2]. CKD has become a major public health concern due to its impact as a direct cause of associated morbidity and mortality. It ranked as the 12th leading cause of death worldwide in 2017 [2].

In Africa, and more specifically, the prevalence of CKD is higher in the southern part of the continent compared to the north, and the most common causes are hypertension and diabetes mellitus, followed by chronic glomerulonephritis and tubulointerstitial disorders [3]. Poverty and lower socio-economic status are two risk factors that contribute to the development of CKD and accelerate the progression of kidney disease [4].

As CKD progresses, renal replacement therapy (RRT), including dialysis, is the only treatment option that enables survival. However, mortality among dialysis patients remains high compared to the general population, at approximately 54% for haemodialysis at 3 years in the United States [5], and 16.5% in France [6]. In sub-Saharan African countries, mortality rates vary from one country to another. In developing countries, mortality rates are even higher, driven by the late referral of patients to dialysis, the type of vascular access and its complications particularly infections [7] [8] as well as cardiovascular disease and anaemia [9].

In Gabon, haemodialysis is the only renal replacement therapy available. To date, there are eleven haemodialysis centres (four public and seven private), three of which are in the provinces, including the Franceville haemodialysis centre. In Gabon, and more specifically in Franceville, no data are available on mortality in haemodialysis, hence the relevance of our study, which aims to investigate the mortality rate, epidemiological aspects and factors associated with mortality among haemodialysis patients at the Franceville haemodialysis centre (Gabon).

2. Methodology

2.1. Description of the Study Site

The province of Haut Ogooué is situated in the south-eastern part of the Gabonese Republic. It is bordered to the north by the province of Ogooué Ivindo, to the east and south by the Republic of the Congo, and to the west by the province of Ogooué

Lolo. With an area of approximately 36,550 km^2, it covers 13.6% of the country's total area. Administratively, the province is currently divided into eleven departments and twelve municipalities: Franceville, which is the provincial capital, Bakoumba, Boumango, Bongoville, Léconi, Onga, Akiéni, Okondja, Ngouoni and Aboumi.

2.2. Study Design and Period

We conducted a descriptive and analytical retrospective-prospective study over a 36-month period, from 1 October 2021 to 30 September 2024. It covered all medical records of chronic haemodialysis patients at the Franceville Haemodialysis Centre.

2.3. Study Population and Sampling

The study population consisted of all chronic haemodialysis patients at the Franceville Haemodialysis Centre during the study period. Our sampling was exhaustive.

2.4. Inclusion Criteria

All records of chronic hemodialysis patients, with or without prior nephrological follow-up at the hemodialysis center, were included in the study during the study period. We will also discuss the circumstances of dialysis initiation: scheduled or emergency. All records of acute hemodialysis patients, those of non-dialysis patients with renal failure, and incomplete records were excluded from the study.

2.5. Determination of the Minimum Sample Size

The minimum sample size for the study was calculated using Cochran's formula.

$$n = \left(\left[Z^2 \times P(1-P)\right]\right) / \mathrm{m}^2$$

n: Sample size.
Z: Confidence interval ($z = 1.96$).
P: Standard deviation ($p = 0.5$).
m: Margin of error ($m = 10\%$).

$$n = \left(\left[1.96^2 \times 0.5(1-0.5)\right]\right) / 0.1^2$$

$n = 96.04$, therefore approximately 97 participants, the minimum required for the sample size.

2.6. Data Collection

Data were collected using a questionnaire containing the parameters to be studied, based on the patients' individual medical records. Data collection was carried out in two stages. Firstly, usable records were extracted from the haemodialysis centre's archives, in accordance with the study's selection criteria. Subsequently, we proceeded to collect data relating to the study variables.

2.7. Study Variables

The dependent variable is mortality among haemodialysis patients; the independent variables included sociodemographic data, medical history, lifestyle factors, clinical and paraclinical data, and dialysis and clinical progression data.

The causes of chronic kidney disease (CKD) and death were attributed based on a combination of factors including medical history, clinical presentation, and paraclinical findings. This also included cardiovascular, infectious, and metabolic complications that could lead to death.

2.8. Definition Criteria

- Chronic kidney disease was diagnosed based on medical history criteria (history of elevated serum creatinine, known systemic diseases), morphological criteria (reduced kidney size on renal ultrasound) and/or laboratory criteria (elevated serum creatinine with eGFR < 60 ml/min, normochromic normocytic non-regenerative anaemia, hypocalcaemia). CKD was classified into 5 stages according to the KDIGO (Kidney Disease Improving Global Outcomes) classification. Chronic kidney disease (CKD) has been classified into 5 stages according to the KDIGO classification (Kidney Disease Improving Global Outcomes). Stage 5, the final stage, is defined as end-stage CKD.

The MDRD (Modification of Diet in Renal Disease) equation, calibrated for racial factors, was used to estimate glomerular filtration rate (GFR) [10].

- Anaemia was defined as a haemoglobin level < 12 g/dl, and considered severe at a haemoglobin level < 8 g/dl. It was classified as regenerative when the reticulocyte count was > 120 × 10^9/l [10] [11].
- Vascular nephropathy (benign nephrosclerosis) was suspected in the presence of a history of or severe hypertension, proteinuria < 1.5 g/24 h without haematuria, and small, symmetrical kidneys on ultrasound, left ventricular hypertrophy and hypertensive retinopathy. The investigations were supplemented by renal artery Doppler.
- Diabetic nephropathy: suspected in cases of proteinuria exceeding 500 mg or albuminuria exceeding 300 mg, associated with oedema, hypertension, and diabetic retinopathy on funduscopic examination.
- Chronic glomerulonephritis (CGN) was suspected in the presence of proteinuria > 1.5 g/24 h, haematuria (intermittent), hypertension, and small, symmetrical kidneys on ultrasound. Secondary causes of CGN were investigated, specifically systemic disease (ANCA, FAN, anti-DNA antibody and complement levels), diabetes, HIV infection, hepatitis C and/or B virus, and amyloidosis [12].
- Chronic interstitial nephropathy was associated with proteinuria < 1 g/24 h and tubular functional abnormalities (leukocyturia). Hypertension is uncommon. In cases of asymmetrical kidneys, the use of analgesics or chronic pyelonephritis was investigated [11].

In the phlebotomy suite, blood samples were collected in tubes containing ethylenediaminetetraacetic acid (EDTA) for the complete blood count (CBC), and in dry tubes for serological tests. The haematology (complete blood count) was performed using a HUMACOUNT 5 D analyser. All viral serology tests were carried out using rapid diagnostic tests: Third-generation enzyme-linked immunosorbent assays (ELISAs): Murex HBsAg (ELISA, Mediff, Aubagne, France) for HBsAg, and the ImmunocombII HCV kit (Alere S.A.S., Jouy-en-Josas, France) for anti-HCV antibodies. As for anti-HIV-1 & 2 antibodies, these were detected using a highly sensitive enzyme-linked immunosorbent assay (ELISA) test kit with Murex HIV Ag/Ab Combination (EIA 1, Mediff, Aubagne, France). The confirmatory test was performed using the ImmunocombII HIV-1 & 2 Bispot test (Orgenics, Yavne, Israel). All these tests were carried out in accordance with the manufacturers' recommendations.

2.9. Data Collection and Analysis

Data analysis was carried out using EpiInfo 7.2.6 software. Descriptive results were expressed as counts and percentages for qualitative variables. Quantitative variables were expressed by calculating the mean, standard deviation and extreme values (minimum and maximum). Tables and graphs were produced using Microsoft Office Excel 2016 (Microsoft Corporation, Redmond, WA, USA). Bivariate analysis was used to identify relationships between variables. Due to the small sample sizes, Fisher's exact test was used for qualitative variables. For quantitative variables, the non-parametric Kruskal-Wallis test was used to compare distributions between groups, with a significance level set at 5% ($p = 0.05$). A logistic regression analysis was performed to investigate associations between the dependent variable and a presumed predictor variable; the odds ratio (OR) and 95% confidence interval (95% CI) were calculated.

2.10. Ethical Considerations

The respect and dignity of all study participants were upheld. The questionnaire used was anonymous, and the work described does not involve experiments on patients, subjects or animals. The study was approved by the medical committee and the General Management of the CHUAB. All principles of the Declaration of Helsinki concerning human subjects in research were respected during the data collection process. Ethical approval was obtained from the regional ethics committee of the Haut-Ogooué province (PROT N°61/2024/MSAS/DRSSEF).

3. Results

3.1. Descriptive Results

3.1.1. Socio-Professional, Clinical, and Dialytic Characteristics of the Chronic Hemodialysis Population

Of the 156 hemodialysis patients seen during the study period, chronic hemodialysis patients represented 99, or a prevalence of 63.46%. Our sample consisted of 99 hemodialysis patients. Men predominated (66.67%), with a male-

to-female ratio of 2. The mean age was 50.1 ± 12.1 years, with a range of 12 to 79 years. The majority of patients were between 30 and 65 years old. Workers were the most represented group in the sample (40.40%). More than 90% of patients had state life insurance that exempted dialysis sessions by 100% (Table 1).

Table 1. Characteristics of all chronic haemodialysis patients.

	Number of People (N)	Percent (%)
Gender		
Women	33	33.33
Men	66	66.67
Age groups		
<18 years	3	3.03
18 - 30 years	9	9.1
31 - 50 years	37	37.37
51 - 65 years	37	37.37
65 years and over	13	13.13
Employment status		
Pupils/students	7	7.07
Retired	16	16.16
Not in employment	36	36.36
Employed	40	40.40
Funding of care		
Insurance	89	89.9
Charity	5	5.05
NGO	1	1.01
Family	4	4.04
Comorbidities and lifestyle		
Hypertension	72	33.18
Diabetes	27	12.44
Heart disease	13	5.99
Stroke and haematoma	4	1.84
Alcohol	27	12.44
Tobacco	12	5.53
Obesity	9	4.15
HIV	18	8.29
Hepatitis C	11	5.07
Herbal medicine/traditional healing	20	9.21

Continued

Prostate enlargement	**4**	**1.84**
Regularity of sessions		
Yes	59	59.6
No	40	40.40
Inter-dialysis weight gain		
≥3 Kg	04	4.04
<3 Kg	95	95.96
Access routes		
Temporary catheters	154	71.96
Tunnelled catheters	16	7.48
Arteriovenous fistulas	44	20.56
Access route complications		
Infection	36	16.82
Haematoma	02	0.93
Dysfunction	44	20.56
Bleeding	06	2.80
Haemothorax	02	0.93
Thrombosis	04	1.87
Aneurysm	04	1.87
fistula abscess	02	0.93

HIV: human immunodeficiency virus, **kg**: kilogram.

3.1.2. Socio-Demographic, Clinical and Haemodialysis Characteristics of Deceased Patients

Of the 99 patients on chronic haemodialysis treated at our haemodialysis centre, 39 had died, representing a prevalence of 39.39%.

Among the deceased patients, there was a predominance of males, with 8 women and 31 men, representing a sex ratio of 3.875. The mean age of the patients was 54.46 years, ranging from 25 to 79 years. Patients aged between 51 and 65 years were the most numerous (35.9%). This study population was predominantly made up of unemployed individuals, followed by pensioners. The majority of deceased patients were from Franceville and Moanda, accounting for 38.41% and 28.21% respectively. State-funded healthcare was provided for 94.9% of our patients **(**Table 2**).**

Table 2. **Socio-demographic characteristics of deceased patients.**

Parameters	Number of People (39)	Percent (%)
Gender		
Women	08	20.5
Men	31	79.5

Continued

Nationality		
Gabonese	37	94.87
Non Gabonese	02	5.13
Age groups		
<18 years	01	2.56
18 - 30 years	05	12.82
31 - 50 years	10	25.64
51 - 65 years	14	35.9
65 years and over	09	23.07
Place of origin		
Franceville	15	38.46
Moanda	11	28.21
Libreville	02	5.13
Koulamoutou	05	12.82
Ngouoni	02	5.13
Akieni	02	5.13
Bakoumba	01	2.55
Pana	01	2.55
Employment status		
Pupils/students	03	7.69
Retired	12	30.77
Not in employment	13	33.33
Employed	11	28.21
Funding of care		
Insurance	37	94.9
Charity	01	2.55
NGO	01	2.55

The most common comorbidities in our study were high blood pressure (56.41%) and diabetes (23.07%). Lifestyle habits were dominated by alcohol consumption (23.07%), followed by smoking (12.82%). The initial cause of kidney disease was vascular in the majority of cases (66.67%), followed by diabetic (25.64%) and undetermined (15.38%) (Table 2).

Clinical and paraclinical parameters at the first dialysis session reported hypertension (38.46%) with a predominance of grade 3 (20.51%), acute pulmonary oedema (51.28%), uraemic encephalopathy (23.07%), gastrointestinal disorders (20.51%) and anuria (15.38%). Furthermore, during the first haemodialysis session, serum creatinine levels in our patients ranged from 400 µmol/L to 2807 µmol/L. In the majority of our patients (58.97%), blood urea nitrogen (BUN) was

below 50 mmol/L, with a mean of 36.47 mmol/L.

The predominant laboratory abnormalities were anaemia (94.87%) requiring transfusion (56.41%), followed by hyperkalaemia (25.64%). The mean haemoglobin level was 7.58 g/dl, with ranges from 4 to 12.70 g/dl.

The most common access route was temporary catheters (58,97%), with the most frequent complications being infections (22.86%) and catheter dysfunction (21.43%) and infectious (28.89%) (Table 3).

Table 3. Comorbidities, clinical and dialysis parameters of deceased patients.

Parameters	Number of People (N)	Percent (%)
Comorbidity and lifestyle		
Hypertension	22	56.41
Diabetes	09	23.07
Heart disease	05	12.82
Stroke and haematoma	04	10.26
Alcohol	09	23.07
Tobacco	05	12.82
Obesity	03	7.69
HIV	01	2.56
Hepatitis C	03	7.69
Herbal medicine/traditional healing	03	7.69
Prostate enlargement	03	7.69
Access methods		
Temporary catheters	23	58.97
Tunnelled catheters	05	12.82
Arteriovenous fistulas	11	28.21
Duration of dialysis in days		
0 - 180	33	84.61
>180 - 365	02	5.13
≥365	04	10.25
Inter-dialysis weight gain		
≥3 Kg	03	7.69
<3 Kg	36	92.31
Access route complications		
Infection	16	42.11
Haematoma	01	2.63
Dysfunction	16	42.11
bleeding	04	10.53
Haemothorax	01	2.63

Continued

Causes of death		
Cardiovascular	15	33.33
Infectious	13	28.89
Neoplasic	04	8.89
Neurological	03	6.67
Discontinuation of dialysis	04	8.89
Unspecified	06	13.33
Place of death		
hospital	28	71.79
home	11	28.21

3.2. Analytical Results

The search for risk factors predictive of mortality in patients on chronic haemodialysis was conducted using univariate and multivariate logistic regression.

The univariate analysis revealed that, among the socio-demographic parameters, the risk factors predictive of mortality were: female gender (OR 0.36 [0.12 - 0.99], p = 0.03), male gender (OR 2.74 [1.01 - 8.1], p= 0.03), age group ≥ 65 years (OR 4.14 [1.04 - 19.95], p= 0.03) and occupational status as retired (OR 6.09 [1.65 - 28.4], p= 0.002) (Table 4).

Table 4. Factors associated with socio-demographic characteristics: univariate analysis.

	Patients Who Died		Patients Who Did Not Die				
Parameters	**(N)**	**(%)**	**(N)**	**(%)**	**P-value**	**Odds Ratio**	**Confidence Interval (CI) 95%**
Gender							
Women	**08**	**24.24**	**25**	**75.76**	**0.03**	**0.36**	**0.12 - 0.99**
Men	**31**	**46.97**	**35**	**53.03**	**0.03**	**2.74**	**1.01 - 8.1**
Age groups							
<18 years	01	33.33	02	66.67	1	0.76	0.01 - 15.18
18 - 30 years	05	55.56	04	44.44	0.31	2.04	0.41 - 11.05
30 - 50 years	10	27.03	27	72.97	0.06	0.42	0.16 - 1.09
51 - 65 years	14	37.84	23	62.16	0.83	0.90	0.36 - 2.24
65 years and over	**09**	**69.23**	**04**	**30.77**	**0.03**	**4.14**	**1.04 - 19.95**
Employment status							
Pupils/students	03	42.86	04	57.14	1	1.16	0.16 - 7.32
Retired	**12**	**75**	**04**	**25**	**0.002**	**6.09**	**1.65 - 28.4**
Not in employment	13	36.11	23	63.88	0.67	0.80	0.31 - 2.02
Employed	11	27.5	29	72.5	0.06	0.42	0.16 - 1.07

Continued

Funding of care							
Insurance	37	41.57	52	58.43	0.31	2.82	0.52 - 28.7
Charity	01	20	04	80	0.65	0.37	0.007 - 3.95
NGO	01	100	00	0	1	ND	ND
Family	00	0	04	100	1	ND	ND

With regard to comorbidities and dialysis parameters, there is a statistically significant association between mortality in haemodialysis patients and the presence of comorbidities: stroke and cerebral haemorrhage (OR 21.3 [1.13–402], p = 0.008), HIV (OR 0.12 [0.003–0.80], p = 0.015), duration of dialysis between 0–180 days (OR 4.15 [1.43–13.9], p = 0.004), dialysis duration > 180–365 days (OR 0.2 [0.02–0.99], p = 0.04) (Table 5).

Table 5. Comorbidities and dialysis parameters: univariate analysis.

	Patients Who Died		Patients Who Did Not Die				
Parameters	**(N)**	**(%)**	**(N)**	**(%)**	**P-value**	**Odds Ratio**	**Confidence Interval (CI) 95%**
Comorbidities and lifestyle							
Hypertension	22	30.56	50	69.44	1	0.97	0.50 - 1.87
Diabetes	09	33.33	18	66.67	0.82	1.14	0.42 - 2.85
Heart disease	05	38.46	08	61.54	0.54	1.43	0.35 - 5.18
Stroke and haematoma	**04**	**100**	**0**	**0**	0.91	1.18	1.13 - 402
Alcohol	09	33.33	18	66.67	0.83	1.13	0.42 - 2.86
Tobacco	05	41.67	07	58.33	0.52	1.64	0.40 - 6.28
Obesity	03	33.33	06	66.67	1	1.12	0.18 - 5.46
HIV	**01**	**5.56**	**17**	**94.44**	**0.015**	**0.12**	**0.003 - 0.80**
Hepatitis C	03	27.27	08	72.73	1	0.83	0.14 - 3.62
Herbal medicine/traditional healing	03	15	17	85	0.13	0.37	0.07 - 1.34
Prostate enlargement	03	75	01	25	0.08	6.91	0.54 - 368.25
Regularity of sessions							
Yes	21	35.59	38	64.41	0.40	0.68	0.28 - 1.66
No	18	45	22	55	0.40	1.48	0.60 - 3.63
Inter-dialysis weight gain							
≥3 Kg	03	75	01	25	0.30	4.84	0.37 - 262
<3 Kg	36	37.89	59	62.11	0.30	0.21	0.04 - 2.68
Duration of haemodialysis (days)							
0 - 180	**33**	**49.25**	**34**	**50.75**	**0.004**	**4.15**	**1.43 - 13.9**
>180 - 365	**02**	**13.33**	**13**	**86.67**	**0.04**	**0.2**	**0.02 - 0.99**
≥365	04	23.53	13	76.47	0.18	0.42	0.09 - 1.50

Continued

Access routes							
Temporary catheters	23	14.94	131	85.06	0.051	0.49	0.22 - 1.08
Tunnelled catheters	05	31.25	11	68.75	0.18	2.18	0.55 - 7.37
Arteriovenous fistulas	11	25	33	75	0.19	1.69	0.69 - 3.94
Access route complications							
Infection	16	45.71	20	54.29	0.52	1.42	0.57 - 3.55
Haematoma	01	50	01	50	1	1.57	0.02 - 125
Dysfunction	16	36.36	28	63.64	0.68	0.82	0.33 - 1.99
Bleeding	04	66.67	02	33.33	0.20	3.33	0.45 - 38.5
Haemothorax	01	50	01	50	1	1.57	0.02 - 125
Thrombosis	01	25	03	75	1	0.51	0.009 - 6.65
Aneurysm	00	0	04	100	1	ND	ND
fistula abscess	00	0	02	100	1	ND	ND

In the multivariate analysis, the factors associated with mortality were duration 0-180 days (OR 3.17 [1.33 - 3.47], p = 0.02) and retired (OR 3.25 [1.18 - 4.84], p = 0.01) (Table 6).

Table 6. Factors associated with death: multivariate analysis.

Terms	OR Adjusted	IC 95% (inf)	IC 95% (sup)	p-value
Gender: Female	0.28	0.03	1.16	0.42
Gender: Male	1.47	0.68	6.71	0.43
Age Group: 30 - 50 years	0.32	0.22	2.33	0.84
Occupational Status: Retired	**3.25**	**1.18**	**4.84**	**0.01**
Occupational Status: Employed	0.33	0.11	2.65	0.19
HIV	0.09	0.00	0.92	0.09
Herbal Medicine/Traditional Medicine	0.28	0.17	3.45	0.63
Beneficial Prostate (BPH)	4.92	0.65	32.27	0.12
Dialysis Time: 0 - 180 days	**3.17**	**1.33**	**3.47**	**0.02**
Dialysis Time: >180 - 365 days	0.19	0.06	1.19	0.52
Dialysis Time: ≥365 days	0.25	0.18	2.45	0.67
Access Routes: Temporary Catheters	0.33	0.19	1.36	0.63
Access Routes: Tunneled Catheters	1.59	0.92	3.41	0.74
Access Routes: Arteriovenous Fistulas	1.02	0.65	2.22	0.81
Bleeding	2.55	0.73	4.02	0.62

4. Discussion

Our study assessed the factors contributing to mortality among chronic haemo-

dialysis patients at the Franceville haemodialysis centre. The results identified the causes and factors associated with mortality in chronic haemodialysis patients, as well as a high rate of morbidity and mortality.

4.1. Limitations of the Study

The sample size over a four-year period may constitute a weakness of the study. Other potential weaknesses of our work include the retrospective nature of the study with incomplete records, as well as confounding and selection biases. To limit selection bias, we calculated the minimum required sample size. To limit confounding bias, we used logistic regression. Furthermore, our results should be interpreted with caution, as the study did not include all haemodialysis patients in the country. However, this study highlights several predictors of mortality that may assist in the management of these specific patient populations.

4.2. Descriptive Statistics

4.2.1. Mortality Rate

The mortality rate observed among our haemodialysis patients was 39.39%, with the majority of deaths occurring within the first six months (84.61%). In our context, this can be explained by patients arriving for dialysis in a severely compromised and multi-systemic state, delayed management due to late presentation for consultation, and the fact that dialysis is most often initiated in an emergency setting. Not to mention poor or non-adherence to dialysis.

Our mortality rate among haemodialysis patients is lower than the 80% reported by Tokpanoude Coovi *et al.* in Benin [13], the 95% reported by Cakanya *et al.* in 2017 in Burundi [14], and the 66.10% reported by Vigan *et al.* in 2019 in Cotonou [15]. This rate is significantly higher than the 23% reported by Coulibaly *et al.* in Mali in 2020 [16].

Regardless of the region, mortality remains high. This high mortality rate is due to the lack of state subsidies, the low monthly income of these patients and consequently their difficulty in affording haemodialysis as well as non-adherence to treatment. We also face difficulties in accessing these dialysis centres, which poses a problem.

In Gabon, specifically in Franceville, haemodialysis sessions are 100% subsidised for patients with insurance. Despite this state subsidy, treatment is delayed and sessions are carried out on an emergency basis due to late consultation, refusal of treatment or poor adherence to treatment.

The most common causes of death were cardiovascular (33.33%) and infectious (28.89%).

In our study, the causes of death were similar to those found in the study by Coulibaly *et al.* Mortality was due to vascular causes (41.7%) and infectious causes (33.3%) (Coulibaly *et al.*, 2020) [16]. The predominance of deaths from cardiovascular disease has been reported in Africa [17]-[19] and in the West [20] [21].

These results demonstrate that despite the challenging conditions of dialysis

due to cost, late transfers, and poor adherence, end-stage renal disease remains a significant cardiovascular risk factor, even in our setting.

4.2.2. Socio-Demographic and Economic Characteristics of Patients

Among the patients who died, a predominance of males was noted (sex ratio = 3.875). The Gabonese population has a slight male predominance, with a sex ratio of 103.7 men to 100 women (Makanisi and Encyclopédie Universalis). This male predominance could also be explained by their habits and lifestyle in our context (alcohol, tobacco, herbal medicine, low levels of physical activity), which are cardiovascular risk factors.

This finding has already been reported by the 2015 STEP survey and Mehier *et al.* 2017 [22].

Our male predominance has been noted by several authors; Vigan *et al.* [15] reported a proportion of 61.5% and Ferreira *et al.* [23] a male predominance of 52.7%. The same male predominance was also reported by Weu TIA *et al.* [24].

The mean age of patients was 54.46 years, with a range of 25 to 79 years. Patients aged between 51 and 65 years were the most numerous, accounting for 30.8%, followed by the 30 - 50 age group (25.64%). This constitutes the working-age population, the human resource contributing to the country's development. Life expectancy in Gabon is 65.9 years for women and 68.4 years for men (ONU; PNUD).

Our mean age is similar to that reported by Jardine *et al.* [25] in South Africa in 2020, with a mean age of 52.5 years. In contrast, Ferreira *et al.* [23] in Brazil in 2020 found a higher mean age of 64.0 ± 15.2 years. A lower average age (46.9 ± 13.1) was reported by Ebana *et al.* [26] in 2021, and by Vigan *et al.* [15] in 2019 in Cotonou (42.50 ± 18.60).

This study population was predominantly made up of unemployed individuals (33.33%), followed by pensioners (30.77%). This brings us back to the financial issue that leads to delays in seeking medical advice and receiving treatment.

The majority of deceased patients were from Franceville and Moanda (42 km from Franceville), accounting for 38.41% and 28.21% respectively; these are the provincial capital and the economic hub of Haut-Ogooué province.

Over 90% of our patients (94.9%) received state-funded care.

Full state-funded haemodialysis is a key factor in reducing mortality. Efforts must therefore focus on the prevention and control of non-communicable diseases (NCDs) in Gabon.

4.2.3. Patients' Lifestyles and Comorbidities

Lifestyles were dominated by alcohol consumption (23.07%) and tobacco use (12.8%). Ahoui *et al.* (Ahoui *et al.*, 2021) [27] had reported the same predominant lifestyle patterns (herbal remedies: 52.46%, alcohol: 59.02% and tobacco: 18.03%).

The patients presented with comorbidities, the most common being hypertension (56.41%) and diabetes (23.07%). The literature has reported the same findings. Ahoui *et al.* (Ahoui *et al.*, 2021) [27] reported the same history (hypertension: 68.85%, diabetes: 26.23%). Ranivoharisoa *et al.* (Éliane Mikkelsen & Ranivo-

harisoa, 2022) [28] reported that among subjects with chronic kidney disease, hypertension and diabetes were found in 41.3% and 17.2% of cases, respectively. Amekoudi *et al.* (E.Y. Amekoudi *et al.*, 2016) [29] also reported that hypertension, present in 63.5% of patients, was the main pre-existing condition.

4.2.4. Clinical and Paraclinical Characteristics of Patients

As CKD is a condition with delayed functional manifestations, patients generally sought consultation following the appearance of a worrying warning sign. This is the reason for the late consultation. The clinical pathway for the condition is characterised by consultations with traditional practitioners, paramedical staff and GPs before referral to a specialist; this is responsible for the often delayed diagnosis.

All patients had hyperuricaemia. The other major laboratory abnormalities were anaemia (94.87%). Keita *et al.* (Kéita *et al.*, 2014) [30] reported that all patients with chronic kidney disease (CKD) had anaemia. Kyelem *et al.* (Kyelem *et al.*, 2020) [31] found anaemia in 88.4% of patients. Diallo *et al.* (Coulibaly *et al.*, 2020) [16] in Mali in 2020 found a similarly high prevalence of 63.3% of anaemia among haemodialysis patients.

4.2.5. Characteristics Related to Dialysis Aspects

Most haemodialysis patients adhered to their treatment (53.85%), with 92.31% gaining less than 3 kg between dialysis sessions. This could be explained by the fact that the majority of patients came from accessible areas (Franceville and Moanda) and by the fact that treatment was covered by the state, which provided 100% exemption from the cost of haemodialysis sessions.

4.3. Analytical Variables

4.3.1. Socio-Demographic Variables

The univariate analysis shows that, for socio-demographic parameters, the risk factors predictive of mortality were: female gender (OR 0.36 [0.12 - 0.99], p = 0.03), male gender (OR 2.74 [1.01 - 8.1], p= 0.03), age group ≥ 65 years (OR 4.14 [1.04 - 19.95], p= 0.03) and occupational status as retired (OR 6.09 [1.65 - 28.4], p = 0.002).

In the multivariate analysis, the factor associated with mortality were occupational status as retired (OR 3.25 [1.18 - 4.84], p = 0.01).

Male gender is a predictor of mortality with a deleterious effect, as the odds ratio is greater than 1. This deleterious factor could be explained by the fact that male subjects are more exposed to risk factors for NCDs. Chronic kidney disease predominantly affects men. This high proportion could be due to men's exposure to cardiovascular risk factors (alcohol, tobacco, etc.), as reported by the 2015 STEP survey. Some researchers have also suggested that kidney function declines more rapidly in men because they accumulate more traditional risk factors and lead a riskier lifestyle (Mehier *et al.*, 2017) [22].

Female gender is also a risk factor, but one that appears to be protective, as the

odds ratio is less than 1. This could be explained by the fact that women experience a slower progression of kidney disease [32]. Mehier *et al.* [22] explain that sex hormone receptors (estrogens and androgens) present in arterioles, as well as in glomerular and tubular cells, may exert a protective effect on renal cells and hemodynamics, while testosterone and androgens are often associated with accelerated kidney damage. The renin-angiotensin system (which regulates blood pressure) influences renal hemodynamics differently in men, more readily promoting glomerular hypertension. Estrogens are therefore generally considered nephroprotective, and androgens potentially nephrotoxic.

However, this area has so far been little studied in humans, and most of the data comes from animal studies.

Series involving a large number of patients have demonstrated through univariate or multivariate analysis [33] [34] that the risk of death increases with age.

Age, a risk factor for mortality in dialysis patients, can be explained by several factors. Older patients experience functional decline in various organ systems, notably the heart, lungs, liver and immune system. Furthermore, older patients often suffer from multiple chronic conditions, such as cardiovascular disease, diabetes and hypertension. These comorbidities not only complicate dialysis treatment but also accelerate damage to other organ systems. The weakened immune system in elderly patients makes them more susceptible to infections, complications and causes of death that are common among dialysis patients.

4.3.2. Comorbidities and Lifestyle

With regard to comorbidities and dialysis parameters, there is a statistically significant relationship between mortality in haemodialysis patients and the presence of comorbidities: stroke (OR 21.3 [1.13 - 402], p = 0.008), HIV (OR 0.12 [0.003 - 0.80], p = 0.015),

Strokes are a major public health issue. As a common condition, the morbidity and mortality associated with strokes are high, and this is even more pronounced in patients on chronic haemodialysis.

Strokes, the second leading cause of death worldwide and the leading cause of disability in adults, represent a public health problem [35] [36]. In developed countries, they are the third leading cause of death and the leading cause of morbidity [37]. In contrast, in developing countries, cardiovascular morbidity and mortality are characterised by a significant increase in cases, with two-thirds of deaths linked to stroke [35] [36] [38].

Shao-Bin Yu *et al.* demonstrated that cardiovascular and cerebrovascular diseases accounted for 55% of all deaths among patients [39].

With regard to HIV, renal failure, primarily represented by chronic kidney disease and end-stage renal disease, is a risk factor for death in patients with HIV/AIDS [40] [41].

Survival rates among patients on haemodialysis are lower than those observed in the general population [42].

But here, HIV has a protective effect. There is no documented protective effect of

the virus itself on the renal system. However, the use of antiretroviral therapy (ART) is generally protective and could explain this protective effect. By controlling viral replication, these treatments prevent serious damage such as HIV-associated nephropathy. And our patients whose HIV status had just been discovered, or who were already known but non-adherent, were systematically started on antiretroviral therapy and monitored regularly, thus reducing mortality related to this disease.

There is also a significant association between the duration of haemodialysis and mortality: dialysis duration of 0 - 180 days (OR 4.15 [1.43 - 13.9], p = 0.004), dialysis duration > 180–365 days (OR 0.2 [0.02 - 0.99], p = 0.04).

In multivariate analysis, we also found the duration 0-180 days (OR 3.17 [1.33 - 3.47], p = 0.02) to be a factor in mortality.

Numerous previous studies evaluating early mortality in incident dialysis patients have reported high mortality within the first 90 days after the start of dialysis [13] [43] [44].

Our data are also consistent with findings from sub-Saharan Africa, where mortality on haemodialysis is estimated at 57%, with a mortality rate of 79% among incident patients [45]. Access to dialysis is a major problem in renal replacement therapy in sub-Saharan Africa. Indeed, 48% of patients with end-stage CKD do not have access to dialysis, and more than 50% of patients who start dialysis discontinue it within 3 months [45].

However, using the US cohort from the Dialysis Outcomes and Practice Patterns Study (DOPPS), Bradbury *et al.* showed that the high rate of early mortality appeared to persist throughout the first 120 days following the start of HD, with mortality rates declining thereafter [46]. Data from large national and regional renal registries suggested that the period of high mortality rates continued beyond the first 90 days [47]-[49], and that the extent and duration of the increase were more pronounced in older patients [47] [48].

This significant mortality rate during the first few months could be explained by certain determinants such as: patient characteristics and general health, medical care prior to the start of dialysis, as well as the patient's attitude towards accepting dialysis; dialysis-related care and adherence to it; and discontinuation of dialysis.

5. Conclusions

Our mortality study, using univariate and multivariate analyses, revealed several detrimental associated factors, namely: male gender, advanced age, retirement status, and the presence of comorbidities such as stroke. However, it also identified some protective factors: female gender, duration > 365 days, use of herbal medicine, and HIV.

These results are a consequence of limited and inequitable access, the heavy burden of comorbidities, the rapid progression of kidney disease, and delays in consultation and treatment, all of which constitute significant barriers to renal replacement therapy in our setting. Even when patients have access to dialysis, they often drop out and are unable to continue treatment long-term. Patients are

frequently lost to follow-up at each stage of the healthcare system, either because they lack access to care, because they cannot continue treatment due to financial difficulties, or because they prefer herbal medicine.

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Author Contributions

All authors contributed to the preparation of the manuscript. They have read and approved the final version.

Conflicts of Interest

The authors declare no conflicts of interest.

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