

Analysis of the Lipid Profile and Prevalence of Cardiovascular Risk Factors in Hemodialysis Patients from an Academic Health Institution in Belo Horizonte

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Abstract

Background: There is a lack of epidemiological data regarding the cardiovascular risk profile of patients with chronic kidney disease (CKD) undergoing hemodialysis in the Brazilian state of Minas Gerais.

Objective: To analyze the lipid profile and assess the prevalence of traditional cardiovascular risk factors among patients with CKD on hemodialysis treated at an academic healthcare institution in Belo Horizonte, Minas Gerais, Brazil.

Methods: This was a cross-sectional, observational, and non-interventional study. The researchers obtained clinical, laboratory, and demographic data from medical records and conducted structured individual interviews with all participants. The chi-square test of independence, Fisher's exact test, and the Wilcoxon rank-sum test were applied. A significance level of 0.05 was adopted to establish the statistical validity of comparisons.

Results: A total of 66 patients were included, representing 91.6% of all individuals undergoing hemodialysis at the study center. The mean age was 56 years. Among participants, 59% were male, and 89% self-identified as mixed race. A high prevalence of traditional cardiovascular risk factors was observed, including hypertension (95%), physical inactivity (69%), dyslipidemia (55%), diabetes mellitus (27%), current smoker (19%), and obesity (15%). The lipid profile analysis showed a median total cholesterol level of 170.9 mg/dL (interquartile range: 142.05 to 195.78 mg/dL) and Low-Density Lipoprotein (LDL-cholesterol) of 98.55 mg/dL (interquartile range: 77.80 to 121.98 mg/dL).

Conclusion: This study demonstrated a high burden of cardiovascular risk factors among hemodialysis patients, with systemic arterial hypertension, dyslipidemia, physical inactivity, and diabetes mellitus being the most prevalent conditions. Furthermore, the lipid profile findings suggest suboptimal control of this lipid fraction in the studied population.

Keywords: Chronic Renal Insufficiency; Renal Dialysis; Heart Disease Risk Factors; Lipids.

Introduction

Chronic kidney disease (CKD) is a progressive condition characterized by irreversible nephron loss, defined as a glomerular filtration rate < 60 mL/min/1.73 m² for ≥ 3 months.^{1,2} Its pathophysiology involves endothelial dysfunction, activation of the renin–angiotensin–aldosterone system, chronic inflammation, interstitial fibrosis, and tubular dysfunction, predisposing patients to hypertension, dyslipidemia, anemia, electrolyte disturbances, and mineral and bone disorders.^{3–5}

In 2017, the Global Burden of Disease study estimated that more than 840 million people worldwide were affected,⁶

with projections indicating that CKD will become the fifth leading cause of years of life lost by 2040.⁷ In Brazil, over 10 million individuals are affected, with approximately 150,000 undergoing dialysis.⁸

From the early stages of CKD, cardiovascular diseases are highly prevalent, affecting up to 44% of patients on hemodialysis.^{1,9} These conditions manifest as coronary artery disease, heart failure, arrhythmias, and sudden cardiac death.² This association is clinically relevant for cardiovascular risk stratification, as traditional risk factors such as obesity, dyslipidemia, diabetes mellitus, smoking, and hypertension are highly prevalent in patients with CKD and vary according to the degree of renal impairment.¹⁰ The high prevalence of these risk factors among patients on hemodialysis has been consistently reported in studies conducted in different countries,^{11–14} as well as in the CORDIAL study, carried out in hemodialysis patients from a capital city in the South Region of Brazil.¹

Dyslipidemia is a common complication of CKD, resulting from alterations in lipoprotein metabolism, associated with a progressive decline in glomerular filtration rate.¹⁵ Patients on hemodialysis typically present with normal total cholesterol levels but elevated triglycerides and reduced high-density

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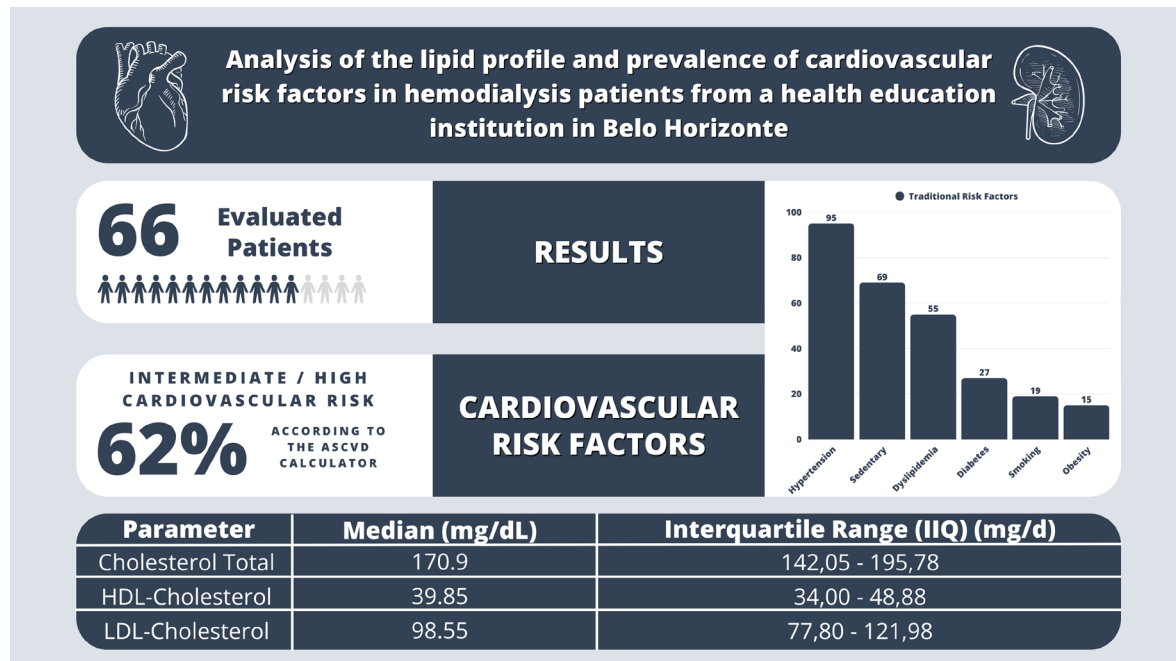
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Central Illustration: Analysis of the Lipid Profile and Prevalence of Cardiovascular Risk Factors in Hemodialysis Patients from an Academic Health Institution in Belo Horizonte



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The Central Illustration summarizes the lipid profile and prevalence of traditional cardiovascular risk factors in hemodialysis patients. Among 66 patients evaluated, 62% were classified as having intermediate to high cardiovascular risk according to the ASCVD calculator. The most frequent risk factors included hypertension, physical inactivity, dyslipidemia, diabetes mellitus, smoking, and obesity. HDL: high-density lipoprotein; LDL: Low-Density Lipoprotein; ASCVD: Atherosclerotic Cardiovascular Disease Calculator.

lipoprotein (HDL) concentrations. Hypertriglyceridemia in this population is influenced by increased concentrations of triglyceride-rich lipoproteins (very low-density lipoprotein, chylomicrons, and remnants), due to reduced hepatic and peripheral lipase activity.¹⁶

A gap remains in epidemiological data addressing the evaluation of lipid profiles and cardiovascular risk stratification in patients treated within an academic health institution in Belo Horizonte, Minas Gerais, Brazil. Therefore, this study aimed to analyze the prevalence of cardiovascular risk factors, assess lipid profiles, and calculate cardiovascular risk among patients receiving care at this teaching institution.

Methods

This was a cross-sectional, observational, and non-interventional study conducted at a medium-sized teaching hospital located in Belo Horizonte, Minas Gerais, Brazil, maintained by the Fundação Educacional Lucas Machado (FELUMA). The institution provides multidisciplinary outpatient and inpatient care, primarily serves patients from the Brazilian Unified Health System (SUS), and functions as a training and research center for undergraduate and residency

programs in health sciences. It also performs kidney transplant procedures and provides hemodialysis services. Data collection was performed using two questionnaires (Annex 1 and Annex 2), administered to patients receiving care at the institution's healthcare services, in addition to reviewing their medical records. Before questionnaire administration, written informed consent was obtained from all participants, as well as authorization of technical and clinical rights from the institution. Multiple visits were carried out to the healthcare center for patient interviews and chart reviews.

This study was approved by the Research Ethics Committee (CEP) of the Faculdade de Ciências Médicas de Minas Gerais, under protocol CAAE: 81556924.0.0000.5134; approval number: 6.990.417, dated August 7, 2024.

Data were collected from February to April 2025. Patient interviews were conducted by the researchers immediately after completion of the questionnaire (Annex B), and additional data were obtained through medical record review (Annex A and Appendix 1). To assess the prevalence of cardiovascular risk factors, a comprehensive questionnaire was used to collect relevant demographic and clinical information from each patient undergoing hemodialysis. Traditional cardiovascular risk factors, such as history of cardiomyopathy, cerebrovascular

accident, and coronary artery disease, were also recorded. Smoking status was documented as both past and current.

Dyslipidemia was defined by the presence of any of the following: total cholesterol > 200 mg/dL, Low-Density Lipoprotein (LDL-cholesterol) > 100 mg/dL, HDL-cholesterol < 40 mg/dL, triglycerides > 150 mg/dL, or ongoing statin therapy. Physical activity was defined based on patient reporting of “any moderate physical activity (e.g., light walking, cycling, gardening) performed at least twice per week,” and the “number of minutes per week” engaged in such activities was recorded. Laboratory data were retrieved from electronic medical records, considering the most recent results within 6 months prior to data collection. All laboratory analyses were conducted in the same hospital where the patients undergo hemodialysis, ensuring methodological standardization and minimizing inter-laboratory variability.

For the sample size calculation, the following formula was used:

$$n = \frac{p(1-p)Z^2N}{\varepsilon^2(N-1) + Z^2p(1-p)}$$

Where: n = sample size; p = expected proportion (44%) according to multicenter studies conducted in several countries (Burmeister, 2014); Z = value from the normal distribution (1.96) considering a 95% confidence interval (Agranonik & Hirakata, 2011); N = population size of 72 patients undergoing hemodialysis per month, according to the institutional report of the academic health institution under study (FELUMA, 2021, p. 18); ε = margin of error (5%).

The inclusion criteria were as follows: approval from the academic health institution to participate in the study, age ≥ 18 years, enrollment in a chronic outpatient hemodialysis program, and the ability to provide informed consent for participation. This study only included patients with medical records available at the institution.

The following exclusion criteria were applied: non-approval of the institution's healthcare services to participate in the study and patient refusal to participate in the interview or complete the questionnaire.

Statistical analysis

In this study, the chi-square test of independence, Fisher's exact test, and Wilcoxon rank-sum test were applied after careful consideration of the specific characteristics of the sample and the variables under investigation. The chi-square and Fisher's exact tests were used to assess associations between categorical variables, whereas the Wilcoxon rank-sum test was applied to compare continuous variables between independent groups, particularly in small samples or when normality assumptions were not met. To determine the p values, cross-tabulations were performed between cardiovascular risk factors and the sample categorizations. Continuous variables were expressed as medians and interquartile ranges (IQR), whereas categorical variables were presented as absolute and relative frequencies (n , %). Given the small sample size, visual inspection and descriptive analysis indicated that the distribution of continuous variables was not normal, supporting the use of non-parametric statistical

tests. A significance level of 0.05 was adopted to establish the statistical validity of comparisons. All statistical analyses were performed using RStudio software (version 2023.09.1+494).

Results

The present study included 66 individuals, corresponding to 91.6% of the hemodialysis population in the healthcare service surveyed in Belo Horizonte, which represents an 8.2% increase relative to the calculated sample size ($n = 61$). The median age of the sample was 58 years. Of the total participants, 59% were male, and 89% self-identified as mixed race.

Table 1 presents the demographic and clinical characteristics of participants, stratified by sex. Table 2 describes the prevalence of major traditional cardiovascular risk factors. A high prevalence of hypertension (95%) was observed, followed by physical inactivity (69%), dyslipidemia (55%), diabetes mellitus (27%), smoking (19%), and obesity (15%). The median time on dialysis in the study population was 5.0 years (IQR: 2.0 to 10.5). When stratified by sex, women had a longer duration of dialysis than men, with a median of 7.0 years (IQR: 2.0 to 15.0) compared with 4.0 years (IQR: 2.0 to 9.0).

Among the 37 patients for whom cardiovascular risk could be estimated using the Atherosclerotic Cardiovascular Disease Calculator (ASCVD) calculator, 62% had intermediate or high cardiovascular risk (Table 3).

Table 4 shows the comparison of cardiovascular risk factor prevalence according to demographic and clinical characteristics. Age was significantly associated with diabetes in the hemodialysis population, as individuals 65 years or older had a higher prevalence of diabetes (50%) compared to those under 65 years (23%) ($p = 0.033$). Another associated factor was physical inactivity, which was significantly more prevalent among women ($p = 0.015$). Among women, 85% reported not engaging in regular physical activity, compared to 57% of men (Table 4).

Discussion

This study demonstrated a high prevalence of cardiovascular risk factors among hemodialysis patients, with systemic arterial hypertension (95%), physical inactivity (69%), dyslipidemia (55%), and diabetes mellitus (27%) standing out (Central Illustration). These findings are consistent with the CORDIAL study¹ conducted in Porto Alegre, Rio Grande do Sul, Brazil, as well as with a study conducted in Montes Claros, Minas Gerais, Brazil, which reported similar prevalences.¹⁷

Arterial hypertension was identified in 95% of evaluated patients, making it the most prevalent cardiovascular risk factor in the sample. This rate was significantly higher than those reported in Brazilian^{1,17} and international cohorts,¹⁸⁻²¹ highlighting the severity of the clinical profile of the population studied. The median pre-dialysis blood pressure was 150/90 mmHg, indicating persistent systolic hypertension, a condition frequently associated with an increased risk of cardiovascular events in individuals with CKD. Systolic blood pressure ≥ 140 mmHg was observed in 67% of participants, with a higher prevalence among women (74%) compared to men (62%). This finding may reflect sex-specific differences in cardiovascular profiles or particularities of the studied sample.

Table 1 – Demographic and clinical characteristics of study participants

	Total N	Female	Male
Demographic data	N = 66	N = 27	N = 39
Age (years)	58 (46–67)	59 (47–65)	58 (44–70)
Race, n (%)			
White	1 (1.5%)	1 (3.7%)	0 (0%)
Mixed race	58 (89%)	25 (93%)	33 (87%)
Black	6 (9.2%)	1 (3.7%)	5 (13%)
Time on dialysis (years)	5.0 (2.0–10.5)	7.0 (2.0–15.0)	4.0 (2.0–9.0)
Clinical data			
Diabetes, n (%)	18 (27%)	5 (19%)	13 (33%)
BMI category			
< 18.5 (kg/m ²), n (%)	5 (7.9%)	2 (8.0%)	3 (7.9%)
18.5 to 24.9 (kg/m ²), n (%)	34 (54%)	13 (52%)	21 (55%)
25 to 29.9 (kg/m ²), n (%)	14 (22%)	6 (24%)	8 (21%)
≥ 30 (kg/m ²), n (%)	10 (16%)	4 (16%)	6 (16%)
Pre-dialysis blood pressure			
Systolic (mmHg)	150 (130–160)	150 (130–160)	150 (130–160)
Diastolic (mmHg)	90 (70–100)	80 (70–90)	90 (80–100)
Systolic ≥ 140 mmHg	44 (67%)	20 (74%)	24 (62%)
Diastolic ≥ 90 mmHg	34 (52%)	12 (44%)	22 (56%)
Systolic ≥ 140 mmHg and diastolic ≥ 90 mmHg	31 (47%)	12 (44%)	19 (49%)
Lipid profile			
Total cholesterol (mg/dL)	171 (142–196)	188 (157–200)	156 (125–183)
HDL-cholesterol (mg/dL)	40 (34–49)	46 (35–54)	37 (33–42)
LDL-cholesterol (mg/dL)	99 (77–123)	114 (89–128)	92 (67–120)
Triglycerides	115 (76–149)	112 (69–146)	122 (76–170)
Total cholesterol > 200 mg/dL, n (%)	13 (20%)	7 (26%)	6 (15%)
HDL-cholesterol < 40 mg/dL, n (%)	33 (50%)	9 (33%)	24 (62%)
LDL-cholesterol > 100 mg/dL, n (%)	30 (45%)	15 (56%)	15 (38%)
LDL-cholesterol < 55 mg/dL, n (%)	7 (11%)	1 (14%)	6 (86%)
Triglycerides > 150 mg/dL, n (%)	16 (25%)	5 (19%)	11 (29%)
Statin use, n (%)	36 (55%)	17 (26%)	19 (29%)
Simvastatin	27 (41%)	11 (17%)	16 (24%)
20 mg	17 (47%)	8 (22%)	9 (25%)
40 mg	10 (28%)	3 (8%)	7 (19%)
Atorvastatin	6 (9%)	4 (6%)	2 (3%)
20 mg	3 (8%)	2 (3%)	1 (2%)
40 mg	3 (8%)	2 (3%)	1 (2%)
Rosuvastatin (10 mg)	1 (2%)	1 (2%)	0 (0%)
Could not report	2 (3%)	1 (2%)	1 (2%)

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Smoking

Current smoker	12 (19%)	4 (15%)	8 (22%)
Former smoker	26 (41%)	10 (37%)	16 (43%)
Years of smoking for current smokers	32 (30–45)	32 (30–38)	34.5 (27–45)
Number of cigarettes/day for current smokers	5 (4.3–13.8)	7.5 (4.8–12.5)	5 (3.5–12.5)
Physical activity, n (%)	18 (29%)	7 (26%)	11 (31%)

Continuous variables are reported as median (interquartile range); categorical variables as n (%). BMI: body mass index; HDL: high-density lipoprotein; LDL: Low-Density Lipoprotein.

Table 2 – Prevalence of cardiovascular risk factors

Hypertension	95%
Diabetes	27%
Dyslipidemia	55%
Smoking	19%
Physical inactivity	69%
Elderly (≥ 65 years)	30%
Male sex	59%
Obesity (BMI ≥ 30)	15%

BMI: body mass index.

Table 3 – Cardiovascular risk stratification according to the ASCVD calculator

	Total N	Female	Male
Risk category	N = 37	N = 19	N = 18
Low	13 (35%)	5 (38)	8 (62)
Borderline	1 (2.7%)	1 (100%)	0 (0%)
Intermediate	10 (27%)	4 (40%)	6 (60%)
High	13 (35%)	9 (69%)	4 (31%)

Table 4 – Comparison of the prevalence of cardiovascular risk factors according to demographic and clinical variables

	Hypertension		Diabetes		Dyslipidemia		Smoking		Physical inactivity		Obesity	
	N = 63	p	N = 36	p	N = 36	p	N = 12	p	N = 44	p	N = 10	p
Sex		p = 0.6		p = 0.2		p = 0.3		p = 0.5		p = 0.015		p > 0.9
Female	25 (40%)		5 (28%)		17 (47%)		4 (33%)		23 (52%)		4 (40%)	
Male	38 (60%)		13 (72%)		19 (53%)		8 (67%)		21 (48%)		6 (60%)	
Elderly (≥ 65 years)		p = 0.5		p = 0.033		p = 0.10		p > 0.9		p = 0.059		p = 0.5
(≥ 65 years)	20 (32%)		9 (50%)		14 (39%)		4 (33%)		17 (39%)		4 (40%)	
Race		p = 0.3		p > 0.9		p = 0.3		p > 0.9		p > 0.9		p = 0.6
White	1 (1.6%)		0 (0%)		0 (0%)		0 (0%)		1 (2.3%)		0 (0%)	
Mixed	56 (90%)		16 (94%)		33 (94%)		11 (92%)		38 (88%)		9 (100%)	
Black	5 (8.1%)		1 (5.9%)		2 (5.7%)		1 (8.3%)		4 (9.3%)		0 (0%)	
Time on dialysis		p > 0.9		p > 0.9		p = 0.8		p > 0.9		p = 0.8		p = 0.6
Years	5.0 (2.0–10.0)		4.5 (2.0–10.0)		4.0 (2.0–9.0)		5.0 (3.5–9.5)		5.5 (2.0–11.0)		6.0 (4.0–12.0)	

Data are presented as n (%) for categorical variables and median (interquartile range) for continuous variables. For categorical variables, p values were obtained using the chi-square or Fisher's exact test. For the continuous variable time on dialysis, comparisons were performed using the Wilcoxon rank-sum test.

Lipid profile analysis revealed a median total cholesterol of 170.9 mg/dL (IQR: 142.05 to 195.78 mg/dL) and LDL-cholesterol of 98.55 mg/dL (IQR: 77.80 to 121.98 mg/dL), suggesting inadequate control of this lipid fraction in the studied population. Lipid abnormalities were slightly higher than those reported in the CORDIAL¹ and UNIMONTES¹⁷ studies. Furthermore, the median HDL-cholesterol was 39.85 mg/dL (IQR: 34.00 to 48.88 mg/dL), indicating suboptimal levels in most patients. Low HDL-cholesterol (defined as < 40 mg/dL for men and < 50 mg/dL for women) reflects impaired reverse cholesterol transport and reduced cardioprotection, a frequent finding in patients with CKD due to chronic inflammation and alterations in lipoprotein metabolism, as highlighted by the Brazilian dyslipidemia guidelines.²² According to the 2019 ESC/EAS dyslipidemia guidelines,²³ individuals with advanced CKD are classified as very high risk, with a therapeutic LDL-cholesterol target of < 55 mg/dL. Regarding lipid-lowering therapy, 55% of patients were on statins, with simvastatin being the most frequently used (41%), followed by atorvastatin (9%) and rosuvastatin (2%). These data suggest a predominance of lower-potency LDL-cholesterol-lowering therapies, which may reflect both the clinical profile of patients and access to medications in the public healthcare system. Although 45% of patients presented LDL-cholesterol > 100 mg/dL, an inadequately controlled level for individuals at intermediate risk, the gap becomes more pronounced when applying the recommended target for this very high-risk population. When considering the guideline-defined goal of LDL-cholesterol < 55 mg/dL, only 7 patients (11%) achieved the recommended threshold, underscoring the need for stricter therapeutic optimization and cardiovascular risk reduction strategies.

In this study, smoking prevalence was 19%, higher than recent estimates in dialysis cohorts, which range from approximately 9% to 15% of active smokers depending on the country and assessment method.^{24,25} Despite potential underreporting biases (common in self-reports), the direction of the effect is consistent. Hemodialysis patients who smoke have a higher risk of mortality and hospitalizations, particularly younger individuals and those with diabetes,²⁶ as well as worse renal outcomes and access to transplantation.²⁷ Obesity occurred in 15% of participants, a proportion lower than contemporary end-stage kidney disease cohorts, where prevalence can approach 40%.⁵ This contrast may reflect differences in demographic profiles and diagnostic criteria. The so-called "obesity paradox" in hemodialysis, whereby higher body mass index (BMI) is associated with improved survival in several cohorts,²⁸⁻³⁰ may partially explain these findings. In hemodialysis patients, higher BMI appears to confer a protective effect against mortality, possibly due to greater nutritional reserves, improved tolerance to catabolic stress, and reduced susceptibility to protein-energy wasting. However, this paradox does not imply that obesity is universally beneficial; it applies primarily to overall body mass rather than fat distribution. Indeed, central adiposity markers, such as waist circumference and waist-to-hip ratio, have been consistently shown to correlate directly with cardiovascular mortality in hemodialysis.³¹ Therefore, while BMI may be a crude predictor of survival, assessment of central fat deposition

provides critical insight into cardiovascular risk, highlighting the need to consider both global and regional adiposity when evaluating patient prognosis. These nuances underscore the importance of individualized risk assessment in hemodialysis populations, integrating traditional anthropometric measures with central adiposity markers to better guide clinical management.

The findings in Table 4 show that the proportion of end-stage renal disease cases attributed to diabetes mellitus increases progressively with age, corroborating Brazilian and international studies that identify aging as a central factor in the development of diabetes among patients with CKD.³² Similarly, the higher frequency of physical inactivity among women has been described in national population studies,¹ reflecting sociocultural barriers and gender inequalities in access to regular physical activity.³³ These findings reinforce the importance of individualized preventive strategies, emphasizing early diabetes screening in older adults and exercise promotion programs targeted specifically at women undergoing dialysis therapy.

Previous Brazilian data indicate that most deaths in this group are attributed to circulatory system diseases, accounting for approximately 34% of total mortality. Within this category, ischemic heart disease and stroke together represent nearly half (48%) of the cardiovascular causes.³⁴ Although cardiovascular mortality has declined in the general population, this trend has not been observed in dialysis patients. This discrepancy is partly explained by the demographic and clinical characteristics of individuals starting renal replacement therapy, who typically present multiple comorbidities such as hypertension and diabetes. The high prevalence of these conditions in our sample underscores the need for early detection and integrated management of cardiovascular risk in the dialysis population.

A limitation of this study is the small sample size, which may limit the generalizability of results. In addition, the cross-sectional design, while limiting causal inferences, is consistent with the study's objective of assessing prevalence and characterizing cardiovascular risk factors in the hemodialysis population.

The study may also be subject to selection and information biases, as some variables were obtained from self-reported data and medical records. Additionally, the findings cannot be generalized to broader populations because the sample was drawn from a single center. Nevertheless, the observed values in the sample were substantially above recommended targets, highlighting a significant gap in lipid control and reinforcing the need for more aggressive cardiovascular prevention strategies in this population.

Conclusion

This study demonstrated a high burden of cardiovascular risk factors among the analyzed hemodialysis population, with systemic arterial hypertension, dyslipidemia, physical inactivity, and diabetes mellitus being the most prevalent conditions. The association of diabetes with advanced age and the higher frequency of physical inactivity among women highlight clinical and sociocultural determinants that exacerbate the risk profile in this group.

These findings are consistent with national and international literature, reaffirming the cardiovascular vulnerability of individuals with CKD undergoing dialysis, and underscore the need for multifaceted intervention strategies. Key measures include strict blood pressure and lipid metabolism control, early screening for metabolic disorders (particularly in older adults), and the promotion of physical activity programs tailored to the realities of women on dialysis.

Author Contributions

Conception and design of the research and writing of the manuscript: Moraes SM, Costa ME, Maia KAP; acquisition of data and obtaining financing: Moraes SM, Costa ME; analysis and interpretation of the data and statistical analysis: Costa ME; critical revision of the manuscript for intellectual content: Costa ME, Maia KAP, Reis FCL.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This study is not associated with any thesis or dissertation work.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of the Faculdade de Ciências Médicas de Minas Gerais under the protocol number 6.990.417. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

Use of Artificial Intelligence

The authors did not use any artificial intelligence tools in the development of this work.

Availability of Research Data

All datasets supporting the results of this study are available upon request from the corresponding author.

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*Supplemental Materials

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