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Prevalence of chronic kidney disease in Brazilians with arterial hypertension and/or diabetes mellitus

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Abstract

The present study aimed to evaluate the prevalence of chronic kidney disease (CKD) in individuals with arterial hypertension (AH) and/or diabetes mellitus (DM) accompanied by Primary Health Care (PHC) in Brazil. The estimated glomerular filtration rate (eGFR) based on creatinine, and urinary albumin-to-creatinine ratio (ACR) were measured in 841 subjects with AH and/or DM, followed by PHC in the city of Viçosa. The CKD was diagnosed according to KDIGO criteria. Sociodemographic, clinical, and anthropometric factors related to the prevalence of CKD were investigated through multiple logistic regression. The prevalence of hidden CKD was 15.4%. Of these, 7.5% were identified by albuminuria (ACR ≥30 mg/g) with slightly decreased eGFR. Age, baseline disease, waist circumference (WC), and systolic blood pressure remained associated with CKD after multivariate analysis. The two major risk factors for hidden CKD were the presence of AH in association with DM and an increase in age. Hidden CKD was more common within people with AH and DM, and with high WC, glycosylated hemoglobin, and serum phosphorus as well as male gender and decreased serum albumin. This knowledge of risk associations can help avoid progression to CKD.

1 | INTRODUCTION

Chronic kidney disease (CKD) consists on the progressive and irreversible loss of kidney function,[1] being recognized as a global public health problem, with significant increase in the number of affected individuals. Patients with arterial hypertension (AH) and diabetes mellitus (DM) were identified as the main causes of the disease.[1-4]

In developed countries, a prevalence of CKD is estimated between 10 and 16% in the adult population.[4-11] In Brazil, its incidence and prevalence have increased considerably and with them the high

costs of its treatment.[12] The progression of CKD causes a significant decrease in the quality of life and work capacity of patients. However, incidence and prevalence data are still uncertain, which highlights the importance of developing preventive policies and actions for this population.[9]

So far, there are not enough studies describing the prevalence of CKD in representative groups of the Brazilian adult population. Consequently, the objective of this study was to evaluate the prevalence and the factors associated with hidden CKD in individuals diagnosed with AH and/or DM.

2 | METHODS

This is a cross-sectional study with subjects with AH and/or DM followed by 16 Primary Health Care (PHC) teams from the municipality of Viçosa, Brazil, from August 2017 to April 2018. The study considered the reference population of 6624 individuals with AH and/or DM in the year of 2017 in the city.[13]

The sample was defined considering 50% of the expected prevalence of the phenomenon, 5% sample margin of error, 50% of the conglomerate effect, 10% of refusals and/or losses, 20% to control confounding factors, and 95% confidence level. The sample calculation resulted in a minimum of 719 individuals, and the final sample consisted of 841 individuals with AH and/or DM. The participants were selected using the conglomerate sampling method (first were selected the territories and then individuals with AH and/or DM were drawn from a list provided by the health service). The sample calculation was performed using the Statcalc program of Epi-Info® version 7.2.

To participate in the study, the following inclusion criteria should be respected: individuals must be 18 years of age or older, be registered with a diagnosis of AH and, or DM in the PHC units, be accompanied by PHC services (groups of AH or DM), have not been diagnosed with CKD and agreed to participate in the study after due clarification. Pregnant women, individuals who could not move to the collection site (PHC unit), with a history of alcohol and/or other drug abuse, and who had severe clinical conditions that required specialized care or an established CKD diagnosis were excluded.

Data were collected in PHC units from August 2017 to April 2018. Semi-structured questionnaires were applied regarding sociodemographic, clinical, and lifestyle information. Anthropometry, blood pressure measurement, and biochemical and urine tests were performed.

The definition of AH used by PHC teams followed the "2017 Guidelines for Hypertension for Primary Care in Portuguese Speaking Countries".[14] The diagnosis of AH was made after two or more high blood pressure values (systolic blood pressure (SBP) ≥140 mm Hg and/or diastolic blood pressure (DBP) ≥ 90 mmHg), on at least two occasions.

Regarding the definition of DM, the PHC teams followed the "Guidelines of the Brazilian Diabetes Society 2017-2018".[15] The diagnosis of DM was made after two altered glucose measurements, either by fasting glucose with values equal to or greater than 126 mg/dL, or values equal to or greater than 200 mg/dL by the glucose test after two hours with overload with 75 g of glucose on at least two occasions.

Serum creatinine and albumin-to-creatinine ratio (ACR) were evaluated for renal function. ACR was used as a diagnostic tool to assess albumin excretion. An ACR ≥ 30 mg/g is recognized as a marker of renal damage and increased glomerular permeability, known as albuminuria. The CKD-EPI formula was used to identify the occurrence of CKD. To classify the stages of CKD, the following criteria were applied: (1) eGFR ≥ 90 mL/min/1.73 m^2; (2) eGFR between 60 and 89 mL/min/1.73 m^2; (3A) eGFR between 45 and 59 mL/min/1.73 m^2; (3B) eGFR between 30 and 44 mL/min/1.73 m^2; (4) eGFR between 15 and 29 mL/min/1.73 m^2; (5) eGFR < 15 mL/min/1.73 m^2. Individuals with eGFR < 60 mL/min/1.73 m^2 (stages 3A, 3B, 4, and 5) or with eGFR> 60 mL/min/1.73 m^2 with coexisting albuminuria (ACR ≥ 30 mg/g) were considered affected by the CKD. eGFR less than 60 mL/min/1.73 m^2 were defined as low eGFR. The ACR was classified as follows: A1 < 30mg/g (normal to slightly increased); A2 between 30 and 300 mg/g (moderately increased); A3> 300mg/g (severely increased). After the presence of CKD was detected, the creatinine and albuminuria tests were repeated in three months to confirm the diagnosis, as recommended by KDIGO.[1] The collection and analysis of the biological material was carried out by a single laboratory previously accredited to the city, using commercial kits.

Descriptive analyzes, estimates of frequencies, averages, median values, standard deviations, and interquartile range were performed to characterize the population studied regarding the variables under study. Then, the inferential analysis was conducted to identify the factors associated with the endpoint studied. Pearson's chi-square was used to verify the associations between the categorical variables. In the continuous variables, normality of the distribution was tested using the Kolmogorov-Smirnov test followed by the parametric (Student's *t*) or non-parametric (Mann-Whitney) test according to the normality test result. For all tests performed, the significance level of 95% was set.

The association between the prevalence of CKD and the explanatory variables was performed using the binary and multiple logistic regression model. In the multivariate model, all the explanatory variables with $P < .200$ were included in the bivariate analysis. For the selection of the final model, the backward elimination method by likelihood ratio (LR) was used. The variables which presented $P < .05$ were considered significant. To assess the magnitude of the associations, odds ratio and its respective 95% confidence intervals were used. All analyzes were performed in the SPSS program *(Statistical Package for the Social Science, version 22; SPSS Inc)*.

This study was approved by the Human Research Ethics Committee of Federal University of Viçosa (UFV) under registration number 1203173/2015 and follows the Declaration of Helsinki. All participants read and signed the Free and Informed Consent Term, guaranteeing the confidentiality and anonymity of the information.

3 | RESULTS

3.1 | Sociodemographic, clinical, and biochemical data of the individuals analyzed

The participants had an average age of 61.4 ± 11.79 years (range, 19 to 100 years), and 65.8% were over 58 years old. Most participants were female (62.7%), had a partner (62.4%), considered themselves black or brown (66.3%), and had 4 years or less of completed studies (64%).

Regarding clinical data, 56.8% of the participants had only AH, 7.6% had only DM, and 35.6% had both diseases. Concerning the use of alcohol and tobacco, 58.7% never smoked, and 73% did not consume alcohol. Almost half of the participants (49.5%) used three or more medications daily. Other results are shown in Table 1.

The participants had a median fasting glucose of 98 mg/dL. The average total cholesterol was 191.57 mg/dL, and the triglycerides were 126 mg/dL. The SBP reached a median of 130 mmHg, and the median DBP reached 80 mmHg. BMI had an average BMI of 28 kg/m^2, and the waist-to-hip ratio and the waist-to-height ratio showed an average of 0.5872 and 0.9049, respectively. Additional results are described in Table 2.

3.2 | Prevalence of CKD

The prevalence of hidden CKD found in the study was 15.4%. Of these, 7.9% identified by glomerular filtration rate (G3a 5.0%, G3b 1.7%, G4 0.8%, and G5 0.4%) and 7.5% were identified by albuminuria (A2 6.6% and A3 0.9%) with normal or slightly decreased eGFR (Table 3).

3.3 | Risk factors associated with CKD

According to univariate analysis (Tables 1 and 2), age, years of study, number of drugs used, smoking habits, baseline disease, glycosylated hemoglobin, fasting blood glucose, HDL, serum albumin, urinary creatinine, systolic blood pressure, WC, and waist/hip ratio were the risk factors related to CKD ($P < .05$).

The reference variable in the multivariate analysis was AH due to its prevalence of more than 92% in the study population. After the multivariate logistic regression analysis, ages above 73 years were independently associated with CKD compared to individuals aged 50 years or younger, individuals with AH and DM compared to individuals who had only AH, former smokers and non-smokers compared to smokers, increased urinary albumin, systolic blood pressure, and WC. When classified only by eGFR, the age groups above 58 years were independently associated compared to ≤50 years and the increase of the urinary albumin and the WC. When classified only by albuminuria, male individuals remained independently associated, individuals with AH and DM compared to individuals with AH alone, the increase in glycosylated hemoglobin, serum phosphorus, and systolic blood pressure and decrease in serum albumin (Table 4).

4 | DISCUSSION

The findings of this study show a prevalence of hidden CKD of 15.4%. These number is lower than the one described by the study conducted by the International Society of Nephrology's Kidney Disease Data Center (ISN-KDDC), which investigated the prevalence of CKD and its risk factors in low- and middle-income countries,[4] whose estimated prevalence was 36.1% in individuals at high risk of developing CKD. In other studies around the world, the prevalence of CKD in the adult population varies around 10-16%.[4-7,10,16,17] Studies on the Brazilian population are still scarce and present different methodologies, as a recent systematic review demonstrated by Wanda et al,[9] which presented a variation in the prevalence of CKD in Brazil between 1.35% and 27.20% depending on the method and population studied.

Through the analysis of ACR, it has been observed that 10.7% of subjects were classified under category A2 (moderately increased), a value similar to that found by Wang et al,[18] who compared the prevalence of CKD and their risk factors in the general population between the United States and China. However, the numbers found in this study are below those reported by Wang[19] et al., whose work aimed to report the prevalence of CKD in individuals with type 2 DM and/or cardiovascular disease (CVD), which are considered to be at risk of developing CKD. Since CKD is a disease that is often asymptomatic, it is reaffirmed that this group of individuals is the one that would most benefit from an adequate nephroprotective treatment. In addition, this data demonstrate the relevance of an active search in order to diagnose the initial albuminuric stages as being crucial for the patient's prognosis. The literature shows that albuminuria is a strong predictor despite of impaired renal function, end-stage renal disease (ESRD), CVD, and mortality in the general population.[20-23]

The initial step must be the screening and detection of the CKD, considered silent, which offers years of opportunity for the discovery and modification of its natural history. Therefore, different studies[2,8,24] showed the importance of the performance of PHC professionals in the early diagnosis of CKD and its proper referral, stressing that only 25%-50% of patients with some degree of renal dysfunction are referred to specialized centers in a timely manner for the implementation of an adequate treatment plan.

Increasing age was positively associated with the presence of CKD in the population studied; reaching approximately 15 times more people aged 73 years or more. Zdrojewski[10] et al. identified a positive correlation between the aging population, CKD, and the decrease in eGFR, corroborating the results of this study. However, in both studies, the association between age and albuminuria was not statistically significant.

Smoking is a risk factor for the development and progression of CKD. Despite finding statistical significance between smoking and CKD, in this study such association occurred between

TABLE 1 Sociodemographic and clinical characteristics of the study population

	Total population		Non-CKD		CKD		*P*-value (CKD vs. non CKD)
	n	%	n	%	n	%	
Age group							
50 or less	146	17.40%	134	18.80%	12	9.30%	<0.001[a]
51-57	142	16.90%	126	17.70%	16	12.40%	
58-62	137	16.30%	113	15.90%	24	18.60%	
63-67	152	18.10%	136	19.10%	16	12.40%	
68-72	125	14.90%	98	13.80%	26	20.20%	
73 or more	139	16.50%	104	14.60%	35	27.10%	
Sex							
Male	314	37.30%	261	36.70%	53	41.10%	0.345
Female	527	62.70%	450	63.30%	76	58.90%	
Civil status							
Single	85	10.80%	73	10.90%	12	10.20%	0.433
Married/ cohabiting	492	62.40%	415	62.00%	76	64.40%	
Separated/divorced	77	9.80%	70	10.50%	7	5.90%	
Widower	134	17.00%	111	16.60%	23	19.50%	
Color							
Black	176	22.60%	155	23.40%	21	18.10%	0.366
Brown/yellow/indigenous	340	43.70%	289	43.70%	51	44.00%	
White	262	33.70%	217	32.80%	44	37.90%	
Years of study							
3 or less	252	33.80%	210	33.20%	41	36.60%	0.036[a]
4	225	30.20%	191	30.20%	34	30.40%	
5-6	83	11.10%	64	10.10%	19	17.00%	
7 or more	186	24.90%	168	26.50%	18	16.10%	
Number of associated diseases							
0	547	65.00%	468	65.80%	79	61.20%	0.395
1	221	26.30%	180	25.30%	40	31.00%	
2 or more	73	8.70%	63	8.90%	10	7.80%	
Number of drugs in use							
1 or less	252	30.00%	210	29.50%	42	32.60%	0.001[a]
2	173	20.60%	158	22.20%	14	10.90%	
3-4	231	27.50%	200	28.10%	31	24.00%	
5 or more	185	22.00%	143	20.10%	42	32.60%	
Tobacco Use							
Smoker	91	11.80%	85	13.00%	6	5.20%	0.028[a]
Former smoker	228	29.50%	186	28.40%	42	36.50%	
Non-smoker	453	58.70%	385	58.70%	67	58.30%	
Alcohol Use							
No	566	73.00%	480	72.70%	86	75.40%	0.546
Yes	209	27.00%	180	27.30%	28	24.60%	
Underlying Diseases							
Hypertension	478	56.80%	426	59.90%	51	39.50%	<0.001[a]
Diabetes	64	7.60%	56	7.90%	8	6.20%	
Hypertension and Diabetes	299	35.60%	229	32.20%	70	54.30%	

(Continues)

TABLE 1 (Continued)

	Total population		Non-CKD		CKD		*P*-value (CKD vs. non CKD)
	n	%	n	%	n	%	
Heart Attack							
No	731	94.60%	624	95.30%	107	91.50%	0.090
Yes	42	5.40%	31	4.70%	10	8.50%	
Stroke							
No	728	93.60%	620	93.90%	107	91.50%	0.312
Yes	50	6.40%	40	6.10%	10	8.50%	
CKD in the family							
No	639	82.30%	549	83.20%	89	77.40%	0.133
Yes	137	17.70%	111	16.80%	26	22.60%	

Note: P-value statistically significant by the Pearson chi-square test.

[a]*P*-values for the comparison between the CKD vs Non-CKD groups.

TABLE 2 Biochemical and anthropometric characteristics of the study population

	Total population	Non-CKD	CKD	*P*-value
Glycosylated hemoglobin[a] (mg/dL)	6.00 (5.60-7.00)	5.90 (5.60-6.80)	6.60 (5.80-7.70)	<.001[c]
Fasting Glucose[a] (mg/dL)	98 (88-126)	97 (87-123)	107 (90-139)	.021[c]
Total Cholesterol[b] (mg/dL)	191.57 (40.71)	191.73 (39.75)	190.32 (45.73)	.718
HDL[a] (mg/dL)	49 (41-59)	49 (42-60)	46 (40-54)	.017[c]
LDL[a] (mg/dL)	107.6 (87.8-133.4)	108.4 (88.6-132.8)	103 (81.2-135.8)	.244
VLDL[a] (mg/dL)	25 (19-34.2)	25 (19-33.8)	26.6 (17.6-35.6)	.630
Triglycerides[a] (mg/dL)	126 (95-174)	125 (95-170)	134 (89-187)	.354
Serum Albumin[a] (mg/dL)	4.47 (4.3-4.645)	4.48 (4.31-4.65)	4.42 (4.22-4.59)	.008[c]
Serum phosphorus [a] (mg/dL)	3.4 (3-3.8)	3.4 (3-3.8)	3.5 (3.1-3.8)	.089
Serum calcium[a] (mg/dL)	9.5 (9.2-9.7)	9.5 (9.2-9.7)	9.5 (9.3-9.8)	.126
Urine creatinine[a] (mg/dL)	95.5 (65-138)	98 (66.5-139)	82 (62-121)	.013[c]
Urine Albumin[a] (mg/dL)	5.8 (3-11.1)	5 (2.8-8.4)	28.7 (9.1-95.4)	<.001[c]
Albumin-to-creatinine ratio (ACR)	5 (3-11)	5 (3-8)	36.5 (10.5-98.0)	<.001[c]
Systolic blood pressure[a] (mmHg)	130 (120-140)	130 (120-140)	140 (124-150)	.001[c]
Diastolic blood pressure[a] (mmHg)	80 (80-90)	80 (78-90)	80 (80-90)	.190
Body mass index[a] (kg/m^2)	28 (25-32)	28 (25-32)	24.8437-33	.667
Waist circumference[b] (cm)	93.74 (11.31)	93.16 (11.03)	96.99 (12.33)	.001[d]
Waist-to-height ratio[a]	0.5872 (0.5417-0.6321)	0.5836 (0.5385-0.6288)	0.5988 (0.5506-0.6603)	.284
Waist-to-hip ratio[a]	0.9049 (0.8538-0.9503)	0.8986 (0.8499-9524)	0.9485 (0.8692-0.9947)	<.001[c]

Note: P-values for the comparison between the CKD vs Non-CKD groups.

Abbreviations: BMI, body mass index; CKD, chronic kidney disease; HDL-c, high-density lipoprotein cholesterol; LDL-c, low-density lipoprotein cholesterol; VLDL-c, very low-density lipoprotein cholesterol.

[a]Median and interquartile range.

[b]Mean and standard deviation.

[c]*P*-value statistically significant by the Mann-Whitney test.

[d]*P*-value statistically significant by Student's t test.

individuals who were former smokers compared to smokers and among non-smokers in relation to smokers, implying a "protection" given to smoking. It is believed that this relation may have been due to reverse causality. Previous studies[10,25] have demonstrated a correlation between smoking and deterioration on kidney function through glomerulosclerosis.[23]

Regarding the underlying diseases, it was observed in the present study that the association of AH and, or DM with CKD happened only when the two diseases were considered together (twice as much chance when compared to individuals with only AH). AH was the variable used as a reference in the multivariate analysis due to its higher proportion in the study population. The increase in systolic

TABLE 3 Prevalence of CKD in the study population

	Category of albuminuria (measured by ACR-mg/g)							
	A1(<30)		A2 (30-299)		A3(≥300)		Total	
	N	%	N	%	N	%	N	%
Category of eGFR (mL. min/1.73m^2)								
G1 (≥90)	286	34.3%	23	2.8%	4	0.5%	313	37.6%
G2 (60-89)	419	50.3%	32	3.8%	3	0.4%	454	54.5%
G3a (45-59)	34	4.1%	4	0.5%	4	0.5%	42	5.0%
G3b (30-44)	12	1.4%	0	0.0%	2	0.2%	14	1.7%
G4 (15-29)	3	0.4%	1	0.1%	3	0.4%	7	0.8%
G5 (<15)	1	0.1%	1	0.1%	1	0.1%	3	0.4%
Total	755	90.6%	61	7.3%	17	2.0%	833	100.0%

Note: Chance of CKD outcome: white, low; light gray, moderately raised; gray, medium; dark gray, very high. Study population: 841 individuals, 19-100 years of age. CKD population: 128 individuals.

TABLE 4 Multivariate logistic regression analysis estimating correlations of eGFR ≤ 60 mL/min/1.73 m^2, ACR ≥ 30 mg/g, and CKD in the study population

	eGFR ≤ 60 mL/min/1.73 m^2			ACR ≥ 30 mg/g			CKD		
	OR	95% CI	*P*-value	OR	95% CI	*P*-value	OR	95% CI	*P*-value
Sex, Male/ female	–	–	–	2.192	1.261-3.802	.005	–	–	–
Age group									
51-57/ 50 or less	1.531	0.249-9.428	.646	–	–	–	1.079	0.374-3.115	.888
58-62/ 50 or less	5.107	1.074-24.286	.040	–	–	–	1.035	0.348-3.074	.951
63-67/ 50 or less	4.922	1.037-23.363	.045	–	–	–	1.047	0.367-2.986	.931
68-\72/ 50 or less	6.072	1.289-28.597	**.023**	–	–	-	1.804	0.664-4.902	.247
73 or more/ 50 or less	14.790	3.339-65.510	**<.001**	–	–	–	3.161	1.237-8.081	**.016**
Underlying Diseases									
DM/ AH	–	–	–	1.863	0.657-5.287	.242	0.663	0.165-2.654	.561
AH associated with DM/ AH only		–		3.373	1.809-6.290	**<.001**	2.219	1.289-3.820	**.004**
Tobacco use									
Former smoker/ smoker	–	–	–	–	–	–	8.843	1.527-51.206	**.015**
Non-smoker/ smoker	–	–	–	–	–	–	8.877	1.556-50.649	**.014**
HbA1c	–	–	–	1.252	1.090-1.439	**.002**	–	–	–
Serum phosphorus	–	–	–	1.687	1.060-2.685	**.027**	–	–	–
Serum albumin	–	–	–	0.132	0.051-0.340	**<.001**	–	–	–
Urinary Albumin	1.005	1.003-1.007	**<.001**	–	–	–	1.032	1.022-1.042	**<.001**
SBP	–	–	–	1.021	1.007-1.035	.003	1.018	1.004-1.032	**.009**
WC	1.041	1.016-1.067	**.001**	–	–	–	1.031	1.008-1.054	**.007**

Note: Bold values are statistically significant.

Abbreviations: ACR, albumin-to-creatinine ratio; AH, arterial hypertension; CKD, chronic kidney disease; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; HbAlc, glycosylated hemoglobin; SBP, systolic blood pressure; WC, waist circumference.

blood pressure also remained independently associated with CKD and albuminuria in the study ($P < .05$). The literature confirms the dominance that AH and DM have in the genesis of CKD[8,20,21,26-28] and that the reduction of blood pressure to adequate levels contributes to the reduction of albuminuria and to a slower decline in eGFR.[29]

Patients with lack of glycemic control often develop diabetic nephropathy, especially if HbA1c concentrations are greater than 11%.[30] Likewise, those patients whose HbA1c concentration is kept < 8.1% will have a lower risk for developing CKD.[30] In this study, increased HbA1c remained associated with increased albuminuria ($P = .002$), showing that a 1% increase in HbA1c increases the chance of developing albuminuria by 25%. These results agree with the findings by Takagi; Bazono; Uchigata,[31] which found that higher levels of HbA1c and urinary albumin-to-creatinine ratio were associated with both an increased risk of developing albuminuria and decreased eGFR.

Obesity is closely linked to DM and AH and may also predispose people to CKD[4,29,32], and the WC may show stronger associations with the risk of end-stage renal failure compared to BMI.[32] In the regression analysis, WC remained associated with CKD ($P < .007$) and low eGFR ($P < .001$), a result that reaffirms what was found by Kramer[32] et al., who observed that higher WC categories (108 cm in women and 122 cm in men) presented an increased risk of 2.81 times (95% CI 1.89, 4.17) for developing CKD, after adjusting for covariates. Body weight control reduces the risk of CKD and improves outcomes in patients with CKD.[33]

It was found in this study that the increase in albuminuria predicts higher levels of serum phosphate (Table 4), regardless of eGFR ($P = .027$). The rise of 1mg/dL in serum phosphate increases the chance of CKD in the studied population by 69%. In a cohort of 351 patients with CKD, serum phosphate showed a direct correlation with ACR. In addition, eGFR and ACR were independent predictors of serum phosphate when adjusted for age and sex.[34-36]

This is the first epidemiological study to estimate the prevalence of hidden CKD in a population at risk treated by PHC in Brazil that performed serum creatinine and ACR analysis more than once to diagnose patients with CKD. It used a cluster sampling procedure stratified in several stages to obtain a representative sample of the population of users of the Public Health Service in the Brazilian municipality, aged between 19 and 100 years, which make the results reliable. The methods used for the diagnosis of CKD are those recommended by the main scientific societies. However, there are two limitations to this study, the first is related to its transversal nature, which does not allow us to infer causality data. Second, the study was restricted to Brazilian participants, which limits the extrapolation of its generalization to countries with populations that have characteristics similar to those of Brazil.

Diagnosing early stage CKD, when the population benefits most from nephroprotective treatments, is still a global public health challenge. The prevalence of hidden CKD found in this study was lower when compared with other studies involving populations at risk. Comorbidities such as AH associated with DM, increase in age, increased urinary albumin, systolic blood pressure, and WC were associated with hidden CKD. When only albuminuria was used to classify them, male individuals, those with AH associated with DM, increased glycosylated hemoglobin, serum phosphorus, systolic blood pressure, and decreased serum albumin were also predictors of hidden CKD.

CONFLICT OF INTEREST

Conflict of Interest Statement: None declared.

AUTHOR CONTRIBUTIONS

LOC, LCO, LDB, RMMC, and LSS involved in research idea and study design. LOC, LCO, LDB, HHD, CRSB, and ESF involved in data acquisition. LOC, LCO, LDB, and TRM involved in data analysis/interpretation. TRM, LOC, and LSS involved in statistical analysis. RGS, GDC, and RMMC involved in supervision or mentorship. Each author contributed important intellectual content during manuscript drafting or revision and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved.

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