Aging Clinical and Experimental Research (2023) 35:2201–2209
https://doi.org/10.1007/s40520-023-02510-y

ORIGINAL ARTICLE

Epidemiology of chronic kidney disease in older indigenous peoples of Brazil: findings from a cross-sectional survey

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Received: 10 April 2023 / Accepted: 16 July 2023 / Published online: 30 July 2023

Abstract

Background Chronic kidney disease (CKD) is a prevalent disease worldwide, with increasing incidence particularly in low- and middle-income countries. Indigenous communities have poorer CKD outcomes due to limited access to healthcare. They are also experiencing a shift toward a sedentary lifestyle and urbanization-related dietary changes, increasing the risk of CKD-related risk factors.

Aim To determine the prevalence of CKD in older Brazilian indigenous and identify the main associated risk factors.

Methods This cross-sectional study analyzed demographic and clinical data of 229 older indigenous individuals aged 60 years and above in 2022–2023. CKD was defined as an estimated glomerular filtration rate < 60 mL/min/1.73 m^2 or a urinary albumin–creatinine ratio > 30 mg/g. Data were presented categorically and analyzed using the Chi-square test or Fisher's exact test.

Results The prevalence of CKD in the population was 26.6%, with higher prevalence in women and increasing with age. The prevalence of hypertension and diabetes was 67.7% and 24.0%, respectively, and these comorbidities were associated with CKD: hypertension (OR = 5.12; 95% CI 2.2–11.9) and diabetes (OR = 5.5; 95% CI 3.7–8.2). No association was found between the prevalence of CKD and obesity, dyslipidemia, cardiovascular disease, or smoking.

Discussion The study found a higher prevalence of CKD among older indigenous populations in Brazil compared to non-indigenous populations, which is exacerbated by risk factors, such as aging, hypertension, diabetes, and lifestyle changes, emphasizing the importance of early detection and intervention in these communities.

Conclusion Older persons' indigenous individuals have a high prevalence of CKD, which is correlated with factors, such as sex, age, diabetes mellitus, and hypertension.

Keywords Chronic kidney disease · Indigenous peoples · Older adults · Prevalence · Risk factors

Introduction

Chronic kidney disease (CKD) is a prevalent disease worldwide with increasing incidence. Approximately 10% of the global adult population is estimated to have CKD, and its prevalence is higher in low- and middle-income countries. CKD leads to numerous hospitalizations and deaths [1, 2], imposing significant costs on healthcare systems due to the rising number of cases [3]. It is characterized by severe and irreversible kidney damage with estimated glomerular filtration rate (eGFR) < 60 mL/min/1.73 m^2 and/or a urinary albumin–creatinine ratio (UACR) > 30 mg/g [4].

The prevalence of CKD varies depending on several factors, such as age, gender, race, lifestyle, socioeconomic

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status, and comorbidities, such as diabetes and hypertension [2]. Access to healthcare is also crucial in early detection and treatment of CKD [5]. Age is a significant risk factor for CKD, as kidneys gradually lose their function with age, leading to CKD [6, 7]. Aging is associated with detrimental changes in the renal parenchyma due to cellular senescence and nephrotoxic agents prescribed over the patient's lifetime [3].

In the United States, the Centers for Disease Control and Prevention CKD Surveillance System reported that the prevalence of CKD is higher in persons 65 years and older (38%) than in people aged 45–64 years (12%) or 18–44 years (6%) [7]. Along with age, other age-related factors, such as high blood pressure, diabetes, and cardiovascular disease, can also increase the risk of developing CKD [6].

Previous studies have shown an increasing prevalence of CKD among Indigenous peoples [8, 9]. When comparing outcomes with the general population, disadvantaged populations have poorer CKD outcomes due to their more difficult access to health services: hospitalizations, less access to transplantation, and higher mortality [5, 8]. In the indigenous population of Canada, the prevalence of CKD is twice that of the general population, and the prevalence of severely elevated albuminuria is five times higher. Not only do they live in more isolated areas, but they also face disproportionate social inequalities, such as poverty and poor access to services [9].

In this context, it is likely that the Brazilian indigenous older population has a significant prevalence of CKD and still suffers from all these inequities. In recent times, there has been a decline in the traditional hunting and agricultural practices among indigenous communities, coupled with an increase in the availability of industrial products. This shift toward urbanization, sedentary lifestyles, changes in dietary habits such as the consumption of industrialized foods as a substitute for naturally grown foods produced in the village itself through family farming or obtained through hunting and fishing, and easy access to cities has had a significant impact on the overall quality of life and mortality rates of these communities. As a result, there has been a complaint about your well-being [10, 11].

The evidence indicates that sedentary lifestyles and dietary changes resulting from urbanization have led to a concerning increase in obesity, diabetes, and hypertension, which are major risk factors for CKD [10, 11]. However, it is worth noting that there is a lack of research on the health status of indigenous people living in highly urbanized areas in Brazil, particularly concerning the risk factors for developing CKD. A previous study conducted on two indigenous populations in Brazil revealed that the more urbanized group had a higher prevalence of CKD. Interestingly, the study did not observe significant differences in renal dysfunction among various age groups in the more urbanized group [11].

Thus, the aim of the present study was to determine the prevalence of CKD and the main risk factors in older persons' Brazilian indigenous. Our hypothesis is that the prevalence of CKD is significant higher in this older population, possibly as a result of the ongoing epidemiological transition process.

Methods

Ethics statement

The Ethics Committee for Human Research of the Federal University of Alagoas-CEP/UFAL (Opinion number 5.818.147), in collaboration with Indigenous leaders of participating groups, approved this research on December 15, 2022. The study fully respects the ethical principles outlined in the Declaration of Helsinki (1964) and complies with Resolutions 466/2012 and 510/2016 of the Brazilian National Health Council.

Study design and recruiting

This is a cross-sectional study conducted from December 2022 to March 2023, which analyzes data from 1715 Truká indigenous individuals aged over 18 years in Cabrobó, Pernambuco state, Brazil. The study aims to examine the health status of the traditional indigenous population in the São Francisco Valley, focusing on sociodemographic, clinical, and laboratory variables.

For this report, we evaluated indigenous men and women aged 60 years and older who voluntarily participated in project. For this study, the calculated sample size was a total of 165 participants, considering a population of 2981 Indigenous people (estimated to have 447 older individuals) [12], 95% confidence interval (CI), 5% precision, and an estimated prevalence of CKD of 21.4%, based on a previous prevalence study conducted on Brazilian older individuals [6], using an online tool http://sampsize.sourceforge.net/iface/. The indigenous community of Truká was invited to participate in the study. Thus, the final population of the study exceeded the calculated sample, being equal to 229. In this case, we try to reach as many people in that age group as possible.

Patients were excluded from the study if they refused to have blood and/or urine samples collected or did not complete all scheduled examinations, even after providing informed consent and undergoing anthropometric measurements.

Population group

The Truká people reside in the submedium region of the São Francisco River, spanning across the states of Bahia and

Pernambuco. The largest concentration of the Truká people can be found on Assunção Island, located in Cabrobó city and covering an area of 6000 m^2; see Fig. 1. The population consists of 2981 individuals. Despite conflicts over land control in the eighteenth century, the group managed to settle firmly on their land in 2002, thus reaffirming their indigenous traditions. However, urbanization and associated activities, such as dam construction, have adversely impacted their agricultural production, particularly rice cultivation, and fishing, which is an essential source of food for the group [10, 12].

Sociodemographic and anthropometric parameters

We collected data on participants' gender using a binary variable (male/female) and defined 'older person' in accordance with the guidelines established by the World Health Organization, which refers to individuals aged 60 years or older. This definition is consistent with the one adopted in Brazil [13, 14]. Age was treated as a continuous variable in years, and also grouped into three proportional categories. Participants with a body mass index (BMI) > 30 kg/m^2 were classified as obese [15].

Clinical parameters and laboratory testing

The blood pressure of the study participants was measured three times on each arm and the mean was calculated. Hypertension was diagnosed if systolic blood pressure was ≥ 140 mmHg, diastolic blood pressure was ≥ 90 mmHg, or the participant was taking medication for hypertension [16]. If blood pressure was below 140 × 90 mmHg, hypertension was considered to be under control [17]. Diabetes was diagnosed if the participant had an HbA1c ≥ 6.5% or was taking diabetes medications [18]. Dyslipidemia was diagnosed if the participant had low high-density lipoprotein cholesterol (< 40 mg/dL for men or < 50 mg/dL for women), high triglycerides (> 150 mg/dL), hypercholesterolemia (> 240 mg/dL), or high low-density lipoprotein cholesterol (> 160 mg/dL) or was taking lipid-lowering medication [19]. The study defined the presence of cardiovascular disease as either a report of coronary revascularization, a medical diagnosis

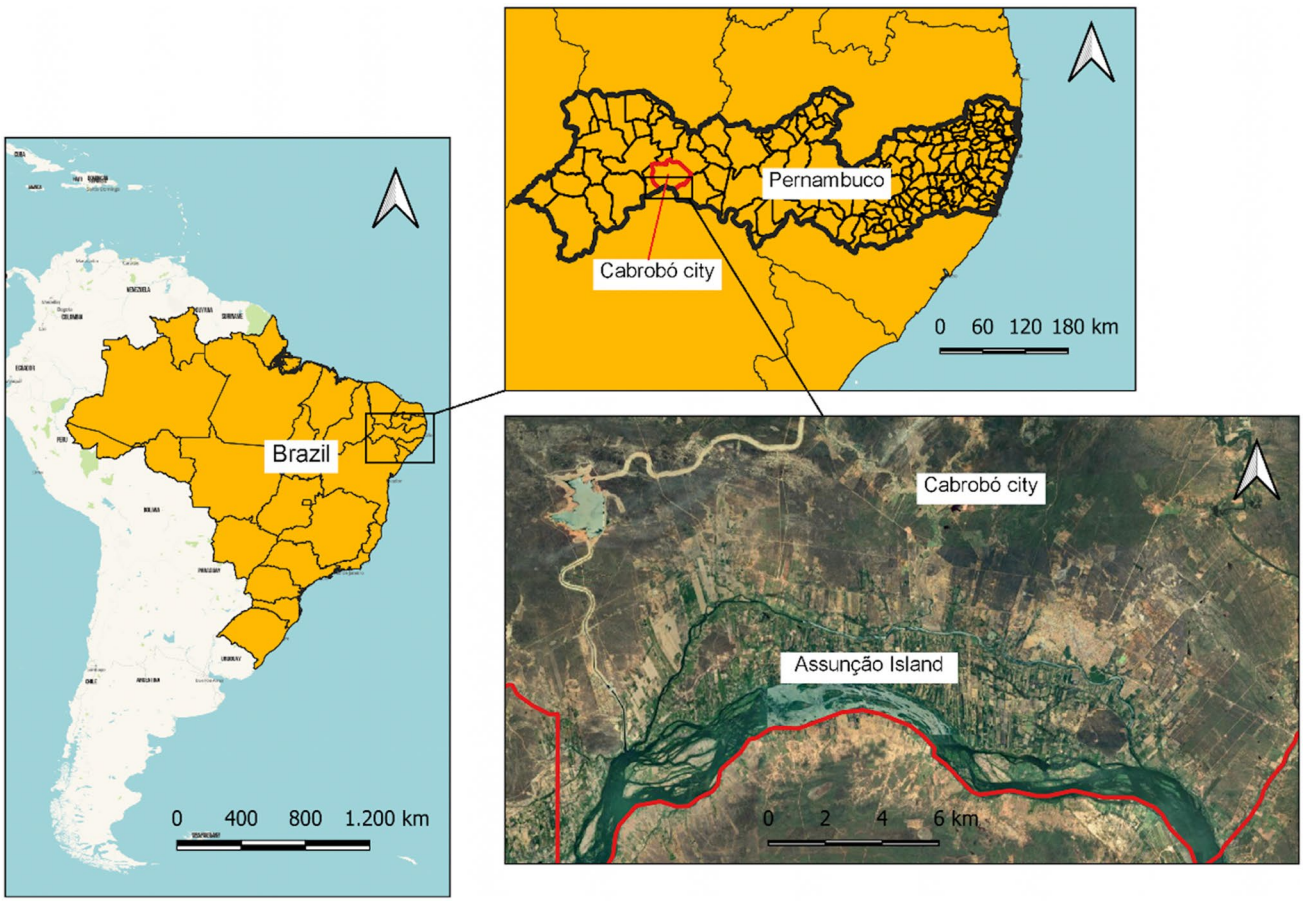


Fig. 1 Geographic location of the study area. Cabrobó, Pernambuco, Brazil. Made with Natural Earth. Map base layers were modified in QGIS software version 2.18. Pictures from the PAI researchers (no Indigenous person shown)

of myocardial infarct, stroke, or heart failure. Smoking was self-referred and computed as active or stopped.

The eGFR was calculated using the CKD Epidemiology Collaboration (CKD-EPI) creatinine equation, without considering race [20]. According to the 2012 KDIGO criteria [4], the participants were divided into six categories: G1—Normal or high (≥ 90 mL/min/1.73 m^2); G2—Mildly decreased (60–89 mL/min/1.73 m^2); G3a—Mildly-to-moderately decreased (45–59 mL/min/1.73 m^2); G3b—Moderately-to-severely decreased (30–44 mL/min/1.73 m^2); G4—Severely decreased (15–29 mL/min/1.73 m^2); G5—Kidney failure (< 15 mL/min/1.73 m^2). Albuminuria was defined as a UACR ≥ 30 mg/g, with a value from 30 to 299 considered A2 or moderately increased and the value ≥ 300 mg/g considered A3 or severely increased. CKD was defined as a single eGFR measurement < 60 mL/min/1.73 m^2 or a UACR ≥ 30 mg/g.

Blood sampling and clinical data collection were performed at participants' homes to avoid selection bias and to increase representativeness. Objective methods, including the use of calibrated scales and measuring tapes, were used for data collection to avoid reliance on self-report. Laboratory data analysis was performed at a single accredited facility to ensure uniformity of equipment and techniques. To avoid measurement bias, the data collection team was adequately trained, and anthropometric measurements were repeated three times.

The data were entered twice into the JASP computer program (software v.0.15) for consistency and amplitude checking. Categorical variables were presented as absolute and relative frequencies, and continuous variables were presented as median after checking for normality using the Shapiro–Wilk test. The frequency of CKD was reported as a percentage. Mann–Whitney *U* test and Pearson's Chi-square test or Fisher's exact test were used to compare positive and negative individuals in univariate analysis for continuous and categorical variables, respectively. Odds Ratio (OR) with respective confidence intervals were calculated. A significance level of 5% was used for all analyses.

Results

A total of 229 older indigenous participants were included. Of these, 115 were female (50.2%). Their ages ranged from 60 to 94 years. Sixty-one (26.6%) of the older individuals studied had CKD defined by a single measurement of elevated UACR (≥ 30 mg/g) or eGFR < 60 mL/min/1.73 m^2. Among those diagnosed with CKD, 33 (14.7%) had reduced function measured by eGFR (< 60 mL/min/1.73 m^2) without albuminuria, whereas 23 (10.0%) had kidney damage manifested by albuminuria alone; 5 (1.6%) had both reduced eGFR and albuminuria (see Table 1).

Statistically significant differences in the distribution of CKD were observed in the variables gender (OR = 2.6; 95% CI 1.4–4.8), age (70–79 years—OR = 3.3; 95% CI 1.6—6.6; ≥ 80 years—OR = 4.4; 95% CI 1.1–10.6), diabetes (OR = 5.5; 95% CI 3.7–8.2), and hypertension (OR = 5.12; 95% CI 2.2–11.9). Fifty-seven (24.94%) subjects were considered obese and 180 (78.6%) had dyslipidemia. No association was found between the prevalence of CKD and obesity, dyslipidemia, smoking, or cardiovascular disease. The details of these parameters are shown in Table 1.

The prevalence of CKD was higher in women than in men (35.7% versus 17.5%; $P = 0.002$) (see Table 1). In addition, a growing trend in the prevalence of reduced renal function with advancing age was observed, particularly in females. In individuals over 80 years old, the prevalence of CKD was 50.0%, primarily using the criterion of eGFR < 60 mL/min/1.73 m^2; see Fig. 2.

According to the 2012 KDIGO criteria, the prevalence of prognostic CKD by risk categories of moderately increased risk, high risk, and very high risk was 22.3%, 3.06%, and 1.31%, respectively. Only 38 individuals had normal or high eGFR. The distribution of patients according to the 2012 KDIGO CKD progression risk staging system is shown in Table 2.

The prevalence of hypertension and diabetes was 67.7% and 24.0%, respectively. Approximately 20.1% of individuals had both comorbidities. Albuminuria was more prevalent among hypertensive individuals than among diabetics (10.1% versus 5.24%). Of the total number of patients with CKD, only 2.2% of participants did not have diabetes or hypertension; see Fig. 3.

Discussion

Our study found a higher prevalence of CKD in indigenous populations compared to non-indigenous populations in Brazil [6, 21]. In a previous study conducted within the same indigenous group, a lower prevalence of 6.2% was reported using eGFR < 60 mL/min/1.73 m^2 as the only diagnostic criterion. However, it should be noted that this previous study had limitations, including a small sample size and the absence of albuminuria as a diagnostic criterion, which may introduce potential bias. Additionally, the previous study focused on a younger age group, specifically individuals aged between 30 and 70 years [11]. CKD is more commonly observed in older individuals due to the natural aging process, which leads to a decrease in eGFR and increased glomerular basement membrane permeability [6, 21, 22]. Older individuals with CKD have a higher risk of hospitalization, mortality, and physical disability than their healthy counterparts [6, 23].

Table 1 Characterization of study population by presence of CKD and criteria for CKD: eGRF < 60 mL/min/1.73 m^2, UACR ≥ 30 mg/g, or both. Cabrobó, Pernambuco, Brazil ($n = 229$)

Variable	CKD				All	OR (95% CI)	*P* value	Criteria for CKD					
	No		Yes					eGFR < 60 alone		UACR ≥ 30 alone		Both	
	n	%	*n*	%				*n*	%	*n*	%	*n*	%
All	168	73.4	61	26.6	229			33	14.4	23	10.0	5	2.2
Gender													
Female	74	64.3	41	35.7	115	2.6 (1.4–4.8)	0.002[a]	23	20.0	15	13.0	3	2.6
Male	94	82.5	20	17.5	114	1.0 (Ref)		10	8.8	8	7.0	2	1.7
Age group (years)													
60–69 years	129	81.6	29	18.4	158	1.0 (Ref)	< 0.001[a]	13	8.2	15	9.5	1	0.6
70–79 years	26	57.8	19	42.2	45	3.3 (1.6–6.6)		10	22.2	7	15.6	2	4.4
≥ 80 years	13	50.0	13	50.0	26	4.4 (1.1–10.6)		10	38.5	1	4.2	2	7.7
Median (IQR)—years	65 (62–70)		71 (66–78)				< 0.001[b]						
Obesity (BMI ≥ 30 kg/m^2)													
No	127	73.8	45	26.2	172	1.0 (Ref)	0.778[a]	22	12.8	18	10.5	5	2.9
Yes	41	71.9	16	28.1	57	1.1 (0.5–2.2)		11	19.3	5	8.8	0	0.0
Diabetes mellitus													
Não	134	77.0	40	23.0	174	1.0 (Ref)	0.030[a]	24	13.8	13	7.5	3	1.7
Sim	34	61.8	21	38.2	55	5.5 (3.7–8.2)		9	16.4	10	18.2	2	3.6
Hypertension													
Não	67	90.5	7	9.5	74	1.0 (Ref)	< 0.00[a]	2	2.7	5	6.8	0	0.0
Sim	101	65.2	54	34.8	155	5.12 (2.2–11.9)		31	20.0	18	11.6	5	3.2
Cardiovascular disease													
No	150	72.8	56	27.2	206	1.0 (Ref)	0.575[c]	30	14.6	23	11.2	3	1.5
Yes	18	78.3	5	21.7	23	0.7 (0.3–2.1)		3	13.0	0	0.0	2	8.7
Dyslipidemia													
No	41	83.7	8	16.3	49	1.0 (Ref)	0.072[a]	2	4.1	4	8.2	2	4.1
Yes	127	70.6	53	29.4	180	2.1 (0.9–4.87)		31	17.2	19	10.6	3	1.7
Current smoking													
No	118	70.2	50	29.8	168	1.0 (Ref)	0.080[a]	29	17.3	19	11.3	2	1.2
Yes	50	81.9	11	18.0	61	0.53 (0.2–1.1)		4	6.6	4	6.6	3	4.9

UACR urinary albumin–creatinine ratio (mg/g), *BMI* body mass index, *CKD* chronic kidney disease, *eGFR* estimated glomerular filtration rate

[a]X^2 continuity correction

[b]Mann–Whitney *U* test

[c]Fisher's exact test

A meta-analysis by Hill et al. revealed an increasing prevalence of CKD with age, from 13.7% in the 30–40 years age group to 27.9% in individuals aged 70–80 years [24]. In Brazil, a study reported a CKD prevalence of 21.4% among non-indigenous individuals over 60 [6]. In a study of public sector workers, the prevalence of CKD in women significantly increased with age, from 3.5% in the 35–44 age group to 21.4% in the 70–74 age group. However, no significant gender differences in CKD prevalence were found in this study [21]. On the other hand, we found a higher prevalence of CKD in women in our study population. A possible explanation for this difference could be the distribution of risk factors. This higher prevalence in women is consistent with most studies on this topic [24]. The reasons for these differences are not yet well understood and are probably multifactorial [2, 24].

Defining CKD based on fixed eGFR thresholds may lead to overdiagnosis in the older people [22]. The impact of a slight reduction in eGFR (45–59 mL/min/1.73 m^2) without proteinuria on the prognosis of non-Indigenous older people is controversial [3, 22], but its applicability to Indigenous populations has not been well established. Furthermore, albuminuria not only predicts the presence of CKD but is also associated with increased overall and cardiovascular mortality [4]. In our study, elevated albuminuria was found in about one in eight individuals, especially in diabetics and

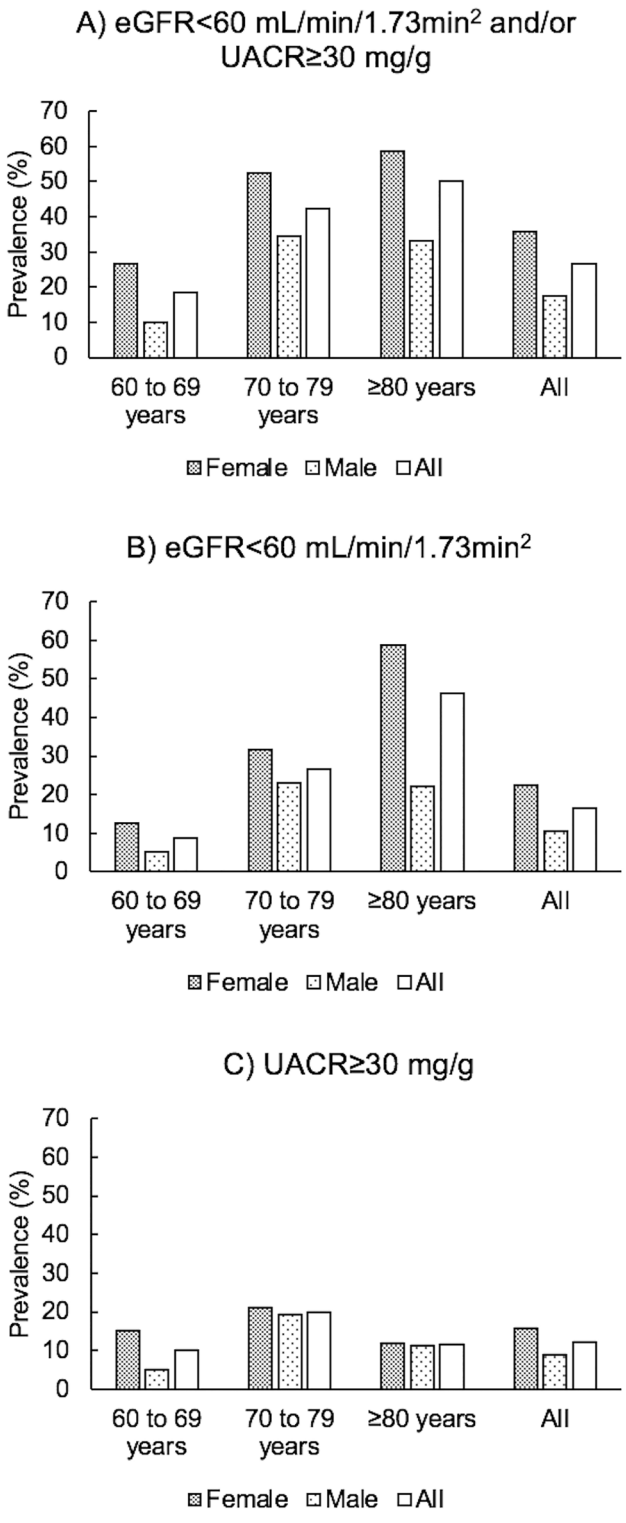


Fig. 2 Prevalence of CKD in older Truká indigenous people according to age group and sex. Cabrobó, Pernambuco, Brazil ($n=229$). *UACR* urinary albumin–creatinine ratio, *CKD* chronic kidney disease, *eGFR* estimated glomerular filtration rate

hypertensives. Early detection and intervention are crucial to reduce the burden of CKD on affected individuals and the healthcare system [4, 9].

The healthcare access challenge faced by indigenous communities is a global issue [5]. Neglecting the eGFR cut-off point of 60 mL/min/1.73 m^2 as a diagnostic criterion for CKD can further hinder healthcare provision, especially in remote areas with limited access to health services [5, 8–10]. Scarce financial resources and inadequate health service infrastructure exacerbate this problem in Brazilian indigenous communities [25, 26]. Remarkably, the prevalence of CKD was higher in our study population compared to an older population living in a Brazilian capital city, which presumably has better access to health services [6].

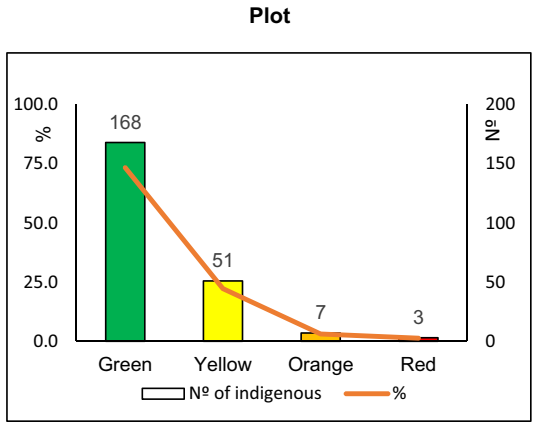
In our sample, a high percentage of chronic noncommunicable diseases, such as diabetes, hypertension, dyslipidemia, and obesity, were observed. These risk factors, together with the natural aging process of the kidney, may exacerbate age-related decline in kidney function and increase susceptibility to developing CKD [6, 7]. Similar trends are observed in indigenous populations in Canada and Australia [8, 9]. In indigenous Canadians with CKD, the majority had DM (60.2%) and a significant percentage had hypertension (27.4%) [9]. These changes in dietary habits are related to the transition from traditional indigenous diets based on locally sourced and hunted foods to the introduction of processed and ultra-processed foods [10, 11, 25].

The prevalence of hypertension increases with age [25–27]. In a study conducted in São Paulo, Brazil, the prevalence was 16% in the population aged 20–59 years and 54.9% in those over 60 years [28]. In our study, hypertension prevalence was higher and strongly associated with CKD. Similar findings are observed in studies with indigenous populations in other regions, indicating higher hypertension rates compared to other populations in the same country or region [5, 8]. Due to the older age of our study population, the prevalence of hypertension was higher compared to other Brazilian indigenous communities, such as the Krenak indigenous people (31.2%) [25] and Mura indigenous people (26.6%) [26].

The study revealed a high prevalence of dyslipidemia and obesity in the indigenous population, consistent with previous research [29, 30]. Specifically, the Guarani, Kaiowa, and Terena ethnic groups had a 31% obesity rate [29]. However, contrary to previous studies in the Brazilian population linking obesity to increased CKD risk [6, 21], we did not find this association in our study. It is important to note that there are conflicting findings in the literature, with the other studies also reporting no connection between obesity and CKD [9, 24, 31]. Nevertheless, the rising obesity rates among indigenous communities increase the risk of DM and hypertension [29]. DM was highly prevalent and associated with CKD in our study, consistent with the rapid increase of

Table 2 Prevalence by risk category of prognostic CKD evolution assessed by eGFR (estimated by CKD-EPI formula without correction for race) and albuminuria in elderly indigenous Truka, Cabrobó, Pernambuco, Brazil

eGRF Stages (ml/min/1.73m²)	A1 Normal to mildly increased <30mg/g	A2 Moderately increased 30 a 300mg/g	A3 Severely increased >300mg/g	All
G1	36 (17.9 %)	2 (8.3 %)	0 (0.0 %)	38 (16.6 %)
G2	132 (65.7 %)	18 (75.0 %)	3 (75.0 %)	153 (66.8 %)
G3a	31 (15.4 %)	2 (8.3 %)	1 (25.0 %)	34 (14.8 %)
G3b	2 (1.0 %)	1 (4.2 %)	0 (0.0%)	3 (1.3 %)
G4	0 (0.0%)	1 (4.2 %)	0 (0.0%)	1 (0.4 %)
G5	0 (0.0%)	0 (0.0 %)	0 (0.0%)	0 (0.0 %)
All	201 (87.8%)	24 (10.5)	4 (1.7%)	229 (100.0%)



Note: Green: low risk (if no other markers of kidney disease, no CKD); Yellow: moderately increased risk; Orange: high risk; Red, very high risk.
CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.
G1- Normal or high (≥90); **G2 -** Mildly decreased (60-89); **G3a** - Mildly to moderately decreased (45-59); **G3b** - Moderately to severely decreased (30-44); **G4** - Severely decreased (15-29); **G5** - Kidney failure (<15).

Green: low risk (if no other markers of kidney disease, no CKD); yellow: moderately increased risk; orange: high risk; red, very high risk

CKD chronic kidney disease, *eGFR* estimated glomerular filtration rate

G1—normal or high (≥90), G2—mildly decreased (60–89), G3a—mildly-to-moderately decreased (45–59), G3b—moderately-to-severely decreased (30–44), G4—severely decreased (15–29), G5—kidney failure (< 15)

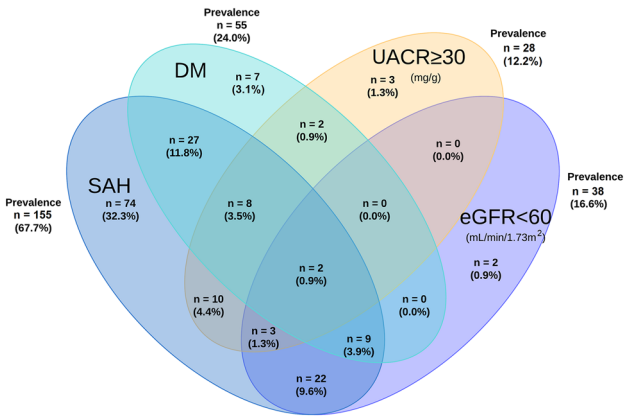


Fig. 3 Venn–Euler diagram of factors associated with CKD in older indigenous Truká people. Cabrobó, Pernambuco ($n=229$). *UACR* urinary albumin–creatinine ratio, *CKD* chronic kidney disease, *eGFR* estimated glomerular filtration rate, *DM* diabetes mellitus, *SAH* systemic arterial hypertension

DM among indigenous peoples [8, 9]. Although a history of cardiovascular disease and smoking are associated with the progression of CKD [4], we did not find an association of these factors with CKD in this study.

The cross-sectional nature of this study is a limitation, as confirmation of CKD requires the presence of abnormalities in eGFR or albuminuria over a period of at least 3 months. Nevertheless, this approach has been frequently utilized in large-scale population surveys [6, 9, 31, 32]. Conducting research in indigenous groups is challenging, especially in communities with limited access. Despite the challenges encountered, our study provides valuable insights into the prevalence of CKD and associated risk factors in an indigenous Brazilian ethnic group. It highlights the importance of access to health care and chronic disease prevention interventions in these communities.

Conclusion

The rapid process of urbanization coupled with dietary changes is significantly contributing to the prevalence of CKD, hypertension, diabetes mellitus, obesity, and dyslipidemia among older indigenous populations. These comorbidities are of great concern and warrant immediate attention. The findings of this study have important implications for public health interventions aimed at promoting health, implementing strategic screening programs, preventive care, and tailored treatments for this vulnerable population.

Acknowledgements The authors would like to acknowledge National Council for Scientific and Technological Development

(CNPq)—Ministry of Science, Technology, Innovations and Communications of Brazil.

Author contributions Conceptualization: OVG, CDFS, and ACA; methodology: OVG and CDFS; formal analysis and investigation: OVG, CDFS, JMN, RFC, VCP, MBN, and ACA; writing—original draft preparation: OVG and CDFS; writing—review and editing: OVG, CDFS, and ACA; supervision: MBN and ACA.

Data availability Data on Brazilian indigenous peoples is restricted by various regulations. Therefore, we are not allowed to freely distribute our dataset. Any researcher interested in our dataset must obtain permission from the official regulatory agency: Fundação Nacional do Índio – FUNAI (https://www.gov.br/funai/pt-br).

Declarations

Conflict of interest The authors declare no conflict of interest.

Ethical standards All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Ethical approval This study was approved by the Human Ethics Committee of the Federal University of Alagoas-CEP/UFAL.

Informed consent Written informed consent was obtained from all participants prior to the study.

Statement of human participants and/or animals All the procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Declaration of Helsinki and its later amendments.

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