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Temporal trend of mortality and hospitalization for chronic kidney disease in adults from Northern Brazil

Alliny Sales Rodrigues, Prof[a,b,c,d], Luiz Carlos de Abreu, PhD[a,d], Mauro Jose de Deus Morais, PhD[c,d,e], Francisco Naildo Cardoso Leitao, Prof[a,c,d], Gardenia Lima Gurgel do Amaral, Prof[e], Edige Felipe de Sousa Santos, PhD[a,d], Ricardo Peres do Souto, PhD[a]

Abstract

We aimed to evaluate mortality and hospital admissions for chronic kidney disease in young adults according to sex and state in the northern region of Brazil, between 1996 and 2017. A population-based time series study using official data on mortality and hospital admissions due to chronic kidney disease in individuals aged 20 to 49 years old, residents of the northern region of Brazil, in the periods 1996–2017 and to 2008–2017, respectively. Chronic kidney disease was defined according to the International Classification of Diseases, 10th revision (N18).

The evolution of mortality from chronic kidney disease decreased by 0.881% per year over the period (1996–2017). In the states of Acre and Amapá, there was a reduction of 5.85% and –5.68% per year, respectively, and in Tocantins, an increase of 4.16% per year. The incidence of hospitalization did not vary between 2008 and 2017. However, 2 states showed an increase in hospitalization rates: Acre (6.08% per year) and Pará (2.83% per year), and 2 states showed a reduction: Amazonas (5.09% per year) and Tocantins (6.23% per year).

In general, there was decrease in mortality rate overtime. However, rate of mortality due to chronic kidney disease increased in the state of Tocantins. The evolution of hospitalization due to chronic kidney disease in a population of young adults remained stationary.

Abbreviations: AIH = hospital admission authorization, APC = annual percent change, CKD = chronic kidney disease, DALY = disability-adjusted life years, DATASUS = information technology department of the national health system, ECKD = end-stage chronic kidney disease, GFR = glomerular filtration rate, IBGE = Brazilian Institute of Geography and Statistics, NCDs = chronic non-communicable diseases, RI = renal failure, RRT = renal replacement therapy, SIH/SUS = Hospital Information System of the Unified Health System, SIM = Mortality Information System, SUS = Unified Health System.

Keywords: chronic kidney disease, hospitalization, mortality, risk factors

1. Introduction

Chronic kidney disease (CKD) currently represents one of the biggest and most relevant public health problems in Brazil and worldwide, with a magnitude that varies from region to region.[1,2] Current international guidelines define CKD as decreased renal function shown by a glomerular filtration rate (GFR) of <60 ml/min per 1.73 m^2.[3] Decreased kidney function is a predictor of hospitalization, cognitive dysfunction, and poor quality of life[4] and can occur at any stage of the disease, regardless of age, generating a high socioeconomic cost for institutions because of the need for disease management.[5] The frequent adverse clinical effects of the disease are associated with a higher risk of individual mortality.[6]

In the most recent update of the Global Burden of Disease Study, the total disability-adjusted life years (DALY) of the CKD has increased significantly from 29.2 thousand to 35.0 thousand in the last decade, which exceeded many neurological disorders, including dementia and Parkinson disease, as well as chronic liver diseases.[7] The main occurrences of hospitalization often coexist with other chronic diseases, such as diabetes and hypertension, which can further limit the functional capacity of individuals,[8,9] impairing quality of life. Cardiovascular diseases are often associated with CKD, which

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[a] Centro Universitário FMABC, Santo André, Sao Paulo, Brazil, [b] Acre State Health Secretariat (SESACRE), Rio Branco, Acre, Brazil, [c] Multidisciplinary Laboratory for Studies and Scientific Writing in Health Sciences (LaMEECCS), Federal University of Acre (UFAC), Rio Branco, Acre, Brazil, [d] Laboratory of Study Design and Scientific Writing (LaDEEC/FMABC), Santo Andre, Sao Paulo, Brazil, [e] Federal University of Acre (UFAC), Cruzeiro do Sul, Acre, Brazil.

Correspondence: Mauro Jose de Deus Morais (e-mail: mauro.morais@ufac.br).

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is of great importance when considering that these patients are more likely to die from cardiovascular disease than to progress to renal failure.[8]

Allied to these clinical conditions, there are psychosocial repercussions that are stressful for patients, impacting their quality of life. In the United States, in a cross-sectional survey of younger adults (20–64 years), the prevalence of self-reported difficulty in activities of daily living was significantly higher in patients with CKD than in those without CKD, after adjustment for age and sex.[10] Once diagnosed with CKD, patients acquire a pattern of expectations and desires related to the exponential impact of the disease on their personal and professional lives, caused by complex therapeutic regimes and changes in their daily lives, requiring adaptation and coping with the disease and/or treatment dialysis.[11]

In most cases, the development of the disease in young adults can have a favorable prognosis when performed early. However, symptoms may be underestimated, allowing for persistent kidney damage and a potential increase in the chronicity of the disease in adulthood.[12] Renal replacement therapy (RRT) is the only way to sustain life in the advanced stages of the disease. RRT options include hemodialysis, peritoneal dialysis, and kidney transplantation. However, more than two-thirds of patients with the disease die without starting therapy, and of those who start, only one-third survive for more than 5 years.[13] Currently, 2.5 million patients receive kidney transplant therapy, and this is expected to increase to 5.4 million by 2030,[14,15],[16].

Worldwide, between 1990 and 2017, CKD health indicators showed a dismal profile: the mortality rate, incidence, and rate of kidney transplantation increased by 2.8%, 29.3%, and 34.4%, respectively.[14] The disease led to 1.2 million deaths in 2017, and, at best, an increase of 2.2 million deaths was projected[17] and will become the fifth largest cause of years of life lost by 2040.[18]

Wide variations between regions and countries were also observed in deaths from CKD; in central Latin America, central Asia, and high-income North America, mortality from CKD increased by approximately 60%. In Central and Andean Latin America, CKD was the second- and fifth-ranked cause of death in 2017, respectively. Overall, these data clearly confirm that low- and middle-income countries increasingly carry the global burden of disease. Middle sociodemographic level,[14,19] In countries with limited resources, there is a need to optimize screening strategies for diseases that often challenge health systems.[20]

In Brazil, it is estimated that more than 10 million people have some degree of renal impairment, aggravating the fact that it is a disease unknown to many people, increasing the possibility of late diagnosis, with consequent abandonment of treatment Census data from the Brazilian Society of Nephrology indicated that, in 2019, 45,852 individuals were on renal replacement therapy, an increase of 7.7% compared to 2018. The incidence was 218 patients per million inhabitants, which was 6.8% greater than that in 2018.[21]

It is estimated that annually in Brazil, about 4000 patients do not get a place to treat CKD.[22] In Brazil, from 2012 to 2017, in the age group of 20 to 49 years, the rate of hospitalization for renal failure (RI) was 27.25%,[23,24] The start of treatment, which is essential for the maintenance of life, should be as early as possible, whether conservative or dialysis.[25] In relation to mortality, in 2009, CKD was responsible for a rate of 3.8/100,000 inhabitants, reaching a level of eighth place in death among the countries of the Americas.[26] In the period from 2014 to 2019, the RI was 12.78%, with the North region standing out with 13.95%.[5]

The northern region of Brazil represents 45% of the national territory, with a population of 18,430,980 inhabitants.[27] According to the 2019 Brazilian dialysis survey, there was a reduction in the average number of patients per nephrologist in this region.[21,28] Regional differences in northern Brazil highlight the precarious living conditions and difficult access to the health of its population, and nephrology services are concentrated in the capitals of the 7 states, which often delays early diagnosis.[21,29]

Although CKD is more common in people aged 65 years or older (38%) than in those aged 45–64 years (12%) or 18–44 years (6%),[3] an increase was found in adults aged 20–55 years, mainly associated with diabetes.[12] The relationship between kidney disease and the risk of death and cardiovascular disease in young adults (mean age 52 years) was investigated in a large and diverse population of adults (1120,295), with a mean follow-up of 2.84 years; there was an independent and graded association between lower estimated GFR levels and the risks of death, cardiovascular events, and hospitalization.[30] In addition, the likelihood of progression to end-stage chronic kidney disease (ECKD) is higher in younger individuals (≤65 years of age).[4]

Given the above, the aim of this study was to evaluate the trend of mortality and the incidence of hospitalization due to CKD in individuals between 20 and 49 years of age in the northern region of Brazil.

2. Methods

2.1. Design, study site, and period

This is an ecological time series study using secondary and official data on deaths and hospital admissions due to chronic kidney disease from the Mortality Information System (SIM) and the Hospital Information System of the Unified Health System (SIH/SUS). These indicators were evaluated based on data from the northern region of Brazil, which comprises the states of Acre, Amapá, Amazonas, Pará, Rondônia, Roraima, and Tocantins. Data on deaths corresponded to the period between 1996 and 2017 and those on hospital admissions to the period between 2008 and 2017. Regarding hospitalizations for CKD, due to database restrictions, it was only possible to compile the data from 2008 onwards. In the latter case, the information referred to the period from January 2008, when the Table of Procedures, Medicines, Orthotics and Prostheses, and Special Materials of the Unified Health System (SUS) was implemented, established by Ordinance GM/MS n. 321, on February 8, 2007. This system provides information available on the website of the SUS IT Department (DATASUS), maintained by the Ministry of Health of Brazil.

2.2. Study population and sample

All deaths and hospitalizations in young adults were considered, defined by individuals with an age cutoff point of 20 to 49 years.[31] Thus, gross and standardized rates of mortality and incidence of hospital admissions due to chronic kidney disease in the North Region, by age group, using the World Health Organization standard population for 2000–2025, were presented.

Data were collected by the place of residence of the deaths. The units of analysis selected for this study were the states of the northern region of Brazil, which have a high degree of urbanization, with an estimated population of 7091,286 million individuals aged 20-49 years.[32]

Population data were extracted from databases made available by the Brazilian Institute of Geography and Statistics (IBGE) and were obtained from the demographic census carried out in 2010 and inter-census estimates for other years.

All deaths that occurred between 1996 and 2017, whose underlying cause was chronic kidney disease, according to the 10th Revision of the International Classification of Diseases (ICD-10) code N18, were included. The age group of the study subjects was 20 to 49 years old, defined as young adults with noncommunicable chronic diseases.[33]

Data on deaths from CKD were collected using for the total population and stratified according to age groups (20–24; 25–29; 30–34; 35–39; 40–44; 45–49 years), states in the North

region, gender (male and female) and calendar years (from 1996 to 2017), available in the DATASUS database.

2.3. Information system

SIM receives, processes, checks the validity, and provides information on deaths, which comprises 96.1% of all deaths registered in Brazil.[34] Data on deaths are available on the website of the Information Technology Department of the National Health System (DATASUS), the country's official, free, and public database of health information, where information on deaths from chronic kidney disease used in these data was collected. It is noteworthy that such a system is used to develop public policies in the country.

Data on admissions were obtained from the SUS Hospital Information System (SIH/SUS). These are information from public hospitals and SUS network hospitals that send information on admissions by hospital admission authorization (AIH) to municipal and state managers. AIHs are processed by DATASUS, and their data are made available for public consultation on the Internet.

2.4. Study variables and data extraction

The mortality and hospital admission rates were constructed according to the distribution according to sex (male and female), age group (20–24, 25–29, 30–34, 35–39, 40–44, 45–49 years old) year (1996–2017 and 2008–2017, respectively), expressed per 100,000 inhabitants, in crude and standardized form. For the standardization procedure, performed by age, the direct method was used, and the percentage distribution of the world population provided by the World Health Organization between 2000 and 2025 was considered as the standard. All these data were extracted and merged into the TabNet program to create a DBF database.

Table 1

Mortality due to CKD (100,000 inhabitants), in individuals aged 20–49 years, according to demographic and clinical characteristics = North Region, Brazil, 1996–2017.

Demographic and clinical characteristics	Deaths 1996–2017	Deaths % 1996–2017	Annual mortality 1996–2017
TOTAL	1259	100%	0.9
Sex			
Male	689	54.7	1.0
Female	570	45.3	0.9
Age group (yr)			
20–24	117	9.3	0.4
25–29	127	10.1	0.5
30–34	163	12.9	0.7
35–39	210	16.7	1.0
40–44	266	21.1	1.6
45–49	376	29.9	2.8
States			
Acre (AC)	42	3.3	0.8
Amapá (AP)	53	4.2	1.1
Amazonas (AM)	292	23.2	1.0
Pará (PA)	580	46.1	0.9
Rondônia (RO)	158	12.5	1.0
Roraima (RR)	58	4.6	1.6
Tocantins (TO)	76	6.0	0.6
Skin color			
White	169	13.4	–
Black	119	9.5	–
Yellow	5	0.4	–
Mixed	752	59.7	–
Indigenous	22	1.7	–
Ignored	192	15.3	–
Marital status			
Single	44	51.1	–
Married	16	29.3	–
Widow/widower	1	1.2	–
Legally separated	1	1.7	–
Other	8	6.4	–
Ignored	3	10.2	–
Education			
Non	157	12.5	–
1–3 years	210	16.7	–
4–7 years	260	20.7	–
8–11 years	191	15.2	–
12 years or more	46	3.7	–
Ignored	377	29.9	–
Place of occurrence			
Hospital	1103	87.6	–
Other health establishment	23	1.8	–
Home	95	7.5	–
Public highway	15	1.2	–
Others	21	1.7	–
Ignored	2	0.2	–

Chronic Kidney Disease (CKD).

Source: Sistema de Informacoes sobre Mortalidade (SIM). Dados do Departamento de Informática do Sistema Unico de Saude (DATASUS – www.datasus.gov.br). Ministerio da Saúde, Brasil.

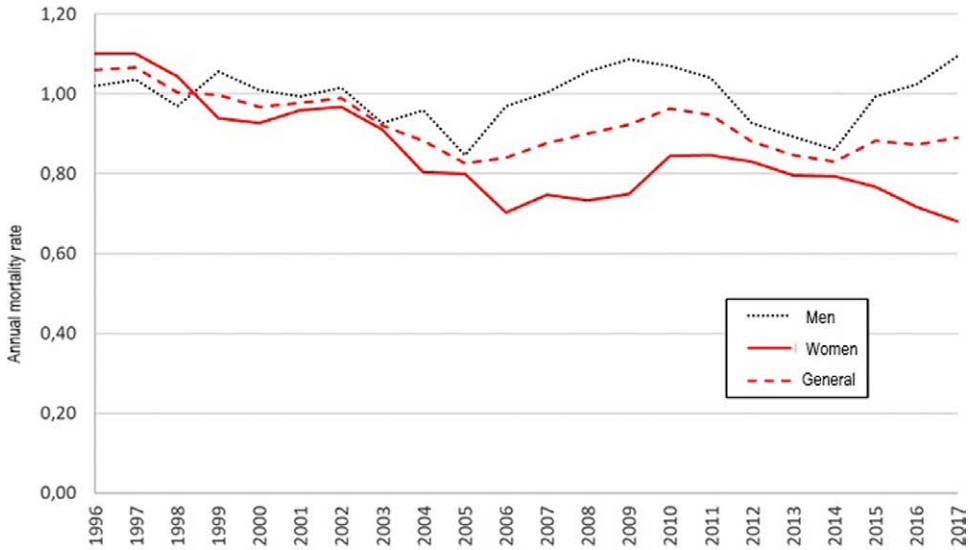

Figure 1. Total Chronic Kidney Disease Mortality and stratified by sex for individuals in the Northern Region of Brazil aged between 20 and 49 years in the period 1996 to 2017.

2.5. Statistical analysis

Population mortality rates were calculated and stratified by sex, age groups, and states, expressed per 100,000 inhabitants. This procedure ensured sufficient cases and the stability of the analyses.

In the time series, which is a set of observations made in sequence over time, where the analyzed times were placed in order, which was fundamental for the final analysis, thus following the methodological indications presented by[35] were used. The time series was constructed using the Prais-Winsten regression model, which allows for first-order autocorrelation correction in the analysis of a series of values organized in time. Thus, the angular coefficient (β) and probability (p) were estimated, considering a significance level of 95%.

The modeling process included transforming the rates into a logarithmic function of the base 10. In addition, the Durbin-Watson test was used, and the annual growth or decline rates were calculated according to the values of the annual percent change specific by sex and states in the northern region of Brazil. This procedure made it possible to classify the temporal trends as increasing, decreasing, or stationary, in addition to quantifying the annual increment. In addition, we used the technique of central moving averages of order 3 to facilitate the visualization of mortality trends and reduce white noise in the graphs of the historical series. All analyses were performed using the Stata 15.1 statistical program (CollegeStation, TX).

2.6. Ethical and legal aspects of research

This study involved only the description and analysis of secondary population data (general population census) and deaths collected in the Information System on Mortality and hospital admissions of the SIH/SUS. All these sources of information are in the public domain. No additional information, which was not freely accessible, was collected. Individual identification information was not obtained in this study. This study did not require approval from the Research Ethics Committee (CEP) of Brazil.

3. Results

Regarding deaths (Table 1), 1259 deaths due to chronic kidney disease were reported in individuals aged 20–-9 years (young adults) living in the northern region of Brazil during the study period (1996–2017). Most deaths occurred among men (54.7%), but the mortality rate was very similar between men and women. The proportion of deaths and mortality rates increased with age. The oldest age group (40–49 years old) in the study had a higher relative frequency of deaths (29.9%) and a higher mortality rate (2.8 deaths per 100,000 inhabitants per year). The states with the highest number of deaths were Pará and Amazonas (46.1% and 23.2%, respectively). The highest mortality rate in the period occurred in Roraima and the lowest in Tocantins, with 1.6 and 0.6 deaths per 100,000 inhabitants per year.

According to the demographic characteristics (Table 1), the predominance of deaths was identified in brown-skinned people (59.7%), single (51.1%), without education or with up to 7 years of study (49, 9%). More deaths occurred in hospitals (87.7%).

The temporal evolution of the annual mortality rate due to general CKD, stratified by sex, is shown in Figure 1. Considering both sexes, in the period 1996 to 2017, there was a reduction of 0.88% per year in mortality among young adults in the northern region of Brazil.

Regarding the specific curves for each sex (Fig. 1), it was noted that in the first 2 years mortality among women was higher than that among men. From 1998 onwards, this relationship was inverted, and the mortality rate for men increased and remained the same until the end of the time series. Mortality in the female population decreased over time, reaching its lowest value in the last year of the series. The male population mortality in the period oscillated in increasing and decreasing intervals, closing in the last year at a higher value than at the beginning of the series. The decrease in the female mortality rate occurred at a rate of –1.86% per year during the study period. In men, there were no statistically significant variations.

When analyzing the annual percentage change in mortality from CKD for young adults in the states of the North Region of Brazil, a stationary trend of the rate was noted in Amazonas, Rondônia, Roraima, and Pará. In Acre and Amapá, there was a reduction in mortality (–5.86% and –5.68% per year). In the state of Tocantins, there was an increase in mortality of 4.16% per year (Table 2).

The states of Acre, Amapá, and Tocantins stood out for their high mortality rates due to kidney disease. However, over the years, Acre and Amapá have declined. In contrast, the state of Tocantins showed an increasing trend over the years, surpassing Acre and Amapá in terms of mortality (Fig. 2).

Table 2

Prais-Winsten regression estimates for mortality rates in individuals aged 20–49, Northern Brazil, 1996–2017.

	Prais-Winsten regression				
Standardized mortality	**B**	***P***	***R²***	**APC (%)**	**APC (95%CI)**
Estado					
Rondonia	0.012	0.162	0.054	2.81	(–1.21: 6.98)
Acre	–0.026	**0.029**	0.213	–5.86	(–10.76: 0.68)
Amazonas	–0.003	0.404	–0.012	–0.63	(–2.16: 0.92)
Roraima	–0.005	0.638	–0.046	–1.25	(–6.52: 4.32)
Para	–0.006	0.214	0.005	–1.41	(–3.67: 0.90)
Amapa	–0.025	**0.030**	0.204	–5.68	(–10.46: –0.65)
Tocantins	0.017	**0.035**	0.172	4.16	(0.33: 8.14)
Men	–0.0004	0.811	–0.044	–0.10	(–0.91: 0.73)
Women	–0.008	**0.002**	0.383	–1.86	(–2.90: –0.80)
Total (North Region)	–0.004	**0.013**	0.238	–0.88	(–1.56: –0.21)

The values in bold are because they had a significance of 0.05%.
APC = annual percent change, 95% CI = 95% confidence interval.

From 2008 to 2017 (Table 3), there were 16,749 hospitalizations of young adults in the northern region of Brazil, corresponding to an average annual incidence of 22.9 hospitalizations per 100,000 inhabitants. The proportion and incidence of hospitalizations were similar for men and women and increased with age. Hospitalization in the last age group (from 40 to 49 years old) was the most frequent (24.7%) and the most incident (53.1 admissions per 100,000 inhabitants per year). The states with the highest proportion of hospitalizations were Pará and Amazonas (43.5% and 18.5%, respectively). The highest incidences of hospitalization occurred in Acre, Tocantins, and Roraima (44.0, 33.1, and 28.2) admissions per 100,000 inhabitants per year). The other states had an incidence of hospitalization close to 20 admissions per 100,000 inhabitants per year.

According to demographic characteristics (Table 3), there was a predominance of hospitalizations in people with mixed skin color (60.3%). Most patients were on an emergency basis (78.2%). The average hospital stay was 11.8 days for men and 12.9 days for women. In 8.5% (1433) of admissions, death occurred in the hospital

Despite the stability of hospitalization incidences for the Northern Region over the period studied, there was a temporal variation of this parameter in some states when analyzed separately (Fig. 3). There was no increase or reduction in hospitalization rates in only 2 states (Amapá and Rondônia). Two others showed an increase in hospitalization rates during the study period: Acre (6.08% per year) and Pará (2.83% per year). Two states showed a reduction in hospitalization rates between 2008 and 2017: Amazonas (5.09% per year) and Tocantins (6.23% per year). The temporal trends of hospitalizations in the 5 mentioned, with an increase or decrease over the period, are shown in Figure 3. In the graph, it is highlighted that in all states, the variations occurred with greater intensity from 2010 onwards.

In Figure 3, during the period 2008–2017, the states of Acre and Pará showed an increasing incidence of hospitalization, unlike the states of Amazonas and Tocantins, which showed a reduction as of 2009.

4. Discussion

In the northern region of Brazil, from 2008 to 2017, the incidence of hospitalization among young adults was higher in the 40–49 age group. It must be considered that, in the same country and within its regions, marked socioeconomic differences can influence the incidence of the disease. Pará was the state with the highest number of hospitalizations (7299). The same state has a higher population concentration, which may be related to the high number of hospitalizations or lack of adequate outpatient and/or specialized treatment, with an increased risk of complications and hospitalization. Therefore, social disadvantage factors, such as geographic distance to healthcare, are strongly associated with disease worsening rates.[35] In turn, the states of Amazonas and Tocantins had a reduction in these rates, suggesting that the health system has beneficial effects on the population, whether through promotion, prevention, and/or rehabilitation, as postulated by.[24]

In general, a study revealed that the worst rates of use of outpatient and specialized health services for CKD are concentrated in the North region, with low availability of doctors (1/1000 inhabitants), 7 times lower than in the capitals of the South of Brazil (7.1/1000).[36]

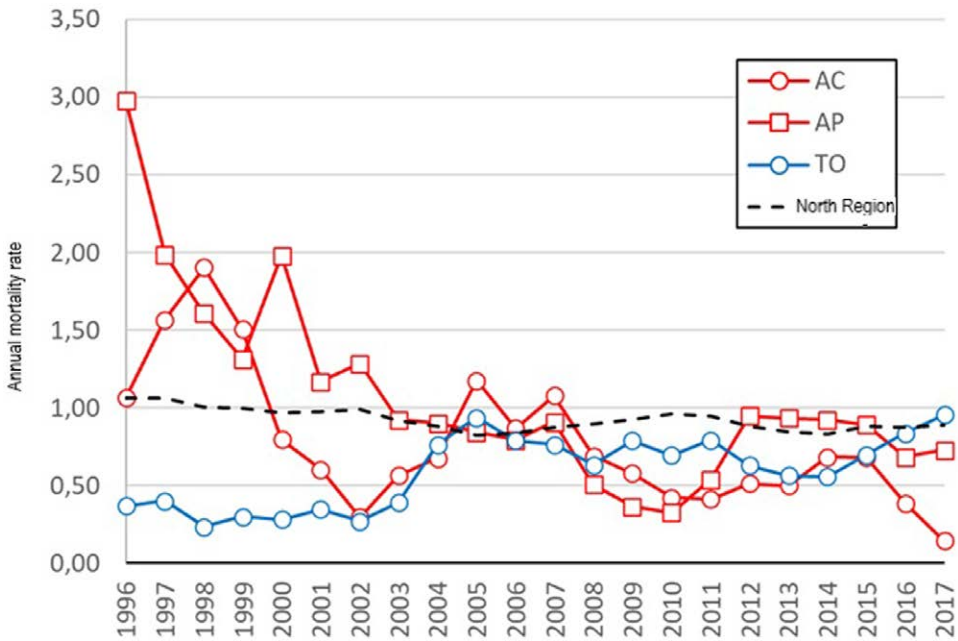

Figure 2. Mortality from Chronic Kidney Disease in the North Region and in the States of Acre (AC), Amapá (AP) and Tocantins (TO) for individuals aged between 20 and 49 years during the period 1996 to 2017.

Table 3

Incidence of hospitalization for kidney disease (100,000 inhabitants) in individuals aged 20–49 years, according to demographic and clinical characteristics, North Region, Brazil, 2008–2017.

Demographic and clinical characteristics	Hospitalizations 2008–2017	Proportion of admissions 2008–2017	Annual incidence 2008–2017
TOTAL	16,779	100%	22.9
Sex			
Male	8526	50.8	23.1
Female	8253	49.2	22.6
Age group (years)			
20–24	1819	10.8	11.3
25–29	2362	14.1	15.4
30–34	2486	14.8	18.6
35–39	2869	17.1	25.7
40–44	3103	18.5	32.8
45–49	4140	24.7	53.1
States			
Acre (AC)	1452	8.7	44.0
Amapa (AP)	679	4.0	21.8
Amazonas (AM)	3124	18.6	19.8
Para (PA)	7299	43.5	20.7
Rondnia (RO)	1541	9.2	20.4
Roraima (RR)	596	3.6	28.2
Tocantins (TO)	2088	12.4	33.1
Skin color			
White	773	4.6	–
Black	443	2.6	–
Yellow	10,125	60.3	–
Mixed	88	0.5	–
Indigenous	76	0.5	–
Ignored	5274	31.4	–
Service			
Elective	3666	21.8	–
Urgency	13,113	78.2	–
Total cost (Brazilian = reais)			
Men	21,539,592.73	54,6	–
Women	17,861,205.09	45,4	–
Average hospital stay (d)			
Men	11.8	–	–
Women	12.9	–	–
Hospital lethality			
Men	688	8,1	–
Women	745	9,0	–
Total	1433	8,5	–

Chronic Kidney Disease (CKD). Renal failure (N17-N19).

Source: Sistema de Informacoes Hospitalares do SUS-SIH/SUS.

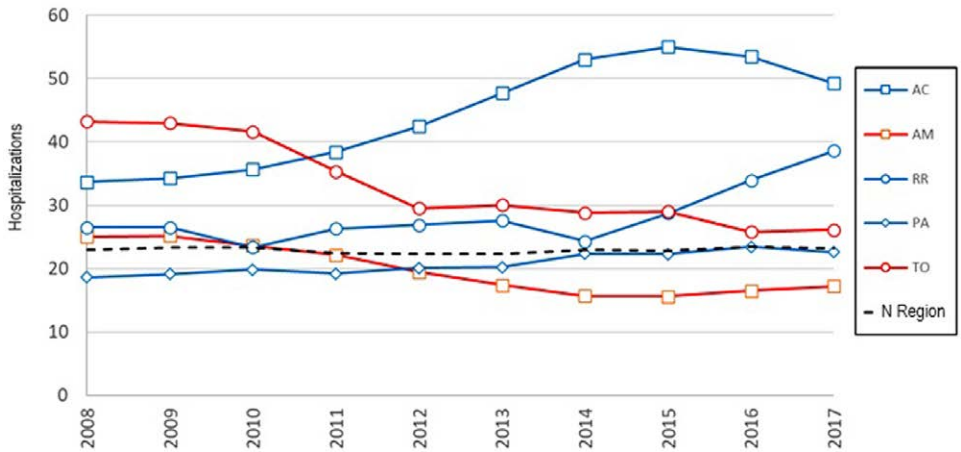

Figure 3. Incidence of hospitalization for Chronic Kidney Disease in the North Region and in the States of Acre (AC), Amazonas (AM), Pará (PA), Roraima (RR) and Tocantins (TO) for individuals aged between 20 and 49 years during the period from 1996 to 2017.

Table 4

Prais-Winsten regression estimates for admission rates in individuals aged 20–49, Northern Brazil, 1996–2017.

	Prais-Winsten Regression				
Standardized hospitalization	β	***P***	***R²***	**APC (%)**	**(IC95%)**
Staye					
Rondônia	0.013	0.141	–0.076	3.01	(–1.21: 7.42)
Acre	0.026	**0.012**	0.466	6.08	(1.72: 10.64)
Amazonas	–0.023	**0.018**	0.950	–5.09	(–8.88: –1.13)
Roraima	0.015	0.223	0.040	3.44	(–2.49: 9.74)
Pará	0.0012	**0.003**	0.980	2.83	(1.23: 4.46)
Amapá	0.001	0.928	–	0.21	(–4.91: 5.62)
Tocantins	–0.028	**0.003**	0.649	–6.23	(–9.53: –2.80)
Men	–0.001	0.983	0.997	–0.01	(–0.68: 0.67)
Women	0.002	0.656	0.858	0.39	(–1.53: 2.34)
Total (North Region)	0.001	0.737	0.947	0.19	(–1.04: 1.43)

The values in bold are because they had a significance of 0.05%.
95% CI = 95% confidence interval, APC = annual percent change.

Another aspect of the study was that the proportion and incidence of hospitalizations were similar for both men and women. With regard to sex, it can be speculated that this result is due to the health care provided by both. Where access to health services and actions is scarce or nonexistent, the search for early intervention is a powerful tool that can minimize the progression of CKD.[29] A study carried out in Brazil, analyzing hospitalizations for CKD from 1996 to 2017, observed that the most affected population was male, with a tendency towards an increase in the number of hospitalizations during that period. A lower incidence of hospitalization was also noted in women. This can be explained by women's greater access to and adherence to treatment, which is more influenced by health promotion and prevention.[24]

In Brazil, when estimating the cost of CKD and ECKD attributable to diabetes, a study found that, with 51% of the population being women, the cost was higher than for men. This finding was explained by 3 factors: a higher prevalence of diabetes, a higher relative risk of CKD and ECKD, and physiological issues in the female sex.[37] Diabetes accounts for 30%–50% of all CKD cases, affecting 285 million (6.4%) adults worldwide, although this number is expected to increase by 69% in high-income countries and 20% in low-income countries. average income by 2030.[38] As for skin color, brown predominated, with 10,125 hospitalizations in the period from 2008 to 2017. A continuous national survey by sample of households showed that, between 2012 and 2016, the percentage of whites in the population fell from 46.6% to 44.2%, while the brown rose from 45.3% to 46.7%.[39] Investigated[40] the prevalence of self-reported medical diagnosis of CKD and found that individuals who identified themselves as brown had the highest prevalence among racial groups.[41] demonstrated that individuals with low socioeconomic status have a 60% higher risk of developing CKD than those with a high socioeconomic status. In Brazil, unemployed and illiterate people are more likely to be black and brown, with a consequent impact on the distribution of chronic noncommunicable diseases (NCDs).[42]

The incidence and progression of CKD also vary among countries according to ethnicity and social class. People in the lowest socioeconomic quartile have a 60% higher risk of progressive CKD than those in the highest quartile.[34] Untangling the socioeconomic effects of the effects of ethnicity can be challenging in societies where disadvantages are associated with racial backgrounds. Although socioeconomic status plays a specific role in the incidence and prevalence of CKD, this does not fully explain the increased risk of racial or ethnic minorities.[37]

Due to the prolonged course of the disease, patients with CKD encounter many health problems and are vulnerable to frequent hospitalization. There are many reasons for this vulnerability, such as the high incidence of infections and late referral to nephrologists. Unadjusted hospitalization rates in the CKD population, reflecting the total burden of disease, are 3–5 times higher than those in patients without the disease. After adjusting for sex, previous hospitalizations, and comorbidities, the rates of patients with CKD were 1.4 times higher.[43]

A higher number of deaths was identified in men from 1996 to 2017, with a higher number of deaths in 2016. In the female population, fewer deaths and a decrease over time were observed. In general, mortality decreased with an increase in mortality rates due to CKD in the state of Tocantins. This approach to sex in nephrology has been incipient in understanding the behavior of CKD and establishing focused and personalized interventions. Despite this situation, the authors argued that environmental and social determinants interact in both men and women to determine the occurrence, progression, and outcomes of the disease.[7,37,44]

It is possible that the closure at a higher value in 2017, compared to 1996, is explained by the lower use of health services, lower adherence to treatments, and psychological variables that influence their health habits. It can also be speculated that, in relation to the state of Tocantins, the increase may be determined by the underdiagnosis related to this and/or other chronic diseases and by the limitations in the availability, access, and quality of health care. More distant areas, where the increase in patients with CKD is found, may harbor the smallest concentrations of health resources (clinics, doctors, nurses, medical equipment), resulting in late diagnosis and suboptimal treatment. These hypotheses should be addressed, researched, and corroborated in future studies.

Using a similar methodology and the same observation period,[24] analyzed mortality and the incidence of hospital admissions for CKD in the state of Espírito Santo, southeastern Brazil. The results showed that the mortality was stationary. When stratified by sex, the phenomenon remained when evaluated over the 20-year period, although there was an increase between 2011 and 2014. However, when evaluating the mortality trend for years above 2005, an increase of 7.87% was observed per year for women.

This study has limitations related to the use of the SIH/SUS database. Data coverage depends on the degree of use and access of the population to hospital services contracted and associated with the SUS. There is no identification of readmissions and transfers from other hospitals, which eventually leads to double or triple counting of the same patient who goes through these situations.

It is hoped that the data found in this study can be considered a valuable resource for guiding the epidemiological monitoring of CKD and prioritizing the most appropriate health interventions for each context.

Knowledge of the disease is necessary, especially in high-risk populations, in addition to strengthening diagnosis and control in its early stages and strengthening institutional capacity through the training of health personnel, especially in primary care, to prevent the incidence of hospitalizations and deaths.

5. Conclusions

In general, there was decrease in mortality rate overtime. However, rate of mortality due to CKD increased in the state of Tocantins. The number of deaths was higher in males, with a higher number of cases in year 2016. The evolution of hospitalization due to CKD in a population of young adults remained stationary. The state of Acre and Pará showed increased rates of hospitalization. The rate of hospitalization was similar between men and women.

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Author contributions

Alliny Sales Rodrigues: Collected the data, carried out the experiments, and wrote the manuscript.

Edit Felipe de Sousa Santos: Wrote the manuscript and followed the guidelines of the journal.

Mauro Jose de Deus Morais: Wrote the manuscript, followed the journal guidelines, and reviewed the statistical analyses.

Francisco Naildo Cardoso Leitao: Wrote the manuscript, followed the journal guidelines, and reviewed the statistical analyses.

Gardenia Lima Gurgel do Amaral: Wrote the manuscript, followed the journal guidelines, and reviewed the statistical analyses.

Luiz Carlos de Abreu: Collected data, conducted the experiments, and wrote the manuscript.

Ricardo Peres do Souto: Collected data, conducted the experiments, and wrote the manuscript.

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