Temporal trend in mortality due to protein-calorie malnutrition among older adults in Brazil during the period 2000-2021

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Abstract

Objective: To analyze the temporal trend in mortality from protein-calorie malnutrition among older adults in Brazil from 2000 to 2021. *Method:* An epidemiological study with an ecological, descriptive analytical design was conducted. Annual data were obtained from the Brazilian Mortality Information System (SIM) for the specified period. Crude and age-adjusted mortality rates were calculated using the direct method and the world population as a reference. The Prais-Winsten model and Annual Percentage Change (APC) were used to observe the mortality trend. *Results:* From 2000 to 2021, the general mortality rate from protein-calorie malnutrition in older adults fluctuated, reaching a maximum in 2006 (28.74) and minimum in 2021 (10.64), with a decreasing trend (β=-0.015; p=0.005; APC=-3.454%). Analysis of standardized mortality rates by sex revealed a decreasing trend for both genders, and higher rates among men throughout the historical series. Regarding age group, a decline in mortality among individuals aged 60-79 years and a stable trend in subjects aged ≥ 80 years was observed. *Conclusion:* The study results showed a drop in the rate of mortality from protein-calorie malnutrition among older adults. However, mortality rates from this modifiable cause remain high, underscoring the need to improve health care for this specific population.

Keywords: Time Series Studies. Mortality. Protein-Calorie Malnutrition. Geriatric Health.

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INTRODUCTION

The increase in life expectancy and low birth rates are transforming age pyramids around the world[1]. This demographic transition is accompanied by a shift in the epidemiological and nutritional profile of populations, particularly for chronic non-communicable diseases (NCDs) which have a high prevalence in older individuals. In 2016, 63.9% of deaths worldwide occurred among the older population, where chronic NCDs were the leading causes of death[2]. In Brazil, NCDs account for almost 70% of disability-adjusted life years[2].

Evidence shows that older individuals are more prone to nutritional deficiencies, particularly in situations of disease and stress. In this scenario, protein-calorie malnutrition can develop as a result of social and physiological factors, negatively impacting activities of daily living and physiological functions of the human body[3]. Moreover, this status is associated with a reduction in quality of life, greater susceptibility to infections and increased mortality rate[4-6].

Although chronic NCDs, especially those related to obesity, are currently the leading cause of death in the global population, deaths from malnutrition remains a serious public health problem, especially in low-to-medium income countries[7,8]. Brazilian data for 2012 shows that the South region of the country had the lowest death rate due to malnutrition in older adults (16.37/100,000), whereas the Northeast region had the highest rate (31.80/100,000)[8].

Amid this scenario, studies on protein-calorie malnutrition-related mortality are important, given this represents a common cause of morbimortality which can be avoided by quality adequate healthcare, guaranteed under government policies for the promotion of active aging[9,10]. In addition, knowing the rates of protein-calorie malnutrition-related mortality in older adults and assessing mortality trends for a historic 20-year series can help inform decision-making by health managers and aid planning and implementation of public policies, given that potential shifts in population patterns may have taken place over this timeframe.

Therefore, the objective of the present study was to analyze the time-trend in protein-calorie-related mortality among Brazilian older adults during the 2000-2021 period.

METHOD

A time-series study was conducted based on retrospective secondary data on protein-calorie malnutrition-related mortality for the Brazilian population of older adults.

For the present study, older adults were defined as individuals aged ≥60 years. Death-related information was extracted from the Sistema de Informação de Mortalidade (SIM) – Mortality Information System run by the Informatics Department of the National Health System (DATASUS) of the Ministry of Health (MS)[11]. Deaths of persons registered in Brazil for the period 2000-2021, by place of occurrence, were selected.

All deaths of older adults due to protein-calorie malnutrition in Brazilian territory notified on the SIM-MS were analyzed. Cases of deaths classified with codes E43 and E46 under the category "protein-calorie malnutrition" during the period by the criteria of the International Statistical Classification of Diseases and Related Health Problems ICD-10 (10th Revision) were selected[12]. Records not containing information on age and sex were excluded from the analysis. During the period spanning from 2000 to 2021, a total of 93,868 deaths of older adults due to the cause specified were registered in Brazil, from which 18 cases were subsequently excluded after applying the criteria, giving a final total of 93.850 for inclusion in the analysis.

The descriptive analysis involved the variables: year of death (2000-2021), sex (male; female), age group in years (60-64; 65-69; 70-74; 75-79; ≥80), race/color (white; black; yellow; brown; indigenous; ignored), education in years of formal study (1-3; 4-7; 8-11; ≥12; ignored), and marital status (single; married; widowed; legally separated; others; ignored).

General and specific mortality rates were calculated by dividing the number of deaths which occurred in the study population (total deaths, deaths by sex, deaths by age group) by the corresponding population in the period and group (sex and age

group), as estimated by the Brazilian Institute of Geography and Statistics (IBGE)[13], multiplied by 100,000 population. Subsequently, rates of mortality from protein-calorie malnutrition of older adults were standardized for age using the direct method and the world population as a reference. The age-adjusted rate calculated was: ∑ (age-specific rate) × (world population reference in age group)/∑ world population reference[14].

For the purposes of analysis, using the data obtained, the absolute and relative distributions, mortality rate indicator, standardization of rates and values of decimal logarithms, were calculated, and graphs plotted.

The time-trend of the indicators was analyzed with Prais-Winsten linear regression, which takes into account serial autocorrelation[15]. To this end, regression analysis was performed of the decimal logarithm (log of base 10) of each indicator (dependent variable – Y) according to year of registration of death (independent variable – X), adopting the formula:

$$\text{Log (Yt)} = \beta)0 + \beta 1x,$$

where: Log(Yt): value of decimal logarithm of indicator Y in year t; β0: constant or intercept; β1: coefficient of linear trend; x: year of registration of death.

The trend was classified as increasing (when β1 coefficient was positive and *p*-value <0.05 on Wald test), decreasing (when β1 coefficient was negative and *p*-value <0.05 on Wald test) or stable (when p-value >0.05 on Wald test, irrespective of value of β1 coefficient)[15].

The following formula was used for Annual Percentage Change (APC):

$$\text{APC} = (-1+10\beta)*100$$

Where β value denotes the coefficient of slope of the straight line formed on regression.

The formula below was used for calculating confidence interval (CI) of the measures of the study:

$$\text{CI95\%} = (-1+10(\beta \pm t*SE))*100$$

Where *t* is the value at which Student´s *t* distribution attains 21 degrees of freedom and a two-tailed $CI_{95\%}$; and *SE* is the standard error of the estimate of β, furnished by regression analysis.

According to Resolution no. 510/2016 of the National Board of Health (CNS) and to Law no. 12.527/2011, studies that utilize information freely available in the public domain and whose data does not enable names to be identified, do not require Research Ethics Committee assessment.

DATA AVAILABILITY

The complete dataset underpinning the results of the present study is available upon request from the corresponding author Ronilson Ferreira Freitas.

RESULTS

During the 2000-2021 period, a total of 93.850 deaths of older adults from protein-calorie malnutrition were registered. The main sociodemographic characteristics of this group are given in Table 1.

Table 1. Sociodemographic characteristics of deaths of older adults from protein-calorie malnutrition, Brazil, 2000-2021 (n=93.850).

Variables	n (%)
Sex	
Male	46.349 (49.38)
Female	47.501 (50.62)
Age group (years)	
60-64	5.096 (5.43)
65-69	6.585 (7.02)
70-74	9.676 (10.31)
75-79	13.366 (14.24)
≥ 80	59.127 (63.00)
Color	
White	45.958 (48.97)
Black	8.242 (8.78)
Yellow	758 (0.81)
Brown	31.579 (33.65)
Indigenous	538 (0.57)
Ignored	6.775 (7.22)
Education (years of study)	
Illiterate	31.370 (33.43)
1-3	20.072 (21.39)
4-7	10.309 (10.99)
8-11	3.714 (3.96)
≥ 12	1.498 (1.60)
Ignored	26.886 (28.65)
Marital Status	
Single	22.318 (23.78)
Married	23.145 (24.66)
Widowed	36.926 (39.35)
Legally separated	2.634 (2.81)
Others	950 (1.01)
Ignored	7.877 (8.39)

Source: Brazilian Mortality Information System (SIM)[11].

During the period investigated, there was a change in the standardized rate of mortality from protein-calorie malnutrition, with an increase in the first few years of the series, followed by a decline from 2010 onwards. For the overall series, the highest rate registered was in 2006 (28.74/100,000 population) and the lowest in 2021 (10.69/100,000 population)(Table 2). Regarding sex-specific standardized mortality rate, the highest level registered for men was in 2005 and 2006 (33.53/100,000 population) and for women was in 2006 (25.01/100,000 population)(Table 2, Figure 1).

The results for age-specific standardized rate of mortality from protein-calorie revealed higher rates with greater age. The highest rates registered for the period were among individuals aged ≥80 years (Table 2, Figure 2).

The results for trend in general and age- and sex-specific standardized rates of mortality from protein-calorie malnutrition in Brazilian older adults for 2000-2021 are presented in Table 3. There was a decreasing trend in mortality from protein-calorie malnutrition among older adults for the time-series investigated (β=-0.015; p=0.005; AAPC=-3.454%). Analysis of sex-specific standardized mortality rates showed a decreasing trend for both genders. For age-specific mortality, results showed a decreasing trend in individuals aged 60-69 years and stable trend among those aged ≥80 years (Table 3).

Table 2. General, and age- and sex-specific standardized rate of mortality from protein-calorie malnutrition in older adults (per 100.000 population), Brazil, 2000-2021 (n=93.850).

Year	Standardized Mortality Rate (SMR)							
	General	By Sex		By Age Group (years)				
		Male	Female	60-64	65-69	70-74	75-79	≥ 80
2000	21.74	25.83	18.56	1.71	2.08	2.69	3.59	11.67
2001	24.28	28.47	20.88	1.67	2.16	3.15	4.02	13.28
2002	24.96	29.61	21.23	1.81	2.22	3.06	4.27	13.60
2003	27.24	32.34	23.23	1.89	2.53	3.52	4.23	15.07
2004	28.09	32.90	24.26	1.83	2.37	3.39	4.65	15.85
2005	27.96	33.53	23.55	1.47	2.40	3.37	4.62	16.10
2006	28.74	33.53	25.01	1.30	2.17	2.84	4.46	17.98
2007	23.39	26.68	20.77	1.28	1.76	2.63	3.42	14.30
2008	21.60	25.29	18.70	1.07	1.70	2.33	3.39	13.11
2009	22.72	27.63	19.05	1.43	1.99	3.03	3.01	13.26
2010	21.38	25.77	18.10	1.08	1.54	2.29	3.19	13.27
2011	21.20	25.38	18.08	1.11	1.55	2.44	2.93	13.18
2012	19.76	22.74	17.45	1.05	1.24	2.00	2.80	12.67
2013	20.66	24.93	17.47	1.05	1.40	2.20	2.99	13.03
2014	18.66	23.25	15.31	0.97	1.22	1.99	2.77	11.71
2015	18.05	21.83	15.30	1.01	1.22	1.74	2.64	11.44
2016	16.92	20.87	14.02	0.86	1.10	1.68	2.49	10.79
2017	15.09	18.63	12.54	0.69	0.99	1.54	2.12	9.74
2018	13.58	16.71	11.28	0.69	0.84	1.37	2.10	8.59
2019	13.20	16.46	10.84	0.70	0.89	1.19	1.97	8.45
2020	11.24	14.03	9.26	0.61	0.69	1.12	1.67	7.14
2021	10.69	13.27	8.78	0.58	0.75	1.15	1.49	6.73

Source: Brazilian Mortality Information System (SIM)[11]

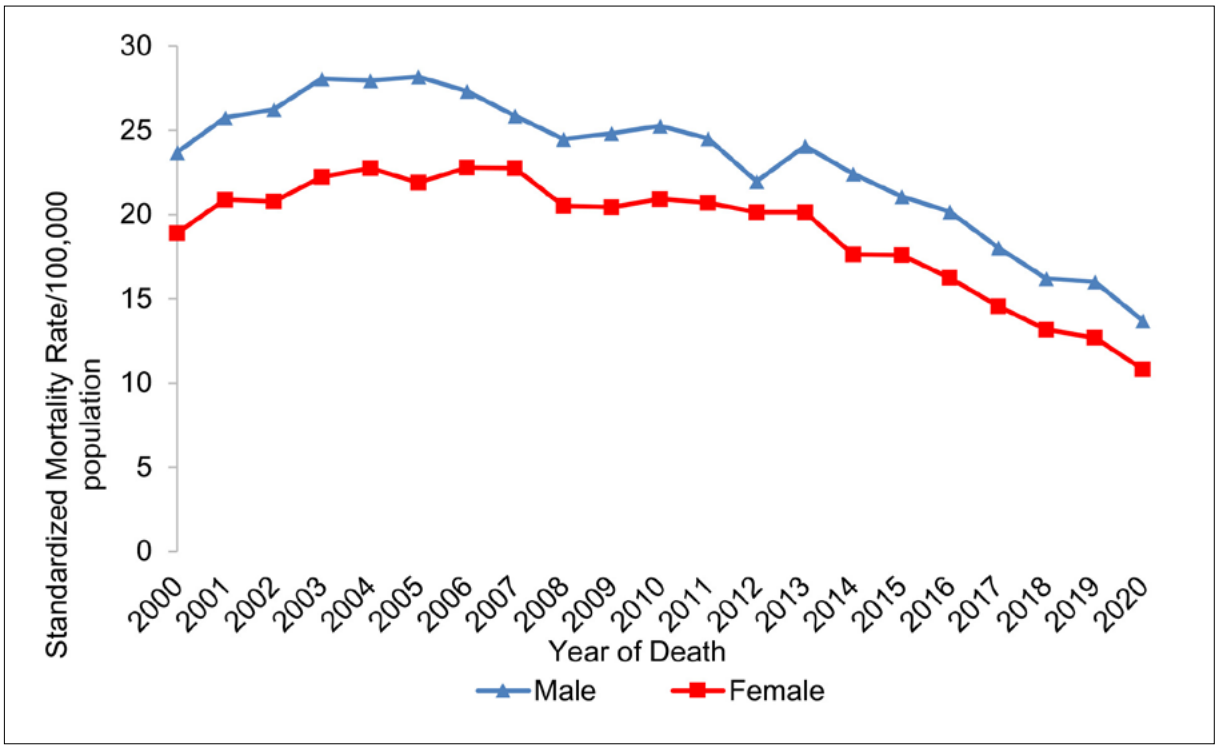

Figure 1. Sex-specific standardized rate of mortality from protein-calorie malnutrition in older adults, 2000-2021.

Source: Brazilian Mortality Information System (SIM)[11].

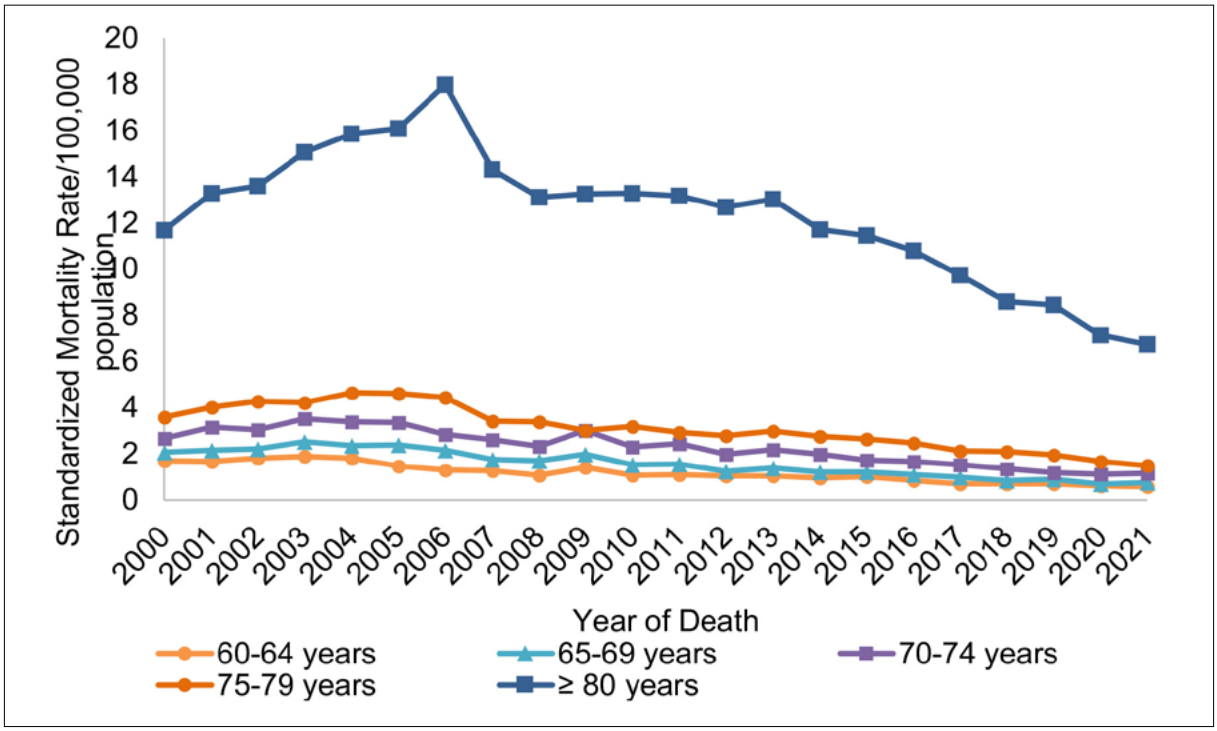

Figure 2. Age-specific standardized rate of mortality from protein-calorie malnutrition in older adults, 2000-2021.

Source: Brazilian Mortality Information System (SIM)[11].

Table 3. Trends in general and sex- and age-specific standardized rates of mortality from protein-calorie malnutrition among older adults, Brazil, 2000-2021.

Variable	Prais-Winsten					Annual Percentage Change (APC)			
		$CI_{95\%}$					$CI_{95\%}$		Trend
	β	Lower	Upper	*p*-value*	R^2	AAPC%	Lower	Upper	
General	-0.015	-0.025	-0.005	0.005	0.901	-3.454	-6.466	-0.344	Decreasing
By sex									
Male	-0.014	-0.022	-0.006	0.001	0.897	-3.357	-5.825	-0.834	Decreasing
Female	-0.015	-0.026	-0.004	0.007	0.874	-3.596	-6.899	-0.175	Decreasing
By age group (years)									
60-64	-0.023	-0.027	-0.020	<0.001	0.897	-5.310	-6.394	-4.214	Decreasing
65-69	-0.025	-0.030	-0.020	<0.001	0.842	-5.620	-7.123	-4.092	Decreasing
70-74	-0.021	-0.027	-0.016	<0.001	0.777	-4.936	-6.650	-3.191	Decreasing
75-79	-0.019	-0.026	-0.012	<0.001	0.772	-4.375	-6.453	-2.252	Decreasing
≥ 80	-0.011	-0.023	0.003	0.056	0.798	-2.679	-6.327	1.111	Stable

$CI_{95\%}$: confidence interval; R^2: coefficient of determination; AAPC: average annual percentage change; *Significance level $p<0.05$.

DISCUSSION

This study analyzed the time-trend of mortality due to protein-calorie malnutrition in Brazilian older adults during the period spanning from 2000 to 2021. The results showed changing rates of mortality over the period assessed, where sex- and age-specific rates were higher in males and in individuals aged ≥80 years. Also, the analysis revealed a general and sex- and age- specific decreasing trend in mortality rates from protein-calorie malnutrition among older adults aged 60-79 years. However, this rate was found to be stable in the ≥80 years age group, where the general decreasing trend in mortality from malnutrition was not seen in oldest-old individuals.

Despite the decline in mortality from protein-calorie malnutrition observed in the present time-series, the literature shows that malnutrition in older adults remains a public health problem in Brazil[5,16] and worldwide[6,17].

Studies exploring the impact of malnutrition on the health of the older population reveal a worse prognosis for health conditions in this group[4-6,18]. It is important to note that protein-calorie malnutrition is a factor predicting other morbidities-mortalities, being associated with declines in functional status, negative impacts on activities of daily living, and overall reduced quality of life[3]. In addition, malnutrition also affects muscle function, decreases bone mass, and can cause immune dysfunction, anemia, decline in cognitive function, poor wound healing, delayed recovery from surgery, and higher rates of hospital readmission, contributing to geriatric syndromes with consequent increase in mortality[4-6,18]. Extremely low weight in older adults has been identified as one of the factors most strongly associated with mortality[18,19].

Notably, the aging process is accompanied by physiological changes in taste, digestive alterations, polypharmacy, reduced lean mass and increased fat mass which contribute to deterioration of nutritional status[5].

Studies investigating malnutrition in older adults warrant greater research attention, given the increase in life expectancy and the challenges faced in aging[7,8]. Thus, although a decrease in protein-calorie related death rates was evidenced, these levels are still high. This problem is regarded as avoidable, lending credence to the view in the literature on the need for greater attention to healthcare in this geriatric group[7,20,21].

The present study found higher rates of mortality from protein-calorie malnutrition among males, corroborating previous Brazilian studies assessing mortality due to malnutrition [20-22] and other causes[23,24] in older adults[23,24].

Evidence suggests this higher mortality for avoidable causes, as in the case of malnutrition in the male population, arises due to negligence on the part of men regarding adherence to a healthy lifestyle and self-care practices[23-25].

This lack of care includes low adherence to a good diet, possibly explained by lower knowledge or concern held by men on matters involving healthy diet and health as a whole. The male population seeks health services to a lesser extent, rendering them more vulnerable to some diseases, and when eventually seeking services, there is often no time to effectively treat the condition, factors which might contribute to higher male mortality rates[23-25].

The present results highlight the need for decision-makers and heath managers to improve policies and programs aimed at male healthcare, particularly the older population, given that care to this group is often inadequate. Initiatives should be implemented to increase the participation of this population in specific groups for improving healthcare, including a healthy diet, and also to provide a forum for discussing a range of issues[26].

The present study revealed that rates of mortality from protein-calorie malnutrition increased with higher age. These findings corroborate the studies conducted by Mostafa *et al.*,[27] and Bardon *et al.*,[28], where this correlation might be explained by transformations associated with the aging process triggering physiological, pathological, social and psychological changes, which also impact nutritional status of the individual. Thus, as a consequence of this increased vulnerability, mortality rates also rise with age, a relationship that might explain the flat trend in mortality observed in oldest-old individuals.

The high rates of malnutrition and, hence, of malnutrition-related mortality, seen in this older population can be attributed to a number of different factors. With advancing age, appetite, and consequently food intake, tends to diminish, a situation which can lead to a state of malnutrition, i.e. an imbalance in amount/type of micro and macronutrients consumed versus the body´s requirements, promoting a measurable reduction in tissue and, in many cases, bodyweight[6,29].

Lower appetite and energy intake associated with late life is referred to as anorexia of aging. This reduction can be related to the presence of chronic and acute diseases, polypharmacy, or specific medications, gastrointestinal processes of satiety, sensory changes typical in aging, central regulation of appetite, and increased body adiposity with a rise in both adipokines and pro-inflammatory cytokines, a phenomenon which tends to worsen with aging[6]. These aspects may explain the higher mortality rates associated with advancing age and the greater susceptibility of oldest-old individuals, as evidenced by the present study results.

The overall decline in mortality from protein-calorie malnutrition seen in individuals aged ≤ 79 years can be attributed to the expansion in social rights and programs, and in health initiatives. Since 1988, marking the enactment of the Constitution of the Federal Republic of Brazil, the Federal government has been implementing public policies to combat malnutrition and its causal factors[30]. During the 1996-2006 period, there was a substantial reduction in hunger, and consequently, in malnutrition. This improvement can be attributed to the higher disposable income of families, particularly since 2003, amid the expansion and creation of income transfer programs, together with broader access to government primary education and health services, progress which continued up until mid-2015, effectively removing Brazil from the world map of hunger[30-32].

Public policies were, by and large, making strides but following sweeping political changes in Brazil from 2016, inequalities again set in, particularly among the poorer population. These changes stemmed from lapses in social policies on food and nutritional security in recent times, especially during the COVID-19 pandemic[32-34].

Amid this scenario of food (in)security in the country and the need for more effective efficient

public policies, malnutrition in the older population has drawn interest from researchers, not only owing to the high number of malnutrition-related deaths every year, but also regarding the nature of this event[4]. Existing public policies should be discussed and improved, and new ones implemented targeting the oldest-old in light of these results showing a stagnation in mortality rates from protein-calorie malnutrition among individuals ≥80 years of age, highlighting the importance of health care in this population group.

Moreover, health services should be disposed to identify individuals at nutritional risk in a timely manner, thereby allowing similarly timely interventions, especially among bedridden patients who have a high incidence of malnutrition, possibly due to the low priority given to the issues surrounding nutritional assessment and nutritional therapy[35].

This study has some limitations, including the source of the data analyzed, drawn from secondary sources and thus susceptible to inaccuracies in record and form completion, as well as to under-reporting, particularly during the COVID-19 pandemic. However, strengths include the fact the study was based on a quality national registry covering a large robust final population and historic 21-year series, enabling monitoring and evaluation of government food and nutrition policies, and informing the planning of public health actions, with a focus on this specific population. A further strength lies in the methodology used, whereby mortality rates were standardized and adjusted according to the world population, allowing comparisons to be made with other studies.

CONCLUSION

This study reported the trend in mortality rates from protein-calorie malnutrition in Brazil over the past 21 years. Although a decreasing trend was evident, malnutrition-related mortality rates in Brazilian older adults remain high, particularly among males. With respect to age, rates increased with higher age, underscoring the importance of monitoring rates and of adopting policies and programs to reduce them.

In this context, these results can help further the knowledge and debates on epidemiological aspects of mortality from protein-calorie malnutrition in older adults in Brazil. Lastly, the evidence presented can inform health professionals and managers in planning strategic health promotion actions for preventing malnutrition among older adults.

AUTHORSHIP

- Danilo Esteves Gomes – Conceptualization, Writing – First Draft, Writing – Review and Editing, Investigation, Validation and Visualization.
- Tomas Ferreira da Silva – Conceptualization, Writing – Review and Editing, Validation and Visualization.
- Luziane dos Santos Rocha – Conceptualization, Writing – Review and Editing, Validation and Visualization.
- Yan Nogueira Leite de Freitas – Critical review of article, Writing – Review and Editing, and Approval of version for publication.
- Angelina do Carmo Lessa – Data analysis and Interpretation, Drafting of article, Writing – Review and Editing, and Approval of version for publication.
- Ronilson Ferreira Freitas – Project Administration, Formal Analysis, Conception, Data Curation, Writing – Review and Editing, Methodology, Funding Acquisition, Resources, Oversight, Validation and Visualization.

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