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Undernutrition as a major risk factor for death among older Brazilian adults in the community-dwelling setting: SABE survey

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A B S T R A C T

Objective: To investigate the independent association between undernutrition and death in older adults in a community-dwelling setting.
Methods: This retrospective study was based on the Health, Well-being and Ageing survey conducted in 2000 that included 1170 older adults (≥60 y) from São Paulo, Brazil. Death occurrences were considered through March, 2007. The variables analyzed were undernutrition (Mini-Nutritional Assessment), gender, income, muscle strength, hip fracture, smoking habits, cancer, depression, diabetes, coronary heart disease, chronic lung disease, cerebral vascular disease, and hypertension. A hierarchical multivariate analysis by logistic regression was performed according to age groups (60–74 and ≥75 y).
Results: Undernutrition frequency was higher in adults ≥75 y old (2.6% versus 2.4%). The frequency of death in undernourished subjects was higher in the 60- to 74-y-old group (7.6%) than in those ≥75 y old (3.9%). Undernutrition was the strongest independent risk factor for death ($P < 0.05$) in the 60- to 74-y-old group (odds ratio 6.05, 95% confidence interval 5.76–6.35) and in the ≥75-y-old group (odds ratio 2.76, 95% confidence interval 2.51–3.04). All other variables were also associated with death, except for hip fracture and cerebral vascular disease, in the two age groups and hypertension in the 60- to 74-y-old group; however, the effect of these variables was less.
Conclusion: Undernutrition represented the strongest risk factor for death in Brazilian community-dwelling older adults 60 to 74 y old and showed a stronger association than for adults ≥75 y old.

Introduction

As people live longer, interest has increased in establishing which risk factors singly or together best describe the likelihood of short-term death of older adults, from clinical and epidemiologic perspectives. In this population, in contrast to non-modifiable mortality risk factors, such as advanced age and male gender, modifiable risk factors are of great interest to public health intervention because they are subject to control or treatment [1].

The association between undernutrition and death in older adults has been reported by several researchers around the world [2–8]. However, in Brazil and Latin America, this association has not been evaluated in community-dwelling older adults. Moreover, as life expectancy increases in Latin America as in other parts of the world [9], older adults represent a population group with a wide spectrum of ages, from 60 to 65 y and 100 y. The impact of undernutrition on mortality rates of community-dwelling older adults across different age groups and regardless of known confounders remains to be studied.

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The Mini-Nutritional Assessment (MNA) is a multidimensional and validated method for the assessment of nutritional status of older adults, and its use overcomes the methodologic problems related to different assumptions that are used to diagnose undernutrition; MNA also provides a solid basis to compare estimates with other populations [10–12]. To our knowledge, the independent association between undernutrition and death in community-dwelling older adults by age group has not been previously evaluated using the MNA and remains to be quantified.

Most studies concerning the association between risk factors and outcomes use multivariate analysis as a statistical approach. In these studies, the decision about which risk factors are to be included in the multivariate model was based purely on the statistical association between variables. However, as was previously suggested by Victora et al. [13–15], the complex hierarchical interrelations between the determinants of outcomes are best managed through the use of conceptual frameworks, where the decision on which factors to include in the statistical model is based on the hierarchical relations among them. However, logistic regression hierarchical analysis has not been previously used to explore the association between undernutrition and death in older adults.

This study aimed to investigate the independent association between undernutrition and death in older Brazilian adults across age groups in a community-dwelling setting using a hierarchical logistic regression model.

Materials and methods

Design and participants

This study is a retrospective analysis of a random population sample of community-dwelling older adults (≥60 years) who participated in the Health, Well-being and Ageing (SABE) survey in the city of São Paulo, Brazil in 2000. The SABE survey, a multicenter study coordinated by the Pan-American Health Organization, aimed to investigate the living and health conditions of older adults in seven cities in Latin America and the Caribbean: Bridgetown, Barbados; Buenos Aires, Argentina; Mexico City, Mexico; Havana, Cuba; Montevideo, Uruguay; São Paulo, Brazil; and Santiago, Chile [16].

The design and methodologic details of the SABE survey in Brazil have been previously reported [16]. Briefly, the sample consisted of 2143 community-dwelling older adults living in the urban area of São Paulo and was based on the population register of the Brazilian Institute of Geography and Statistics of 1996. This random sample was composed of 1568 older men and women combined with another random sample of 575 elders taken from a pool of older men and women ≥75 y old. The combined group corresponded to the enlarged sample (of free composition) and attempted to compensate for the lower population density of the older (≥75 y) group. To offset the higher mortality rate in older men, the sample was also adjusted for male compared with female gender [16].

The sample was identified through the cluster-sampling method in two stages. Households were randomly selected using division in proportion to the size of the sample criteria based on 72 census tracts. To adjust sample distribution according to the composition of the population, weights were calculated for each age group, gender, and census sector and the sample weight was taken into account during data analysis.

Two inclusion criteria were considered: participation in the SABE survey in 2000 and availability of information for all studied variables. This study included 1170 older adults (498 men and 672 women). The participants (54.6% of the initial sample) differed from non-participants in age, cerebral vascular disease, and death ($P < 0.01$). Among the non-participants there was a larger proportion of older adults ≥75 y old (26.8% versus 18.4%) and deaths (37.6% versus 22.6%) and a smaller proportion of older adults with cerebral vascular disease (9.6% versus 5.3%).

Data collection and study variables

The data for the SABE survey were obtained by previously trained health professionals and nutrition trainees in household interviews using a questionnaire with 11 sections: personal data, cognitive assessment, health status, functional status, medication, use and access to health services, family and social support network, employment history and sources of income, characteristics of housing, anthropometry, flexibility, and mobility. Eighty-eight percent of interviews were performed directly with the subjects and the remaining interviews were conducted through a proxy.

The occurrence of death was verified by the Mortality Information System of the municipality of São Paulo, Brazil, taking into consideration cases through March 2007, although the study was completed in June 2009.

Undernutrition was assessed by the MNA (total score <17 points). Older adults at risk of undernutrition were identified through a MNA score from 17 through 23.5 [10]. This is a multidimensional method and is composed of 18 items, including anthropometric characteristics, feeding, cognitive status, functional status, living conditions, medication use, presence of skin lesions or scabs, self-perception of health, and nutrition. Because information about the presence of skin lesions or scabs (question I) was not investigated in the SABE survey, a score of 1 was given for all participants. Dementia (question E) was identified using the Mini-Mental State Examination as modified and validated by Icaza and Albala [17]. Weight and height measurement techniques (question F) were performed according to the method of Frisancho [18]. Upper arm circumference (question Q) and calf circumference (question R) were measured according to the method of Callaway et al. [19]. All measurements were performed in triplicate and the average value used was for the analysis. Some adaptations were made to complete the MNA to accommodate the food habits of the Brazilian population. Regarding selected consumption markers for protein intake (question K), an affirmative answer was assigned if adults consumed pulses or eggs at least once a day and ate two or more servings of meat, fish, or poultry per week.

The control explanatory variables were gender (female, male), income for daily living (insufficient, sufficient), hypertension (no, yes), diabetes (no, yes), chronic pulmonary disease (no, yes), coronary disease (no, yes), cancer (no, yes), cerebral vascular disease (no, yes), hip fracture (no, yes), depression (no, yes), smoker (no, yes), and low muscle strength (no, yes). All variables were self-reported by older adults, except low muscle strength and depression.

Hip fracture occurrence was considered when it occurred in the 12 mo before the interview. Depression was evaluated with the Geriatric Depression Scale [20]. Muscle strength was measured in the dominant hand, from the maximal value of three consecutive evaluations, using a handgrip dynamometer (TK 1201 model; Takei Scientific Instruments Co. Ltd, Niigata-City, Japan). It was classified as low when the values were below the 10th percentile from the reference data of Barbosa et al. [21], which were developed for individuals in the city of São Paulo, Brazil.

The SABE survey and the present study were approved by the research ethics committee of the Faculty of Public Health at the University of São Paulo and by the Brazilian National Research Ethics Committee. All the participants gave their informed consent to participate in the study.

Statistical analysis

Descriptive analysis was used to characterize the population and the sample data were stratified according to age groups 60 to 74 y and ≥75 y. The Rao-Scott test, which is a test adjusted to complex samples described by an F distribution, was used to test associations between categorical variables. The rationale for its use is based on the consideration of a complex probability sample in which different sample weights were assigned to the older adults depending on age group, gender, and the census tract to which they belonged [22]. The results were considered statistically significant at $P < 0.05$. In all tests, weighted data were taken into account, as described earlier.

Hierarchical multivariate analysis [13] was performed by logistic regression, according to a theoretical model (Fig. 1), to assess the effect of undernutrition on death occurrence in the two age groups. First, a univariate analysis was performed for the identification of significant variables ($P < 0.20$) that could be included in the construction of the hierarchical model, according to the four levels shown in Figure 1. Odds ratios and respective 95% confidence intervals were estimated. All variables with a P value <0.20 were selected. Then, a multivariate analysis was performed between the variables of each level and only those with a P value <0.05 were selected.

The inclusion of confounders in the unconditional logistical regression model was based on hierarchical analysis, consisting of a theoretical model that prioritizes the interrelations between several risk factors and death (Fig. 1). The variable selections that constituted the theoretical model were based on a consideration of variables with distal, intermediate, or proximal action to the outcome. According to this model, the factors in the top level influence the outcome (death) through an intermediate effect of factors in the lower levels. This is reflected by assessing the effect of the factor of interest (undernutrition) adjusted only for the confounding factors belonging to a higher level. For the hierarchical multivariate analysis, level 1 variables of the theoretical model were included simultaneously in the analysis. Variables with $P < 0.05$ remained in the model. Next, level 2 variables were added and those with $P < 0.05$ remained in the model, regardless of changes in the P values of level 1 variables. The same procedure was performed for each level up to level 4. Statistical modeling adjustments were based on the Hosmer-Lemeshow test. Data were analyzed using SPSS 14.0 [23].

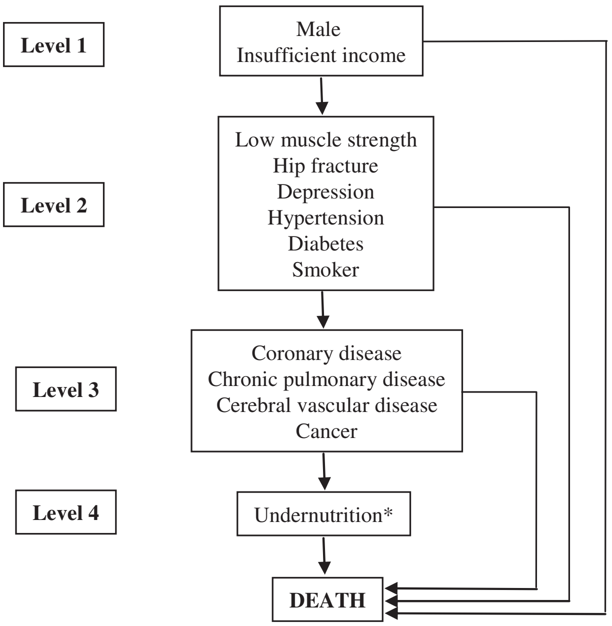

Fig. 1. Hierarchical model. * Main explanatory variable.

Results

Most (81.6%) study participants (1170 older adults 60–96 y old) were in the 60- to 74-y age group. Detailed characteristics of subjects in the present study, according to age group, are listed in Table 1. Undernutrition was identified in 2.4% of the older adults, with a slightly larger proportion in the ≥75-y age group (2.6%) than in the 60- to 74-y age group (2.4%). The risk of undernutrition was identified in 25.6% of all older adults, and a larger proportion was found in the ≥75-y age group (30.9% versus 24.5%), but no significant association between nutritional status and age group was found. Most older adults were women (57.1%) and did not have sufficient income to meet their daily needs (69.1%). There was also a larger proportion of older adults who reported insufficient income, health problems, and diseases (except depression and diabetes mellitus) within the 60- to 74-y age group. Only coronary disease was associated with nutritional status ($P < 0.005$), with a larger proportion of older adults ≥75 y old who reported this illness compared with those in the 60- to 74-y age group.

During the 7-y follow-up period, 332 of the 1170 older adults died, and most of them were the 60- to 74-y age group (65.9%). Of those who died, 5.1% had been undernourished, whereas of the survivors this proportion was only 1.5%. Of participants from the 60- to 74-y group, there was a larger proportion of older adults who died and were undernourished (7.6%) than in the ≥75-y group (3.9%; Table 2). A smaller proportion of undernourished participants was found among living older adults (both age groups) compared with the older adults who had died (Table 2).

Hierarchical multivariate analysis revealed that most of the variables originally proposed were associated with death in older adults 60 to 74 y old ($P < 0.05$). The exception was hip fracture, which lost its significance after statistical adjustments for the variables of the previous hierarchical level (level 1). Although hypertension (level 2) and cerebral vascular disease (level 3) variables were statistically associated with death, they did not constitute a risk factor for this outcome and were therefore excluded from the model. Undernutrition was the parameter most strongly associated with death. In fact, this association increased after adjusting for control variables of hierarchical levels more distal to the outcome (odds ratio 6.05, 95% confidence interval 5.76–6.35; Table 3).

In the older adults ≥75 y of age, undernutrition was also the parameter most strongly associated with death (odds ratio 2.76, 95% confidence interval 2.51–3.04), but this association was weaker than that estimated for older adults 60 to 74 y of age. Hip fracture (level 2) and cerebral vascular disease (level 3) lost significance after statistical adjustments were made between variables of the same hierarchical levels; these variables were not included in the final hierarchical model (Table 3).

In older adults 60 to 74 y of age, other characteristics such as male gender, low income, depression, smoking, cancer, and coronary disease proved to be associated with a higher mortality risk than for older adults ≥75 y of age. In contrast, low muscle strength, hypertension, diabetes mellitus, and chronic lung disease represented a higher mortality risk in older adults ≥75 y of age. It is important to emphasize that the risk of undernutrition is also a risk factor for death in community-dwelling older adults; however, it is not the main risk factor (Table 3).

Table 1
Sample characterization by age group. Health, Well-being and Ageing survey, Brazil

Variables	No. (%) of older adults*			P†
	60–74 y	≥75 y	Total sample	
Gender				
Female	410 (56.3)	262 (60.3)	672 (57.1)	NS
Male	265 (43.7)	233 (39.7)	498 (42.9)	
Income				
Sufficient	211 (30.6)	162 (32.6)	373 (30.9)	NS
Not sufficient	464 (69.4)	333 (67.4)	797 (69.1)	
Cancer				
No	656 (97.4)	479 (96.2)	895 (97.1)	NS
Yes	19 (2.6)	16 (3.80)	275 (2.9)	
Coronary disease				
No	546 (80.9)	373 (75.8)	919 (80.0)	0.047
Yes	129 (19.1)	122 (24.2)	251 (20.0)	
Chronic pulmonary disease				
No	588 (87.3)	426 (86.2)	1014 (87.1)	NS
Yes	86 (12.7)	70 (13.8)	156 (12.9)	
Cerebral vascular disease				
No	638 (94.6)	468 (94.8)	1106 (94.7)	NS
Yes	37 (5.4)	27 (5.2)	64 (5.3)	
Depression				
No	513 (76.7)	382 (76.7)	895 (76.7)	NS
Yes	162 (23.3)	113 (23.3)	275 (23.3)	
Diabetes				
No	548 (81.2)	402 (81.6)	950 (81.3)	NS
Yes	127 (18.8)	93 (18.4)	220 (18.7)	
Hypertension				
No	309 (46.2)	224 (44.3)	533 (45.8)	NS
Yes	366 (53.8)	271 (55.7)	637 (54.2)	
Hip fracture				
No	672 (99.5)	493 (99.7)	1165 (95.5)	NS
Yes	3 (0.5)	2 (0.3)	5 (0.5)	
Muscle strength				
Normal	638 (94.6)	475 (96.2)	1113 (94.9)	NS
Low	37 (5.4)	20 (3.8)	57 (5.1)	
Smoking				
No	559 (81.8)	438 (89.0)	997 (83.1)	0.002
Yes	116 (18.2)	57 (11.0)	173 (16.9)	
Nutritional status				
Not undernourished	487 (73.1)	328 (66.5)	815 (72.0)	NS‡
At risk for undernutrition	170 (24.5)	155 (30.9)	325 (25.6)	
Undernourished	18 (2.4)	12 (2.6)	30 (2.4)	

* Weighted percentage.
† Rao-Scott test for comparisons within age group.
‡ Older adults not undernourished and at risk of undernutrition were grouped in the same category for the calculation of the Rao-Scott test.

Table 2
Proportion of living or dead older adults—Health, Well-being and Ageing survey, Brazil, in March 2007 by age groups and nutritional status

	No. (%)* of living participants			No. (%) of deaths		
	60–74 y	≥75 y	Total	60–74 y	≥75 y	Total
Not undernourished	414 (74.5)	204 (72.4)	618 (73.7)	73 (61.3)	124 (58.1)	197 (59.3)
At risk for undernutrition	133 (23.9)	74 (26.2)	207 (24.8)	37 (31.1)	81 (38.0)	118 (35.5)
Undernourished	9 (1.6)	4 (1.4)	13 (1.5)	9 (7.6)	8 (3.9)	17 (5.1)
Total sample	556 (100)	282 (100)	838 (100)	119 (100)	213 (100)	332 (100)

* Weighted percentage.

Discussion

Most older adults in Brazilian sample (81.6%) were in the 60- to 74-y age group. This percentage is comparable to previous reports of the rapid aging process of populations in Latin America and the Caribbean [9]. The frequency of undernourished older adults (2.4%) estimated by the MNA was similar to that previously reported by Guigoz [10] who measured a frequency of 2.0 ± 0.1% for the community-dwelling population. That review used the same method of nutritional assessment as described in the present study and included 14 149 older adults from 14 developed and developing countries including the United States, France, Spain, Sweden, and Brazil.

The higher frequency of older adults who died and were undernourished in the 60- to 74-y age group may be associated with the increased occurrence of death in the oldest adults and/or the poorer health and living conditions of this population. Around the world, undernutrition is often associated with lack of food. However, in older adults living in São Paulo, Brazil and other developed countries, this is not the main cause of

Table 3
Factors associated with death in older adults 60 to 74 and ≥75 y of age according to a hierarchical model. Health, Well-being and Ageing survey, Brazil

Level	Variables	Older adults 60–74 y				Older adults ≥75 y			
		Unadjusted OR (95% CI)	*P*	Adjusted OR (95% CI)	*P*	Unadjusted OR (95% CI)	*P*	Adjusted OR (95% CI)	*P*
1	Gender								
	Female	1.00		1.00		1.00		1.00	
	Male	2.17 (2.14–2.21)	<0.001	2.20 (2.16–2.24)	<0.001	2.06 (2.00–2.12)	<0.001	2.06 (2.01–2.12)	<0.001
	Income								
	Sufficient	1.00		1.00		1.00		1.00	
	Not sufficient	1.43 (1.40–1.45)	<0.001	1.47 (1.44–1.50)	<0.001	1.03 (1.00–1.06)	0.03	1.06 (1.03–1.09)	<0.001
2†	Muscle strength								
	Normal	1.00		1.00		1.00		1.00	
	Low	1.54 (1.45–1.60)	<0.001	1,45 (1.40–1.49)	<0.001	1.73 (1.61–1.85)	<0.001	1.80 (1.74–1.87)	<0.001
	Hip fracture								
	No	1.00		1.00		1.00		‖	
	Yes	1.28 (1.15–1.42)	<0.001	1.01 (0.90–1.12)	*	1.33 (1.03–1.71)	0.03		
	Depression								
	No	1.00		1.00		1.00		1.00	
	Yes	1.32 (1.30–1.34)	<0.001	1.40 (1.38–1.43)	<0.001	1.18 (1.14–1.22)	<0.001	1.17 (1.13–1.21)	<0.001
	Hypertension								
	No	1.00		1.00		1.00		1.00	
	Yes	1.02 (1.01–1.04)	0.01	0.95 (0.93–0.97)	<0.001	1.12 (1.09–1.15)	<0.001	1.24 (1.20–1.27)	<0.001
	Diabetes								
	No	1.00		1.00		1.00		1.00	
	Yes	1.33 (1.30–1.35)	<0.001	1.46 (1.43–1.49)	<0.001	1.86 (1.79–1.92)	<0.001	1.80 (1.74–1.87)	<0.001
	Smoking								
	No	1.00		1.00		1.00		1.00	
	Yes	2.65 (2.60–2.70)	<0.001	2.40 (2.35–2.44)	<0.001	1.94 (1.86–2.03)	<0.001	1.63 (1.55–1.70)	<0.001
3‡	Chronic pulmonary disease								
	No	1.00		1.00		1.00		1.00	
	Yes	1.32 (1.29–1.35)	<0.001	1.23 (1.20–1.26)	<0.001	1.56 (1.50–1.62)	<0.001	1.26 (1.21–1.31)	<0.001
	Coronary disease								
	No	1.00		1.00		1.00		1.00	
	Yes	2.52 (2.48–2.57)	<0.001	2.73 (2.67–2.78)	<0.001	1.51 (1.46–1.55)	<0.001	1.54 (1.49–1.60)	<0.001
	Cancer								
	No	1.00		1.00		1.00		1.00	
	Yes	2.28 (2.18–2.38)	<0.001	2.07 (1.98–2.16)	<0.001	1.45 (1.36–1.56)	<0.001	1.39 (1.30–1.50)	<0.001
	Cerebral vascular disease								
	No	1.00		1.00		1.00		‖	
	Yes	1.26 (1.22–1.31)	<0.001	0.72 (0.93–0.97)	<0.001	1.63 (1.53–1.73)	<0.001		
4§	Nutritional status								
	Not undernourished	1.00		1.00		1.00		1.00	
	At risk for undernutrition	1.65 (1.62–1.68)	<0.001	1.57 (1.53–1.60)	<0.001	1.61 (1.56–1.66)	<0.001	1.73 (1.67–1.78)	<0.001
	Undernourished	5.55 (5.32–5.79)	<0.001	6.05 (5.76–6.35)	<0.001	2.90 (2.66–3.16)	<0.001	2.76 (2.51–3.04)	<0.001

CI, confidence interval; OR, odds ratio
* Variable excluded from the model ($P > 0.05$).
† Adjusted for variables of level 1.
‡ Adjusted for variables of levels 2 and 3.
§ Adjusted for variables of levels 1, 2, and 3.
‖ Variable excluded from the model ($P > 0.05$) when adjusted for variables of the same level.

nutritional problems; rather, undernourishment was the result of the presence of disease, the use of multiple medications, or changes in lifestyle [24].

Older adults comprise a heterogeneous population group and there are multiple physical, psychological, social, and economic factors associated with aging that can interfere with nutritional status. These factors interact with other conditions that determine the purchase, preparation, and consumption of food. The imbalance in some of these factors or conditions can lead to undernutrition [25]. Many older adults who were evaluated reported chronic diseases, insufficient income, smoking, and loss of muscle strength, which increase the susceptibility of older adults to the development of undernutrition. Therefore, the impact of these factors highlights the importance of introducing public health measures in these age groups that are living longer.

The hierarchical model was used in the investigation of different risk factors for a particular outcome [13–15]. However, there have been no studies using this method of analysis for the investigation of risk factors for death in older adults. Hierarchical analysis permitted the identification of undernutrition as a critical risk factor of death in older adults. The risk of death differs according to age group and is independent of sociodemographic variables, health problems, and diseases analyzed.

The hierarchical model proposed in the present study is an alternative approach applicable to epidemiologic studies with large numbers of variables. In our study, the choice of possible confounding variables exceeded purely statistical concerns. The ranking of the independent variables in a conceptual framework was established and maintained for data analysis, allowing the selection of variables most strongly associated with death. Thus, a model was built using the variables needed to test associations and avoiding saturation by extraneous variables [13–15]. The loss of statistical significance of some control explanatory variables in the final models of the hierarchical analysis could be explained by their strong association or by a low frequency of exposure in the population studied, as is the case with hip fracture, for example.

Older adults 60 to 74 y of age were two times more likely to die (odds ratio 6.05) than older adults ≥75 y of age (odds ratio 2.76) if they were undernourished, despite the low undernutrition frequency in the two age groups. The observed lower risk of death associated with undernutrition in older adults ≥75 y of age may reflect a “survivor effect,” as described by Palloni et al. [26]. This effect describes older adults who have a history of higher-quality health and lifestyles. Moreover, the rapid aging process in the population of the region may have favored the largest number of older adults in the 60- to 74-y age group who are exposed to disease and its complications.

A higher risk of death was also observed for the older adults who were diagnosed as at risk for undernutrition, but it was lower than that observed for those older adults in the two age groups who had been confirmed as undernourished. Thus, the implementation of social, health, and nutritional programs targeted at these older adults at risk becomes relevant to prevent progression toward undernutrition.

Apart from the direct and independent relation of undernutrition to mortality as identified by hierarchical analysis, other factors had important but smaller effects on this outcome, even after making adjustments for undernutrition. When comparing age groups, undernutrition and other variables such as male gender, insufficient income, depression, smoking, coronary disease, and cancer represented higher risk factors for death in older adults 60 to 74 y of age. Moreover, low muscle strength, hypertension, diabetes, and chronic pulmonary disease represented major risks for death in older adults ≥75 y of age.

Some researchers have used the MNA to investigate the association between undernutrition and mortality in older adults in a community-dwelling setting, but no previous studies have investigated the risk differences by age group, although adjustments have been routinely incorporated for age groups [6,27,28]. Beck et al. [28] and Visvanathan et al. [27] considered a MNA score lower than 24 points as a criterion for classification of undernutrition. The investigators justified this approach based on the low prevalence of undernutrition in older adults of a community-dwelling setting. However, it was observed in the present study that the risk of death in undernourished older adults is much greater than that observed for older adults simply at risk for undernutrition, which verifies the decision to conduct independent analyses of risk of death in older adults who are undernourished (MNA <17 points).

Studies conducted in the United States have reported an association between undernutrition and death by age group. Although the age ranges and nutritional assessment method (body mass index) in the U.S. studies were different from those adopted in the present study, which limits the possibility of data comparison, some investigators have suggested that this relation may be more relevant in older adults at younger ages [3,29,30], as we have found. Therefore, the influence of age on the relation between undernutrition and mortality in older adults has not been significantly explored; ours is the first study to adopt a multidimensional method, the MNA, for the diagnosis of undernutrition to investigate this relation.

There were larger proportions of older adults ≥75 y of age and deaths in the non-participating group than in the study participants. Although these differences are statistically significant, they are small and it is thought that they did not influence the direction of the adjusted odds ratio data for older adults ≥75 y of age. However, the possibility of underestimating the association between undernutrition and mortality for older adults in the ≥75-y age group cannot be ruled out.

The retrospective design of this study can be regarded as a limitation. A prospective design would permit a survival analysis, namely the Cox proportional hazards regression analysis. It would also be valuable toward understanding why undernutrition is associated with a greater risk of death in 60- to 74-y-old adults than in those ≥75 y old. Unfortunately, this analysis was not possible due to the unavailability of data for other variables besides death, so we were limited to a retrospective study.

In regard to the clinical significance of undernutrition and its effect on mortality, it is important that undernutrition be prevented or at least diagnosed in a timeframe that will access older adults still living at home, because after hospitalization and/or occurrence of serious health problems, the effects of undernutrition may be irreparable.

In conclusion, we have confirmed that undernutrition is an independent risk factor that contributes significantly to death in older Brazilian adults, and its effect is most strongly associated with older adults 60 to 74 y of age.

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