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Influence of Alzheimer's disease on the relationship between nutritional status and risk of fall

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ABSTRACT. Although malnutrition and risk of falls in the elderly have increased in recent years, uncertainties exist as to whether these conditions are associated after controlling for sociodemographic variables, body composition, metabolic condition, and Alzheimer's disease (AD). This study aimed to analyze the association between nutritional status and risk of fall in the elderly population. Participants were matched by gender and age, after they had been grouped on the basis of diagnosis of AD. The risk of falls, nutritional status, and mental status were assessed using the Downton Fall Risk Score (FRS), Mini Nutritional Assessment (MNA), and Mini Mental State Evaluation (MMSE), respectively. Logistic regression models adjusted for the main confounders were used in the analyses. Among the 68 elderly individuals studied, participants who were malnourished or at risk of malnutrition were more likely to fall (odds ratio = 8.29; 95% confidence interval = 1.49-46.04) than those with normal nutritional status, regardless of gender, age, education, body composition, and metabolic condition. This association did not remain significant after adjustment for AD, a potential confounder in this association. Malnutrition or its risk was independently associated with high risk of fall; thus, malnutrition should be considered in the prevention of falls among the elderly population.

Keywords: accidental falls; elderly; dementia; elderly nutrition; malnutrition.

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Introduction

Falls have been considered as one of the most important public health concerns in our aging society (Park, 2017). They have been linked with high disability and hospitalization, with significant impact on individual and social aspects (Pfortmueller, Lindner, & Exadaktylos, 2014).

Beside all efforts to understand fall outcomes among the elderly population, the impact of a worsened nutritional status on the risk of fall remains unclear (Isenring, Baker, & Kerr, 2013; Westergren, Hagell, & Hammarlund, 2014). Neyens et al. (2013) found an association between malnutrition and an increased risk of fall. However, this association did not consider important confounders (e.g., mental diseases).

One important type of dementia (i.e., roughly 70% of the cases), associated with aging, is Alzheimer's disease (AD) (Reitz, Brayne, & Mayeux, 2011). At the beginning, AD induces memory and cognitive impairments, as well as a decrease in judgment and problem-solving abilities, which may lead to compromised temporal and spatial location skills with consequent personality changes (Alzheimer's Association Report, 2013). Nevertheless, cognitive impairment can also interfere with functional and physical capacities, causing a progressive loss of independence and autonomy in everyday life (Talmelli, Vale, Grato, Kusumoto, & Rodrigues, 2013).

Some longitudinal reports have also highlighted a significant worsening of the gait along with the disease's progression that could decrease steadiness with a consequent significant risk of falling (Cederval, Halvorsen, & Alberg, 2014). Usually, AD patients have a higher risk of falls than healthy individuals matched by age (Suttanon, Hill, Said, & Dodd, 2013). With the findings of our study being consistent with those of a study conducted in a public hospital in Brazil, falls could result in severe psychological and social issues, which fractures are the most frequent, followed by the fear of further falls and hospitalization. Moreover, everyday activities are strongly compromised, making the elderly less independent and inducing radical lifestyle changes (Fabricio, Rodrigues, & Costa Junior, 2004).

The risk of falls in AD patients is multifactorial and could be due to environmental factors, dizziness, insecurity (Kato-Narita & Radanovic, 2009), alterations in vision or in hearing, neuroleptic medications, nervous system lesions (typical in AD progression), factors that compromise cognitive function, and postural balance (Horikawa et al., 2005). Besides, nutritional status has also been related to an increased risk of falls (Neyens et al., 2013; Tsai & Lai, 2014).

Alterations, such as weight loss and malnutrition and its risk, have been observed in AD patients (Droosgma et al., 2013; Goes et al., 2014a), and those characterized by a stronger form of malnutrition presented more severe functional and cognitive impairments than individuals with normal nutritional status (Vellas et al., 2006). Goes et al. (2014a) described that a worsening in nutritional status is related to disease progression and showed that AD patients also had risk of weight loss and malnutrition.

That being said, the aim of this study was to verify the role played by the presence of AD in the association between nutritional status and risk of fall. We therefore conducted a case-control study of AD patients in a community, in Guarapuava, Brazil.

Material and methods

Participants

In this case-control study, a group of AD patients was recruited according to the following inclusion/exclusion criteria:

Inclusion: AD patients in a community in Guarapuava registered in Special Component of Pharmaceutical Care, GM/Ministry of Health from Brazil no. 1554/2013.

Exclusion: Patients who were bedridden, wheel chair users, unable to ambulate, and whose evaluations were not concluded.

AD was diagnosed according to the criteria of the National Institute of Neurologic and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA) (McKhann et al., 1984).

Additionally, a control group was formed, which included elderly people outside of the NINCDS-ADRDA criteria for AD. They were matched by age, gender, absence of other dementias, residence in the community, and ability to walk (i.e., with or without) gait helpers. This group was recruited from subjects living in the community that the Family Health Program (FHP) or Integrated Care Center (ICC) registered in the 'Hiperdia' Program (Hypertension and Diabetes Program), Ordinance No. 2.583, October 10th, 2007 of the Ministry of Health from Brazil.

Ethical consideration

In the first meeting, AD patients and caregivers were informed about the study's purpose and were invited to sign the Research Consent Form. The Ethics Board, under register number 2.037.103, approved the present study.

Participant's evaluation

All participants were evaluated during a scheduled home visit. Mental statuses of members of both groups were assessed using the Mini-Mental State Examination (MMSE), a questionnaire that categorizes cognitive functions by 30 questions, divided into the following sections: spatial and temporal orientation, words registration, attention and calculation, memory evocation, and language (Folstein, Folstein, & McHugh, 1975).

The Clinical Dementia Rating scale (CDR) was used to describe AD stages. According to this scale, elderlies were classified in: CDR 0: healthy; CDR 0.5: questionable dementia; CDR 1: mild dementia; CDR 2: moderate dementia; and CDR 3: severe dementia. The CDR scale is based on a questionnaire that validates 6 categories: memory, learning, judgment and problem-solving, personal relationships, home activities, and hobbies (Morris, 1993).

The risk of falls was evaluated by Downton Fall Risk Score (FRS). This instrument has a sensitivity of 81.8% (Vassallo, Poynter, Sharma, Kwan, & Allen, 2008) and describes elderlies' risk of fall according to 5 criteria: fall occurrence, administered medications, sensorial deficits presence, mental status, and gait pattern information. The instrument was completed by the participant (self-report) or based on the caregiver report of the patient. The use of the following medications is accounted for by the FRS:

tranquilizers or sedatives, diuretics or antihypertensive drugs, antiparkinsonian and antidepressant drugs. The sensorial deficits presence is self-reported by the patient or the caregiver when they confirm having impaired vision, impaired hearing, and/or impaired limbs (reduced limb sensibility such as neuropathies, sequelae of stroke or amputations). With regards to the gait pattern information, it was determined if the patient could perform it in a secure manner when assisted by equipment (i.e., walking stick or walker), or if they were insecure when walking with or without equipment. For each item of the instrument that represents a factor for increased risk of falls, a score of 1 is attributed. Scoring varies from 0 to 11: scores higher than 3 indicate, proportionally, the increased risk of falling.

Mini Nutritional Assessment (MNA) was used for nutritional status evaluation. The instrument constitutes 18 items, comprehending a gauge of anthropometric measures, eating habits, and living conditions with 6 triage items and 12 others for global evaluation. Scoring is from 0 to 30: scores <17 indicate malnutrition; 17-23.5 indicate a malnutrition risk; and ≥ 23.5 indicate a normal nutritional status (Vellas et al., 2006).

Statistical analysis

Descriptive statistics was used for continuous variables and these data were expressed as means and standard deviations. Paired t-test, Chi square, and Fisher's exact test evaluated the differences across groups.

Logistic regression models were used to estimate the odds ratio and 95% confidence interval of associations. The dependent variable was the risk of fall, which was divided into two categories, low risk of fall (FRS ≤ 3), which was used as the reference, and high risk of fall (FRS > 3). The independent variable, nutritional status, was divided into two categories of ≤ 23.5 (malnutrition and malnutrition risk status) and > 23.5 (normal nutrition status). The first model was adjusted for gender, age, and education. In the second model, the body mass loss (calf circumference < 36 cm) was added to those already inserted in the previous model. The third model included all confounders used in the second model and metabolic variables (hypertension and diabetes). Lastly, the fourth model was additionally adjusted for AD.

As a sub-analysis, we compared AD patients according to their CDR classification (i.e., mild, moderate, and severe dementia sub-groups) for risk of falls and MNA score using an one-way ANOVA followed by Bonferroni *posthoc*. Homogeneity of variances was confirmed by the Levene statistic. This analysis allows us to verify if the AD progression may increase fall risk and malnutrition risk.

The significance level was established to be $p < 0.05$ for all the analysis of the present study.

Results and discussion

Initially, 78 individuals with AD were identified, among them 11 were bedridden, 10 died before data collection, 23 did not sign the consent form nor completed the protocol. Therefore, they were excluded from the final sample that included 34 individuals in the AD group. Considering this sample size, 34 controls were matched according to the previously established criteria. Both groups had 22 females and 12 males each, with an average age of 76.5 ± 8.65 years.

In the AD group, 11 (32.53%) patients were classified as CDR1 (mild dementia), 14 (41.17%) patients as CDR2 (moderate dementia), and 9 (26.7%) patients as CDR3 (severe dementia). The elderly with AD had a higher score for risk of falling than the controls ($p < 0.001$), as well as lower MMSE ($p < 0.001$) and MNA scores ($p < 0.001$). No differences in anthropometric characteristics were found (Table 1).

Table 2 presents the categorical variables from the study and demonstrates that prevalence of falls was higher in the AD group than in the control group ($p = 0.041$) and worse nutritional status was also more prevalent among AD patients ($p < 0.001$). No significant differences between the groups were found with regards to specific medications investigated, visual and auditory impairment, mental status, sensorial deficits, and gait pattern.

Table 3 describes the main association of the study (risk of falls x nutritional status). Malnutrition and its risk (MNA score ≤ 23.5) were associated with a higher risk of fall (FRS > 3) after adjustment for sociodemographic, body composition, and metabolic variables (adjusted odds ratio, aOR: 8.29; 95% confidence interval, CI: 1.49-46.04) than normal nutritional status (MNA score > 23.5). However, the statistical significance of the association did not remain after adjusting for diagnosis of AD (aOR: 2.54; 95% CI: 0.29-22.53) (Table 3).

Table 1. General characteristics with respect to age, education, body weight and height, MMSE, MNA, and FRS for Alzheimer's disease and control groups.

	Alzheimer's disease group (n = 34)		Control group (n = 34)		P
	Mean	SD	Mean	SD	
Age (years)	76.65	8.65	76.65	8.65	---
Education (years)	3.91	2.29	2.94	2.55	0.066
Body weight (kg)	69.37	14.49	69.57	11.14	0.948
Height (m)	1.57	0.09	1.58	0.09	0.434
MMSE	13.06	5.64	24.50	3.06	<0.001
MNA	20.69	3.07	26.43	2.71	<0.001
FRS	5.21	1.61	2.79	1.44	<0.001

SD = Standard deviation; MMSE = Mini-Mental State Examination; MNA = Mini Nutritional Assessment; FRS = Fall Risk Score

As a sub-analysis in our dataset, we compared AD patients according to their CDR classification (i.e., mild, moderate, and severe dementia sub-groups) for risk of falls and MNA score. This analysis allows us to verify if the AD progression may increase fall risk and malnutrition risk. FRS was significantly higher ($p < 0.05$) in the moderate (5.71 ± 1.38) and severe (6.11 ± 1.54) dementia sub-groups compared to the mild dementia sub-group (3.82 ± 0.98). The mild dementia sub-group (22.64 ± 3.70) presented higher MNA score compared to the moderate dementia sub-group (19.45 ± 2.34), but no differences were observed when compared to the severe dementia sub-group (20.22 ± 2.18).

Table 2. Fall occurrence, use of specific medications, visual and auditory impairment, mental status, sensorial deficits, and gait pattern in Alzheimer's disease and control groups.

		Alzheimer's disease group (n = 34)		Control group (n = 34)		P
		N	%	N	%	
Fall occurrence	No	10	29.4	26	76.5	0.041
	Yes	24	70.6	8	23.5	
Sedatives	Not using	26	76.5	27	79.4	0.315
	Using	8	23.5	7	20.6	
Diuretics	Not using	24	70.6	26	76.5	0.565
	Using	10	29.4	8	23.5	
Antihypertensives	Not using	8	23.5	7	20.6	0.315
	Using	26	76.5	27	79.4	
Antidepressants	Not using	13	38.2	27	79.4	0.210
	Using	21	61.8	7	20.6	
Antiparkinsonians	Not using	25	73.5	34	100.0	---
	Using	9	26.5	0	0.0	
Visual impairment	No	22	64.7	22	64.7	0.583
	Yes	12	35.3	12	35.3	
Auditive impairment	No	19	55.9	25	73.5	0.640
	Yes	15	44.1	9	26.5	
Sensorial deficit in Members	No	28	82.4	32	94.1	0.674
	Yes	6	17.6	2	5.9	
Mental Status	Oriented	1	2.9	21	61.8	0.382
	Confused	33	97.1	13	38.2	
Normal gait	No	20	58.8	4	11.8	0.627
	Yes	14	41.2	30	88.2	
Gait using equipment	No	28	82.4	33	97.1	0.824
	Yes	6	17.6	1	2.9	
Abnormal gait	No	20	58.8	31	91.2	0.555
	Yes	14	41.2	3	8.8	
Nutritional status (MNA)	Malnutrition	2	5.9	0	0.0	<0.001
	Malnutrition risk	26	76.5	7	20.6	
	Normal nutrition	6	17.6	27	79.4	

MNA = mini nutritional assessment.

Our results added cross-sectional evidence that malnutrition is associated with high risk of fall among elderly patients independent of gender, age and education, body mass status, and metabolic conditions. Furthermore, AD acts as a confounder in the relationship between nutritional status and risk of fall. We additionally observed that fall and malnutrition risk increased as the degree of dementia progressed in the AD patients.

In this study, elderly patients at risk of malnutrition or malnourished were more likely to have a higher risk of fall than elderly patients with normal nutritional status, regardless of sociodemographic, physical,

and metabolic confounders. These results corroborate the ones from Saunders, Smith and Stroud (2014), who indicated that malnutrition could lead to several systematic complications, such as reduced skeletal muscle mass, body weight, and bone mass loss.

Table 3. Adjusted odds ratio (95% Confidence Interval) of high risk of fall according to nutritional status among elderly patients from Guarapuava, Brazil in 2013 (N = 68).

Variables	Total n (%)	High risk of fall n (%)	Adjusted by gender, age, and education aOR (95% CI)	+ body mass loss ^a aOR (95% CI)	+ metabolic conditions ^b aOR (95% CI)	+ Alzheimer's disease ^c aOR (95% CI)
Nutritional status						
> 23.5	33 (48.5)	22 (66.7)	1.00	1.00	1.00	1.00
≤ 23.5	35 (51.5)	32 (91.4)	6.74 (1.49; 30.43)*	8.69 (1.73; 43.63)*	8.29 (1.49; 46.04)*	2.54 (0.29; 22.53)

^aOR: Odds ratio obtained through a logistic regression model adjusted by the variables indicated; CI: confidence interval. ^aPrevious model adjusted by calf circumference (< 36 cm: body mass loss). ^bPrevious model adjusted by hypertension and diabetes. ^cPrevious model adjusted by diagnostic of Alzheimer's disease. *p < 0.05.

The association between risk of fall and nutritional status has important health implications. In a sample of 6,701 elderly patients living in Dutch residential long-term care, Neyens et al. (2013) indicated that malnutrition was related with frequent falls (OR: 1.78; p < 0.01). This increase in the risk of falling was also stated by Westergren et al. (2014) in the elderly population with risk of malnutrition. Moreover, the malnourished residents exposed to nutritional intervention were less likely to fall than those in the control group (Neyens et al., 2013).

Although their multivariate analysis confirmed the relationship between malnutrition and falling independently of activity (Neyens et al., 2013), other studies have demonstrated that changes in the nutritional status are also strongly associated with severe cognitive and functional impairments, which is in line with findings from our sub-analysis showing that patients with moderate dementia had lower MNA score compared to patients with mild dementia. Spaccavento, Del Prete, Craca and Fiore (2009) stated that AD patients at risk of malnutrition have a greater impairment of functional, cognitive, and neuropsychiatric abilities. This damage in sensory and motor systems was also demonstrated by Albers et al. (2015) in aging patients. Furthermore, other deficits in olfactory, auditory, visual, and motor systems could be related to the appearance of cognitive symptoms, common in AD (Albers et al., 2015). In line with that, our sub-analysis demonstrated that patients with moderate and severe dementia had higher risk of falls compared to those with mild dementia.

Some nutritional status issues, such as weight loss and the risk of losing weight, are frequent in all AD stages (Droosigma et al., 2013). This is consistent with the results of the present study that reported a high prevalence of malnutrition and risk of malnutrition in AD patients. In the AD group, 17.65% of patients were eutrophic or well-nourished, 76.46% were at risk of malnutrition, and 5.8% were malnourished. Conversely, 79.4% patients from the control group were well-nourished and 20.58% were at risk of malnutrition, highlighting that changes in nutritional status are more frequent in AD patients than in elderlies without dementia.

Different factors related to cognitive loss, such as memory and olfaction deficits, behavioral discrepancies (depression or unrest), and motor difficulties that can occur at the onset of disease, are known as potential influencers of nutritional status in AD individuals (Bonini et al., 2014). Goes et al. (2014b) reported that risk of dysphagia occurs in all stages of AD and gets worse with dementia progression and pointed to dysphagia as a plausible cause of changes in the nutritional status.

This study has some methodological aspects that should be considered. First, we examined the main association in a sample of elderly patients and that the analyses were adjusted for several potential confounders (i.e., sociodemographic, body composition, metabolic conditions, and AD). Second, the drug classes evaluated in this study were only the ones considered by the FRS. However, some patients were possibly using other drugs. Third, the sample size was limited by the difficulty in finding community-dwelling patients with preserved gait ability for inclusion in this study. Last, the cross-sectional design of the study did not permit the establishment of a causal relationship between nutritional status and risk of fall.

Conclusion

The present study found a significant association between nutritional status and high risk of falls, regardless of gender, age and education, body composition, and metabolic condition. However, this association did not remain after adjustment for AD, which indicates that AD acts as an important confounder on the relationship between risk of fall and nutritional status. Given the several complications related to falls in the elderly population, health professionals should pay attention to nutritional status to prevent falls, particularly for individuals with AD. Prospective studies are needed to investigate whether the worst nutritional status, in fact, increases the risk of fall.

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