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Anthropometric Indicators and Balance Deficit as Predictors of Frailty in Elderly People

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ABSTRACT

Purpose: The aim of this study was to estimate the prevalence of frailty and identify associated factors in elderly people registered in primary health care.

Methods: This is a cross-sectional study of 218 elderly people (aged ≥ 60 years) registered at two Family Health Units in Jequié, Bahia. Measures such as age, gender, level of education, family income, marital status, presence of pain, chronic diseases, medication in use and nutritional status were extracted from the bio sociodemographic questionnaire, Mini Mental State Examination (MMSE), Edmonton Frailty Scale, Barthel Index and Lawton Scale and anthropometric measurements. The association between independent variables and frailty was verified using adjusted Poisson regression, with prevalence ratios (PR) and 95% confidence intervals (95%CI).

Results: Frailty was significantly associated with dependence in BADL[A5] (PR = 0.60; 95%CI: 0.45-0.78; p < 0.001), risk of falling (PR = 0.43; 95%CI: 0.25-0.73; p = 0.002) and reduced muscle strength (PR = 0.96; 95%CI: 0.94-0.98; p = 0.001).

Conclusion: The factors analyzed are important predictors of impaired frailty and should be prioritized in health interventions aimed at promoting healthy aging and reducing impaired functional balance.

Keywords: Anthropometry; Elderly; Frailty; Primary Health Care; Health

INTRODUCTION

Population aging is a global phenomenon that poses significant challenges for public health, especially in countries like Brazil, where the proportion of elderly people is growing rapidly. With ageing comes physiological changes that compromise mobility, balance and functional autonomy, increasing the vulnerability of this population. Among these changes, loss of muscle strength, known as dynapenia, is one of the main causes of frailty, functional disability, directly associated with impaired functional balance, hospitalizations and even mortality [1].

In addition, functional balance deficit has been widely recognized as a relevant predictor of frailty in older people, a condition that negatively impacts quality of life [2]. Functional balance, which depends on muscular and neurological factors, plays a crucial role in preventing falls and preserving autonomy in daily activities [3].

In this context, frailty, conceptualized as a clinical syndrome that increases vulnerability to adverse events, is often accompanied by changes in body composition, such as reduced muscle mass and increased visceral fat [4]. These changes can be assessed using anthropometric indicators such as Body Mass Index (BMI), calf circumference and waist circumference, which provide important information about the health of the elderly. Recent studies have shown that these indicators are effective in predicting functional decline and the risk of frailty, helping to identify elderly people who are more susceptible to health complications [4].

Primary health care is responsible for preventing various diseases and is an important pillar for monitoring the elderly population on a daily basis. In this context, the assessment of anthropometric indicators and functional balance plays a strategic role, enabling early interventions aimed at preventing frailty and reducing morbidity associated with falls. These assessments allow not only for an understanding of the physical condition of the elderly, but also for the identification of risk factors that can be modified through physical exercise programs and nutritional adjustments. Thus, the combination of anthropometric measurements and the frailty index offers a comprehensive approach to monitoring the health of older people and improving their prognosis [5].

This study is justified by the need to deepen our knowledge of the relationship between anthropometric indicators and impaired balance as predictors of frailty in elderly people treated in primary care. Understanding these relationships can help to create targeted intervention strategies that promote healthy ageing and reduce frailty, thus promoting greater autonomy and quality of life for the elderly population [6].

In this context, this study aims to analyze anthropometric indicators and balance deficit as predictors of frailty in elderly people in primary health care.

MATERIALS AND METHODS

This is a cross-sectional study of individuals aged ≥ years. Data was analyzed from the research project entitled: Construction of health, social and environmental indicators for dependent elderly people and their caregivers in primary care in Brazil and Portugal, which is part of the international research network entitled: “Vulnerability and social and health conditions of the elderly in primary care and long-term care institutions: a comparative study in Brazil, Portugal and Spain”.

The research was carried out in two Family Health Units (USF) in the interior of Bahia, from July 2022 to March 2023. The participants were 218 elderly people of both sexes. The study included people aged 60 or over registered at the two-Family Health Units, classified as having preserved cognitive conditions by the Mini Mental State Examination/MEEM and who were able to travel (with or without the help of third parties) to the collection site for the intervention and project evaluation.

Excluded from the study were elderly people who did not make effective telephone contact, who were classified as having cognitive impairment by the MMSE, who were unable to walk or who were unable, for whatever reason, to travel to the place where the intervention and project evaluations were carried out.

The following instruments were used to survey the health demands: bio sociodemographic and health conditions survey, Time Up and Go Test (TUGT), Mini Mental State Examination (MMSE), Edmonton Frailty Scale (EFS) and the Self-Reported Frailty Scale [7], nutritional status, Functionality Scales (Barthel Index and Lawton Scale), health conditions and anthropometric measurements (weight, height, Brachial Perimeter (BP), Leg Perimeter (LP), handgrip strength, waist-to-hip ratio and abdominal circumference.

The bio sociodemographic and health conditions survey includes information such as age, gender, level of education, family income, marital status, presence of pain, chronic illnesses, medication in use and nutritional status.

The Time Up and Go Test (TUGT) is a sensitive and specific measure for identifying functional balance impairment in the elderly and is widely used to assess the functional mobility of this population. This test is the study's main instrument for verifying functional balance impairment. The TUGT assesses, in seconds, the time needed for an elderly person to stand up from a chair (45 cm high), walk a distance of three meters, turn around, walk back towards the chair and sit down again safely [8].

The Mini-Mental State Examination (MMSE) is a quick test to assess cognition, useful for identifying mental deficits, especially in cases of dementia. It examines 11 areas, including orientation in time and space, memory (immediate and recall), calculation, language (naming, repetition, comprehension) and visual skills (copy drawing). Each area has a score which, when added together, can reach a total of 30 points. The minimum score considered to be preserved cognition varies between 17 and 24 points, depending on the level of education and other factors; scores below 17 generally indicate cognitive impairment and the need for more detailed assessment [9].

The Edmonton Frailty Scale (EFS) was used to screen for frailty, assessing nine domains: cognition, general health status, functional independence, social support, medication use, nutrition, mood, continence and functional performance. After classification, they were recategorized into frail and non-frail. Individuals with a score between zero and four are considered not to be frail, those between five and six are apparently vulnerable, those between seven and eight are mildly frail, those between nine and ten are moderately frail and those 11 or over are severely frail [10]. In this study, all those who did not score between zero and four were considered frail. The Self-Reported Frailty Scale was also used to screen frailty. This scale assesses the perception of elderly people or their assistant/substitute informants regarding the components of the frailty syndrome.

The Barthel index assessed the basic activities of daily living (eating, bathing, dressing, personal grooming, urination, defecation, toilet use, bed/armchair transfer, walking and steps), with scores ranging from 0 to 100: independence: 100 points; mild dependence: 60 - 95; moderate dependence: 40 - 55; severe dependence: 20 -35; total dependence: less than 20 [11].

The Lawton and Body scale was used to assess instrumental activities of daily living (telephone use, travel, shopping, meal preparation, housework, medication use and finances). Its score ranges from 0 to 21, with Total dependence: less than or equal to 5; Partial dependence: greater than 5, less than 21; Independent = 21 [12].

The Body Mass Index (BMI) was the result of the body weight of elderly people in Kilograms (KG) divided by height squared, as follows: underweight (BMI $\leq$ 22); normal (BMI =<27); and overweight/obese (BMI $\geq$ 27) [13,14]. The participant's weight was measured using a G-tech Balgl10 portable digital platform scale with a

maximum capacity of 150kg and an accuracy of 100g. Height was measured using a portable stadiometer, positioning the elderly person with their head in the Frankfurt plane [15].

Abdominal waist circumference was measured using a flexible, inelastic tape measure, with a scale in millimeters, at the midpoint between the last rib and the iliac crest, with the participant standing, without compressing the skin. The average of three measurements will be used for analysis. Hip circumference was measured at the height of the iliac crests using a flexible, inelastic tape measure with a scale in millimeters, with the participant standing. The average of three measurements will be used for analysis [16].

The circumference of the leg (calf) was measured using a flexible, inelastic measuring tape, with a scale in millimeters, with the participant sitting down, with the knee bent at a 90° angle, at the height with the greatest circumference, on the dominant leg. Three measurements were taken, and the average will be used for analysis. In addition, the circumference of the ankle, immediately above the malleoli, will be checked [17].

Brachial circumference was measured with the arm extended along the body, palm facing the thigh, at the midpoint between the acromion and the olecranon using a flexible, inelastic tape measure with a scale in millimeters [18].

Muscle strength was assessed using the Hand Grip Strength (HGS) test, using a hydraulic dynamometer (Saehan Corporation SH5001, Korea) with a handle adjusted to the size of each individual's dominant arm. The elderly person was then positioned in a sitting position, with their elbow resting on a table at a 90° angle, forearm in a neutral position and wrist ranging from 0 to 30° of extension. Two attempts were made, with an interval of 1 minute between them, and the highest value (kilogram/force - kgf) was considered for analysis [19].

Descriptive analyses included calculations of absolute and relative frequencies for categorical variables and means and standard deviation for continuous variables. Data distribution was verified using the Kolmogorov-Smirnov test. The mean values and proportions according to frailty were compared using the t-test for independent samples and the chi-squared test, respectively. Fisher's exact test was used when the expected frequency was less than five in at least one case. The association between the independent variables and frailty was verified by crude and adjusted analyses using Poisson regression with robust adjustment and expressed as Prevalence Ratios (PR) with the respective 95% confidence intervals (95%CI). Variables with a p-value < 0.20 in the crude analyses remained in the adjusted model. A significant level of 5% was adopted and all the analyses were carried out using the IBM SPSS v.25.0 statistical package.

The multicenter project was submitted to the Research Ethics Committee (CEP) of FAINOR - Faculdade Independente do Nordeste, under CAAE number: 36278120.0.2002.5578 and approval protocol Opinion Number: 4.351.219.

RESULTS

The sample was made up predominantly of women (66.1%), aged between 60 and 68 (52.8%), living with a partner (50.9%) and with some level of schooling (87.6%). Most of the elderly (85.3%) took medication, 45.4% were overweight or obese and 42.2% were classified as frail.

Frailty was prevalent in 67% of the sample, being higher in females among those aged over 68, with multiple chronic diseases and altered nutritional status. In addition, mean strength values were significantly lower among those at risk of falling when compared to individuals not at risk of falling (Table 1).

Table 1: General characteristics of the sample according to frailty profile, Jequié/BA, 2025.

Variables	Total n (%)	Fragility n (%)		p-value
		No	Yes	
Gender				
Female	144 (66,1)	77 (53,5)	67 (46,5)	
Male	74 (33,9)	49 (66,2)	25 (33,8)	0,071
Marital status				
Without partner	107 (49,1)	57 (53,3)	50 (46,7)	
With partner	111 (50,9)	69 (62,2)	42 (37,8)	0,184
Education				
No schooling	27 (12,4)	13 (48,1)	14 (51,9)	
With schooling	191 (87,6)	113 (59,2)	78 (40,8)	
Age group				
60 to 68 years old	115 (52,8)	76 (66,1)	39 (33,9)	
> 68 years old	103 (47,2)	50 (48,5)	53 (51,5)	0,278
Income				
Up to 1 minimum wage	106 (48,6)	56 (52,8)	50 (47,2)	
2 or more minimum wages	112 (51,4)	70 (62,5)	42 (37,5)	0,009
Chronic illnesses				
One Disease	105 (48,2)	72 (68,6)	33 (31,4)	
>One Disease	113 (51,8)	54 (47,8)	59 (52,2)	0,002
Use of Mdications				
No use	32 (14,7)	12 (30,6)	20 (62,5)	
Use	186 (85,3)	101 (54,3)	85 (45,7)	0,012
Pain				
Absence	71 (32,6)	47 (66,2)	24 (33,8)	
Presence	147 (67,4)	79 (53,7)	68 (46,3)	0,081
BADL				
Independent	169 (77,5)	113 (66,9)	56 (33,1)	
Dependent	49 (22,5)	13 (26,5)	36 (73,5)	<0,001
IADL				
Independent	2 (0,9)	1 (50,0)	1 (50,0)	
Dependent	216 (99,1)	125 (57,9)	91 (42,1)	0,667
BMI				
Low weight	35 (16,1)	17 (48,6)	18 (51,4)	
Eutrophic	84 (38,5)	47 (56,0)	37 (44,0)	
Overweight/Obesity	99 (45,4)	62 (62,6)	37 (37,4)	0,319
Risk of falling				
No	69 (31,7)	58 (84,1)	11 (15,9)	
Yes	149 (68,3)	11 (45,6)	81 (54,4)	<0,001
Continuous variables, mean (SD)				
Muscle Strength, kg	24,4 (8,8)	27,2 (9,2)	20,7 (6,59)	<0,001
Brachial Perimeter, cm	31,0 (5,0)	31,4 (4,9)	30,5 (5,7)	0,187#
Leg circumference, cm	34,9 (3,9)	35,2 (3,8)	34,4 (4,0)	0,151#
Waist circumference, cm	92,6 (13,0)	93,3 (12,7)	92,0 (13,4)	0,455#
Hip circumference, cm	100,3 (11,6)	100,6(12,0)	99,8 (11,0)	0,627#

BMI: Body Mass Index; sd: standard deviation; BADL: Basic Activities of Daily Living; IADL: Instrumental Activities of Daily Living; *Fisher's exact test; *Teste t for independent samples.

Table 2: Association between frailty and the study's independent variables. Jequié, Bahia, Brazil, 2025.

Variables	Fragility		Adjusted PR PR (IC95%)	p
Gender				
Female			-	-
Male				
Marital status				
With partner	-		1,11 (0,83-,44)	
Without partner				0,50
Education				
With schooling	-	-	-	-
Without schooling				
Age group				
60 to 68 years old	-	-	0,94 (0,71-,26)	
> 68 years old			1	0,70
Income				
Up to 1 minimum wage	-		1,23 (0,92-,64)	
2 or more minimum wages				0,15
Chronic diseases				
One disease	-		0,79 (0,571,09)	
>One disease	-			0,15
Use of medication				
Uses	-		1,42 (0,752,70)	
Does not use			1	0,27
Pain				
Absence	-		0,88 (0,64-,20)	0,43
BADL				
Independent			0,60 (0,45-,78)	
Dependent			1	<0,001
AIVD				
Independent			-	-
Dependent				
BMI				
Underweight			1,28 (0,82-,00)	0,27
Eutrophic			-	-
Overweight/Obesity			-	-
Risk of falling				
No			0,43 (0,25-,73)	0,002
Yes			1	
Brachial Perimeter			0,99 (0,96-1,03)	0,95
Leg circumference			1,01 (0,97-,06)	0,46
Waist circumference			-	-
Hip Circumference			-	-

PR: Prevalence Ratio; adjusted PR: model adjusted for all variables in the model; 95%CI: 95% Confidence Interval; BADL: Basic Activities of Daily Living; IADL: Instrumental Activities of Daily Living; BMI: Body Mass Index.

Table 2 shows the crude and adjusted analysis of the regression model to assess the association between independent variables and frailty in elderly people. The crude analysis showed that gender, marital status, age group, chronic diseases, medication use, nutritional status, dependence on Basic Activities of Daily Living (BADL), risk of falling and muscle strength were significantly associated with frailty.

However, after adjusting the model, only nutritional status (PR = 0.63; 95%CI: 0.46-0.87; p = 0.005), dependence on BADLs (PR = 0.60; 95%CI: 0.45-0.78; p < 0.001), the risk of falling (PR = 0.43; 95%CI: 0.25-0.73; p = 0.002) and muscle strength (PR = 0.96; 95%CI: 0.94-0.98; p = 0.001) remained significantly associated with frailty. These results indicate that functional dependence, muscle strength and altered nutritional status are associated factors in the frailty of the elderly people assessed.

DISCUSSION

Analysis of the results of this study reveals an understanding of the factors associated with frailty in older people, highlighting the importance of variables such as nutritional status, functionality in Activities of Daily Living (ADLs), risk of falling and muscle strength as predictors of frailty. This discussion goes beyond the simple interpretation of the data and addresses the implications of the findings in the context of public health and the planning of targeted interventions.

Firstly, altered nutritional status stands out as a critical factor, reflecting the impacts that nutritional imbalance can have on the structure and physical function of elderly people. Studies indicate that both malnutrition and overweight are conditions that compromise functional capacity [20-22].

Overweight individuals tend to overload their joints and face mobility difficulties, while malnourished individuals lack muscle and energy reserves, increasing functional balance impairment and injuries. Therefore, nutritional interventions in primary care can be one of the pillars of health programs for the elderly, aimed at both reducing obesity and preventing malnutrition.

Dependence on Basic Activities of Daily Living (BADL) emerges as one of the main indicators of functional frailty. This result is in line with what has been described in the literature, as independence in BADLs is often used as a criterion to measure the autonomy of the elderly. Frailty limits the individual's ability to carry out daily activities, such as bathing, dressing and eating, which not only impacts their quality of life, but also increases the burden on health and social care systems [23].

In this study, dependence in BADLs was significantly associated with frailty, suggesting that basic functional impairment precedes or coincides with the manifestation of clinical frailty. This emphasizes the need for rehabilitation and functional training programs focused on preserving or restoring the independence of older people, as well as showing that community support can be essential for those who already have some degree of dependence.

Another fundamental point revealed was the high prevalence of the risk of falling in the sample, a factor that remained associated with frailty even after adjustments. This finding is particularly relevant, as it shows that falls in elderly people are a marker of frailty that deserves special attention. Previous studies have shown that recurrent falls are associated with abrupt declines in the functionality and quality of life of older people, contributing to the cycle of frailty [24]. The vulnerability to falls identified in this study suggests that frail elderly people probably have

balance and motor control deficits, often associated with chronic diseases and low muscle strength. Thus, intervention strategies in primary care, such as balance and strength training programs, can be effective in reducing functional balance impairment and, consequently, minimizing the progression of frailty.

Finally, muscle strength stands out as an essential factor in the prevention and control of frailty. The analysis revealed that higher levels of muscle strength were inversely associated with frailty, confirming dynapenia (loss of muscle strength) as one of the central mechanisms of frailty in older people. Loss of strength, according to [25], compromises not only the ability to perform physical activities, but also endurance and motor coordination, which are fundamental for safe mobility and autonomy for the elderly. This study reinforces the importance of muscle strength in preventing frailty, which suggests that practices such as muscle strengthening and resistance training, adapted to the capacity of each elderly person, should be a priority in health interventions.

Given these findings, this study strengthens the understanding that frailty in the elderly is multifactorial and requires an integrated approach in primary care. The presence of conditions such as low muscle strength, impaired functional balance, inadequate nutritional status and functional dependence in BADLs indicate that frailty results from a complex interaction between physical, nutritional and functional factors [24]. Primary care should therefore adopt a comprehensive care model, with regular assessments of anthropometric indicators and balance tests, which allow for early identification of risk factors. In addition, multidisciplinary strategies involving physiotherapists, nutritionists and physical education professionals can be crucial in developing programs to prevent or reduce frailty [23].

Thus, promoting healthy aging requires actions that address frailty in a preventive and personalized way, promoting not only longevity, but also quality of life and autonomy for the elderly, contributing to a more efficient health system and a more resilient and independent elderly population.

CONCLUSION

It can be concluded that the factors analyzed in this study, especially muscle strength, nutritional status, risk of falling and dependence on Basic Activities of Daily Living (BADL), are significant predictors of frailty in elderly people treated in primary health care.

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