

Association of falls, fear of falling, handgrip strength and gait speed with frailty levels in the community elderly

Associação da queda, medo de cair, força de preensão palmar e velocidade da marcha com os níveis de fragilidade em idosos da comunidade

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ABSTRACT

Introduction: The Frailty Syndrome is not synonymous with disability, but may be a precursor of etiological and physiological dysfunction, which affects mobility before causing reduced functional capacity, explaining conditions of weakness, weight loss, and abnormal gait. **Study design:** This is an analytical, observational, cross-sectional study. **Objective:** To verify the association of handgrip strength, gait speed, fear of falling, and falls with the level of frailty. **Methods:** Study consisting of 54 participants, aged 65 and older, enrolled in a health care and monitoring government program in the municipality of Uberaba, Minas Gerais, Brazil. The volunteers were assessed for frailty, – non-frail group (NG), pre-frail group (PG), and frail group (FG) – according to the Fried criteria, and based on the outcomes of handgrip strength, gait speed, fear of falling, and falls. An inferential descriptive statistical analysis followed, with Chi-square and Kruskal-Wallis tests performed by the Stata11.0 software. **Results:** In the comparative analysis between the groups studied there was statistical significance relative to handgrip strength (FG and NG), gait speed (NG and FG / NG and PG), and fear of falling (NG and FG). There was no significant difference between the levels of frailty and falls. **Conclusions:** Frailty is associated with reduced muscle strength, decreased gait speed, and greater fear of falling in elderly people of the community.

Keywords: Aging. Frail Elderly. Hand Strength. Gait. Falls, accidental. Muscle Strength.

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RESUMO

Introdução: A síndrome de fragilidade não é sinônimo de incapacidade, mas pode ser um precursor fisiológico e etiológico de disfunção, que afeta a mobilidade antes de causar redução da capacidade funcional, explicando condições de fraqueza, perda de peso e alterações de marcha. **Modelo do estudo:** Estudo analítico, observacional e transversal. **Objetivo:** Verificar a associação da força de preensão palmar, velocidade da marcha, medo de cair e quedas com os níveis de fragilidade. **Métodos:** Estudo composto por 54 participantes com idade igual ou superior à 65 anos cadastrados em um programa governamental de atendimento e acompanhamento em saúde no município de Uberaba – Minas Gerais. Os voluntários foram avaliados quanto à fragilidade (grupo não-frágil (GN), grupo pré-frágil (GP) e grupo frágil (GF), segundo os critérios de Fried e quanto aos desfechos força de preensão palmar, velocidade da marcha, medo de cair e quedas. Procedeu-se à análise estatística descritiva e inferencial com os testes Qui-quadrado e Kruskal-Wallis por meio do software Stata11.0. **Resultados:** Na análise de comparação entre os grupos estudados, houve significância estatística em relação à força de preensão palmar (GN e GF), velocidade da marcha (GN e GF, GN e GP) e medo de cair (GN e GF). Não houve significância entre os níveis de fragilidade e quedas. **Conclusão:** A fragilidade está associada à menor força muscular, diminuição da velocidade da marcha e maior medo de cair em idosos da comunidade.

Palavras-chave: Envelhecimento. Idoso Fragilizado. Força da Mão. Marcha. Acidentes por Quedas. Força Muscular.

Introduction

The Frailty Syndrome can be defined as a physiological condition of declining energy reserves and resistance to stressors, resulting in systemic changes and increased vulnerability to adverse conditions.¹

According to the study carried out by Moreira and Lourenço² the prevalence of Frailty Syndrome is of 9.1%; 47.3% for pre-frail individuals, and 43.6% for non-frail ones, which is similar to the statistics of other international studies.^{1,3,4}

The operational definition of frailty has been a challenge for gerontologists. Two international groups have been researching the concept of frailty – one in Canada and one in the USA. *Canadian initiative on Frailty and Aging* researchers have considered cognition, humour, use of medication, and social support as key elements to evaluate frailty.⁵

The *Cardiovascular Health Study* is based on physiological principles and stems from the hypothesis that the concept represents a geriatric syndrome that can be identified through a phenotype of five measurable components.¹ Such operational definition was adopted because this is what is most reported within the literature studied.

Fried et al¹ proposed a phenotype of frailty with five measurable assessment items: unintentional weight loss, low muscle strength, low gait speed, reduced physical activity, and exhaustion. A frail individual is one with three or more of these characteris-

tics; a pre-frail individual has one or two, and a non-frail individual has none.

Frailty presents a variety of predictors, such as old age, cognitive deficit, comorbidities, polypharmacy, social support, and sarcopenia, which is cited as one of the components of the syndrome's triad.^{2,5,6}

Sarcopenia is defined as loss of strength and muscle mass, and it is caused by an increase in inflammation, which reduces hormones and number of neuromuscular junctions, idleness and poor nutrition.⁷ Serum levels of the cytokine interleukin-6 in muscle fiber satellite cells cause loss of these fibres and, consequently, a reduction in musculoskeletal mass.^{8,9} Such different and systemic cellular responses, when assessed during regular aging, would actually be further accelerated under frailty syndrome.⁹

Sarcopenia has consequences such as high decline in walking capacity, increased risk of physical limitations, falls, and disabilities.^{8,10,11,12}

The decrease in muscle strength shows up before other disabilities, such as decreased gait speed, which is associated with falls and fear of falling.^{13,14} Reduction in gait speed exposed the elderly to a risk of frailty six times higher,^{13,15,16} and is considered as a predictor to frailty.¹⁷

Falls and fear of falling may be the cause or the consequence of frailty.¹⁸ Frail elderly are more prone to falling, and therefore, more fearful of it.¹⁹ Elderly who fear falls actually restrain their level of activity, decrease gait speed, and lower the quality of

performance for daily activities, as well as lower self-efficacy in relation to falls.²⁰

Considering the importance of frailty as a predictor of mortality, disability, hospitalization, and institutionalization, studying its relationship with variables such as handgrip strength, gait speed, falls, and fear of falling may provide a basis for policy planning and the enforcement of preventive measures to help the elderly population. Furthermore, the information about such relationships may serve as a tool in preventive clinical decision-making for health care professionals who work with Gerontology.

Thus, the aim of this study was to verify the association between handgrip strength, gait speed, fear of falling and falls and frailty levels in the elderly of the community studied.

Material and Methods

Participants

This is an analytical, observational, cross-sectional study. The sample consisted of 549 elderly people enrolled in a governmental health care and monitoring program in the municipality of Uberaba, Minas Gerais, Brazil, from July to October, 2011. A population of 390 elderly aged 65 and older was selected as an inclusion criterion. To calculate sample size, the maximum percentage was considered, as per the frailty prevalence (6.9%) in the study of Fried et al.¹, and a confidence level of 90%, which resulted in a sample requiring 73 elderly. A loss in sample between 15 and 20% was accounted for, and initially the study proceeded with a selection of 86 individuals.

For the inclusion criteria adopted people were aged 65 and older, of both genders, willing to take part in the study, with fixed abode, and able to walk with or without mobility aids. Seniors with cognitive impairment (verified through MMSE - Mini Mental State Examination)²¹, inability to walk independently, visual, hearing, and speech impairment were not included in the sample, for those would preclude conducting assessments.²²

A selection of 86 participants was done through random drawing, phone, and door to door invitations to attend on-site evaluations. Of this total, 11 subjects refused to take part in the study, an elderly man died, 9 had no physical condition to attend, 5 changed addresses, 6 did not meet the MMSE cutoff point, totaling 32 elderly excluded. Finally, the sample con-

sisted of 32 women and 22 men. The study was approved by the Ethics Committee of the Federal University of the Triângulo Mineiro (Protocol nº.1815), and the subjects participating in the study signed a consent form.

Instruments and Analysis Procedures

During the first stage the MMSE²¹ was used to assess the mental state of the participants. To characterize the sample, a semi-structured questionnaire was designed considering: gender, age, comorbidities, and medications in use.

Anthropometric data were measured using a calibrated anthropometric scale (Filizola®), with subject wearing as little clothing as possible. Body mass index (BMI) was obtained in kilograms (kg) and height in meters (m) was calculated by dividing body weight by the square of height (kg/m²).

The presence of the frailty syndrome was verified by the criteria for identifying the frailty phenotype proposed by Fried et al.¹ as follows: 1 – *Unintentional weight loss*: evaluated by the question “In the last year, have you unintentionally lost more than 4.5 kg (i.e. without dieting or exercise)?” Positive score was assigned to the frailty criterion when there was a self-report of weight loss greater than 4.5 kg in the last year, or greater than 5% of the body weight; 2 – *Muscular strength*: verified based on grip strength using the hydraulic hand dynamometer (NC701/42 – North Coast™). The cutoff points proposed by Silva et al.⁴ were used, adjusted for gender and BMI. The cut-off points were based on the 20th percentile of the sample. 3 – *Self-reported fatigue*: verified using questions 7 and 20 of the Brazilian version of depression scale of the *Center for Epidemiological Studies (CES-D)*²³ 4 – *Low gait speed*: measured by the time to walk a distance of 4.6m with own footwear, mobility aids (when necessary), and usual gait speed. Following verbal command, each senior walked a total distance of 8.6 meters, out of which the two initial and the two final meters were disregarded in the calculation for the average time, in seconds, of three measurements. The cutoff points proposed by Silva et al.⁴ were used, adjusted for gender and height. The cutoff points were based on the 20th percentile of the sample; 5 – *Physical activity level*, evaluated by the Human Activity Profile (HAP),²⁴ considering the weekly energy expenditure kilocalorie (kcal). The cutoff point was determined by 20th percentile of the values assumed by the variables in the sample, ac-

ording to gender. This item scored seniors who achieved weekly caloric expenditure less than 163.23 kcal for men, and 173.17 kcal for women. The elderly with three or more of the characteristics above were measured and classified as frail, and those with one or two of them, as pre-frail. Those who tested negative for all the criteria of the frailty syndrome were considered non-frail.¹

Regarding the fear of falling the Falls Efficacy Scale-International (FES-I), was used, after being translated and culturally adapted for the Brazilian population (FES-I-BRASIL).²⁵ The scale poses questions about the concern of falling when performing from basic to more complex activities, both physically and socially, and is composed of 16 activities with scores from one to four. The total score can range from 64 points for individuals with extreme concern of falling to 16 points for individuals with no concern whatsoever. It is noteworthy that scores of less than 23 points suggest greater independence. Thus, an eventual fall is classified as a score of 23 points or greater, and a recurrent fall, as a score of 31 points or greater²⁵.

As a last aspect evaluated, a history of falling incidents was obtained through self-report, by the patients answering the question: Have you had a fall in the last 12 months? The number of falls was reported for affirmative answers.

Statistical Analysis

Descriptive analysis was performed to characterize the sample, using raw numbers, percentages, medians, and standard deviations. For the inferential analysis, initially, the continuous variables of handgrip strength, gait speed, and fear of falling had their normality tested by the Shapiro-Wilk test, presenting nonparametric distribution.

The comparison of these variables according to the frailty components was done by the Kruskal-Wallis test, with Dunn's post-testing; however, data is presented as medians and standard deviations so as to allow for comparisons with other studies using parametric data. The chi-square test was used to test for differences between categorical variables (gender, age, BMI, musculoskeletal abnormalities, labyrinthitis, drug consumption, level of physical activity). The level of significance was set at 5%, and statistical software used was Stata11.0.

Results

The sample included 54 elderly people, 32 women (59.2%) and 22 men (40.7%) with an average age of 72.9 ± 6 years, and body mass index (BMI) of 26.5 ± 4.5 kg/m². Most seniors (62.9%) reported musculoskeletal changes (comorbidities), 83% stated they took more than three different drugs a day, and 57.4% were classified as moderately active for the physical activity level. There was a prevalence of 11.1%, or six seniors, classified as frail (FG); 46.2%, or 25 subjects, in the intermediate frailty phase (PG); and 42.5%, or 23 persons, classified as non-frail (NG).

Reduction in handgrip strength was found in 66.6% in the FG, and 4% in the PG. It was found that 66.6% of the elderly the FG showed lower gait speed, followed by the PG, with 36%. Regarding the fear of falling, the possibility of recurrent falling (in other words, total score ≥ 31 pontos) was 83.3% in the FG, 32% in the PG, and 30.4% in the NG. The incidence of a fall or more within the previous year was observed in 66.6% in the FG, 40% in the PG and 43.4% in the NG.

There was no significant difference of age, gender, BMI, comorbidities, and physical activity levels among the three groups; however a statistically significant difference was observed between the NG and the PG for consumption of 3 or more drugs. **Table 1** shows the characteristics of the participants (total sample and stratified by frailty levels).

The comparative analyses between the FG and the NG showed significant difference for handgrip strength ($p=0.0004$). As for gait speed, there was a difference between NG and PG ($p=0.0001$), and NG and FG ($p=0.0023$), when compared to PG and FG ($p=0.0622$). There were significant values over the fear of falling between the NG and the FG ($p=0.0074$). There was no significance between the levels of frailty and falls ($p=0.1888$), as shown in **Table 2**.

Discussion

Population aging in Brazil has been happening fast and radically. Acknowledgement of the traits of the elderly provides information to back up strategies for health awareness and illness prevention, as well as public health policies geared towards that population niche. This study found a greater index of frailty

Table 1: Anthropometric and clinical characteristics between groups.

Variables	Frailty			Total	p value
	NG	PG	FG		
Female b	10 (43.47)	17(68.00)	5(83.33)		
Male b	13 (56.53)	8 (32.00)	1 (16.67)	22 (40.75)	
Age (years)a	71.3±5.5	74.7±7.5	71.6±4.4	72.9± 6	0.1142
BMI (Kg/m2) a	25.7 ±3.1	26.6 ± 5.4	28.9 ±4.5	26.5 ± 4.5	0.3110
Musculoskeletal abnormalities b	12 (52.17)	18 (72.00)	4 (66.66)	34 (62.96)	0.3570
Labyrinthitis b	2 (8.69)	2 (8.00)	1 (16.66)	5 (9.25)	0.7990
Drug consumption					0.028*
Up to 2 b	8 (36.36)	1 (4.00)	0 (0)	9 (16.98)	
3 or more b					
Physical Activity Level	14 (63.64)	24 (96.00)	6 (100.00)	44 (83.02)	
Active b	5 (21.74)	0 (0)	1(16.6)	6 (11.11)	0.0710
Moderately active b	14 (60.87)	15 (60.00)	2 (40.00)	31 (57.41)	
Idle b	4 (17.39)	10 (40.00)	3 (60.00)	17 (31.48)	

FG: frail group; PG: pre-frail group; NG: non-frail group; BMI: body mass index; HAP: human activity profile; SD± (standard deviation); data are expressed in ^a averages± SD or ^b n (%);* Statistical significance is p<0.05 between frailty levels (NG and PG). ^{i,ii}: nonparametric data – Kruskal-Wallis test, with Dunn's post-testing.

Table 2: Comparison between groups for frailty indicators (HS and GS), fear of falling, and fall incidents

Variables	Averages	±SD	p (NG vs. PG)	p (NG vs. FG)	p (PG vs.FG)
HS (kgf)					
NG	32.31	±9.09	0.0562	0.0004*	0.0622
PG	27.11	±7.55			
FG	19.22	±5.18			
GS (sec)					
NG	4.19	±0.69	0.0001*	0.0023*	0.0687
PG	5.40	±1.12			
FG	6.60	±1.37			
Fear of falling					
NG	24.69	±9.45	0.2842	0.0074*	0.0718
PG	29.92	±17.51			
FG	40.00	±12.36			

FG: frail group; PG: pre-frail group; NG: non-frail group; HS: handgrip strength; GS: gait speed; vs.: versus; data are expressed in averages and SD± (standard deviation); the averages comparison was done through the Kruskal-Wallis test, with Dunn's post-testing. Statistical significance is p<0.05 between frailty levels.

among elderly females of around 72.9 ± 6 years, with a 26.5 average BMI, showing comorbidities, moderately active and taking 3 or more prescription drugs daily, which matches previous studies about the subject.^{2,4,26}

The prevalence of frailty in the sample, according to the classification used by Fried et al.,¹ was similar to the results of other studies, where there is a predominance of pre-frail seniors in relation to frail and non-frail ones.^{1,12,27} Pre-frail elderly are at higher risk of becoming frail; hence the importance of implementing prevention programs to minimize the adverse effects of such transitional population.¹

The study shows a relationship between the drug consumption in the PG and the NG, which is consistent with the literature, because frailty is associated with higher inflammatory markers, reduced drug metabolism, and increased risk of adverse reactions.^{28,29} Adverse reactions and drug interactions may cause the elderly sedation, postural hypotension, and other severe consequences, such as falls.³⁰ The FG showed no significance, and that may have happened because of the limited sample size; studies with more robust samples are highly recommended.

There were no significant differences among the three groups regarding the incidence of falls in the previous year, and the same result was found by Silva et al,²⁶ although the literature reports that the frail elderly are more likely to fall.¹ During a study of elderly Chinese, Fang et al³¹ found that frailty is associated with increased risk of recurrent falls, fractures, and mortality.

However, associations were observed between the NG and the FG regarding handgrip strength, gait speed and concern about falling. Seniors who restrict their activities for fear of falling, may suffer functional decline, and increased risk of fall incidents.³² The fact that there was no significance between the frailty levels and the number of falls may be justified by a few factors such as difficulty in telling the exact number of falls during the last year, protective strategies (short gait steps, decrease in the balance phase, use of upper members as support, and higher alertness to surroundings) when performing the most basic and instrumental daily activities, as well as a decrease in the frequency those activities are performed, so as it seems they are avoiding accidents, under the same risk of falling.

The difference in the FES-I scores was statistically significant in the NG and the FG. Silva et al²⁶

found a significant correlation between the non-frail and frail elderly, and between the pre-frail and frail ones, which indicates greater fear of falling in those classed as frail. A high number of falling incidents, a great fear of falling, and a higher need for assistance in basic and instrumental activities of daily living were found in pre-frail seniors when compared to non-frail ones, despite the weak correlations between these variables.³³ This could be explained by the fact that muscle weakness is an important risk factor for decreased mobility, which can lead to poor gait performance, and greater concern about falling. Thus, it is important to consider that frailty impairs body functionality, reduces balance, and increases the risk of falling.^{3,31}

The decreased muscle strength in the elderly can be evidenced by the evaluation of handgrip strength, which is a good marker of physical performance, and a viable form of assessing the population.³⁴ Low handgrip strength was observed the pre-frail elderly,³⁵ and the frail elderly.³⁶ This study showed lower muscular strength for the FG, if compared to the NG. These findings were similar to the ones in the study of Doba et al.,³⁷ and can be explained by the protein oxidation, which increases with age, causing cellular dysfunction and decrease in tissue function, with consequent functional decline,^{38,39} and can contribute to sarcopenia,⁴⁰ resulting in frailty, functional disabilities, and ambulation decrease.^{10,11,38}

During a longitudinal study of the elderly community, Doba et al³⁷ found gait speed as the most significant indication of the frailty syndrome. Significant differences were observed in this study between the NG and the PG, when compared to the ones between the NG and the FG. Montero-Odasso et al⁴¹ found a significant association between gait speed, time, and step width and frailty levels. Gait speed is lower in frail, older females.^{12,36} This may be related to morphological declines, to functional declines of the musculoskeletal system,³⁵ and to cognitive deficits, which may be a predictor of fall incidents, disabilities, institutionalization, and death.¹⁷

Factors such as low gait speed, physical idleness, and reduced mobility are associated with sarcopenia, and are characteristics of the frailty syndrome that may contribute to an increased risk of falling.^{1,42}

This study provided an analysis based on reasonable possibilities that may be confirmed by other studies; however, further investigations are needed

to assess the relationship between handgrip strength, gait speed, fear of falling, falls, and the frailty level.

Some limitations permeated the study because of its cross-sectional nature, and did not allow inferring causality. The few studies^{26,39} that associate handgrip strength, fear of falling, and falls with frailty levels limited comparisons of the results presented here, as well as the consensus about the concept and evaluation criteria of frailty.

Conclusion

In conclusion, frailty is associated with reduced handgrip strength, decreased gait speed, and greater fear of falling. The prevalence of frailty was similar to what was found in other studies, and predominant on pre-frail elderly, followed by non-frail and frail ones.

PG presented significant values on the consumption of 3 or more drugs when compared to NG. This present study has not shown an association between frailty and number of falls within the previous year. Such investigation allows professionals to identify the association between all the variables and levels of frailty, searching for more specific strategies of health awareness, prevention, and rehabilitation of frail, pre-frail and non-frail elderly, thus trying to hinder frailty in pre and non-frail elderly.

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