ORIGINAL ARTICLE

Association between functional performance and falls in older women classified by age

Thiago Rogério Padilha Amarante[1], Anna Raquel Silveira Gomes[2], Flavia Pinotti dos Santos[1], Rodrigo Augusto Coelho[3], Silvia Valderramas[4]

ABSTRACT

Objective: To evaluate the functional performance and the history of falls in older women. **Method:** Observational cross-sectional study, 57 community-dwelling elderly women were divided into 3 groups, based on their age: G1- 60 to 69 years-old; G2- 70 to 79 years-old, and G3- 80 to 89 years-old. The following were assessed: Functional mobility (Timed "Up & Go Test"); muscle power (Five Times Sit To Stand Test); handgrip strength (JAMAR® hand dynamometer), and the prior history and prevalence of falls. The analyses of differences among groups were done by the one-way ANOVA and the Tukey post hoc test. The correlations were performed using Spearman's test. **Results:** The women in the G3 group, when compared to G1 and G2, showed less handgrip strength (18.08 ± 3.29 Kgf *vs*. 28.10 ± 4.26 Kgf; 18.08 ± 3.29Kgf *vs*. 22.92 ± 4.01, $p = 0.001$); muscle power (14.44 ± 2.85s *vs*. 12.27 ± 2.34s; 14.44 ± 2.85s *vs*. 13.16 ± 2.27s, $p = 0.04$) and functional mobility (11.56 ± 3.10s *vs*. 8.57 ± 2.25s; 11.56 ± 3.10s *vs*. 10.30 ± 2.58s, $p = 0.004$). In the previous 6 months, the highest incidence of falls was in the G2 (5.6%): 26% fell once, 5% fell twice; and 10% fell 3 and 4 times. The women of G1 and G3 had fallen only once. The frequency of falls showed correlation with functional mobility ($r = -0.52$, $p = 0.018$). The age groups displayed correlation with the handgrip strength ($r = -0.67$, $p = 0.0001$); muscle power ($r = 0.31$, $p = 0.02$) and the functional mobility ($r = 0.49$, $p = 0.0001$). **Conclusion:** The prevalence of falls was more pronounced in the women aged between 70-79 years-old and, the older the women, the worse their muscular and functional performance.

Keywords: Aged, Muscle Strength, Accidental Falls

[1] Physiotherapist, resident of the Multiprofessional Residence Program in Health of the Hospital de Clínicas - UFPR.
[2] Physiotherapy Professor at the Master's/Doctoral Program in Physical Education and Multiprofessional Residency in Health of the Hospital de Clinicas - UFPR.
[3] Physiotherapist, Hospital Nossa Senhora do Rocio.
[4] Physiotherapy Professor at the Master's/Doctoral Program in Internal Medicine and Multiprofessional Residency in Health at the Hospital de Clinicas - UFPR.

Mailing address:
Universidade Federal do Paraná
Setor de Ciências Biológicas da UFPR - Curso de Fisioterapia
Silvia Valderramas
Av. Cel. Heráclito dos Santos, s/n, Caixa Postal 19031
CEP 81531-900
Curitiba - PR
E-mail: svalderramas@uol.com.br

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INTRODUCTION

An increase in life expectancy may be accompanied by the emergence of chronic and degenerative diseases, especially in the musculoskeletal system, causing physical decline and impairing functional performance and balance.[1-3]

The reduction of mobility is one of the biggest causes of musculoskeletal dysfunctions related to senescence and is decisive in the reduction of the muscular strength, called dynapenia, of muscle power, called kratopenia, and of balance, called presbyastasis.[4-7]

Falling is considered one of the greatest health problems in the elderly population.[8] In Brazil, it is estimated that 30% of the elderly over 60 years of age have had the experience of at least one fall in a period of twelve months.[9] Women aged between 65 and 75 have twice the probability of suffering a fall compared to men of the same age.[10]

The reduction in muscle strength and power and the loss of functional mobility may influence the number of falls, especially in elderly and are predictors of their functional status.[11]

OBJECTIVE

The present study sought to analyze the functional performance of the elderly by age groups, in order to check which age range presents a highest incidence of falls and its relationship with the musculoskeletal function and functional mobility.

METHOD

This was an observational study with a cross-sectional design, approved by the Research Ethics Committee of the *Sociedade Evangélica Beneficente do Paraná* (protocol No. 225.797/2013) and carried out at the *Universidade Federal do Paraná*.

The convenience sample included elderly women with ages between 60 and 89 years, with cognitive state preserved, according to the cutoff points of the Mini Mental State Examination - MMSE: illiterate: 20 points; 1-4 years of schooling: 25 points; 5-8 years of schooling: 26.5; 9-11 years of schooling: 28 points. Participants were excluded if they presented neuromuscular and/or neurodegenerative diseases, arthrodesis and/or prostheses in the lower limbs, severe cardiac arrhythmias, or any dysfunction that could hinder the performance of the proposed tests.[12]

Prior to the assessment and data collection, the individuals signed an informed consent form, which explained the objectives, procedures, possible risks, and benefits of the study. The study assessed functional mobility, muscular power of lower limbs, handgrip strength, and the number of falls in the last 6 months.

Functional Mobility

Their functional mobility was evaluated by the *Timed up and go* (*TUG*) test, which consists in standing up from a chair (seat height of 45 cm and arm height of 65 cm), without the help of the arms and walking a distance of three meters at a comfortable and safe pace, turning around, returning, and sitting. To start and finish the test, the subject remained with her back resting on the back of chair. After the verbal command "Now!" to start, the test was timed (in seconds), up to the moment at which the subject leaned back in the chair once again. The test was demonstrated once by the researcher, after which the subject performed once for familiarization, and a second time for timing. The subjects were instructed to perform the test at a comfortable pace ("when I say 'Now!' you will rise from the chair, walk to the cone, turn around, and return to the chair").[13] The scores for the TUG test were considered as follows: 60-69 years: 8.1s; 70-79 years: 9.2s; 80-99 years: 11.3s.[14,15]

Functional power in lower limbs

The Five Times Sit to Stand test can be used to estimate the functional strength and power of lower limbs and has a strong correlation with the risk of falling.[14,16] The test began with a subject in the sitting position, with her arms crossed over the chest and with her back against the chair, with the seat at a height of approximately 43 cm from the ground. The evaluator was positioned next to the subject, giving instructions and preventing the subject from falling. The following instructions were given: Stand up and sit down 5 times as fast as possible when I say: "Now!" The time was measured from the command "Now!" to the end of five repetitions by a digital timer (*WTO38 DLK SPORTS*).[17] To analyze the strength/power of lower limbs, the cutoff points described by Bohannon were used:[17] 60 to 69 years: 11.4s; 70 to 79 years: 12.6 s; 80 to 89: 12.7s.

Handgrip strength (HGS)

The measurement of HGS was obtained with a manual hydraulic dynamometer (Jamar *Hydraulic Hand Dynamometer - Model PC-5030J1, Fred Sammons, Inc., Burr Ridge, IL: USA*), respecting the protocol recommended by the *American Association of Hand Therapists*. For this test, the individual should be sitting in a chair, with the shoulders positioned in the neutral position, one of hands supported on the thigh while the elbow from the limb to be evaluated remained flexed at 90 degrees, with the forearm in neutral rotation.[18]

For all subjects, the grip of the dynamometer was adjusted individually, in accordance with the size of the hands so that the rod nearest to the dynamometer's body was positioned on the second phalanges of the fingers: index, middle, and ring. Three trials of the test were conducted for each hand, alternating, starting with the hand that the subject considered stronger. The recovery period between the measurements was approximately one minute. The best reading in three trials for each hand was used as the measurement. To classify muscular strength 17 Kg was adopted for BMI ≤ 23; 17.3 for BMI < 26; 18 kg for BMI < 29; and 21 kg for BMI > 29, following the classification proposed by Cruz-Jentoft *et al.*[19]

Prevalence and number of falls in 6 months

The number of falls was evaluated with the following questions: "Have you fallen within the last 6 months?" and "If yes, how many times?"[20]

Statistical Analysis

The data analysis was performed by the statistical program *SPSS software*, version 16.0 for Windows. The Kolmogorof-Smirnov test was used to check the distribution of data for continuous variables. The descriptive analysis of the data was represented by the mean and standard deviation and median and interquartile interval. The intergroup differences were analyzed by the ANOVA *one-way and Tukey post hoc tests*. Association measurements were made in contingency tables through the prevalence odds ratio and their respective confidence intervals. The correlations were performed through the Spearman test. The statistical significance level adopted was $p < 0.05$.

RESULTS

This study had the participation of 57 healthy elderly women from the community, who were divided into three groups according

to age: G1 - between 60 and 69 years (n = 27), G2 - between 70 and 79 years (n = 19), and G3 - between 80 and 89 years (n = 11). The demographic, anthropometric, and clinical characteristics of the groups are given in (Table 1).

Data given in mean ± standard deviation and median (interquartile range); BMI: body mass index; MMSE: Mini Mental State Examination. G1 between 60 and 69 years; G2 between 70 and 79 years, and G3 between 80 and 89 years.

Functional performance

The women in group G3 (80 to 89 years) presented a significant decrease in functional mobility, muscle power, and handgrip strength (Table 2).

Prevalence of Falls

The highest prevalence of falls was with the women between 70 and 79 years (Table 3), being that during the last 6 months, 26% had fallen 1 time, 5% 2 times; and 10% had fallen 3 and 4 times. The women from the other groups (G1 and G2), had fallen only once.

Correlation of falls with age and with functional performance

The percentage of falls showed a correlation with functional mobility (p = 0.018). There was no significance in the association between falls and muscle power (p = 0.83) or handgrip strength (p = 0.76). Age showed a correlation with functional mobility (p = 0.0001), muscular power (p = 0.02), and with handgrip strength (p < 0.0001) (Table 4).

Table 1. Demographic, anthropometric, and clinical characteristics of the elderly by age group

Characteristics	G1 (n = 27)	G2 (n = 19)	G3 (n = 11)	*p* value
Age (Years)	63.71 ± 3.17	73.55 ± 2.64	81.45 ± 1.29	0.0001
BMI (m/kg2)	29.69 ± 5.49	28.81 ± 6.08	28.44 ± 3.96	0.765
Cognitive state, MMSE	27 (26-29,75)	26.50 (22-29)	26 (19-28)	0.907

Data given in mean ± standard deviation and median (interquartile range); BMI: body mass index; MMSE: Mini Mental State Examination. G1 between 60 and 69 years; G2 between 70 and 79 years, and G3 between 80 and 89 years.

Table 2. Comparisons of functional performance among the age groups

Functional Mobility, TUG (s)	8.47 ± 2.25	10.30 ± 2.58	11.57 ± 3.10 #	0.004
Muscle Power, Sitting and Standing Test (s)	12.27 ± 2.33	13,.16 ± 2.27*	14.44 ± 2.85 #†	0.040
HGS (kgf)	28.10 ± 4.26	22.92 ± 4.01*	18.08 ± 3.29 #	0.0001
FPM (kgf)	28,10 ± 4,26	22,92 ± 4,01*	18,08 ± 3,29 #	0,0001

Data described in mean ± standard deviation; HGS: Handgrip strength. G1 between 60 and 69 years; G2 between 70 and 79 years, and G3 between 80 and 89 years. * p < 0.05 in relation to the comparison of G1 and G2, # p < 0.01 in relation to the comparison of G1 and G3, † p < 0.01 in relation to the comparison of G2 and G3.

Table 3. Prevalence of falls among elderly women, distributed according to age range

Age Range	Falls (yes)	Falls (no)	Odds Ratio	CI
	n (%)	n (%)		
60 to 69 years	5 (18.5)	22 (81.5)	0.22	0.075 - 0.688
70 to 79 years	10 (52.6)	9 (47.4)	2.34	0.369 - 3.346
80 to 89 years	4 (36.4)	7 (63.6)	0.89	0.129 - 2.524

CI: confidence interval.

Table 4. Correlation coefficient of falls and age with functional performance

Variables	% Falls	Age
	r	r
Functional Mobility	-0.52*	0.49**
Muscle Power	0.02	0.31*
Handgrip Strength	-0.49	-0.67**

* p < 0.05; ** p < 0.01

DISCUSSION

The anthropometric data and the cognitive status of the elderly in the three age groups evaluated in this study presented similarities, enabling the comparison of outcomes. It was verified that elderly with age above 70 years presented worse functional mobility, muscle power, and handgrip strength, in relation to the elderly in the age range of 60 to 69 years. These outcomes agree with the number of falls since the elderly women between 70 and 79 years had fallen more times in the last 6 months than those between 60 and 69. In addition, the falls showed a moderate association with the functional mobility and balance assessed by the TUG test, and age increase showed a correlation with the decrease of functional performance and muscular strength.

The results of this study show that the time for performing the TUG test, stratified by age group, was similar to what is described in the international literature: 8.1s (7.1-9.0s) for elderly women of 60 to 69 years; 9.2 s (8.2-10.2s) for 70 to 79 years, and 11.3s (10-12.7s) for 80 to 99 years.[14] In the Brazilian literature, the cutoff point of 12.47s for completion of the TUG test was proposed for older community-dwelling people, in the 60-82 years age range.[15] Therefore, it can be suggested that the Brazilian community-dwelling elderly women assessed in the present study, in the age range from 60 to 89 years, showed good functional mobility and low risk of falling, considering their performance in the TUG.

In a study conducted by Souza *et al.*[21] with 72 institutionalized elderly and 341 community-dwelling elderly, aged between 60 to 89 years, better mobility was observed in those aged between 60 and 69 years, corroborating the results of the present research. Still, the same authors affirm that, parallel to the decrease in functional mobility, there is an increased risk of falling.[21] However, the results of the present study showed that elderly women with ages between 70 and 79 years had fallen twice as much during a period of 6 months as the other age groups investigated. The falls among the elderly are related to multiple intrinsic and extrinsic factors, with the assessment of functional mobility as one of these factors, corroborating the present results, which indicate an association between falls and worse performance in this aspect.[22]

The women of all age groups showed adequate handgrip strength, according to the classification proposed by Cruz-Jentoft *et al.*[19] considering BMI: 17kg for BMI ≤ 23; 17.3 Kg for BMI < 26; 18 kg for BMI < 29; and 21kg for BMI > 29. Still, the women in the present research presented higher values of HGS than shown in the international

literature, specifically a study that also stratified the community elderly by age range: 65-74 years 22.2 (21.2-23.2Kg); 75-85 years 19.3 (17.9-20.7 kg); > 85 years 14.5 (12.9-16.2Kg).[23]

On the other hand, in the present study it was observed that the group of women with the greatest age presented lower handgrip strength. Silva and Menezes[24] made a study evaluating HGS and flexibility and their relation with the anthropometric variables in 420 elderly people, divided into 3 groups (60-69, 70-79, and 80 or more) and reported a probable influence of age, since the individuals aged 80 years or more showed lower handgrip strength than the younger groups, corroborating the results of the present research.

It is also noteworthy that handgrip strength (HGS) is an important indicator of total muscular strength, and is the measure indicated for the evaluation of strength, because it does not require major physical effort on the part of the elderly. For outpatient care, this measure is of great scientific value, because any deficit of muscular strength may be related to the functional performance and strength of lower limbs.[17,25,26]

As for muscle power, assessed through the 5 Times Sit To Stand test, the results of this study are suitable for gender and age range - however, presenting decrease with age, in agreement with the international literature.[14,17,27] This physical parameter directly influences the functional capacity of exercise and the usual speed gait for the elderly.[22,28] Therefore, gait analysis of the elderly should be suggested for future studies.

In relation to the outcomes of this study, limitations were found in relation to the number and selection of the sample of elderly women over 80, because they did not fulfill the inclusion criteria. In addition, for future studies, it is recommended that the assessment of muscular power of lower limbs be performed with methods that investigate the neuromuscular and motor control actions, such as electromyography associated with dynamic tests in a strength platform, in order to investigate this outcome more thoroughly.

CONCLUSION

This study concludes that the prevalence of falls was greater in the age range between 70-79 years. In addition, those aged 70 years or more presented worse functional performance, evaluated by the muscular strength and power and functional mobility, when compared to the women in the age range of 60 to 69. Therefore, it is suggested that greater attention and assistance be given to the community-dwelling elderly above 70 years, emphasizing strength and muscular power training to improve their functional performance and to prevent falls.

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