Manual Therapy, Posturology & Rehabilitation Journal
ISSN: 2236-5435

RESEARCH ARTICLE

Effects of time since the fall on strength, functional performance, and postural control in physically independent older adults: a cross-sectional analysis

Edine K. Matsui[1,4], Fernando T. Yabushita[2,4], Flávia Caroline Kobzinski[3], Ana Paula Sousa[3] Nuno N. C. Bispo[1], Natália Rossini[2], Henrique M. Mariotto[2], Denilson C. Teixeira[2], Rubens A. Silva[5], Márcio R. Oliveira[1,3,4]

[1] Unopar Anhanguera University, Londrina (PR), Brazil
[2] State University of Londrina (UEL), Londrina (PR), Brazil
[3] Rehabilitation Science Graduate Program, Unopar University (UNOPAR) associated with State University of Londrina (UEL), Londrina (PR), Brazil
[4] Physical Exercise in Health Promotion Graduate Program, Unopar University (UNOPAR), Londrina (PR), Brazil
[5] Université du Québec à Chicoutimi (UQAC), Canada

Abstract

Background: The growth of the older adult population requires special attention to their health, as chronic diseases can affect their functional capacity and quality of life. Falls are frequent in this group, but it is unclear whether the time elapsed since the fall influences muscle strength, agility, and postural control. **Objective:** To investigate differences in strength, functional performance, and postural control in physically independent older adults, divided into three groups based on the time since the fall: less than 6 months, 6 to 12 months, and more than 12 months. **Method:** A total of 137 participants were evaluated, analyzing fall characteristics, fear of falling, and medication use. Muscle strength was measured using the handgrip test, while agility was assessed with the AGILEQ test. Postural control was examined using a force platform, analyzing unipedal balance. **Results:** The results showed that the participants' average strength was 25 kgf, below the cutoff for men (27 kgf) and above for women (16 kgf), but with no clear association with the time since the fall. Tripping was the most common cause. Regarding agility, no significant differences were found between the groups, suggesting that independent older adults maintain strength and confidence in mobility. In postural control, previous studies indicate worse performance in older adults who have fallen, but our analysis found no variations between groups according to the time since the fall. **Conclusion:** In conclusion, no significant differences in functional performance were observed among the groups analyzed. Longitudinal studies are needed to better understand recovery and adaptation after falls, including factors such as physical activity levels. This may contribute to the development of more effective strategies for rehabilitation and fall prevention in older adults.

Keywords: Elderly; accident due to falls; function performance; physical assessment.

Corresponding author: Márcio R. Oliveira, Ph.D. PT

Email: marxroge@hotmail.com

Received: 23 Jun, 2025
Accepted: 09 Set, 2025
Published: 10 Set, 2025

BACKGROUND

The older adult population is growing yearly, requiring specific care to address their needs. Chronic diseases and the risk of falls can have a negative impact on the functional capacity and quality of life of older adults. Falls are particularly common among this group. Data indicate that 30% of adults over 65 experience falls annually[1], and 10% of older adults fall at least twice a year[2]. The risk of falls among older adults is associated with reduced muscle mass, mineral components of bone structure, and loss of balance[3].

Although physiological outcomes are directly associated with falling, their assessment is complex and multifactorial. Therefore, various methods are used to assess falls, ranging from interviews using questionnaires and direct questions about the history of falls, to the use of technology, such as accelerometers and force platforms[4,5].

The literature uses a variety of tools to collect information about falls, including scales, questionnaires, and specific questions. Typically, this information is collected from records spanning the last 12 months[6]. Despite some concerns about the retrospective nature of data collection, it is critical to understand the incidence, risk factors, and outcomes associated with falls. Fall assessment includes an analysis of the mechanism of the fall, identification of risk factors, and the consequences of the fall, such as injury, functional deficits, and psychological effects[7].

For patients who have experienced falls in the past year or have a fear of falling that restricts their daily activities, it is recommended to also conduct gait, balance, and strength tests[8].

Therefore, assessing whether different periods in which falls occurred influence performance in field tests is essential to expanding the understanding of this phenomenon, especially since this relationship is still underexplored in the literature.

This knowledge can contribute to a better interpretation of functional tests and the development of more effective fall prevention strategies, promoting greater safety and quality of life for older adults. Thereby, this study aimed to investigate the differences in muscle strength, agility, and postural control scores, including older adults who had suffered falls, divided into 3 different stages, based on the time of the fall: Less than 6 months, 6 to 12 months, and more than 12 months before the assessment.

METHODS

Type of study and participants

This is a cross-sectional study. Participants were conveniently recruited through personal contact, advertisements, and flyers in different primary healthcare units in Londrina. This sample is part of a project called EELO (Study of Ageing in Londrina). A total of 137 participants took part in the study, all of whom gave their informed consent by signing a form and agreed to participate in the study evaluations. The eligibility criteria were: a) Being over 60 years old; b) being physically independent, classified in level 3 or 4 of the functional status scale proposed by Spirduso[9]; c) having a good cognitive status (>18) according to the Mini-Mental State Examination questionnaire[10]; d) having good general health; e) having suffered a fall. Exclusion criteria were: Inability to perform the proposed tests, cognitive or physical impairments limiting safe participation, and being classified as a multiple faller (more than two falls in the past year). This project was approved by the local ethics committee (pp0070/09).

All initial data were collected in a temperature-controlled room (22°C). The main questions related to falls were as follow: a) Period since the fall (<6 months, 6-12 months, >12 months); b) consequences of the fall on physical health; c) reason for the fall; d) period in which the fall occurred; e) location of the fall; f) fear of falling; g) use of medication. The questions were formulated by the authors according to a previous questionnaire[11]. Based on the literature and the study criteria, a fall was defined as an unintentional event that results in the individual's position changing to a lower level from their initial position, without sufficient time for correction and determined by multifactorial circumstances that compromise their stability[12].

Protocol Assessment

Muscle strength

To evaluate handgrip strength, a digital manual dynamometer (Takei T.K.K. 5401 Grip-D, Takey®, Smedley; Tokyo, Japan) was used. The grip size of the dynamometer was adjusted to fit each subject's hand comfortably. The subjects stood upright with their feet shoulder-width apart, and the arm being tested was fully extended downward and not touching the body, with the dynamometer held close to the body. Each subject was instructed to squeeze the dynamometer with maximal effort, including two attempts for each hand, starting with the right hand, followed by the left hand. Each handgrip attempt was held for approximately five seconds, and subjects were given verbal encouragement to exert maximum effort during each trial. There was a one-minute rest period between each attempt to minimize fatigue effects. The best performance out of the four attempts (two per hand) was recorded and used for analysis. The test was conducted in a quiet room at a consistent temperature to ensure standard testing conditions. Before the test, all subjects received standardized instructions and a demonstration of the procedure. This assessment aligns with the recommendations of the European Working Group on Sarcopenia in Older People, which emphasizes handgrip strength as a practical measure of general muscle strength for application in clinical practice, highlighting its significance[8].

Agility test

The agility/dynamic balance test (AGILEQ) is recommended by the American Alliance for Health, Physical Education, Recreation & Dance (AAHPERD). The test evaluated the time required for the participant to complete a given task. The participants were initially seated on a standardized chair with their heels on the floor. Upon hearing a signal, they stood up and moved first to the right, circling a cone positioned 1.50 m behind and 1.80 m to the side of the chair.

They then sat back down on the chair, briefly raised their feet, and repeated the circular movement with another cone placed symmetrically on the left side and, finally, they returned to the original position on the chair. Two tests were conducted on this circuit, and the best performance in seconds was recorded as the result[12].

Postural Control – Force Platform

Postural balance was evaluated using a force platform (BIOMEC 400, EMG System do Brazil Ltda, Brazil). The reaction force signals were filtered (second-order low-pass filter, Butterworth, 35 Hz, with 100 Hz sampling) and processed by routine stabilographic analysis in the system with its own software. Before starting the test, participants were familiarized with the equipment and the experimental protocol. The balance test involved participants standing barefoot with one-legged support (on the lower limb indicated by everyone), while the contralateral limb was flexed approximately 90° with the upper limbs loose close to the body[13].

The participants kept their eyes open and directed toward a target placed in front of them, at eye level (2 meters away). All participants completed 3 trials, each lasting a maximum of 30 seconds, with a rest interval of approximately 30 seconds between each trial. A mark on the force platform was used to standardize the position of the feet during each attempt. To prevent falls or accidents during the test, a trained assessor was positioned behind each participant[13]. The data acquisition commenced 5 seconds after the participants declared their readiness for the test.

The main parameters for stabilographic analysis used in this study were: a) Area of the center of pressure of the ellipse with 95% confidence (A-COP in cm2), and b) mean COP oscillation velocity (VEL in cm/s) in the anteroposterior direction (A/P) and mediallateral direction (M/L). The variables were computed in time series for each attempt, and the average was used for analysis[14,15].

Statistical analysis

Levene's test was employed to assess the data distribution between the groups. Once data normality was confirmed, the results were presented as means and standard deviations. Subsequently, one-way analysis of variance (ANOVA) was used to compare the groups, based on the period of the fall (less than 6 months, between 6 and 12 months, more than 12 months), considering the dependent variables of muscle strength, agility, and postural control. All statistical analyses were conducted using SPSS 22.0 for Windows (SPSS Inc., Chicago, IL, USA) with a significance level of P <0.05.

RESULTS

Table 1 illustrates that older adults participants in the study exhibited a higher incidence of falls in the street (33%), particularly during the morning and afternoon (42%), and with a prevalence of superficial injuries (51%). Furthermore, polypharmacy was found to be a common practice among the participants, reaching a rate of 55%.

Table 1. Relative distribution (%) of the circumstances and consequences of falls among the study participants.

	<6 months (n= 42)	6-12 months (n= 18)	>12 months (n= 74)
Fall location			
Inside the home	7(17)	2(11)	18(24)
Outside the home	16(38)	5(28)	17(23)
On the street	16(38)	7(39)	27(36)
Inside a public place	1(2)	1(6)	3(4)
Outside a public place	2(5)	3(17)	7(9)
On the farm	0	0	1(1)
At work	0	0	1(1)
Period			
Morning	20(48)	12(67)	31(42)
Afternoon	19(45)	5(28)	32(43)
Evening	3(7)	1(6)	11(15)
Consequences			
None	15(36)	5(28)	17(23)
Superficial injury	21(50)	11(61)	45(60)
Fracture	0	1(6)	6(8)
Other	6(14)	1(6)	6(8)
Polypharmacy (3 drugs or more)			
Yes	26(62)	12(67)	37(50)
No	16(38)	6(33)	37(50)

Note: Categorical data is described by absolute (relative) frequency.

Table 2. Characteristics of participants.

	G1 Falls <6M (n=42)	G2 Falls 6-12M (n=19)	G3 Falls >12M (n=76)	P Anova
Age (years)	69 ± 6	68 ± 6	68 ± 6	0.662
Weight (kg)	66 ± 14	70 ± 13	68 ± 15	0.476
Height (m)	1.55 ± .10	1.53 ± .05	1.57 ± .09	0.192
BMI (kg/m²)	27 ± 5	30 ± 5	27 ± 5	0.075
Mini-mental	22 ± 5	24 ± 4	23 ± 5	0.387

Note: Data is presented as mean and standard deviation. BMI: Body Mass Index. G1: older people who fell 6 months before the assessment; G2: elderly people who fell between 6-12 months before the assessment; G3: older people who fell 12 months before the assessment.

Table 2 highlights the individual characteristics of each group examined. In general, group 3, which comprises older adults who had fallen more than 12 months before the assessment, recorded the highest number of participants (n=76). This was followed by Group 1, which covers older adults who fell 6 months before the assessment (n=42), and finally, group 2, which comprises older adults who fell between 6 and 12 months before the assessment, containing 19 participants. Overall, no significant differences were found for any of the variables explored in characterizing the sample. Additionally, the results for muscle strength, agility, and postural control, as presented in Table 3, showed no significant differences between the groups studied.

Table 3. Performance results in muscle strength, agility, and postural balance tests between the groups.

	G1 Falls <6M (n=42)	G2 Falls 6-12M (n=19)	G3 Falls >12M (n=76)	P Anova
Muscle strength				
RUL (Kgf)	25±7	24±5	25±8	0.727
LUL (Kgf)	25±8	22±5	25±8	0.395
Agility/ balance				
Agility (s)	25±6	26±5	26±4	0.596
Force platform				
One-legged stance				
A-COP (cm²)	13.8±9	20.7±20	13±10	0.093
Vel-AP (cm/s)	3.6±1.3	3.9±1.4	3.6±1.6	0.614
Vel-ML (cm/s)	3.7±1.1	4.5±1.9	3.8±1.1	0.060

Note: Data is presented as mean and standard deviation. RUL: Right upper limb. LUL: Left upper limb. A-COP: Area of the Center of Pressure. Vel-AP: Anteroposterior Velocity. Vel-ML: Mediolateral velocity.

DISCUSSION

This study aimed to investigate the differences in the results of muscle strength, agility and postural control in older adult individuals who had experienced falls at three different stages, based on the elapsed time since the incident. Our results found no significant differences in any of the variables explored. This approach allowed us to assess how the time elapsed since the fall can influence these important aspects of physical function in older individuals.

Overall, the participants in this study did not suffer any significant injuries as a result of falls. The literature indicates that minor falls are more frequent and result in relatively minor injuries, such as abrasions and bruises[16], while serious injuries such as fractures, soft tissue injuries or traumatic brain injuries affect approximately 10-19% of older individuals who fall[17].

On the other hand, we found that most of the sample was taking three or more medications. However, a study found no association between medication use and falls[18]. It is possible to identify that drug interactions can act systemically, due to drug toxicity that can cause delirium and more frequent falls with musculoskeletal injuries[19].

In terms of muscle strength, our results indicate that participants generally had an average strength of 25 kgf. The literature indicates that frailty in the older adults is described when muscle strength in the handgrip test is below 14 kgf, and this factor may be related to falls[20]. Moreover, data from the literature indicates that muscle weakness in the handgrip test is detected when the resulting values are below the cut-off points defined in kilograms of force (kgf) which are 27 kgf for men and 16 kgf for women up to 80 years of age[21]. In this study, we can describe that this variable may not have been fully involved in the event and that an accidental situation may have caused the fall. Of all the causes, tripping seems to be responsible for the highest proportion of falls[22].

As far as agility is concerned, there were no discrepancy patterns between the groups. It is understood that older people with greater agility have a lower risk of falling, as agility is closely related to muscle strength and balance[23]. The lack of significant changes between the groups may be related to muscle strength and confidence in the sample of independent people. It is important to note that the risk of falling can impair the ability to move quickly, due to fear[24].

Regarding postural control, studies investigating differences between groups of older people classified as fallers and non-fallers are common. For example, research has found that older adults who experienced falls had worse postural control on various measures assessed using the force platform, compared to those who had not experienced such an event[11,25]. According to the authors, this is one of the first studies to investigate the time of the fall. which makes it difficult to compare the results. The temporal classification of fall occurrence represents an innovative approach to guide tailored clinical interventions and follow-up strategies in community-dwelling older adults.

However, this study has some limitations that should be acknowledged. These include the lack of stratification by sex and physical activity level, as well as the reliance on self-reported fall history, which may be affected by recall bias, particularly for events that occurred more than 12 months prior. Moreover, the unequal sample sizes across groups may have limited the statistical power to detect significant differences. In short, our results highlight the importance of considering the time elapsed since the fall when assessing physical function in older people. Nevertheless, more longitudinal research is needed to better understand the trajectories of recovery and adaptation after falls in older people and to develop more personalized and effective approaches to rehabilitation and fall prevention in this population.

CONCLUSION

The findings of this study show that there were no significant differences in muscle strength, agility and postural control among older adults who had experienced falls, at three distinct stages. This indicates that the duration since the fall event may not significantly impact on the health of older adults without fall-related complications.

Author Contributions: E.K.M: Conceptualization, data curation, supervision, writing – original draft, writing – review & editing; F.T.Y.: Formal analysis, investigation, methodology, visualization; F.C.K.: Investigation, methodology, project, administration; A.P.S.: Investigation, methodology, project, administration, field support, methodological assistance, logistics; N.N.C.B.: Data organization, implementation support, administrative assistance; N.R.: Investigation, methodology, project, administration; H.M.M.: Investigation, methodology, project, administration; D.C.T.: Methodological refinement, operational coordination; R.A.S.: Methodological refinement, operational coordination M.R.O.: Conceptualization, data curation, methodology, writing – review & editing.

Financial Support: National Foundation for the Development of Private Higher Education –

FUNADESP.

Conflict of interest: The authors declare that they have no conflict of interest.

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