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Age-dependent changes in physical performance in community dwelling elderly women. A cross-sectional study

Cambios dependientes de la edad en el rendimiento físico en mujeres mayores no institucionalizadas

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Abstract. Aging process is accompanied by a gradual and sustained loss of physical abilities which leads to a progressive muscle weakness with important consequences for daily living especially in women. This study aimed was to analyze the differences by ages in dynamic balance and lower limb strength in community-dwelling women, and secondly to assess the differences in dynamic balance scores and lower limb strength between fallers and non-fallers in community-dwelling women. A total of 1025 community-dwelling women were recruited for the study. The sample were divided into six groups based on age: G1, from 60-65 yrs. (n=282); G2, from 66-70 yrs. (n=178); G3, from 71-75 yrs. (n=108); G4 from 76-80 yrs. (n=397); G5 from 81-85 yrs. (n=51) and G6, from 86-90 yrs. (n=9). The number of falls during the last year were also recorded. Significant differences were found in Sit to stand test (STS) and Timed up and go test (TUG) scores among age groups ($p \leq 0.05$). Additionally, poorer scores were found between fallers than non-fallers group ($p \leq 0.05$) both in STS and TUG test. Physical fitness performance decline as age group increase, and this decline is more striking after 70 years in community dwelling elderly women. In addition, faller elderly women show poorer scores in TUG and STS than non-fallers, reinforcing the idea that lower limb muscle strength and dynamic balance play an important role in falls in elderly women.

Key words: Aging, Functional mobility, Falls, Timed up and go, Sit to stand

Resumen. El proceso de envejecimiento va acompañado de una pérdida gradual y sostenida de las capacidades físicas que conduce a una debilidad muscular progresiva con importantes consecuencias para la vida diaria, especialmente en las mujeres. El objetivo de este estudio fue analizar las diferencias por edades del equilibrio dinámico y la fuerza de los miembros inferiores durante la vejez en mujeres mayores no institucionalizadas y, en segundo lugar, evaluar las diferencias en las puntuaciones de equilibrio dinámico y la fuerza de los miembros inferiores entre las personas que se caen y las que no se caen en las mujeres mayores no institucionalizadas.
Un total de 1025 mujeres fueron reclutadas para el estudio. La muestra se dividió en seis grupos según la edad: grupo 1, de 60 a 65 años. (n=282); grupo 2, de 66-70 años. (n=178); grupo 3, de 71-75 años. (n=108); grupo 4, de 76-80 años. (n=397); grupo 5 de 81-85 años. (n=51) y grupo 6, de 86-90 años. (n=9). También se registró el número de caídas durante el último año. Se encontraron diferencias significativas en las puntuaciones de las pruebas Sit to Stand (STS) y Timed up and go test (TUG) entre los grupos de edad ($p \leq 0.05$). Además, se registraron puntuaciones más bajas entre el grupo que presentaba caídas comparado con el grupo que no que no presentaba caídas ($p \leq 0.05$) tanto en la prueba STS como en la TUG. Como conclusión podemos decir que, el rendimiento físico disminuye a medida que observamos grupos de edad más avanzada, y esta disminución es más llamativa después de los 70 años en las mujeres mayores no institucionalizadas. Además, las mujeres que se caen obtienen puntuaciones más bajas en TUG y STS que las que no se caen, lo que refuerza la idea de que la fuerza muscular de las extremidades inferiores y el equilibrio dinámico juegan un papel importante en las caídas en las mujeres adultas mayores.

Palabras clave: Envejecimiento, Movilidad funcional, Caídas, Timed up and go, Sit to stand

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Introduction

It is well known that the aging process is accompanied by a gradual and sustained loss of physical abilities (Lima, Rodrigues, Bezerra, Rodrigues, & Cancela, 2020). In this sense, muscle size and muscle power show a significant decrease in aged adults (Keller & Engelhardt, 2013).

This progressive muscle weakening has important consequences for daily living activities such as walking, standing and sitting on a chair affecting directly the dynamic balance and increasing the risk of falling and morbidity (Alcazar et al., 2020; Benavent-Caballer et al., 2016; Bernardi et al., 2004; Bisciotti, Bisciotti, & Bisciotti, 2022) and health care costs. In this sense, (Gray & Paulson, 2014) sustain that muscle power is a very good predictor of functional limitations. For this reason, the main objective of a great number of researchers has been to find easy, reliable and valid clinical tools that help them to detect and prevent the development of disability (Bisciotti et al., 2022). In this sense, TUG has been used to examine balance gait speed and functional ability (Barry, Galvin, Keogh, Horgan, & Fahey, 2014; Benavent-Caballer et al., 2016), and STS tests have been used extensively to assess lower limb muscle strength (Glenn, Gray, & Binns, 2017; Jerez-Mayorga et al., 2022), both are common tests used in older adults, and also had been used as a predictor of falls (Reynaud et al., 2019).

It has been published that this reduction of physical capabilities shows an important acceleration in the 6Th decade of life and reach up to a 2-3% loss per year in healthy adults (Ikezoe, Mori, Nakamura, & Ichihashi, 2011), and it also seems that age-related declines show differences between male and female, suggesting that this decrease could be more relevant in female specially in grip strength and

walking speed (Makizako, Shimada, Doi, Tsutsumimoto, Lee, et al., 2017). Furthermore, it has been demonstrated that falls are more common in female than in male (Moreland, Richardson, Goldsmith, & Clase, 2004), indicating that the effects of physical decline and the loss of quality of life are different in male than female. This aspect seems to be interesting to prepare better physical training plans for this population (Liang & Cameron Chumlea, 1998; Peña et al., 2022) and indicates that these training plans should be different depending on age and sex. Beside of this knowledge, the research on elderly women about this topic is scarce and are not conclusive (de Souza Moreira et al., 2015; Ikezoe et al., 2011; Larsson et al., 2021; Milanovic et al., 2013)

This study aimed was to analyze the differences by ages in dynamic balance and lower limb strength in community-dwelling women, and secondly to assess the differences in dynamic balance scores and lower limb strength between fallers and non-fallers in community-dwelling women.

Materials and methods

Participants

The present study uses a cross-sectional observation design. 1025 community-dwelling women of a total of 3161 older adults registered on a local program were recruited for the study. All women were part of a regular physical exercise program funded and organized by community members of a city in north Portugal. Recruitment occurred via advertisement and word mouth.

The sample were divided into six groups based on age as previously reported by Makizako, Shimada, Doi, Tsutsumimoto, Lee, et al., (2017): group1 (G1), from 60-65 yrs. (n=282); group 2 (G2), from 66-70 yrs. (n=178); group 3 (G3), from 71-75 yrs. (n=108); group 4 (G4), from 76-80 yrs. (n=397); group 5 (G5) from 81-85 yrs. (n=51) and group 6 (G6), from 86-90 yrs. (n=9). Physical characteristics of the sample are shown in table 1.

The inclusion criteria used in the present study were: (a) being 65 years of age and older and (b) to have physical, motor and psychic independence. The exclusion criteria were: (a) presence of prostheses or use of locomotion aids, (b) having a neurological or orthopedic pathology, or (c) recent injury in the lower or upper limbs. All participants completed socio-demographic information and health status questionnaires.

In addition, the number of falls during the last year were recorded. (Asai et al., 2021) A fall was defined as "an event that resulted in the participant unintentionally coming to the ground or other level" (Gibson, Andres, Isaacs, Radebaugh, & Wormpetersen, 1987). Participants were classified in two groups: fallers (if they had suffered one or more falls during the last year) and Non-fallers (if they had not suffered a fall during the last year).

Written informed consent was obtained from each participant. The study was approved by the local Institutional Review Board and was conducted in accordance with the provisions of the Declaration of Helsinki.

Procedures

Anthropometric assessment

Height and weight were measured respectively to the nearest 0.1 cm using a stadiometer (SECA 217, Germany) and to the nearest 0.5 kg using the Tanita BC-545 Body Composition Analyzer (Tanita, Inc., Tokyo, Japan). Subjects were asked to dress light clothing and stood barefoot, with eyes directed straight ahead according to the standards procedures of the International Society for the Advancement of Kinanthropometry (ISAK). The body mass index (BMI) was calculated as weight (kg) divided by height ^{2} (m).

Muscle strength

Lower limb muscle strength was assessed with the 30s-sit to stand test (STS). Participants have to perform the maximum of full stands that can be completed in 30 s with arms folded across the chest, as previously described by (Rikli & Jones, 2013). After one to three familiarization trials, all participants performed a single 30-second test trial. The total number of right repetitions were recorded for further analysis.

Timed-up and go test (TUG)

Participants were required to perform TUG test followed a verbal instruction to stand up from an armless chair with (46cm height), walk 3m as fast as possible, turn around 180 degrees in a cone placement, walk back, and sit down again while turning 180 degrees.

All participants were assessed with Wiva® science sensors. Total time required to complete the test was recorded for further analysis. After a familiarization trial, subjects were required to complete a single trial of the test.

Statistical Analysis

Statistical analysis was carried out using SPSS software (version 22; SPSS,Inc., Chicago, IL). A descriptive analysis of the variables *TUG* and *STS* were made with all the subjects together and also by 5-year age periods. The Kolgomorov-Smirnov test was used to check normality. The results showed that our sample do not meet the assumption of normality. Subsequently, the Kruskal-Wallis test was performed and a Dunn's post hoc test were conducted in order to find differences between groups. The statistical significance was set at 0.05. Additionally, U Man Whitney test were used in order to establish the differences between fallers and non-fallers.

Results

There no significant differences among groups in BMI however, G1 and G2 were heavier than G5 ($p \leq 0.046$ and $p \leq 0.047$ respectively) and G2 were taller than G5 ($p \leq 0.034$) (table 1).

Table 1.
Physical characteristics of the sample

	Total (n=1025)	G1 (n=282)	G2 (n=178)	G3 (n=108)	G4 (n=397)	G5 (n=51)	G6 (n=9)
Weight (kg)	69.9±11.1	70.9±11.1	71.4±12.1	70.0±10.6	69.2±10.6	65.8±11.1	63.0±7.5
Height (cm)	152.2±5.5	152.4±5.7	152.7±5.6	151.9±5.3	152.3±5.3	150.3±6.5	149.0±4.8
BMI (kg/m^2)	30.2±4.5	30.6±4.9	30.6±4.8	30.3±4.3	29.8±4.3	29.1±4.3	28.1±2.8

Legend: G1 (60-65yrs.); G2 (66-70 yrs.); G3 (71-75yrs.); G4 (76-80yrs.); G5 (81-85yrs.); G6 (86-90yrs.).

Regarding TUG results, we found significant differences among groups (p≤ 0.001) (Figure 1). G1 obtained lower values in TUG than G3 (p≤0.001). G5 (p≤0.001). and G 6 (p≤0.005) additionally, G 4 showed lower values than G5 (p≤0.001): and G6 (p≤0.05): Moreover, G3 showed higher values than G4 (p=0.001) in TUG test.

When we analyze STS results, we found that there were significant differences among groups in STS results (p≤ 0.001) (Figure 2). In the post hoc comparisons, we found that G5 showed lower scores in STS test than G1 and G2 (p≤ 0.005) and G3 obtained lower values in STS test than G1 (p≤ 0.05)

Analyzing the sample without division of age groups, fallers group showed higher records in TUG than non-fallers group (p=0.01) and in the same line, fallers group obtained lower values in STS than non-fallers group (p=0.032), but when we analyzed our sample by age groups, we only found significant differences in TUG and STS records between fallers and no-fallers in G1. When G1 was analyzed we found higher values in TUG in fallers than non-fallers (p=0.001) and lower scores in STS in fallers than in non-fallers group (p=0.002). (Figure 3).

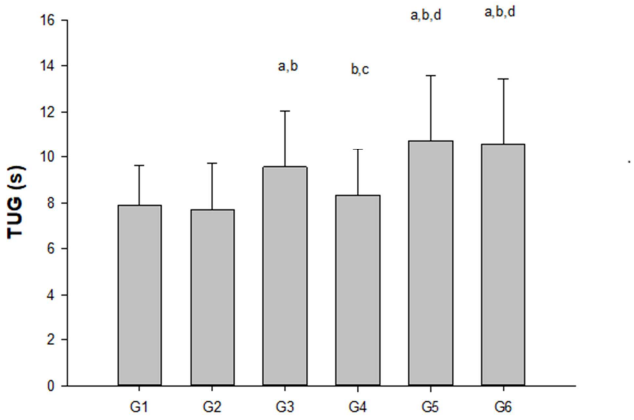

Figure 1. Differences among age groups of women in TUG. Legend: a: significant differences with G1.; b: significant differences withG2; c: significant differences with G3.; d: Significant differences with G4. G1 (60-65yrs.); G2 (66-70); G3 (71-75yrs); G4 (76-80yrs.); G5 (81-85yrs.); G6 (86-90yrs.)

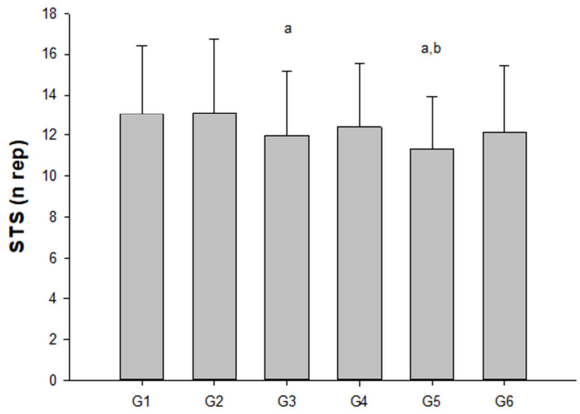

Figure 2. Differences among age groups of women in STS. Legend: a: significant differences with G1; b: significant differences with G2. G1 (60-65yrs.); G2 (66-70yrs); G3 (71-75yrs.); G4 (76-80yrs.); G5 (81-85 yrs.); G6 (86-90yrs.)

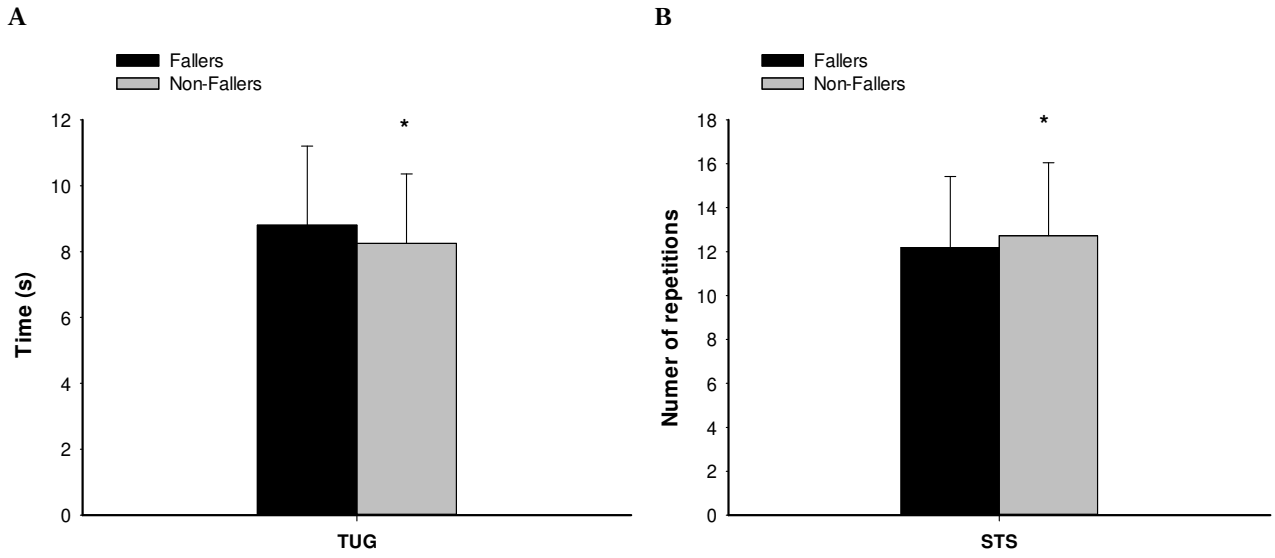

Figure 3. Differences between women fallers and women non-fallers in TUG and STS test. Legend: A) *= p≤ 0.001; B) *= p≤ 0.05

Discussion

The current study describes age-dependent changes in physical performance and its relation with falls in elderly women. The results showed that physical performance decline with advancing age group, that looks noticeable from the 70s Although this decline show different patterns depending on the physical capacity analyzed. Dynamic balance presents a significant decrease as age increases, while the lower body strength shows lower decrease values, being only significant among the youngest group with the groups of 71-75 and 81-85 years. Additionally, fallers women obtained poorer values in TUG and STS test reinforcing the idea of an existing relationship between physical condition and risk of falls in elderly women.

Related to TUG, our results showed that when advancing age group, performance decreases. When we analyze the complete sample without differentiating age our sample obtained a mean TUG value of 8.4±2.2s. These results are not in line with most of the research published that showed poor performances than ours., but are in line with those published by Asai et al., (2021) (between 6.4 and 8.7s) reported in their longitudinal study by age group and worse than those reported by Langeard et al., (2019) (6.43±1.18s) in a cross-sectional study. These differences could be due to the way in which this test is applied in particular to the instructions that the researchers gave to the subjects about the speed at which to perform the test. Another thing that could explain the differences in performance among the studies could be the physical fitness of the adults. Our population is an active population since they are involved in physical exercise programs, so their decline in physical fitness could be lower than those adults who keep a sedentary life.

It is well known, that physical activity decreases with age and it is also associated with a decline in functional fitness (Milanovic et al., 2013). This study was carried out dividing by age ranges of 5 years to know in which age group range the declines in physical fitness is greater.

Related TUG values, we found that for women aged 60-65 years, a mean TUG performance of 7.9 ±1.7s was recorded, similar with those recorded for women aged 66-70 (7.7±2.0s). For women aged 71-75 years, a mean TUG values were higher than those obtained for their younger counterparts (9.5±2.5s) This results are in line with those obtained in cross-sectional studies by Benavent-Caballer et al., (2016) in older adults aged 65-75 years and with Medley & Thompson, (2015) in the same aged group population.

Nevertheless, our data, showed differences between women under 70 and over 70. We found that 70 years is an important point in elder women, because a significant decline in TUG performance is observed. We hypothesized that when the decline in physical condition began, it would increase as age increased, but surprisingly, in the age group between 75 and 80 we found a significant improvement in Physical fitness that only shows in this age group, after this improvement, the decline of physical fitness follows the expected pattern. Except for this event our results are in line with the cross-sectional-study published by Marques et al., (2014), who reported higher scores in TUG among age group. Our adults showed higher scores in TUG than those reported by Marques et al., (2014). These differences can be explained because Marques applied the 8Ft up and go test. We have to take in mind that 8ft are 2.44m and out TUG test was around 3m, so their scores are lower than ours.

The lower body strength was assessed using 30s STS test. Our result showed that the STS performance decreases as age increases, and this deterioration is more relevant after 70^{ths}. When we analyze total sample without ages groups, we found that our women recorded a mean of 12.6± 3.3rep in 30s and are in line those reported by Marques et al., (2014) and Sardinha, Santos, Marques, & Mota, (2015) cross-sectional study, and are lower than those reported by Alcazar et al., (2020) who found mean scores of 15.9 ±5.3 in a cross-sectional study with 346 Danish women with a mean age of 73.0±8.0 years.

When we analyze the sample by groups of age STS performance showed similar pattern than TUG. Physical fitness decreases as age increases and it is relevant after 70 years. These results are in line with those reported by Milanovic et al., (2013),in their cross-sectional study who found a similar decrease in STS performance after 70 and show the same decrease patter than those published by Marques et al., (2014). It is important to notice that their sample showed higher values in age groups of 65-69 years and 70-74 years than our sample but the values after these age groups are similar than ours. We can't forget that after the age of 75 years, muscle strength decrease is likely to be at an average of 3.4% annually, so older women could lose between one quarter and one third of muscle strength over a 10-year period (Milanovic et al., 2013), and could be the reason because the performance in STS decrease significantly after 70 years old and these decline remains during the next decades. Taking into account that our sample is a population who are involved in a physical training program as we aforementioned, we can conclude that the decline during those decades can only be weaken or smoothed but not eliminated. This conclusion is supported by Milanovic et al, (2013).

In spite of this, it is really important to design physical programs for elder population in order to keep as much as possible their muscle strength and balance, to maintain their independence and to avoid falls.

As we sated before, the number of falls increase in elderly, especially among women (Beauchet et al., 2011; Makizako, Shimada, Doi, Tsutsumimoto, Nakakubo, et al., 2017). It seems like this increase is a consequence of reduced muscle strength, balance and flexibility (Milanovic et al., 2013). In this line, TUG and STS tests have been proposed as valid tools to predict adverse health events such as falls (Makizako, Shimada, Doi, Tsutsumimoto, Nakakubo, et al., 2017; Ziegl et al.,

2020). Reinforcing this idea, we found poorer scores in STS and TUG between fallers and non-fallers, which could mean that the loss of physical condition is related to falls in older women. These results are in line with Buatois et al., (2010) who reported that five times STS provides added value to stratify risk for falls in elderly people, and also with Bower et al., 2019; Makizako, Shimada, Doi, Tsutsumimoto, Nakakubo, et al., (2017) who found that Five times STS and TUG are good predictors of disability risk Furthermore, the use of both in combination improves the sensitivity for detecting the development of disability. (Nightingale, Mitchell, & Butterfield, 2019) reported that TUG scores lower than 12s indicates a lower risk of falls.

But the truth is that other authors (Barry et al., 2014; Beauchet et al., 2011) report that neither the STS nor the TUG are valid tools for predicting falls, since falls depend on many factors and not only on dynamic balance and lower body strength.

Conclusions

In conclusion, confirming previous reported findings, this study showed that physical fitness performance decline as age-group is increase, and this decline is more striking after 70 years in community dwelling elderly women. In addition, faller elderly women show poorer scores in TUG and STS than non-fallers elderly women, reinforcing the idea that lower limb muscle strength and dynamic balance play an important role in falls in elderly women.

Limitations

The main limitation of this study is that it is only a descriptive approach with a cross-sectional design, it could be interesting to carry out a longitudinal study to evaluate/asses the age related physical decline in elderly women and also trying to attenuate this decline with an exercise program based on elderly women needs

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