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# Physical fitness according to the number of steps in adult and older women

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**Abstract**
**Introduction:** The analysis of the number of steps has been associated with several variables related to the health of the elderly, in physical fitness, body composition, functional capacity and its reduction is related to several chronic non-communicable diseases. The reduction in the number of steps/day is associated with negative outcomes on body composition, disease development, and risk of death from cancer. **Objective:** To determine the profile of physical fitness and functional capacity according to the level of physical activity assessed in adult women practitioners of physical activities. **Methods:** This study included 159 women who regularly practice physical activity, aged 50 to 86 years (69.55±7.9 years), participating in the *Longitudinal Project of Aging and Physical Fitness of São Caetano do Sul*. The level of physical activity was measured by the number of steps, using a pedometer (Digiwalker 700SW 200 C) for seven consecutive days. The evaluation of physical fitness was performed by upper and lower limb strength and agility. Functional capacity was measured by mobility and balance. The statistical analysis used was One-Way ANOVA, followed by Bonferroni Post Hoc, and for non-parametric data, the Kruskal-Wallis and Mann-Whitney tests were used. The number of steps was divided into tertile (tertile 1 < 5,618 steps/day; tertile 2 5,619-9,054 steps/day and tertile 3 > 9,055 steps/day). The level of significance adopted was $p<0.05$. **Results:** It was found that tertile/3 resulted in statistically significant differences in anthropometric variables: weight, BMI, waist circumference and hip circumference, neuromotor variables: lower limb strength and agility, and functional capacity in general mobility and locomotion. **Conclusion:** Women with a daily step pattern higher than 9,050 had a better fitness profile and functional capacity.
**Keywords:** functional physical performance, physical activity, and aging.

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## Introduction

Advancing age has shown an inadequate lifestyle pattern related to the practice of daily physical activity. Elderly people with a lower level of physical activity have lower fitness and physical performance scores. Many of these deleterious effects are secondary to physical inactivity[1], which can compromise the ability to perform daily activities. The number of steps/day reduction is associated with higher body mass index (BMI), peripheral and total adiposity, and the risk of developing metabolic syndrome[2]. Studies also point to the positive action of walking in reducing body fat percentage, lower prevalence of cardiovascular disease, improved immune system, and lower risk of death from cancer[3,4].

Walking is the most frequent form of aerobic physical activity in most individuals, regardless of socioeconomic status, and can be performed throughout life. Small changes in behavior can have a significant impact on health. Individuals over 65 should accumulate about 6,500 to 8,500 steps daily to obtain such health benefits [5-7].

Considering the ease of creating intervention strategies based on walking, this study aims to evaluate physical fitness according to the category of the number of steps taken by adult women practicing physical activities.

## Materials and Methods

### Sample and type of study

The sample consisted of 159 physically active adult women aged 50 to 86 (69.5 ± 7.9 years) who participated in the Longitudinal Project of Aging and Physical Fitness of São Caetano do Sul. The women participate in a structured physical activity program, consisting of low-impact aerobic exercises, stretching, flexibility, and muscle strength, performed twice a week, lasting 50 minutes, offered by the City Hall of São Caetano do Sul, with a mean time of practice of 4.8 years.

### Inclusion and Exclusion Criteria

The inclusion criteria were: not having cognitive and musculoskeletal limitations. Exclusion criteria: not having used the pedometer for at least 3 days a week and 1 day on the weekend, and/or not having correctly filled out the pedometer use form. All participants signed an informed consent form, approved by the Ethics Committee nº028/2010-A of the Fundação Municipal da Saúde de São Caetano do Sul - FUMUSA.

### Procedures

The establishment of physical fitness was through the assessment of anthropometric variables of body weight (kg), measured on an electronic scale with a capacity of 200 kilograms and an accuracy of 100 grams. Body height (cm) was taken with the help of a metallic measuring tape graduated in centimeters and tenths of centimeters on a stadiometer, with a cursor in inspiratory apnea and the head in the Frankfurt plane parallel to the ground. The cursor was positioned at a 90° angle to the scale to take the measurement. Three measurements were taken, and the average was considered the actual value of height.

To calculate body mass index (BMI, kg/m2), the equation of weight divided by height squared was used. The waist and hip circumferences were measured using a flexible metallic measuring tape with an accuracy of 1 millimeter, and the waist/hip ratio was calculated by dividing the value of the waist circumference in centimeters by the value of the hip circumference in centimeters, the sum of the 3 skinfolds: subscapular, supra iliac, and triceps[8].

The neuromotor variables assessed were lower limb muscle strength through the upper limb unassisted vertical impulsion test (cm) and upper limb strength through the handgrip test with a dynamometer; in agility (sec), the "Shuttle Run" test was used. Functional capacity was measured by general mobility tests using the walking speed (sec) and maximum walking speed (sec), and chair-stand speed (sec) tests. Body mobility was measured by the sit-to-stand and move test (sec) and the Unipodal static balance test (sec). All measurements and tests followed the CELAFISCS standardization[9].

The physical activity level was determined by counting the number of steps/day with the help of a pedometer, model Digiwalker SW200 and SW C 700, positioned on the right side at the iliac crest. The study subjects were instructed to use the equipment for seven consecutive days, including weekends, during all normal activities and to remove it during aquatic activities, bath time, and bedtime. Before using the SW200, the subjects ensured that the counter was reset to zero. The participants recorded on a daily control form the number of steps they took during the day, the time they started and stopped using the device, and their daily activities in terms of locomotion, household activities, and transportation. The equipment model SW C 700 was configured with the weight and height of the subject evaluated. Trained evaluators performed all the procedures and the configuration of the pedometer, and valid data from at least 10 hours of use were used for the analyses.

The Kolmogorov-Smirnov test was used to assess the normality of the data, while descriptive data were presented using the mean and standard deviation. One Way ANOVA was used for parametric data, followed by Bonferroni Post Hoc. For non-parametric data, the Kruskal-Wallis test was used, followed by the Mann-Whitney U test. The significance level adopted was $p<0.05$.

**Results**

The average number of steps in 7 days measured using a pedometer showed that 60.4% of the sample met the recommendation of the new positioning of 6,500 to 8,500 steps/day, and 39.6% did not reach the minimum recommendation as indicated (Table 1). The number of steps was divided into tertiles (tertile/1 <5,618 steps/day; tertile/2 5,619-9,054 steps/day and tertile/3 >9,055 steps/day), and it was identified that the 1st tertile had a low number of steps during the week (4,754 steps/day) and a higher amount on weekends (4,938 steps/day) having a weekly average of 4,833 steps/day. In the tertile/2, the average was 7,000 steps/day, while in the tertile/3, the average achieved was over 9,600 steps/day. For all tertiles, a similar behavior was found, with the beginning of the week having the highest accumulation in the number of steps, with a slight decrease on Thursdays and higher figures on Fridays, all of these differences being statistically significant (Graph 1).

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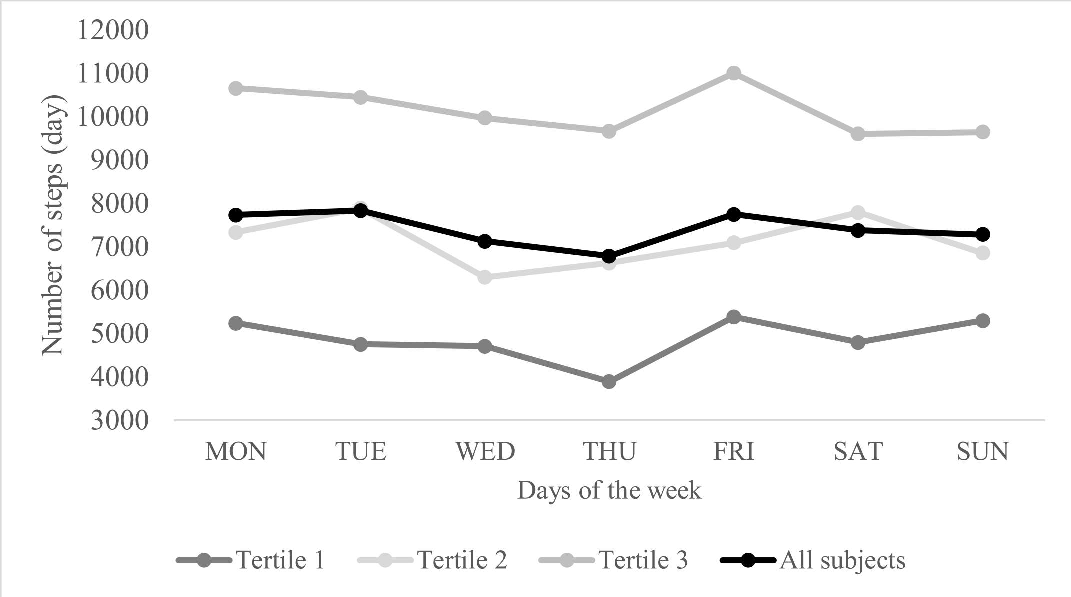



**Graph 1.** Distribution of the total number of steps accumulated during the weekdays in the group of adult women practicing physical activities according to the tertile associated with the number of steps.

When we compared the tertiles associated with the number of steps with the anthropometric variables, it was found that tertile/3 and tertile/2 showed significant differences in weight (p<0.00), lower waist circumference (p<0.00), and hip circumference (p<0.02). It was evident that the number of steps showed differences with the anthropometric variables analyzed (Table 1).

**Table 1.** Anthropometric variables, number of steps standard according to the tertile associated with the number of steps of adult women practicing physical activities.

| **Variables** | **Tertile 1** < 5618 steps/day | **Tertile 2** 5619 - 9054 steps/day | **Tertile 3** > 9055 steps/day |
|---|---|---|---|
| **Age (years)** | 71,8±8,0 | 70,6±7,5 | 66,2±7,2 |
| **Weight (kg)** | 69,9±13,4 [a] | 68,6±13,9 [b] | 61,9±11,2 [c] |
| **∑3DC (mm)** | 20,2±6,8 | 21,2±7,6 | 18,4±7,1 |
| **WC (cm)** | 91,8±12,8 [a] | 90,8±12,6 [b] | 82,3±11,0 [c] |
| **HC (cm)** | 101,9±10,7 | 101,1±10,1 | 96,4±10,7 [c] |
| **RCQ** | 0,95±0,15 | 0,91±0,12 | 0,92±0,17 |
| **Nº steps/weekdays** | 4.754±1.229 | 7.032±3.609 | 10.229±2.058 |
| **Nº steps/weekends** | 4.938±1.920 | 7.384±3.961 | 9.603±2.106 |
| **Nº total steps** | 4.833±1.059 | 7.123±3.600 | 10.083±1.719 |

Data described as average ± SD. ∑ - the sum of the three folds, WC – waist circumference, HQ – hip circumference. Differences between tertiles: [a] 1–2; [b] 2–3 e [c] 1–3; p≤0,05.

In the physical fitness variables (Table 2), upper limb strength measured by dynamometry showed no significant differences between the tertiles. The significant differences found were lower limb strength between tertile/3 compared to tertile/1 ($p<0.05$).

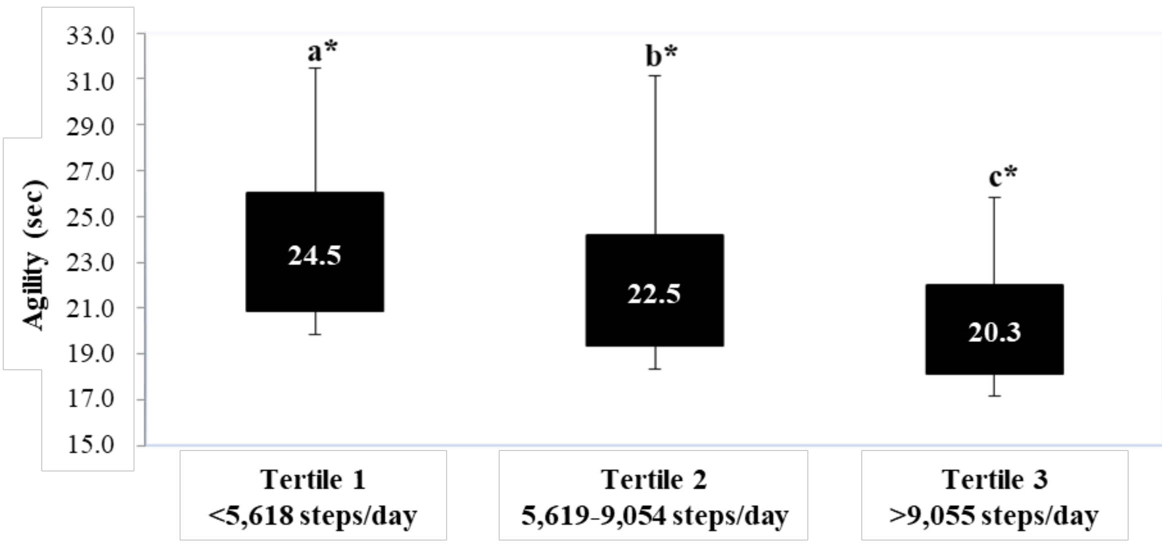
In terms of functional capacity (Table 2), differences between tertiles were found; the shortest time at maximum walking speed between tertile/3 and tertile/1 ($p<0.03$) and the shortest time to get up from a chair in tertile/3 between tertile/1 ($p<0.04$). Those with a higher number of steps demonstrated better body mobility performance.

**Table 2.** Neuromotor and functional capacity variables, according to the tertile associated with the number of steps achieved by adult women practicing physical activities.

| **Variables** | **Tertile 1** < 5,618 steps/day | **Tertile 2** 5,619 – 9,054 steps/day | **Tertile 3** > 9,055 steps/day |
|---|---|---|---|
| **Dinamometry - R (kg)** | 23,2±4,5 | 22,8±4,6 | 24,6±4,3 |
| **Dinamometry - L (kg)** | 22,6±4,5 | 22,2±4,8 | 23,3±3,5 |
| **Strength of MMII (cm)** | 11,9±4,2 | 12,5±4,2 | 13,8±3,5 [c] |
| **Balance (sec)** | 15,9±10,7 | 17,3±10,1 | 19,8±9,3 |
| **Walking speed (m/s)** | 3,1±0,6 | 2,9±0,4 | 2,9±0,5 |
| **Max Walking speed (sec)** | 2,7±1,5 | 2,4±0,4 | 2,3±0,4[c] |
| **Chair-Stand speed (sec)** | 0,8±1,4 | 0,6±0,2 | 0,6±0,1[c] |
| **Body agility (sec)** | 30,9±7,5[a] | 31,3±7,4[b] | 26,6±4,4[c] |

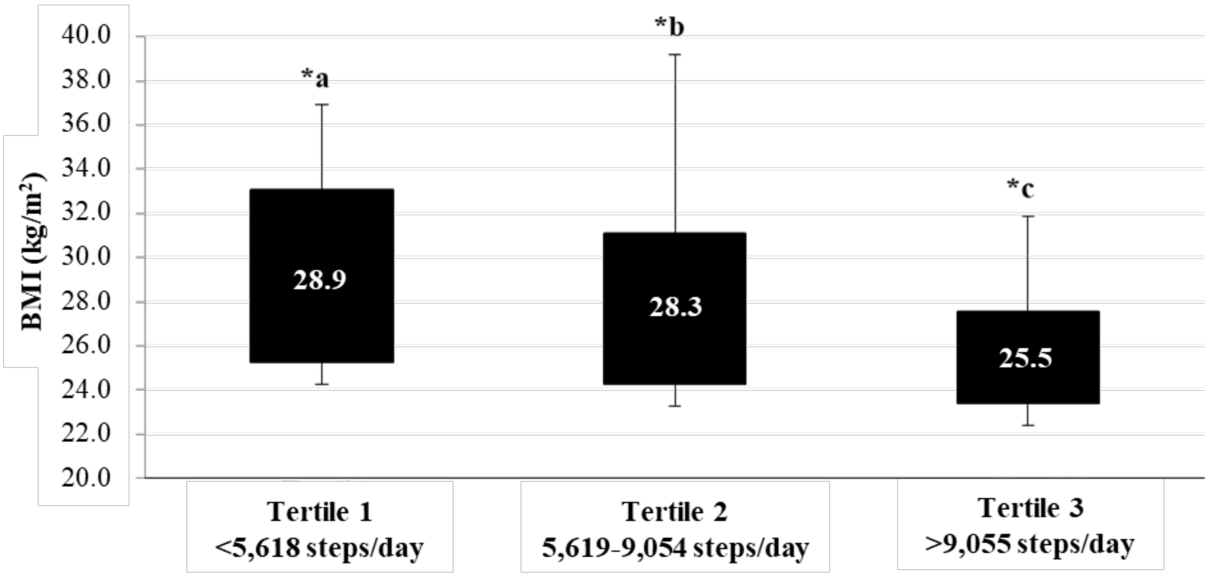
Data described as average ± SD. Differences between tertiles: [a] 1–2; [b] 2–3 e [c] 1–3; $p\leq0,05$.

The ability to perform quick changes with directional shifts resulting in alteration of the center of gravity, which explains agility, was also significantly different according to the tertiles related to the number of steps taken by physically active elderly women, as shown in graph 2.




**Graph 2.** Body agility of physical activity practitioners according to the tertile associated with the number of steps. Caption: Differences between tertiles: [a] 1–2; [b] 2–3 e [c] 1–3; $*p\leq0,05$.

The same phenomenon was verified regarding body composition; the more significant accumulation in the number of steps resulted in an acceptable body mass index profile (Graph 3).




**Graph 3.** Variation of body mass index of physical activity practitioners according to the tertile associated with the number of steps. Caption: Differences between tertiles: [a] 1–2; [b] 2–3 e [c] 1–3; *p≤0,05.

## Discussion

The present study aimed to use the pedometer to verify the levels of physical activity during a 7-day period and its impact on the physical and functional capacity of adult women who practice physical activities. Previous studies with the same population were carried out by Cruciani et al.[10], using an accelerometer to compare the energy expenditure between exercise classes and walking used as a means of transport to and from home to exercise classes, found a significant difference between the number of steps performed between the two categories of activities 1,673 ± 929.4 and 905.1 ± 374.5 counts/minutes (walking and exercise class respectively), i.e., walking as a means of transport accounted for a more significant number of steps than gym class.

Data from both sexes, aged ≥40 years, selected for convenience in the city of Santos/SP[11], showed the average number of daily steps obtained by motion sensor was 10,112 ± 3,761 steps/day. Presenting a variation during the days of the week and correlated with the domains of physical activity at work (r=0.453; p=0.008), of physical activity in sports, exercise and leisure (r=0.518; p=0.002) and with the total score (r=0.473; p=0.005) of the IPAQ; with dyspnea (r=-0.360; p=0.039) and lower limb fatigue (r=0.459; p=0.007) at the end of the 6-min Walk Test.

The study by Harris *et al.*[12], verified 12 weeks of intervention with data from the Pedometer And Consultation Evaluation-UP (PACE-UP) with baseline analyzed in the period of 3 and 4 years of the mean daily count of steps in the 7 days of week in 10-minute sessions showed an increase in the number of daily steps in the intervention group compared to the control group. It was verified that the control group increased 627 steps/day while the intervention group increased 670 steps/day, and this difference was significant.

The recommendation of Physical Activity for people aged >65 years or 50-64 (limitations)[13] is associated with several benefits for cardiovascular health, for the population with several diseases such as hypertension, health professionals are recommended to encourage the practice of regular physical activity, with the objective of reducing the risk of diseases beyond 150 min of aerobic activities, strength exercises, balance and flexibility. When addressing the number of steps to be achieved, they should vary between 6,000 – 8,500 steps/day. It presents a decrease in cardiovascular risk, and therefore has a protective effect on health.

Step counting interventions with different intensity emphases can cause different effects. Data from Tudor-Locke[14] present data from 120 sedentary/low-active postmenopausal women who were randomly assigned to one of the following 3 groups: (1) 10,000 steps per day (no emphasis on walking intensity/speed/cadence; basic intervention, 49 complete), (2) 10,000 steps per day and at least 30 minutes at moderate intensity (i.e., at a cadence of at least 100 steps per minute; enhanced intervention, 47 completers), or (3) a control group (19 completers) during the 12-week intervention. They found that the "basic group" increased from 5173 to 9602 steps per day and from 9.2 to 30.2 active minutes per day. The "enhanced group" similarly increased 5,061 to 10,508 steps per day and 8.7 to 38.8 active minutes per day. The only significant change over time for clinical variables was body mass index. Concluding that interventions using simple step counters can achieve high volume and intensity of daily physical activity, regardless of emphasis on intensity. Despite this, few clinical outcomes were apparent in this sample of postmenopausal women with generally normal or controlled hypertension[14].

Amagasa *et al.*[15] in a review study, found that the recommendations of daily steps for this population depend on the health status (bedridden, presence of chronic disease, functional limitation), but in the healthy elderly group, strategies are recommended to perform 7,100-8,000 steps daily in order to achieve 30 minutes of daily physical activity in moderate to vigorous intensity (MVPA), and in cases of more sedentary elderly, the recommendations are about 4,600-5,500 steps daily. What can be verified in our findings where we found lower values for body weight, body mass index, and visceral adiposity according to the tertiles of the number of steps accumulated by elderly women practicing physical activity.

Data from the CADENCE-Adults[16] study aimed to identify step cadence thresholds associated with metabolic intensity during treadmill walking in adults throughout adulthood (21 to 85 years of age). Ninety-eight ostensibly healthy community-dwelling ambulatory elderly (age = 72.6 ± 6.9 years; 49% female) found ≥100 steps/min as a cadence threshold associated with absolutely definite moderate intensity with an excellent rating. And the increase in cadence at similar walking speeds may be an additional explanation for why metabolic costs differ across adult life. Since it is especially important for this age group, given the recognized dose-response relationship between intensity/volume of physical activity, function and health. Including various biological and anthropometric factors (ie gender, age, leg length, BMI). The strength of the relationship is such that a cadence of ≥100 steps/min is clearly established indicative of absolutely defined moderate intensity for level or nearly level walking expressed in terms of mass-specific oxygen cost (i.e., 3 metabolic equivalents [METs]; 1 MET = 3.5 mL/kg/min)[16].

A systematic review[17] and a meta-analysis[18] included eighteen studies with adults and elderly people whose age ranged from 58 to 74.2 years and found that increasing the number of steps leads to clinical improvements, as well as Daskalopoulou *et al.*[18] in longitudinal analyses, with a cohort study, demonstrated that number of step are predictive of good balance, muscle strength, and reduced number of falls.

A study by Ballin *et al.*[19] evaluated the incidence of diabetes in the elderly in the community, with an average age of 70 years, and observed that a cutoff well below 10,000 steps/day, specifically 4500 steps/day, was the cutoff point that presented the lowest risk of the incidence of the disease, regardless of sex, education, sedentary time and other comorbidities. This study demonstrates that a small change from physical inactivity to a modest increase in physical activity was enough to show a big benefit.

Regarding quality of life, we also emphasize that Leite *et al.*[20] evidenced that the number of steps taken per day is discriminative of the negative perception of sleep in elderly women. A total of 122 elderly women were assessed, the average age being 68.5 ± 5.12 years, the age group 60 to 78 years, and the average number of steps per day was 3,617 ± 2.44. The negative perception of sleep was reported by 39.0% (n=32) of the elderly women[20].

A cohort study[21], lasting 7 years, comprising 78,500 individuals aged 40 to 79 years, showed that accumulating more steps per day, up to 10,000 steps/day, was associated with a lower risk of mortality and incidence of cancer and cardiovascular diseases. The study did not show a minimum limit for the beneficial association of increasing the number of daily steps with mortality and morbidity. In addition, a higher cadence, (peak-30 cadence defined as average of steps/min for the highest 30, but not necessarily consecutive, min/d), may be associated with reduced risk for an incident illness. Another prospective study by the same author[22], with a cohort of 78,430 adults aged between 40 and 79 years, followed for 6.9 years, observed that 9,800 steps/day was associated with a lower risk of incidence of dementia, with a higher cadence resulted in stronger associations.

Based on such evidence, it is possible to develop improved interventions for disease prevention and reduction in medical expenses, as evidenced in the study conducted by Silva et al.[23], , considering a sample in the same population as our study, consisting of 271 women aged over 60 years involved in a program of physical activity and beneficiaries of the Family Health Strategy Program. The level of physical activity was inversely associated with the use of medications. The active group with more than 8,500 steps/day presented 47% less consumption of medications when compared with sedentary individuals with less than 6,000 steps/day.

As limitations, the subjects' difficulty in describing and recording the activities developed during the day on the study notes sheet and the proper use of the pedometer generated a sample loss of 49% of the data on the number of steps, which made a more robust analysis impossible.

The study also has strengths and applicability, such as the use of a direct instrument to assess the level of physical activity, by which we achieved reliable data for interpretation, which allowed us to verify the different levels of physical activity in the adult women group by walking time or the number of steps per day taken continuously or cumulatively, which provide improvements in physical and functional capacity. Therefore, we suggest strategies and interventions that encourage compliance with the number of steps per day. We also recommend adding muscle strength, balance, and flexibility exercises to the physical training program.

## Conclusion

Adult and older women who practiced physical activities and achieved a higher number of steps/day showed better physical and functional fitness performance. This emphasizes the need to adopt a more active lifestyle.

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