Gait speed, balance and age: a correlational study among elderly women with and without participation in a therapeutic exercise program

Velocidade de marcha, equilíbrio e idade: um estudo correlacional entre idosas praticantes e idosas não praticantes de um programa de exercícios terapêuticos

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Abstract

Background: Previous studies have shown that the aging process is associated with changes to gait patterns and balance. Analysis of these motor functions contributes towards identifying situations with the risk of falling. Such events are a serious public health problem. Objective: To investigate whether there were correlations between gait speed, body balance and age in two groups of elderly women, one that participated in a therapeutic exercise program and the other did not. In addition, the two groups were compared in these variables. Methods: This was an observational study, conducted among 40 elderly female volunteers aged between 65 and 89 years, who were recruited at a social center for the elderly. They were divided into two groups: one group of 20 elderly women who participated in a therapeutic exercise program and another group of 20 who did not participate in the program. The subjects' normal gait speed was measured and two balance scales were applied: Berg's balance scale and Tinetti's Performance-Oriented Mobility Assessment of Gait and Balance (POMA). Results: The results obtained did not reveal significant correlations between gait speed and body balance. Conclusions: It was shown that, independent of a good degree of balance, gait speed declined with age in both groups.

Key words: gait; balance; woman; elderly person.

Resumo

Contextualização: Estudos anteriores têm mostrado que o processo de envelhecimento está associado a modificações no padrão da marcha e no equilíbrio. A análise destas funções motoras contribui para identificar situações de risco para quedas, evento que representa um grave problema de saúde pública. Objetivo: Investigar a existência de correlação entre as variáveis: velocidade de marcha, equilíbrio corporal e idade de dois grupos de idosas praticantes e não praticantes de um programa de exercícios terapêuticos e compará-las entre os grupos. Métodos: Trata-se de um estudo observacional realizado com 40 voluntárias idosas com idades entre 65 e 89 anos, recrutadas em um centro de convivência para a terceira idade, divididas em dois grupos: um grupo de 20 idosas praticante de um programa de exercícios terapêuticos e 20 idosas não praticantes. Foi mensurada a velocidade de marcha usual dos sujeitos da pesquisa e aplicadas duas escalas de equilíbrio: escala de equilíbrio de Berg e a Performance-Oriented Mobility Assessment of Gait and Balance (POMA) de Tinetti. Resultados: Os resultados obtidos não revelaram correlação significativa entre a velocidade de marcha e o equilíbrio corporal dos sujeitos estudados. Conclusões: Foi evidenciado que independente de um bom nível de equilíbrio, o parâmetro velocidade de marcha declinou com a idade nos dois grupos.

Palavras-chave: marcha; equilíbrio; mulher; idoso.

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Introduction :⋮:.

Previous studies have shown that the aging process is associated with changes in gait pattern and balance. Analyzing these motor functions may contribute towards identifying situations with the potential risk of falling. Such events are a serious public health issue, because of their frequency and the physical, psychological and social consequences that they may cause[1-3].

From the existing elderly population in Brazil (14.5 million), Anderson[4] estimated that there are at least 4.35 million falls each year. Among these, around 2.175 million (50%) give rise to some type of injury, of which 10% (217.000) are serious. In addition to representing an important cause of mortality among elderly people, falls lead to a higher risk of decreased functional independence and an increased need for hospitalization and institutionalization, thereby burdening the health services[5]. Thus, the comprehension of the factors that lead to increased numbers of falls among elderly people has become a matter of interest to many investigators.

Postural control has been defined as the set of processes through which the central nervous system generates patterns of muscular activity needed for regulating the relationships between the center of the body mass and its support base. Postural balance is related to controlling the relationships between gravitational forces acting on the body, and internal forces (joint torque) that are produced by the body[6,7].

It is clear in the literature that elderly people demonstrate decreased postural control capacities. However, the reasons for this reduction in their capacities have not been completely clarified[8,9].

Gait is an extremely complex motor ability composed of a sequence of cyclical movements of the lower limbs that generate body movements[10]. The modifications to the gait patterns among elderly people have not been completely clarified, but many studies on this subject have been published[7,11-13]. One of the most consistent findings from these studies is that elderly people walk more slowly than young adults do[14-16]. This phenomenon has been interpreted by some authors as a compensatory strategy to ensure stability[17].

On the other hand, this modification has been associated with structural changes to the locomotor system, such as reductions in muscle strength, which are considered to be specific changes caused by aging[18-20]. In addition to reductions in this component, other kinetic and kinematic changes that influence gait speed have been found in the literature[11,21].

Within this context, the present study investigated the existence of any correlations between gait speed, balance and age of two groups of elderly people (one participating in a therapeutic exercise program and the other not participating), and

compared the results between the groups. The analysis was done separately with the intent of comparing the correlations between these variables in the two groups, which showed the distinct characteristics of either practicing therapeutic exercises or not doing so.

For this study, the subjects' usual gait speed was measured and two balance scales were applied: the Berg[22] balance scale and the Performance-Oriented Mobility Assessment of Gait and Balance (POMA) devised by Tinetti[23]. Both scales are widely used in scientific studies in this field and have been culturally adapted for Brazil[24, 25].

The POMA scale was created in 1986 by Tinetti, Williams and Mayewski[23] and was culturally adapted for Brazil by Gomes[24] in 2003. It is divided into two parts: one evaluates balance and the other gait.

There are many studies that demonstrate the validity of POMA. Tinetti, Williams and Mayewski[23] showed that lower scores were predictive of recurrent falling. Berg and Norman[26] showed the associations between measurements of postural oscillation and the Tinetti scale. Other studies have used the POMA scale in full or in part, as an element in a set of evaluations, normally associated with longitudinal and screening studies[27-29].

Berg's balance scale, which was developed in 1989 by Berg et al.[22], aims to evaluate the functional balance of elderly individuals and patients who demonstrate balance deficits. It is made up of 14 common tasks that involve static and dynamic balance. The tasks are evaluated through observation, on an ordinal scale of five alternatives ranging from zero to four, thus producing a maximum score of 56 points. Points are deducted if the times or distances are not achieved, or if the subject requires supervision to perform the task or requires external support. The Berg scale was culturally adapted for Brazil in 2004, by Miymoto et al.[25].

Materials and methods :⋮:.

Forty autonomous independent female volunteers (without any limits on their functional capacity) participated in this study. They were aged between 65 and 89 years and were recruited at the social center of the Open University for the Third Age Program (UnATI) - UERJ. They were divided into two groups: 20 elderly women undergoing outpatient supervision (OPG) who, when questioned, reported that they were not performing any physical activity; and 20 participants in a therapeutic exercise group (TEG) who were performing a weekly general exercise program. This exercise program included: five minutes of warm-up (walking); five minutes of overall stretching; 15 minutes of balance training (plantar

flexion, knee flexion, hip flexion and lateral elevation of the lower limb in an erect posture with small support; swinging backwards and forwards on the ankles without bending at the hips; crossed gait and gait on the heels); five minutes of motor coordination (coordinated movements of the upper and lower limbs) and five minutes of relaxation.

The exclusion criteria were as follows: demonstration of any comprehension deficits that would limit the performance of movements upon verbal command; and the presence of any motor neurological sequelae or serious conditions of degenerative or chronic diseases that might compromise the locomotor system. For the elderly women in the TGE, lack of assiduity was considered to be an exclusion criterion.

Means and standard deviations were calculated and the Shapiro-Wilk test was used to verify data normality, in order to characterize the sample in relation to age, height and body mass. All the continuous variables were uniform in both groups, given that the variation coefficient was lower than 20%. In these groups, the estimates were believed to be constant within the population, because the standard error was always less than 3.5% (Table 1).

To evaluate the gait speed, the individuals were instructed to walk at their habitual pace along a 14-meter track. The first three and last three meters were disregarded, since these corresponded to the periods of acceleration and deceleration of gait[30]. Therefore, the time spent on completing the central eight meters was measured. To avoid measurement bias, a digital chronometer was used, connected to a photocell mechanism, which was activated and halted at the beginning and end of this track. The average time taken in three attempts was used to calculate the gait speed expressed in meter per second (m/s). To investigate the influences of the time of the day on gait speed, the tests were applied to both groups in the morning and in the afternoon. All the study subjects were evaluated at both times of the day. The Brazilian versions of the Berg and POMA balance scales were applied and their results were compared with the measurements of gait speed.

In addition to the investigator, two physical therapists trained for this purpose participated in the data collection. To verify the quality of the data collected, intra- and inter-evaluator reliability tests were applied, using the intraclass coefficient correlations (ICC). All of the instruments used showed high levels of intra-evaluator reliability (BERG: ICC=0.86 with a confidence interval (CI) of 0.60 to 0.96; POMA: ICC=0.99, with CI=0.96 to 1; gait speed: ICC=0.97, with CI=0.91 to 0.99) and inter-evaluator reliability (BERG: ICC=0.92, with CI=0.76 to 0.97; POMA; ICC=0.95, with CI=0.86 to 0.98; gait speed: ICC=0.98, with CI=0.95 to 0.99).

The Pearson correlation coefficient was used to investigate the influence of the time of the day on gait speed and to analyze the correlations between gait speed and balance and the participants' ages. The Student's t-test for independent samples was used to evaluate the differences found between the two groups. The significance level was selected at 0.05 for the statistical analyses.

The investigation of data normality using the Shapiro-Wilk test showed that the data distribution was close to normal in both groups for all variables, with the exception of the body mass variable in the TGE. All elderly people who accepted participation in this study signed an informed consent statement in accordance with the provisions of resolution 196/96 of the National Health Council. This research project was submitted to the Research Ethics Committee of the School of Medical Sciences of the State University of Rio de Janeiro, and it was approved through report number 00120228.000.

Results

The results will be presented based on comparisons of balance levels in the two groups. Next, the findings relating to gait speed will be shown, including the analysis of the values found according to the time of day (morning or afternoon). Finally, the existence of significant correlations between speed and balance and speed and age will be analyzed.

With regard to balance, the analysis allowed it to be seen that the TGE showed significantly higher values (p<0.05) on the Berg and POMA scales (55.80±0.69 and 56.80±0.36, respectively) than in the OPG (53.05±3.28 and 54.00±2.47, respectively). Figure 1 illustrates the balance level responses of the individuals in the two study groups.

To investigate the influence of the time of day on gait speed, the tests were applied to both groups in the morning and in the afternoon. The results can be seen in Figure 2 (OPG) and Figure

Table 1. Descriptive statistics on the outpatient (OPG, n=20) and therapeutic exercise groups (TEG, n=20).

	$\bar{x}$		Md		sd		SEm		CV		Confidence level	
	OPG	TEG	OPG	TEG	OPG	TEG	OPG	TEG	OPG	TEG	OPG	TEG
Age	73.30	73.84	75.00	74.00	5.36	5.57	1.19	1.27	7.31	7.53	2.50	2.68
Height (m)	1.53	1.54	1.54	1.54	0.03	0.04	0.00	0.01	2.42	3.02	0.17	0.02
BM (kg)	56.17	58.15	56.10	54.30	2.59	7.78	0.57	1.78	4.61	13.37	1.21	3.75

BM=body mass; x̄=mean; Md=median; sd=standard deviation; SEm=standard error of mean; CV=coefficient of variation.

3 (TEG). From the demonstrated results, it was seen that this variable did not have any influence on gait speed, since none of the groups showed any significant differences, so the morning period was taken for analysis purposes.

In relation to gait speed, as already was expected, the group that was performing therapeutic exercises showed significantly higher values (p<0.05) for gait speed (0.99±0.10 m/s) than did the OPG (0.83±0.12 m/s), as can be seen in Figure 4.

In relation to the correlational levels in the OPG, the estimates remained low both for the POMA test (0.25) and for the Berg test (0.26). (p>0.05). In the group that was performing the therapeutic exercises, the estimates were lower: POMA test (0.09) and Berg test (0.07, p>0.05). According to the statistical results, there was no evidence for any significant correlations between the study variables.

The correlational analysis between gait speed and age in the two groups revealed that the correlation level was moderate (0.56, p<0.05) in the OPG and high in the TGE (-0.73, p<0.05).

Discussion ⠸⠇

Reduced gait speed among elderly people has been associated with decreased capacity for control of body balance. In a cohort study evaluating gait speed in a group of elderly people, Odasso et al.[32] differentiated them into three speed levels (high, moderate and low). They found that the group with the lowest gait speed demonstrated higher incidence of falls, among other adverse events.

Teixeira et al.[17] studied the biomechanical aspects of elderly people's walking and found longer support and shorter suspension phases than among younger populations. They suggested that in elderly populations, there is a need for greater security, as represented by increased use of double support to allow them to better keep their balance. Furthermore, increased duration of this gait phase implied decreased speed[10].

However, the results found in the present study did not reveal any significant correlations between gait speed and balance that could support the idea that these elderly people were using speed reduction as a compensatory strategy to ensure adequate balance. According to other authors, the decrease in this parameter is due to decreased muscle elasticity, joint mobility and muscle strength[11,33]. David et al.[18] reported a significant correlation between lower limb strength and gait speed, thus providing evidence that the strength loss due to age is one of the factors that causes the decline in this parameter among the elderly. Fiatarone et al., apud Carvalho[20], also found these correlations.

Kerrigan et al.[21] investigated the comfortable gait speed patterns of healthy young and elderly people with the aim of
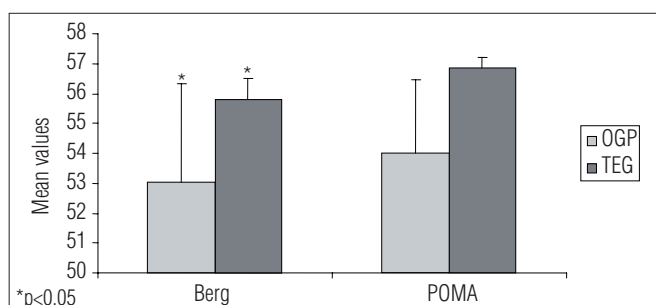

Figure 1. Mean response to the balance test, according to the Berg and POMA (Performance-Oriented Mobility Assessment of Gait and Balance) scales, for the therapeutic exercise group (TEG) and outpatient group (OPG). The columns represent mean values and the vertical bars represent standard deviations.
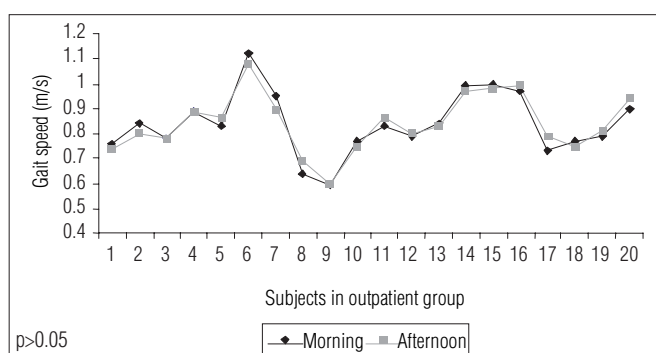

Figure 2. Gait speed response during the test in the outpatient group (OPG) in the morning and in the afternoon.
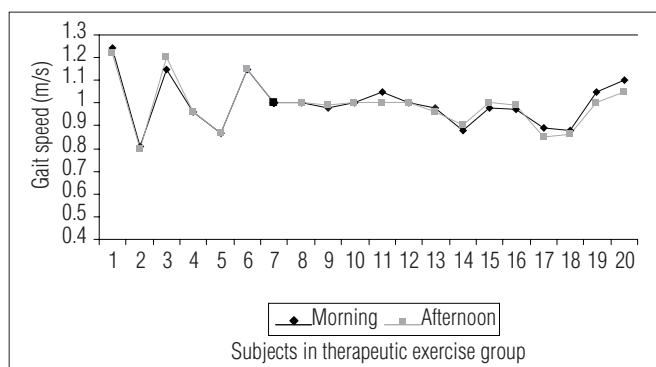

Figure 3. Gait speed response during the test in the therapeutic exercise group (TEG) in the morning and in the afternoon; p>0.05.
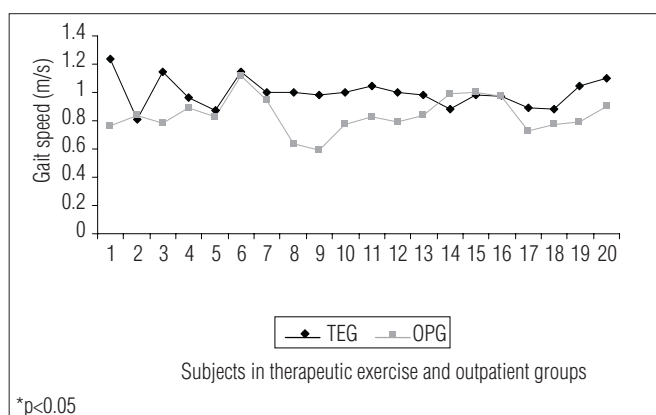

Figure 4. Gait speed response during the tests in the therapeutically exercise group (TEG) and outpatient group (OPG).

identifying specific kinematic and kinetic changes and determining whether these persisted in fast gait among elderly individuals. Reductions were found in 11 of the 28 parameters evaluated. Among these 11 parameters that were considered significantly different between the young and elderly groups, only four persisted both at the comfortable and fast gait speeds. These parameters were: hip extension reach; anterior pelvic inclination, reduction in power generation and reduction in the plantar flexion range of motion. With the persistence of these parameters, it becomes clear that these changes found in elderly individuals' gait are not adaptive changes, but specific limitations related to age, since these remained changed even when the elderly individuals increased their gait speed, at the cost of increased cadence. Moreover, following biomechanical reasoning, it can be inferred that the reduction in the hip extension range of motion that occurs during gait, which was considered by Kerrigan et al.[21] to be a specific change, may be responsible for limiting the step length, a parameter that has been associated with gait speed reduction among the elderly[34]. These findings support the hypothesis that the decline in this parameter is related to structural changes in the locomotor system that are associated with aging.

Within this context, the notion that the gait speed decreases that occur among the elderly are strategies used to ensure good balance cannot be generalized. It may be that this mechanism occurs among those who suffer from repeated falls. It is clear in the literature that fear of a new fall is one of the consequences from the occurrence of this event[35,36]. The fact that the TGE showed better balance levels corroborates other studies that reported improvements of healthy elderly people's balance after they underwent general exercise programs similar to the one implemented in this study[28,34,37].

Not only did the results from the present study show higher gait speeds in the group of elderly women performing therapeutic exercises, in comparison with those in the OPG, but the statistical analysis also revealed an inverse correlation between gait speed and the age in the studied groups. These correlations were more significant in the TGE, which was not expected, since this group might have obtained benefits from the therapeutic exercise program, thereby minimizing the physiological effects of aging. These correlations would probably have been more significant in the group of elderly women who did not practice therapeutic exercise, if the study sample had been larger. Furthermore, it is important to take into consideration the program's components. It was evident that the elderly people who practiced therapeutic exercise showed better balance, but the gait speed did not appear to be very notable among the individuals of more advanced age. As already mentioned, lower-limb muscle strength is closely related to gait speed[18]. Sipila et al.[19] found increased gait speed among elderly women after 18 weeks of muscle strength training. These findings show the importance of including muscle strengthening in exercise programs destined for elderly populations.

The observation that there was an association between greater age and decreased gait speed, which was observed especially in the TGE, was of particular importance in this study. It confirmed that reductions in this parameter were not always associated with balance changes, since a high score was observed in the scales that evaluated this variable.

One of the limitations of this study was that it only evaluated elderly people, and did not include males. This characteristic of the study was defined from the sample, because of the small number of elderly males in the TGE. On the other hand, according to the literature, decreased muscle strength, which is a component associated with the gait speed parameter, is more evident among women[38].

Another limitation that must be considered is the fact that field tests alone were used to evaluate the variables studied. No laboratory tests, which would have provided objective measurements , could have been used.

Conclusions ⠢⠆

The results from this study did not reveal any significant correlations between gait speed and balance among the elderly women studied, independent of whether they were participating in therapeutic exercises or not. In addition, it was found that regardless of whether their balance level was acceptable, the gait speed parameter decreased with age in both groups studied.

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