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Balance and aerobic capacity of independent elderly: a longitudinal cohort study

Estudo longitudinal do equilíbrio postural e da capacidade aeróbica de idosos independentes

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Abstract

Objective: To evaluate the variation in aerobic capacity and postural balance of independents elderly for a period of three years. **Methods:** The aerobic capacity of the volunteers was assessed using a six minutes walk test (6MWT), the postural balance was assessed using the Berg Balance Scale (BBS), the number of falls was self-reported and physical activity level was assessed using the International Physical Activity Questionnaire (IPAQ - long version). Evaluations undertaken in 2008 were compared to those performed in 2005. **Results:** There were no differences in balance and number of falls between 2008 and 2005 ($p>0.05$). There was a decrease in aerobic capacity over time of 52.46±8.4 meters walked. The IPAQ showed an increase in physical activity on the second evaluation (83.3%). **Conclusion:** The present study demonstrated that balance, evaluated using BBS did not change in the active independent elderly for a period of three years. However, over the there year period there was a decrease in aerobic capacity evaluated using the 6MWT.

Keywords: physical therapy; elderly; balance; aerobic capacity.

Resumo

Objetivo: Avaliar a variação da capacidade aeróbica e do equilíbrio postural em idosos independentes por um período de três anos. **Métodos:** A capacidade aeróbica dos voluntários foi avaliada por meio do Teste de Caminhada de 6 minutos (TC6); o equilíbrio postural, por meio da Escala de Equilíbrio de Berg (EEB); o número de quedas foi registrado por autorrelato e o nível de atividade física, pelo Questionário Internacional de Atividade Física (IPAQ – versão longa). As avaliações realizadas em 2008 foram comparadas às realizadas em 2005. **Resultados:** Não houve diferença na pontuação da EEB e no número de quedas dos idosos avaliados ($p>0,05$). Houve diminuição da distância percorrida entre as duas avaliações, sendo que os voluntários percorreram 52,46±8,4 metros a menos na segunda avaliação. O IPAQ evidenciou aumento de indivíduos considerados ativos na segunda avaliação (83,3%). **Conclusão:** O presente estudo demonstrou que o equilíbrio postural, avaliado pela EEB, não se alterou nos idosos independentes e ativos no período de três anos. Nesse mesmo momento, observou-se uma redução da distância percorrida, avaliada pelo TC6.

Palavras-chave: fisioterapia; idoso; equilíbrio; capacidade aeróbica.

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Introduction

Individual's ability to remain on a standing position, effectively correcting the body's movements and reacting to external stimuli, represents strategies of postural control essential to daily activities. After 65 years of age, up to 30% of elderly have progressive worsening of balance and posture over the years. In most cases, the lack of balance can not be attributed to a specific cause, but to a compromise of the balance system as a whole (including afferent and efferent neural pathways and musculoskeletal components of postural response)[1].

With aging, the musculoskeletal system capacity is reduced, with loss of muscle mass and strength, in addition to the effects of changes in the nervous and cardiopulmonary system[2,3]. A decrease in aerobic capacity and in physical activity levels can cause changes in gait and balance. These changes lead to an increased susceptibility to falls and impairment in the functional capacity of the elderly[4]. Similarly, changes in components of the vestibular, visual and proprioceptive systems are also associated with a decrease in postural balance[5].

Physical performance, such as postural balance and aerobic capacity, are important health indicators and have been reported to be significant predictors of physical disability and dependence in the elderly[6,7]. Moreover, these measures are also used as predictors of health care and population's needs. Thus, it is important to identify longitudinal changes in physical performance that occur with aging.

In physical therapy practice, several tests, with varying degrees of sophistication, can be used to evaluate postural balance and aerobic capacity. However, it is known that the evaluation of physical performance by means of laboratory tools, that consider only one particular parameter, does not always completely reflect the functional activities performed in everyday life. The Berg Balance Scale (BBS)[8,9] and the Six Minute Walk Test (6MWD)[10] used in the elderly provide information about functional activities and have been widely used because of its low cost and easy application.

Studies that evaluate changes in balance and gait over time, keeping the elderly in their spontaneous physical activity are still insufficient. Thus, it is essential to obtain information on longitudinal changes of balance and aerobic capacity of the elderly to understand the natural history of postural control and functional capacity changes, allowing the planning of specific physical therapy interventions.

In clinical practice, these tests are repeated after varying periods. However, little is known about the variation that is expected to occur over the years for this population. For these reasons, the aim of this study was to evaluate the variation of distance walked and postural balance of independent elderly in a period of three years, using the 6MWT and the BBS.

Methods

The study was approved by the Committee of Ethics of the Faculty of Medicine of Ribeirão Preto (FMRP), Universidade de São Paulo (USP), Ribeirão Preto, SP, Brazil (protocol 12152/2007), and all volunteers received detailed information about the objectives and procedures of the study and participated in the study after signing the consent form.

The present study represents the reassessment of the elderly who participated in a study conducted in 2005 at the Hospital of the FMRP, with the objective to evaluate body composition, energy expenditure and physical activity of independent elderly living in an urban area of Brazil.

Population

The studied population was comprised of 100 individuals aged between 60 and 75 years, that were members of the Family Health Program associated with the FMRP-USP. The selection was random, covering all census areas of the region (Census 2000). This sample represents 10% of the population in this age group living in that area during the study period,and therefore, is representative of the population.

Volunteers bedridden, dependent for activities of daily living, who had cognitive impairment, musculoskeletal and joint impairment and serious sequelae of stroke were excluded from the study. Amputated volunteers or volunteers who used orthoses and prostheses and patients with acute or chronic uncompensated disease were also excluded. To detect these conditions, all volunteers underwent complete and detailed clinical evaluation by physical therapists and doctors participants of the study.

Evaluation procedures

The volunteers underwent the same evaluations in two phases: the first evaluation was conducted in 2005 and the second in 2008. The three-year period was considered sufficient for the occurrence of any detectable changes. All evaluations were conducted by health professionals properly trained and linked to the project.

The evaluation's sequence was in the following order: first, information about the objectives of the study were given to the volunteers and a consent form was signed; then, they answered clinical evaluation questionnaires (including questions about personal data, history of illness, independence in carrying out activities of daily living, number of falls suffered in the last year) and to the International Physical Activity Questionnaire (IPAQ - long version). In sequence, they underwent anthropometric measurements of body mass and height to calculate body mass

index (BMI). Finally, they were evaluated using the BBS and the 6MWT. All evaluations were conducted in the morning and volunteers performed all tests in sequence with rest periods of 15 to 20 minutes between tests.

Measurement protocols

The IPAQ, proposed by the World Health Organization (WHO) in 1998 and which had its long version validated in Brazil in elderly men by Benedetti et al.[11] was used to evaluate physical activity level. According to the aforementioned authors, the questionnaire has high reproducibility, is easy to use and have low cost.

Subjects answered the questionnaire with the help of a trained physical therapist. The long version of the questionnaire was used and participants reported the activities carried out in a common week. Activities were divided into activities at work, at home and as means of transport and leisure[11]. After the interview, the time spent on each specific activity was added to a weekly total time spent on physical activity and further classified as: little active (who performs activity lasting less than 150 minutes per week) or very active (who performs physical activity lasting 150 minutes or more per week).

The BBS was used to evaluate postural balance. BBS consists of 14 items involving specific functional tasks in different support bases. The total score ranges from 0 to 56 and each item has an ordinal scale with five alternatives from 0 to 4 points, where 0 indicates that the individual was not able to accomplish the task and 4 that the individual was able to accomplish the task without difficulty.

The BBS is simple, requires little time, and is easy and safe to use in the elderly[8,9]. The test have been reported to have excellent reliability (0.96) and good correlation with other instruments of balance functional evaluation such as the Tinetti scale (r=0.91), the Barthel Index of daily living activities (r=0.67) and the Timed Up and Go Test (r=0.76)[12].

The BBS was conducted in a closed and quiet room with the use of a stopwatch, ruler, two chairs with adequate height to patients and a ladder.

The 6MWT was performed in a corridor of 30 meters and the volunteers were instructed to walk as fast as possible without running. They could stop the walk if they felt any discomfort, fatigue or shortness of breath. Subjects received verbal encouragement to each minute of testing. Besides the distance walked other parameters such as heart rate, blood pressure, dyspnea sensation, fatigue and respiratory rate were recorded at rest and immediately after the end of the test[13]. The equipments used in the test were: frequency counter to evaluate variation in heart rate during activity, sphygmomanometer and stethoscope.

Statistical analysis was performed using STATA (*Stata Corp. 2007; Stata Statistical Software: Release 10.0. Special Edition, Stata Corporation, College Station, TX, USA*). First, descriptive statistic analysis was performed (mean and standard deviation). The Kolmogorov-Smirnov test was used to test data normality. The Fisher's exact test was used to verify the association between level of physical activity and the evaluations performed. Anthropometric variables and physical tests were compared between the two evaluations using paired Student t test, and level of significance was set at 5% for all tests ($p<0.05$)[14].

Results

The first phase of the study (n=100; 50 women) was conducted in 2005, and the second, in 2008. All elderly participating in the first evaluation were contacted by telephone and mail. From the initial total number of volunteers six had died, 32 refused to participate in the reassessment, 12 reported health problems and were excluded from the study and eight were lost to follow-up due to addresses and phone numbers changes. Therefore, from the first 100 elderly evaluated initially, 42 individuals (28 women),participated in the reassessment in 2008 and were included in the longitudinal analysis.

The mean age of volunteers in 2005 was 66.37±3.77 years and in 2008 was 69.37±3.77. Anthropometric measurements and the number of falls did not change significantly over three years (Table 1). Likewise, the BBS score between evaluations was not significantly different (Figure 1).

Regarding to the 6MWT, there was a decrease of 52.4±8.4 meters in the distance walked between the two evaluations (Table 1 and Figure 2).

There was significant difference in the level of physical activity between the first and second evaluations although most of the sample was very active on both evaluations. Among those who had changed their classification, most were reclassified as very active (Table 2).

Discussion

The aim of this study was to evaluate the variation in the distance walked and in the postural balance of independent elderly in a period of three years, using the 6MWT and the BBS. In this research, the results showed that among independent and active elderly living in an urban community there was, over a three year period, a stability in balance, evaluated

using the BBS, and a decrease in gait performance, evaluated using the 6MWT.

This study evaluated the physical performance and balance of independent elderly in a period of three years, using methods easily applied. The evaluations of functional performance in the elderly are mainly targeted at early identification of individuals at higher risk of disability, at the prevention of adverse clinical outcomes, such as institutionalization, falls and hospitalization, and also at facilitating the implementation of these instruments in physical therapy research and clinical practice.

In this study, there was no significant change in anthropometry during the studied period. However, some authors have reported that there is a progressive body weight decrease from 65 years of age attributed to a decrease in food intake, chewing difficulty and body composition changes related to aging, such as increase in fat deposition and loss of bone mass and muscle mass[15-17].

Regarding the reporting of falls and postural balance evaluated using the BBS there were no significant difference in these variables in three years, although there are studies in the literature reporting changes in balance related to aging, such as increase in reaction time, greater postural sway in standing position and decrease in efficiency of motor strategies of postural balance[18].

It is known that the postural control system is a multifactorial and redundant mechanism as even in the absence of information from one of the sensory systems (visual, proprioceptive or vestibular), and individual is still able to maintain postural balance. A decrease in sensory and musculoskeletal information is expected with aging. These changes can appear small in magnitude but can cause a large loss in the function of the elderly[19].

Based on clinical experience, Berg et al.[8] reported that a BBS score below 45 indicates impaired balance and relates to increased risk of falls. It was observed that the elderly evaluated in this study had high BBS scores (above 45) which is similar to the results of other studies that evaluated an elderly population with no reports of falls[20,21]. In addition, the elderly evaluated in this study showed no changes related to postural balance over a three year period. Therefore, it can be assumed that they have used strategies to maintain appropriate stability on the BBS.

Another important findings of this study that deserves to be highlighted is that there was an increase in the number of elderly who engaged in physical activity, going from 52.4% in the first evaluation to 83.4% in the second. Many studies have shown that the elderly who practice regular physical activity improve muscle strength, the ability to walk, posture balance and show less risk of falls[22,23]. Thus, the elderly evaluated may have benefited from physical activity practice, with no falls during the studied period and maintenance of the BBS scores.

Table 1. Anthropometry, number of falls and physical test results (mean±standard deviation) in 2005 and 2008 (n=42).

Variables	1° evaluation (2005)	2° evaluation (2008)
Height (m)	1.5±0.1	1.5±0.1
Weight (kg)	67.7±11.6	67.5±11.0
BMI (kg.m^{-2})	27.1±4.4	26.9±4.7
Falls (n)	0.3±0.6	0.2±0.8
6MWT (m)	544.8±81.7	492.4±73.3*
BBS (score)	53.6±2.2	54.1±2.7

BMI=body mass index; BBS=Berg Balance Scale; 6MWT=Six Minute Walk Test. * p<0.01.

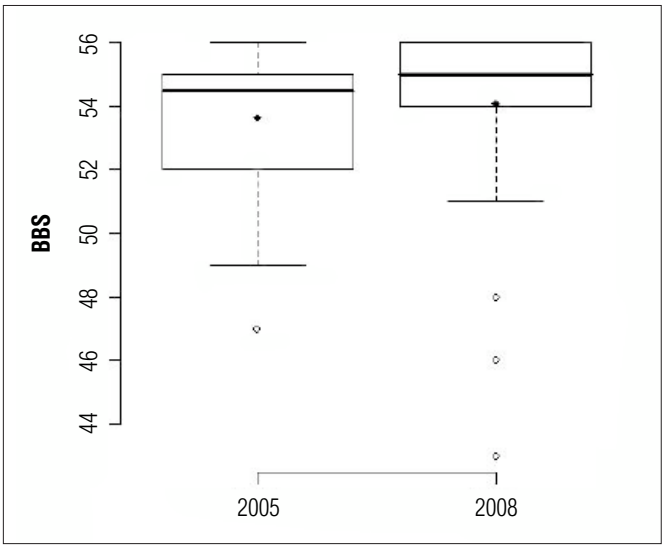

Figure 1. Box-plot of mean and standard deviation of the Berg Balance Scale in 2005 and 2008.

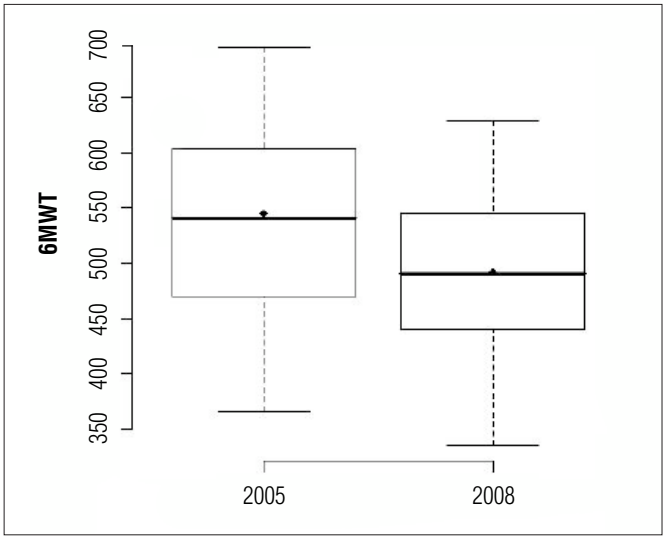

Figure 2. Box-plot of mean and standard deviation of distance walked during the Six Minute Walk Test in 2005 and 2008.

Table 2. Distribution of physical activity levels in 2005 and 2008.

IPAQ	1° evaluation (2005)	2° evaluation(2008)	P-value*
	N (%)	N (%)	
Low active	20 (47.6%)	7 (16.6%)	<0.01
Very active	22 (52.4%)	35 (83.4%)	

* Fisher exact test.

In relation to the 6MWT, the results of this study showed a decrease in the distance walked during the studied period. This result corroborate with studies conducted on the Brazilian and American population[22,24]. This result suggest that there is a decrease in physical capacity of the elderly over time.

According to Enright et al.[25], some variables can influence the distance walked on the 6MWT, such as age, body mass and height. In addition, previous studies suggest that a decrease in muscle mass and strength, that occur with advanced age, and progressive changes of the various systems involved in the maintenance of aerobic capacity can contribute to a decrease in performance[26]. However, to evaluate this association was not within the scope of this study.

Visser et al.[27], in a prospective study of three years with individuals aged 55 to 85 years, noted that the mobility performance (evaluated using the six-minute walk test and the sit to stand from a chair test) decreased in 45.6% of the studied sample. In addition, it was noted that the level of physical activity was positively associated with better performance in physical tests, showing that individuals who remained active had a lower decline in mobility.

Therefore, considering physical activity as an effective resource to minimize the impact of aging on physical performance[28,29] and the variables that can influence the performance of this test, especially in the elderly, we can consider that the observed decrease in the distance walked, although statistically significant, was clinically mild and relatively expected, in view of the physiological changes of the aging process[30]. Thus, it is believed that the decline found for the distance walked was not higher possibly due to benefits of physical activity.

In many Brazilian cities, physical activity programs for the elderly are established with the intention of minimizing the changes triggered by aging and consequently maintain the physical ability and independence of the elderly. Some studies have indicated the effectiveness of these programs in improving and maintaining muscular strength, flexibility, balance and physical conditioning[28,29]. In this study, the level of physical activity was evaluated using the IPAQ and the results demonstrated that the most commonly performed activities were performed on public squares and sports courts, were of moderate intensity, were performed twice a week for one hour and included walking, dancing, stretching and balance exercises.

Finally, it was noted that the elderly in this study performed regular physical activity in 2005 and 2008 and yet there was an increase in the number of the elderly who were reclassified as very active in the second phase of the research. This information suggests that the maintenance of physical activity practice may be associated with the maintenance of body weight, postural balance and number of falls over the studied period. Assuming that aging leads to progressive changes in functional capacity and postural control of individuals, we can consider that this study found satisfactory results in terms of maintenance of these variables in the elderly who maintained their spontaneous physical activity.

However, as a limitation of this study, it is not possible to say whether these elderly have remained active throughout the three years, since there was no evaluation between this period. Other limitations should be considered: from the first to the second phase of the study there was considerable sample loss,especially due to refusal, which may have selected the elderly more active and with better preservation of functional status. Another aspect to be considered is that this study was conducted on an urban and independent population and the study results may not apply to other populations that have different characteristics. Finally, the study included the mean age variation from 66 to 69 years and the results may not reflect changes that occur in other age groups, especially if they are not linear.

Conclusion

The present study demonstrated that postural balance evaluated using the BBS did not change between active independent elderly over three years. At that same time, there was a decrease in the distance walked, evaluated using the 6MWT.

In general, the results of this study reinforce the need of maintenance of physical activity in the elderly population to prevent changes in balance and aerobic capacity since physical exercises can decrease the impact of the aging process.

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