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Functional balance among older adults from the community: a comparison of their history of falls

Equilíbrio funcional de idosos da comunidade: comparação em relação ao histórico de quedas

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Abstract

Background: Human balance is a complex motor task. Its maintenance is essential to accomplishing daily tasks. The aging process and the chronic diseases that affect older adults lead to serious balance disorders, thus making such individuals more susceptible to falls. **Objectives:** To evaluate the functional balance of community-dwelling older adults and to make a comparison between those with no history of falls, those with one fall and those with recurrent falls. **Methods:** A cross-sectional study was carried out. The sample was composed of 96 individuals from the community aged 65 years or older. They were divided equally into three groups according to their reported history of falls over the preceding year. Functional balance was evaluated using the Berg Balance Scale (BBS) and the Timed up and Go Test (TUGT). **Results:** The older adults with a history of one fall or recurrent falls had longer performance times in the TUGT than did those with no history of falls, and this difference was statistically significant (p=0.002). In the BBS evaluation, the older adults with a history of recurrent falls scored significantly lower than those with no history of falls (p=0.013). A moderate association was found between the BBS and TUGT results in the three groups (p<0.001). **Conclusion:** The older adults with a history of falls performed poorly in the functional balance evaluation compared to those with no history of falls. These data demonstrate the importance of the balance tests in clinical practice as screening tools for older adults who are more susceptible to falls.

Key words: older adult; balance; falls.

Resumo

Contextualização: O equilíbrio humano é uma tarefa motora complexa, e a sua manutenção é essencial para a realização das tarefas cotidianas. O processo de envelhecimento e as doenças crônicas que acometem os idosos geram sérios distúrbios de equilíbrio, tornando-os mais suscetíveis às quedas. **Objetivos:** Avaliar e comparar o equilíbrio funcional de idosos da comunidade sem história de quedas, com uma queda e com quedas recorrentes. **Métodos:** Estudo de corte transversal com amostra constituída por 96 sujeitos, com idade igual ou superior a 65 anos, residentes na comunidade e divididos igualmente em três grupos de acordo com o histórico de quedas relatado no último ano. Para a avaliação funcional do equilíbrio, foram utilizados como instrumentos a *Berg Balance Scale* (BBS) e o *Timed Up and Go Test* (TUGT). **Resultados:** Idosos com histórico de uma queda e quedas recorrentes realizaram o TUGT em um tempo maior do que idosos sem relato de quedas, sendo esta diferença significativa (p=0,002). Na avaliação pela BBS, idosos que apresentaram quedas recorrentes pontuaram significativamente menos do que aqueles sem quedas (p=0,013). Verificou-se moderada associação entre a BBS e o TUGT nos três grupos (p<0,001). **Conclusão:** Idosos com histórico de quedas apresentaram comprometimento na avaliação do equilíbrio funcional em relação àqueles sem quedas. Esses dados revelam a importância dos testes de equilíbrio na prática clínica como instrumentos de rastreio dos idosos mais suscetíveis ao evento quedas.

Palavras-chave: idoso; equilíbrio; quedas.

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Introduction

Posture control in humans depends on the interaction between the individual's intrinsic characteristics, his surroundings and the demands of the task he is performing[1]. Posture maintenance is mediated by information from the sensory systems, by the Central Nervous System (CNS) programming and by the execution of the musculoskeletal system[2]. The aging process affects the components of postural control, and it is difficult to differentiate the effects of age from those caused by disease and lifestyle. Regardless of the cause, however, the accumulation of alterations in body balance reduces the individual's compensatory capacity, increasing instability and, consequently, the risk of falling[3].

Falls are one of the main causes of morbidity and mortality among the older adult population[4]. The causes of falls are multifactorial, including intrinsic, behavioral and environmental factors, and the probability of a fall increases as the risk factors accumulate[4-10]. Therefore, diagnosing the clinical parameters associated with falls in older adults became a great challenge for the scientific community and led to the development of several instruments to evaluate postural control in that population[11]. The instruments that analyze balance are divided into systems assessments and functional assessments[12]. The identification of the components responsible for postural instability (sensory system, CNS, musculoskeletal system) is carried out by systems assessment. The functional assessment is even more important because it determines how specific deficits affect the individual's overall function during the accomplishment of daily tasks. It also identifies, in advance, older adults with higher chances of falling[8].

Functional scales such as the Berg Balance Scale (BBS) and Timed Up and Go Test (TUGT) demonstrate good correlation with laboratorial and clinical measures concerning falls and instability. Furthermore, they point out differences between the balance of fallers and non-fallers[13-19]. Studies with BBS[13,20,21] and TUGT[17,22] propose different cutoff scores to predict the risk of falls and to evaluate the balance deficit in older adults. However, the literature regarding these scales[13,17,20-22] diverges on the most appropriate parameter to differentiate older adults according to the history of falls. The heterogeneity in the selection of older subjects, such as wide age range and different functional levels, interferes with the interpretation of the results of these instruments. In clinical practice, the use of these cutoff scores, without considering such diversity, can result in erroneous individual prognoses and, consequently, inadequate treatment. The use of more homogeneous samples helps to distinguish older adults in terms of functional balance deficit and increases the power of the cutoff scores of the functional scales in terms of the history of falls.

The present study aims to evaluate and compare the functional balance of community-dwelling older adults with no history of falls, with one fall and with recurrent falls. Another aim is to verify how the BBS and TUGT functional scales behave in relation to the cutoff scores, proposed in the literature, for the history of falls of these older adults. It is important to be aware of the limitations of the scales to differentiate older adults on the basis of history of falls in order to use them appropriately for instability screening as well as for monitoring balance training and rehabilitation.

Methods

A descriptive cross-sectional study was carried out with prior approval from the Research Ethics Committee of the School of Medical Sciences of Universidade Estadual de Campinas (UNICAMP), protocol 766/2005.

Sampling

The sample was composed of community-dwelling older adults pre-selected from a database of a population study on aging carried out in the city of Amparo, SP, called "Prevention of falls and disabilities community-dwelling older adults (within the family health program)". The population study's database was consulted to select the subjects according to the inclusion and exclusion criteria. The sample included subjects aged 65 or above of both sexes and able to walk without walking aids. The exclusion criteria were: physical and sensorial limitations that might prevent the performance of the balance tests, such as inability to understand and answer simple verbal commands and/or inability to imitate movements; seriously impaired visual and hearing acuity that might prevent the performance of activities of daily living (ADLs); amputations; use of prostheses; neurological sequelae; Parkinson's disease and inability to walk independently.

The sample size was calculated on the basis of the central limit theorem which states that a sample size of at least 30 subjects will suffice for comparison with its original population (population study)[23]. The final sample was composed of 96 subjects, divided into three groups (n=32 each) according to the history of falls (without falls, one fall and recurrent falls). This division was accomplished after consulting the population study's database which contained

information about the number of falls per year of each individual. As there was a time interval between the assessments of the population study and the present study, it was necessary to make prior contacts over the phone to verify changes in the subjects' history of falls. This results in group changes in some of the cases.

The cases were selected by means of a homogenization filter according to sex (male and female) and age group (65-69, 70-74, 75-79 and 80 or more) to reduce the sample and homogenize the groups. The anthropometric data were evaluated to guarantee similarity between groups. Mass (kilograms-kg) and height (meters-m) were measured on a medical scale (Filizola®) to calculate the Body Mass Index (BMI). All subjects read the information letter and signed the consent form agreeing to take part in the study voluntarily.

Assessment instruments

All groups were submitted to the same research protocol composed of the functional balance evaluation tests, BBS[13,24] and TUGT[17]. These instruments were chosen due to their easy application, low cost and for being widely used in research and clinical practice[13-15,17,18,20-22]. The BBS was developed and validated by Berg et al[13] and later translated and cross-culturally adapted to Brazilian Portuguese, and it has high intra- and interobserver reliability (ICC 0.99 and 0.98 respectively)[24]. The scale consists of 14 common ADLs: sitting to standing, standing unsupported, sitting unsupported, standing to sitting, transfers, standing with closed eyes, standing with feet together, reaching forward with outstretched arm, retrieving object from floor, turning to look behind, turning 360 degrees, placing alternate foot on stool, standing with one foot in front, standing on one foot[13,24]. Each item of the scale has five choices with scores that vary from zero to four points, zero being the inability to perform the task and four being the ability to perform the task safely. The total score can vary from 0 to 56 points, and the highest score is interpreted as a better performance in the test[13].

The total score was used in the evaluation between groups according to history of falls. The instrument was also classified with three cutoff scores described in the literature to compare the ability of each cutoff score to differentiate fallers from non-fallers. The cutoff scores were: 45 points as proposed by Berg et al.[13], 47 points as proposed by Chiu, Au-Yeung and Lo[20] and 49 points as proposed by Shumway-Cook et al.[21]. Higher scores indicate normal balance, and equal or lower scores indicate a risk of falls.

TUGT was developed to assess balance, the risk of falls and the functional capacity of older adults. It consists of observation while the subject gets up from a chair, walks three meters in straight line, comes back to the chair and sits down. This course is timed in seconds, and the subject's performance is scored according to the time taken to completion[17]. The TUGT total time and the cutoff score proposed by Podsiadlo and Richardson[17] were used for comparison between groups. The authors advocate that a total time of up to 10 seconds is considered normal for healthy, independent adults without risk of falls; a total time between 11 and 20 seconds is expected for frail older adults or those with deficiencies, partial independence and low risk of falls; over 20 seconds indicates important physical mobility deficit and risk of falls.

The subjects were initially contacted by an independent researcher who had knowledge of the groups to which the older adults belonged. They were invited to the Basic Health Unit for the application of the evaluation protocol. The balance tests were carried out by a researcher who was blind to the information about the history of falls. The researcher received previous training on the application of the instruments. Both the BBS and the TUGT were performed only once by the participants after a practical demonstration given by the examiner.

Statistical analyses

Given the normal distribution of data, parametric tests were used for the statistical inference. For comparison between groups in relation to the categorical variables, the chi-square test was used (χ^2) in contingency table and, for the quantitative variables, analysis of variance (ANOVA) was used. When there was significant difference ($p<0.05$) between groups, the chi-square statistic from the table was partitioned, and the Tukey test for ANOVA was applied; both to identify the differences between pairs. The Pearson Correlation Coefficient (r) was applied to analyze the relationship between the BBS total score (quantitative variable) and the TUGT time (quantitative variable). The statistical tests were carried out through the software SPSS 10.0 for Windows (Statistical Package for Social Sciences, version 10.0, 1999), and the α level adopted was set at 5% ($\alpha=0.05$).

Results

The total sample consisted of 96 community-dwelling older adults distributed equally among the three groups

with 32 older adults each. Participants were distributed according to sex (50.0% male and 50.0% female) and age group (25% of cases for each age group). Due to the division by age group, there were no statistical differences in mean age (p=0.919) between group 1 (74.81±7.25 yrs old), group 2 (75.19±7.32 yrs old) and group 3 (74.47±6.39 yrs old). No statistical differences were found in BMI (p=0.972) between group 1 (27.38±5.02 Kg/m^2), group 2 (27.62±4.40 Kg/m^2) and group 3 (27.61±4.35 Kg/m^2).

In the functional balance evaluation through TUGT, the mean total time was 11.43±2.95 seconds for group 1, 14.57±4.23 seconds for group 2 and 14.48±4.46 seconds for group 3. The difference between means was significant between groups 1 and 2 (p=0.005) and between groups 1 and 3 (p=0.007), and it was possible to verify that older adults with a history of falls took more time to complete the test, as demonstrated in Figure 1.

In the balance evaluation by means of the BBS, the mean score for group 1 was 52.00±3.60 points, 49.97±4.60 points for group 2 and 48.91±4.55 points for group 3. The difference was statistically significant between groups 1 and 3 (p=0.013), i.e. older recurrent fallers showed balance decline compared to older non-fallers, as observed in Figure 2.

According to Table 1, the distribution of cutoff scores showed a statistically significant difference between groups 1 and 3 (p=0.044 and p=0.012 respectively) for the cutoff scores of 49 and 47 points. There was no statistical difference between groups for the cutoff score of 45 points. In accordance with the classification suggested for the TUGT, most of the older adults performed the test within 10.1 to 20 seconds, and a statistically significant difference was observed between groups 1 and 2 (p=0.007) and between groups 1 and 3 (p=0.001). There were no statistical differences between groups 2 and 3 in either scale.

The results also show that both instruments showed moderate, negative and significant correlation for all the evaluated groups with statistically significant differences (Table 2).

Discussion

Evaluating and comparing the functional balance of older adults according to the history of falls can be a difficult task, especially when taking into account the great variety of risk factors associated with the aging process which result in functional loss and, consequently, increased risk of falls. Thus, the present study gave equal importance to factors that could result in differences during the balance evaluation between groups, such as sex and age group. Studies point to the female sex and the increase in age as highly relevant risk factors for the occurrence of falls in older adults[25,26]. Although overweight, the groups did not differ in regard to BMI, another factor capable of interfering with balance tests. The sample was also standardized with respect to the occurrence of one fall (possible accidental falls) and recurrent falls (two or more), because the mechanisms and risk factors for the occurrence of those kinds of falls are different and could influence the results if they were grouped[27].

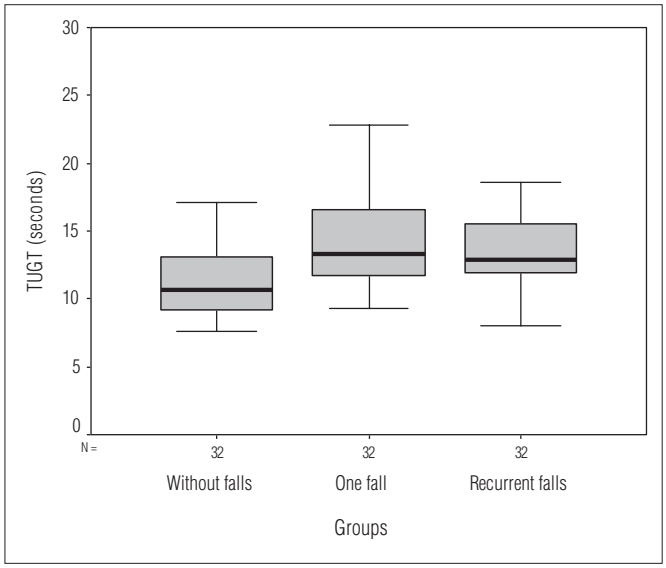

Figure 1. Difference in the time (seconds) taken to complete the Timed Up and Go Test (TUGT) according to the history of falls.

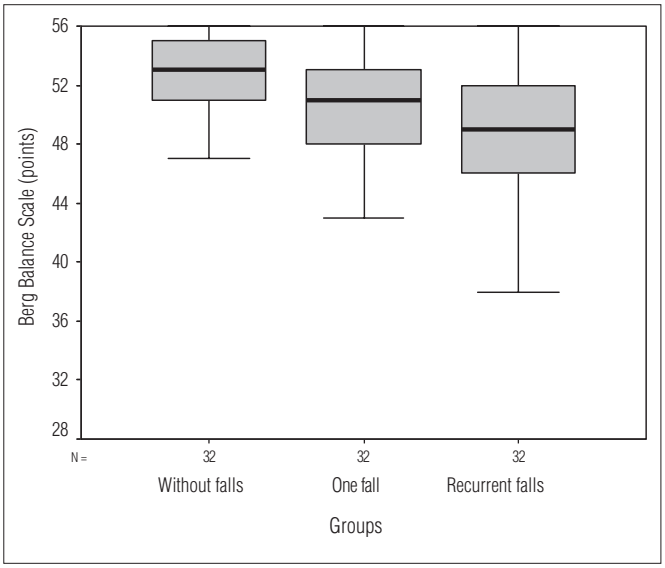

Figure 2. Difference between groups according to the Berg Balance Scale (BBS) score.

Table 1. Group comparison according to the Berg Balance Scale (BBS) and Timed Up and Go Test (TUGT) cutoff scores.

	Category	Frequency n (%)			Chi-Square p- value*
		Group 1	Group 2	Group 3	
BBS (Shumway-Cook et al.[21])	≤49 points (fall risk) >49 points (no fall risk)	6 (18.8) 26 (81.2)	11 (34.4) 21 (65.6)	18 (56.2) 14 (43.8)	0.007
BBS (Chiu et al.[20])	≤47 points (fall risk) >47 points (no fall risk)	4 (12.5) 28 (87.5)	8 (25.0) 24 (75.0)	14 (43.8) 18 (56.2)	0.018
BBS (Berg et al.[13])	≤45 points (fall risk) >45 points (no fall risk)	3 (9.4) 29 (90.6)	7 (21.9) 25 (78.1)	7 (21.9) 25 (78.1)	NS
TUGT (Posiadlo & Richardson[17])	≤10 seconds (no fall risk) 10.1 - 20 seconds (low fall risk) >20 seconds (fall risk)	14 (43.8) 18 (56.2) -	2 (6.2) 26 (81.1) 4 (12.5)	2 (6.2) 27 (84.4) 3 (9.4)	<0.001

α=0.05; Non-significant (NS).

Table 2. Relationship between Berg Balance Scale (BBS) and Timed Up and Go Test (TUGT) scores in the three groups.

Correlation	Groups	Pearson correlation r	p*
BBS-TUGT	Group 1	-0.686	<0.001
	Group 2	-0.828	<0.001
	Group 3	-0.780	<0.001

* α=0.05.

Regarding the functional balance evaluation, the non-faller group had the highest mean value in the BBS. Thus, there is a balance decline as falls occur and the BBS instrument was able to detect these differences in the postural control of the community-dwelling older adults. These data corroborate studies that show that older fallers score significantly lower when compared to older non-fallers[15,16,20,21]. Shumway-Cook et al.[21] verified that the community-dwelling older fallers performed poorly in the BBS evaluation, which indicates that older fallers have a balance decline.

With regard to the BBS mean score, the present study showed that this mean was higher in comparison with the one reported by Chiu, Au-Yeung and Lo[20], in which the BBS mean was 41.65 points for one-time fallers and 23.18 points for recurrent fallers. This can be explained by the differences between the samples. The sample of the abovementioned study consisted of older adults assisted by the fall clinic of a regional hospital, and it also included older adults who used walking aid, i.e. older adults with more functional impairment. Another difference is that the older adults classified as fallers had fallen in the previous six months (less time than in the present study), and the older recurrent fallers showed a prevalence of 3.8 falls, while, in the present study, the prevalence was of approximately two falls.

In studies with community-dwelling older adults, the BBS mean was 52.6 points for non-fallers[21], a value similar to the one observed in the present study. In contrast, the mean score for the fallers was 39.6 points, again a lower score than the one observed in the present study. This may be associated with the fact that, in the abovementioned study, the older adults were classified as fallers if they reported recurrent falls in the last six months, which shows that the use of a shorter time period for the occurrence of two or more falls adds to the sample older adults with greater functional balance impairment.

The studies by Lajoie, Girard and Guay[15] and Lajoie and Gallagher[16] also reported a lower score than the present study, however these two studies included older adults from the community and from institutions. This differentiates them from the present study because it is known that institutionalized older adults tend to have greater deficiencies. This shows that methodological aspects differ between studies in terms of the studied population, the use of walking aids and the period used for the report of falls. These factors are decisive in obtaining a higher or lower score in the BBS. However, all the studies indicate a poorer performance by individuals who had already fallen.

As concerns the TUGT, the older non-fallers completed the task in less time than the other groups, which shows that the fallers demonstrated higher mobility deficit. As in the present study, Günter et al.[28] found that older non-fallers were significantly faster in the execution of the TUGT when compared to the older one-time fallers or recurrent

fallers (p<0.01). Shumway-Cook et al.[18] applied the TUGT to community-dwelling older adults with no falls and with two or more falls in the six previous months, and the results suggested that older adults who completed the task in over 14 seconds had a high risk of falls. Chiu, Au-Yeung and Lo[20], comparing older one-time fallers to controls, found significant differences in test performance (p=0.025). Bischoff et al.[22] also set a cutoff value greater than 12 seconds for falls in healthy older adults. The results of the present study corroborate the abovementioned studies.

As for the BBS classification, three cutoff scores for risk of falls were verified in the literature: 49 points[21], 47 points[20] and 45 points[13]. A comparison of these cutoff scores between groups showed that only the 47 and 49 point scores had statistical differences between non-fallers and recurrent fallers, which demonstrates their capacity to differentiate those groups in terms of the history of falls. The one-time faller group did not have significant differences compared to the other two groups. For this group, the fall may have been accidental and consequently they may not have another episode or it may signal the imminence of a deficit in postural control, predisposing them to become recurrent fallers and, therefore, the prevention of a future fall is indispensable.

Berg et al.[13] defined the cutoff value as 45 points based on clinical experience, and the sample was composed of older adults from a nursing home who could use walking aids and of older adults who had suffered a stroke. In the present study, the sample was composed of healthy older adults, which could explain why a lower cutoff value did not show statistical differences between groups. Chiu, Au-Yeung and Lo[20] verified that the cutoff score of 47 points had 88.2% sensibility and 76.5% specificity to discriminate between non-fallers and one-time fallers, unlike the result of the present study, in which that cutoff score only showed statistical differences between the non-fallers and the recurrent fallers. Again, the difference between the samples may explain the present result. It is worth noting that older adults monitored by a hospital and who use walking aids are noticeably different from community-dwelling older adults. In contrast, the cutoff score of 49 points used in the study by Shumway-Cook et al.[21] and the present study showed significant differences between non-fallers and recurrent fallers, and both studies had similar samples.

Thus, it can be stated that different cutoff scores should be used to determine the risk of falls in community-dwelling older adults, in institutionalized older adults, in those who use walking aids and in those with neurological disease because these aspects have a direct influence on test performance. The objective of the present study was not to determine the best cutoff score for community-dwelling older adults. The objective was to discuss the need to define different cutoff scores for different populations, which makes the instrument more sensitive.

The TUGT, as a categorical variable, was used in the present study following the classification proposed by Posiadlo and Richardson[17]. There were significant differences between groups 1 and 2 and between groups 1 and 3, which show that older non-fallers completed the task in less time, as already confirmed by the continuous variable of this instrument. Nevertheless, the classification adopted by the abovementioned authors did not apply to the older adults of the present study. The authors evaluated frail older adults, and the task performance time varied between 10 and 240 seconds, which shows that the subjects were more debilitated, while in the present study even the fallers completed the test in 7 to 28 seconds. According to the classification by Posiadlo and Richardson[17], only those who performed the task in more than 20 seconds were considered to be at risk of falls; however, in the present study, more than 80% of one-time fallers and recurrent fallers completed the test in less than 20 seconds. These data suggest the need for another type of classification to make the instrument more sensitive to the risk of falls in community-dwelling older adults.

However, with the TUGT mean, it was possible to differentiate between older non-fallers and one-time fallers, unlike the result observed in the evaluation through the BBS. The TUGT is an objective test because task performance times are measured, which makes it a more sensitive instrument. In contrast, the BBS uses the examiner's observation to analyze the task performance.

Regarding the cutoff scores, neither test found significant statistical differences between groups 2 and 3. This occurred because the cutoff scores seek to distinguish non-fallers from fallers and not occasional fallers from recurrent fallers. It would be useful to differentiate these two groups because they have different characteristics with regard to balance deficit that need individual treatment in clinical practice.

The correlation between the BBS and the TUGT was significant in the three groups. It was a moderate negative correlation, meaning that the older adults with higher scores in the BBS had lower TUGT times. This indicates that the better the ability to maintain body balance, the better the performance in functional tasks, which corroborates the literature[2,17,24,29].

These present study introduces relevant information on the difference between the functional balance of older adults in terms of the history of falls. The use of cutoff scores for the balance tests should be used with caution and always considering the individual characteristics of the evaluated older adult. The total scores allow greater clinical judgment on the part of the therapists because they classify any score below the maximum score as a change in normal balance and, therefore, likely to require fall prevention and postural control intervention.

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