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Factors associated with body balance of long living elders

Fatores associados ao equilíbrio postural de idosos longevos

Factores asociados con el equilibrio postural de ancianos longevos

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Abstract

Introduction: It is estimated that the elderly life is related to disturbances of balance, freedom in activities and social isolation. **Objective:** Measures to balance the body in the long-lived elderly. **Method:** An analytical cross-sectional study was performed on patients aged 80 and over, male and female. Patients underwent clinical assessment and physical-medical tests: Berg Balance Scale (BBS), Dynamic Gait Index (DGI), Timed Up and Go (TUG) test and sit to stand test. Descriptive analyses singles with the testing of Mann-Whitney and Kruskal-Wallis, consecutively by the Dunn test and Spearman's alpha coefficient < 0.05. **Results:** There was a significant association between BBS and the following variables: fear of falling ($p = 0.029$), use of walking aid ($p = 0.001$), physical activity ($p < 0.001$), stroke episode ($p = 0.007$), musculoskeletal diseases ($p = 0.027$) and pain ($p = 0.045$). Significant correlations are variables between the BBS scores and the quantitative variables such as age ($\rho = -0.316$, $p < 0.001$), number of diseases ($\rho = -0.26663$, $p = 0.0062$), number of falls ($\rho = -0,214$, $p = 0,0279$), DGI ($\rho = 0,713$, $p < 0,0001$), sit to stand test ($\rho = -0.418$, $p < 0.001$), and TUG ($\rho = -0.658$, $p < 0.05$). The results were statistically significant ($p < 0.01$) 0.001). **Conclusion:** Body balance in the elderly gets more compromised with age, higher number of diseases, more falls, worse

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gait performance, decreased strength in the lower limb and mobility, stroke and musculoskeletal disorders, presence of complaints, use of marching support, fear of falling and not doing physical activity.

Keywords: Elders. Elders Aged 80 Years or More. Postural Balance.

Resumo

Introdução: *Estima-se que a população idosa está associada a distúrbios do equilíbrio, limitação nas atividades e isolamento social.* ***Objetivo:*** *Avaliar o equilíbrio corporal de idosos longevos.* ***Método:*** *Estudo transversal, analítico, em idosos com idade igual ou superior a 80 anos, dos sexos masculino e feminino, avaliados clinicamente e através dos testes: Escala de Equilíbrio de Berg (EEB), Dynamic Gait Index (DGI), teste Timed Up and Go (TUG) e Teste de Sentar-Levantar. Análises descritivas simples e os testes de Mann-Whitney and Kruskal-Wallis, pós teste de Dunn e coeficiente de alpha de Spearman < 0,05.* ***Resultados:*** *Houve associação significante entre BBS e as variáveis: medo de cair (p = 0,029), uso de dispositivo de auxílio à marcha (p = 0,001), atividade física (p < 0,001), episódio de AVC (p = 0,007), doenças musculoesqueléticas (p = 0,027) e dor (p = 0,045). Houve correlação significativa entre EEB e as variáveis, como idade (ρ = - 0,316, p < 0,001), número de doenças (ρ = -0,26663, p = 0,0062), número de quedas (ρ = -0,214, p = 0,0279), DGI (ρ = 0,713, p < 0,0001), Teste de Sentar-Levantar (ρ = -0,418, p < 0,001) e TUG (ρ = -0,658, p < 0,001).* ***Conclusão:*** *O equilíbrio corporal em idosos fica mais comprometido com a idade, maior número de doenças, mais quedas, pior desempenho da marcha, diminuição na força de membros inferiores e mobilidade, presença de AVC e as doenças do sistema musculoesquelético, queixa de dor, uso de dispositivo de auxílio à marcha, medo de cair e não realização de atividade física.*

Palavras-chave*: Idoso. Idoso com 80 Anos ou Mais. Equilíbrio Postural.*

Resumen

Introducción: *Se estima que la población anciana está vinculada a alteraciones del equilibrio, limitaciones en las actividades y aislamiento social.* ***Objetivo:*** *Evaluar el equilibrio corporal de ancianos longevos.* ***Método:*** *Se realizó un estudio analítico en pacientes de 80 años o más, hombres y mujeres, que se sometieron a una evaluación clínica por medio de las pruebas: Escala de equilibrio de Berg (BBS), Dynamic Gait Index (DGI), Timed Up and Go (TUG) test y la prueba de sentarse y levantar. Los análisis descriptivos individuales y la prueba de Mann-Whitney y Kruskal-Wallis, tras la prueba de Dunn y el coeficiente alfa de Spearman < 0,05.* ***Resultados:*** *Hubo una asociación significativa entre BBS y las siguientes variables: miedo a caerse (p = 0,029), uso de mecanismo de apoyo para la marcha (p = 0,001), actividad física (p < 0,001), episodio de accidente cerebrovascular (p = 0,007), enfermedades musculoesqueléticas (p = 0,027) y dolor (p = 0,045). Hubo correlaciones significativas entre BBS y las variables: edad (ρ = -0,316, p < 0,001), el número de enfermedades (ρ = -0,26663, p = 0,0062), el número de caídas (ρ = -0,214, p = 0,0279), DGI (ρ = 0,713, p < 0,0001), la prueba de sentarse y levantar (ρ = -0,418, p < 0,001), y TUG (ρ = -0,658, p < 0,001).* ***Conclusión:*** *El equilibrio corporal en los ancianos está más comprometido con la edad, mayor número de enfermedades, más caídas, peor rendimiento de la marcha, reducción de la fuerza de las extremidades inferiores y movilidad, presencia de accidentes cerebrovasculares y de trastornos musculoesqueléticos, quejas de dolor, uso de mecanismo de apoyo para la marcha, temor a caerse y no hacer actividad física.*

Palabras clave*: Ancianos. Ancianos con 80 Años o Más. Equilibrio Postural.*

Introduction

There is a significant increase in the number of long living elders (aged 80 years or more). It is estimated that this population is at a higher frequency of chronic degenerative diseases associated with aging and may be accompanied by balance disorders, limitations in functional activities and social isolation [1]. It is important to note that the amount of long living elders living alone is high, especially among women, this is mainly due to widow situations and marriage of their children [2].

Falls are a common problem among the elderly. This event tends to increase with age, because about 40% of older adults aged 80 years or more fell in a 1 year period [3]. Seniors aged 75 and 85 years, with limitations in daily life activities are 14 times more likely to fall than independent elders of the same age [4].

In the pertinent scientific literature, there are already studies well delineated with the elderly population, but a large part of these studies consider as population elderly up to 75 years. Knowing that elderly people with 80 years or more present peculiarities, it is of extreme importance to investigate and characterize the profile of the body balance of these elderly, providing specific information not yet so elucidated in the literature, allowing a more comprehensive look that will increase the functional evaluation, and will provide support for the development of specific strategies for diagnosis, prevention and early rehabilitation, with the main objective of stimulating the autonomy and independence of the elderly.

This study aimed to evaluate the factors associated with body balance in long living elders, volunteers from the community and that are part of a follow-up clinic/ management in the city of São Paulo.

Method

This is an observational cross-sectional study, approved by the Research Ethics Committee from the Federal University of São Paulo (Unifesp), protocol number 1968/11.

The sample consisted of elderly people of both genders, from the Clinic of long living elders for the courses of Geriatrics and Gerontology, at Unifesp, with 80 years of age or more. The elderly participants of the clinic were invited using media outlets and their inclusion in the clinic is not associated with the presence of clinical conditions that necessarily require medical attention. All of the participants and / or their designated responsible person read and signed the consent form. The elderly with physical and sensory limitations that prevented the achievement of body balance tests, as well as the elderly who had undergone some form of body balance rehabilitation in the last six months prior to the assessment were excluded from the study (Figure 1).

The variables analyzed were classified as demographic data, clinical and functional and body balance.

The instruments used for body balance, gait, mobility, lower limb strength and functionality were respectively Berg Balance Scale (BBS) [5], Timed Up and Go (TUG) test [6], Dynamic Gait Index (DGI) [7] and sitting and standing [8, 9] Test.

The BBS evaluates the postural balance in 14 functional tasks, namely: sitting to standing, standing unsupported, sitting unsupported, standing to sitting, transfers, standing with eyes closed, 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 and standing on one foot. Each item is scored along a 5-point scale, ranging from 0 to 4. The total score ranges from 0 to 56. The higher the score, the better the postural balance.

The TUG test consists of measuring the time taken to rise from a chair (from a sitting position with back support), walk 3 meters to a mark on the floor, turn around and walk back along the same course, and sit down again on the chair with back support.

Dynamic Gait Index (DGI) consists of eight walking tasks: speed and gait instability performed by the individual at their normal speed, acceleration/ deceleration, movement of cephalic rotation, movement of cephalic flexion-extension, axial body rotation movement, obstacle overtaking (shoe box), circling obstacle (traffic cones) and up and down stairs. The score is based on concepts of absent (three-point), minimum (two-point), moderate (one point) or marked (zero). The scores of the eight items are summed in a total score ranging from 0 to 24 points, the highest score being related to better performance.

During the sit and lift test, the participant should stand with his arms crossed in the chest and be able to position the support base as needed to maintain

balance. At the "start" signal the participant must rise to the maximum extent (vertical position) and return to the initial seated position. This is recommended to complete the maximum number of replicates in a time interval of 30". The result will be determined by counting the number of times the participant correctly performed sitting and lifting movements.

To calculate the sample size for this study the mean score of the BBS study was used [9]. We observed the lowest correlation coefficient between this score and some variables near 0.28. Assuming that in this study we would find equal or greater values to apply to tests of significance of 5% and 80% power need of at least 99 cases for analysis.

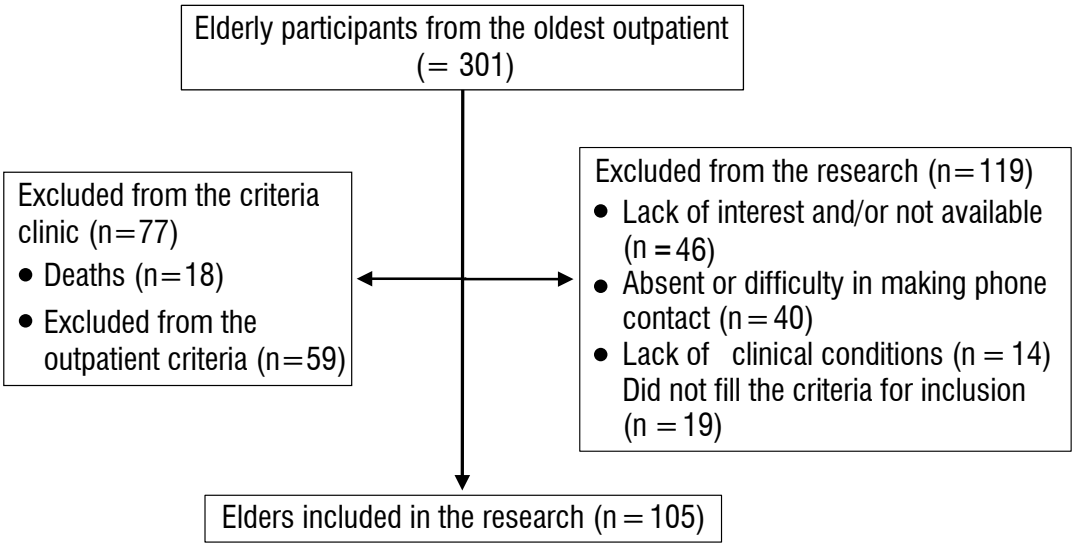

Figure 1 – Flowchart of the samples of the oldest outpatients in the Department of Geriatrics and Gerontology, Unifesp, São Paulo, Brazil.

Inferential analysis showed associations between total BBS score and the qualitative independent variables using the Mann-Whitney and Kruskall-Wallis tests. When there was a significant difference, Dunn's test was applied to identify inter-category differences. Correlations between total BBS score and the quantitative independent variables were assessed, using Spearman's correlation (ρ). A 5% significance level was adopted for all statistical analyses ($p < 0.05$).

Results

The sample consisted of 105 long living elders, in the care of the clinic, with a mean age of 86.03 ± 4.5. The sample characterization is shown in Table 1.

Table 1 – The sample characterization is shown (São Paulo, Brazil)

Variables	Categories	N	%
Gender	Female	71.0	67.6
	Male	34.0	32.4
Race	White	72.0	69.2
	Black	7.0	6.7
	Brown	15.0	14.4
	Indigenous	1.0	1.0
	Other	9.0	8.7

(To be continued)

(Conclusion)

Variables	Categories	N	%
Education	Illiterate	27.0	25.7
	1-4 years	47.0	44.8
	5 years	11.0	10.5
	8 years or more	2.0	19.0
Marital Status	with marital life	34.0	32.7
	without marital life	70.0	67.3
Housing condition	Alone	29.0	27.9
	1 generation	35.0	33.7
	2 or 3 generations	25.0	24.0
	Other	12.0	11.5

The average number of diseases per individual was 4.24 ± 1.88. Among the most frequently reported diseases are hypertension (84.47%), dyslipidemia (63.11%), osteoarthritis (52.00%) and osteoporosis (39.81%).

In regards to the subjective health assessment, 59.04% of seniors rated it as "good or excellent". The self-assessment of visual acuity and hearing of the long living elders was classified as "fair or poor" by 58.25% and 36.19%, respectively. The average number of medications use by the elders was 5.68 ± 2.9.

Twenty percent of the sample batch used walking aids and the practice of physical exercise was reported by 39.05% of the seniors. Falls in the last year and the fear of falling were reported by 40.00% and 63.46% of participants, respectively. The ratings for body balance, according to the risk of falling by BBS at TUG, as well as body balance during gait by DGI are presented in Table 2.

In the assessment of muscle strength in the lower limbs, the elderly had an average of 16:02 ± 5:59, the individual with the best performance performed the test in 6.75 seconds, and the worst performed in 43.39 seconds.

Table 2 – Absolute and relative Frequencies of the categories BBS Balance Scale, Dynamic Gait Index and Timed Up and Go test of long living elders (São Paulo, Brazil)

	Categories	(n)	(%)	Aver	SD	Variation
BBS	0 a 45 points**	16	15.24	50.20	5.22	35.00-56.00
	46 a 56 points*	89	84.76			
DGI	0 a 19 points**	79	75.24	16.61	5.59	6.00-24.00
	20 a 24 points*	26	24.76			
TUG	Up to 13.5 seconds*	61	58.09	14.29	6.93	5.50-51.60
	Above 3.5 seconds**	44	41.91			

Note: *no risk for falling; **risk for falling.

Comparative analysis

The variable body balance (BBS) showed negative and significant correlation with age (ρ = -0.31687, $p < 0.001$), number of diseases (ρ = -0.26663, $p = 0.0062$), number of falls (ρ = -0.21461, $p = 0.0279$), sit to stand test (ρ = -0.41845, $p < 0.001$) and TUG (ρ = -0.65826, $p < 0.001$) tests although BBS variable had positive and significant DGI correlation (ρ = 0.71384, $p < 0.0001$), as shown on Table 3.

Qualitative variables related to comorbidities, the elderly group showed that concomitant osteoarthritis and osteoporosis ($p = 0.027$), as well as seniors who have had an episode of stroke ($p = 0.007$) obtained a value of BBS significantly lower than the group that did not present the same issues. The complaint of pain was also associated to a BBS performance ($p = 0.045$).

The group of seniors who reported fear of falling, and used DAM showed poorer performance on body balance ($p = 0.029$ and $p = 0.001$), respectively. The physical activity was positively and significantly associated with the BBS ($p < 0.001$).

Table 3 – Comparative analysis between body balance and quantitative variables for long living elders (São Paulo, Brazil)

	Variables	Spearman correlation r-value	Significance p-value
Body balance	Age (n = 105)	-0.31687	0.0010
	Number of illnesses (n = 104)	-0.26663	0.0062
	Number of falls (n = 105)	-0.21461	0.0279
	DGI (n = 105)	0.71384	< 0.0001
	Sit to stand test (n = 105)	-0.41845	< 0.0001
	TUG (n = 105)	-0.65826	< 0.0001
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Discussion

There are few studies focused on the "long-living" population and in Brazil a study to evaluate these associations was not found. However, the findings go against the literature, reinforcing the impact of age and aging on physiological alterations of body balance in the elderly. It is noteworthy that even with performance within the limits previously established for the risk of falling, the instruments when evaluated in isolation, may not demonstrate the pre-existing risks, reinforcing the need for a comprehensive review, covering the different components of body balance and other factors that may interfere with this system and especially in the functionality of the elderly person.

In the present study, we observed a significant correlation between BBS and age, corroborated by previous studies' [10, 11] results. This relationship can be justified by the involvement of body systems involved in balance and that may be under the influence of the physiological changes of aging, with gradual loss of functional performance tests over time [12].

BBS score showed a negative and significant correlation with the number of diseases, corroborating other studies that highlight clinical conditions that interfere with the ability to maintain body balance and predisposition for falling [12, 13].

Patients who have osteoarthritis, osteoporosis and a previous stroke and pain present faults on body balance, muscle weakness, change in range of motion, decrease in walking speed among others, can also cause difficulties in functional activities and increased risk of falling [12, 14-16].

Studies have shown that older adults with a history of falls tend to impair the answers when compared to disturbances of body balance, which reinforces the association between BBS and the number of falls [2, 17]. Fear of falling is one of the consequences for those who have already fallen or have had balance and mobility disorders [18]. In the current study an association with the fear of falling was found. The relationship between the use of walking support and the risk of falling is not very well understood. Several studies have reported that the use of walking support device is a high risk potential predictor of falls in the elderly, while others suggest that the use is simply a commitment indicator of body balance, functional decline and/or risk of falling [19, 20]. Associations similar to the current findings were found, and those aged 80 years or more had a higher frequency of falls and these were associated with the use of a walking support device [21].

An association was found between the use of walking support device and the score on the BBS. Similar to current findings associations were found, and the elderly aged 80 or more had a higher frequency of falls than those associated with the use of walking support device [20].

Physical activity appears to exert benefits on the fall event. Studies have shown that both isolated interventions, as combined, are able to prevent the risk of falling. These findings reinforce those found in the present study, in which elderly subjects who practiced physical activity performed better on the BBS, highlighting the need for encouraging physical activity in the elderly, especially long living elders [21].

In the Gait assessment by DGI, this instrument was positively and significantly correlated with the BBS. Importantly, most studies using the DGI have a specific medical condition, for example, a vestibular disorder previously diagnosed, making it difficult to compare these studies [22, 23]. With aging, there is a decrease in gait velocity, and this change may be more relevant in the elderly 80 years or more [24].

As expected, there was a negative and significant correlation between performance on the BBS and worsening performance on the TUG test, similar and divergent results were found [18, 25].

These data reinforce the performance of this population, both in the evaluation of more static functional tasks such as those performed in BBS, as in most activities related to dynamic stability during gait assessed by the DGI and TUG. The reviews showed that approximately two thirds of the study population was within the standards for risk for falling. Despite the commitment equilibrium being just one of the risk factors, evidence clearly suggests that the risk can be reduced through early identification and treatment, preventing or reversing the adverse consequences [26].

Studies report that older adults with disorders of body balance have difficulties in performing transitional movements, such as sitting and standing [27] The performance of the elderly in the chair stand test showed an average of 16.57. It was difficult to find in the literature, studies using this test alone to evaluate the strength of the lower limbs in this population. This instrument is part of the performance of lower limbs Short Physical Performance Battery (SPPB) test, therefore this value lies within the score "two" on the SPPB instrument (13.70 to 16.69 seconds). A study to

assess the physical capacity and decreases in active and sedentary older adults found between sedentary participants a frequency of 33% in this range [28].

Different than expected, the average total BBS score was high for a sample of the seniors, although the overall evaluation of all the instruments used, the seniors were within the parameters to be considered at risk for falling. As expected, there was a negative and significant correlation between performance in the BBS and worsening in TUG, similar and divergent results were found [19, 26]. These values differ from studies that had an average age above 80 years [29].

We emphasize the importance of studies with longitudinal follow-up of the seniors, subject to various assessments and therapeutic interventions, so that it can provide the means for a more efficient evaluation, avoid scaling of functional limitations, tone down or delay progressive degenerative processes and improve the quality of life of these patients.

Conclusions

The body balance in seniors is more committed to advancing age, greater number of diseases, higher number of falls, worse gait performance, decrease in lower limb strength and mobility, presence of prior stroke and diseases of the musculoskeletal system, presence of pain complaints, use of walking support device, fear of falling and not doing physical activity.

References

1. Lourenço TM, Lenardt MH, Kletemberg DF, Seima MD, Tallmann AEC, Neu DKM. Capacidade funcional no idoso longevo: uma revisão integrativa. Rev Gaúcha Enferm. 2012;33(2):176-85.

2. Lebrão ML, Duarte YAO. The SABE Project in the city of São Paulo: an initial approach. Brasília, DF: Organização Pan-Americana da Saúde; 2003 [cited 2014 May 1]. Available from: https://bit.ly/2lQcjDA

3. Batchelor FA, Williams SB, Dow B et al. Subjective and objective sleep measures in older people with a history of falls. J Sleep Disord Treat Care. 2014;3(1):1-5.

4. Silva A, Almeida GJM, Cassilhas RC, Cohen, M, Peccin, MS, Tufik, S, et al. Equilíbrio, coordenação e agilidade de idosos submetidos à prática de exercícios físicos resistidos. Rev Bras Med Esporte. 2008;14(2):88-93.

5. Miyamoto ST, Lombardi I Jr, Berg KO. Brazilian version of the Berg balance scale. Braz J Med Biol Res. 2004;37(9):1411-21.

6. Nordin E, Lindelo N, Rosendahl E, Jensen J, Lundin-Olsson L. Prognostic validity of the Timed Up-and-Go test, a modified Get-Up-and-Go test, staff's global judgement and fall history in evaluating fall risk in residential care facilities. Age Ageing. 2008(4);37:442-8.

7. Castro SM, Perracini MR, Ganança FF. Dynamic Gait Index – Brazilian version. Rev Bras Otorrinolaringol. 2006;72(6):817-25.

8. Marzilli TS, Schuler PB, Willhoit KF. Effect of a community-based strength and flexibility program on performance-based measures of physical fitness in older African-American adults. Calif J Health Promot. 2004;2(3):92-8.

9. Shubert TE, Schrodt LA, Mercer VS. Are scores on balance screening tests associated with mobility in older adults? J Geriatr Phys Ther. 2006;29(1):33-9.

10. Brito TA, Fernandes MH, Coqueiro RS, Jesus, CS. Falls and functional capacity in elderly people living in the community. Texto & Contexto Enferm. 2013;22(1):43-51.

11. Pereira VV, Maia RA, Silva SMCA. The functional assessment Berg Balance Scale is better capable of estimating fall risk in the elderly than the posturographic Balance Stability System. Arq Neuropsiquiatr. 2013;71(1):5-10.

12. Moreno-Martíneza NR, Ruiz-Hidalgob D, Burdoy-Joaquima E. Incidencia y factores explicativos de las caídas en ancianos que viven en la comunidad. Rev Esp Geriatr Gerontol. 2005;40(Supl 1):11-7.

13. Zambaldi PA, Costa TAB, Diniz GCLM. Efeito de um treinamento de equilíbrio em um grupo de mulheres idosas da comunidade: estudo piloto de uma abordagem específica, não sistematizada e breve. Acta Fisiatr. 2007;14(1):17-24.

14. Hsu WL, Chen CY, Tsauo JY, Yang RS. Balance control in elderly people with osteoporosis. J Formos Med Assoc. 2014;113(6):334-9.

15. Duffell LD, Southgate DFL, Gulati V, McGregor AH. Balance and gait adaptations in patients with early knee osteoarthritis. Gait Posture. 2014;39(4):1057-61.

16. Cho K, Lee K, Lee B, Lee H, Lee W. Relationship between postural sway and dynamic balance in stroke patients. J Phys Ther Sci. 2014;26(12):1989-92.

17. Pua YH, Clark RA, Ong PH, Bryant AL, Lo NN, Liang Z. Association between seated postural control and gait speed in knee osteoarthritis. Gait Posture. 2013;37(3):413-8.

18. 18. Ferrer A, Formiga F, Sanz H, Vries OJ, Badia T, Pujol, R. Multifactorial assessment and targeted intervention to reduce falls among the oldest-old: a randomized controlled trial. Clin Inter Aging. 2014;9:383-94.

19. Bateni H, Maki BE. Assistive devices for balance and mobility: benefits, demands, and adverse consequences. Arch Phys Med Rehabil. 2005;86:134-45.

20. Cruz DT, Ribeiro LC, Vieira MT, Teixeira MT, Bastos RR, Leite IC. Prevalence of falls and associated factors in the elderly. Rev Saude Publica. 2012;46(1):138-46.

21. Buckinx F, Beaudart C, Maquet D, Demonceau M, Crielaard JM, Reginster JY, et al. Evaluation of the impact of 6-month training by whole body vibration on the risk of falls among nursing home residents, observed over a 12-month period: a single blind, randomized controlled trial. Aging Clin Exp Res. 2014;26(4):369-76.

22. Funabashi M, Santos-Pontelli TEG, Colafemina JF, Grossi DB. Proposta de avaliação fisioterapêutica para pacientes com distúrbio do equilíbrio postural. Fisioter Mov. 2009;22(4):509-17.

23. Walker ML, Austin AG, Banke GM, Foxx SR, Gaetano L, Gardner LA, et al. Reference group data for the functional gait assessment. Phys Ther. 2007;87(11):1468-77.

24. Garcia PA, Dias JMD, Dias RC. A study of the relationship between muscle function, functional mobility and level of physical activity in community-dwelling elderly. Rev Bras Fisioter. 2011;15(1):15-22.

25. Karuka AH, Silva JAMG, Navega MT. Analysis of agreement between instruments for assessing body balance in the elderly. Rev Bras Fisioter. 2011;15(6):460-6.

26. Muir SW, Berg K, Chesworth B. Use of the Berg Balance Scale for predicting multiple falls in community-dwelling elderly people: a prospective study. Phys Ther. 2008;88(4):449-59.

27. Whitney SL, Wrisley DM, Marchetti GF, Gee MA, Redfern MS, Furman JM. Clinical measurement of sit-to-stand performance in people with balance disorders: validity of data for the five-times-sit-to-stand test. Phys Ther. 2005;85(10):1034-45.

28. Silva TO, Rúbia SF, Monteiro MR, Borges SM. Avaliação da capacidade física e quedas em idosos ativos e sedentários da comunidade. Rev Soc Bras Clin Med. 2010;8(5):392-8.

29. Downs S, Marquez J, Chiarelli P. Normative scores on the Berg Balance Scale decline after age 70 years in healthy community-dwelling people: a systematic review. J Physiother. 2014;60(2):85-9.

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