

Effects of a Physical Activity Program on Static Balance and Functional Autonomy in Elderly Women

Fernanda Daniel¹, Rodrigo Vale², Tânia Giani³, Sílvia Bacellar⁴, Estélio Dantas⁵

¹Castelo Branco University (UCB), Laboratory of Human Motricity Biosciences (LABIMH), Rio de Janeiro, Brazil; ²Castelo Branco University (UCB), Laboratory of Human Motricity Biosciences (LABIMH), Rio de Janeiro, Brazil; ³Estácio de Sá University (UNESA), Rio de Janeiro, Brazil; ⁴National Institute of Cancer (INCA), Rio de Janeiro, Brazil; ⁵Castelo Branco University (UCB), Laboratory of Human Motricity Biosciences (LABIMH), Rio de Janeiro, Brazil

Abstract

Citation: Daniel F, Vale R, Giani T, Bacellar S, Dantas E. Effects of Physical Activity Program on Static Balances and Functional Autonomy in Elderly Women. *Maced J Med Sci*. 2010; 3(1):XXX-XXX. doi:10.3889/MJMS.1857-5773.2010.0083.

Keywords: Balance; activities of daily living; elderly; postural stability.

Correspondence: Fernanda de Noronha Ribeiro Daniel. Av. Marechal Castelo Branco, 611/701 Teresina-PI - Brazil. CEP: 64000-810. Phone: +(55) 86-3223-5702/86-9982-4980
E-mail: fernanda@fermandadaniel.com.br

Received: 31-Oct-2009; Revised: 22-Dec-2009; Accepted: 05-Jan-2010; Online first: 18-Jan-2010

Copyright: © 2010 Daniel et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Competing Interests: The authors have declared that no competing interests exist.

Aim: The aim of study was to assess the effects of a physical activity program on static balance and functional autonomy in elderly women.

Materials and Methods: The sample was randomly divided into an experimental group (EG), submitted physical activity program, and a control (CG). Mean postural amplitude oscillations were measured in displacement from the center of pressure (COP), left lateral (LLD), right lateral (RLD), anterior (AD) posterior (PD) and elliptical (EA) areas by an electronic baropodometer. Functional autonomy was composed of: walking 10 m (10MW), rising from a sitting position (RSP), rising from a ventral decubitus position (RVDP), rising from a chair and moving about the house (RCMH) and putting on and removing a t-shirt (PRTS).

Results: Two-way ANOVA showed that amplitude oscillation of COP in RLD, AD, PD and EA of the EG was significantly lower ($p < 0.05$) than the oscillation obtained by the CG in the post-test. The RSP, RCMH, 10MW and RVDP tests showed that execution times in the RSP, RCMH, 10MW and RVDP tests of the EG were significantly lower ($p < 0.05$) than the times executed by the CG in the post-test.

Conclusion: These results show that the elderly in the EG improved balance and performance in the activities of daily living.

Introduction

The elderly individuals have shown a decrease of the neuromuscular function, accompanied by loss of muscle mass and reduced strength, endurance and articular mobility [1,2]. These factors may cause limited coordination and control over static and dynamic body balance [3,4].

Postural control decreases with age and deterioration occurs in various systems. This may generate gait abnormalities and postural instability [5,6]. Postural

imbalance may affect the functional capacity to execute activities of daily living (ADL), leading to falls and restricted movements [7,8]. Falls may be a consequence of imbalance and locomotion difficulties, followed by fractures, accounting for 70% of accidental deaths in individuals 75 years of age or older [9].

Postural control results from the integration of sensory information (visual, vestibular and somatosensory), active and passive properties of the skeletal muscle system and a portion of the nervous system [10]. This

integration enables individuals to preserve their postural system in balance [11,13]. Balance is the ability to maintain the center of body mass over a base of support, shifting body weight swiftly and precisely in different directions within this support base. This allows the individual to move safely and quickly in a coordinated fashion, and to adjust to external disturbances [13,15]. Thus, for body balance control to occur, a number of body systems must be integrated under a central command, since the performance of these systems reflects directly on performance in ADL [4,16,17].

Balance analysis with a force platform is an objective and reproducible method that can be used in individuals of either sex and regardless of weight or height [18]. The aim is to obtain different values related to stability and postural systems, such as parameters characterizing the behavior of standing. In addition, use of force platforms is the method applied to evaluate the interaction between the foot and the support surface in baropodometry [19] because measurement of the pressure of the sole of the foot on the ground provides an indication of the function of the ankle and foot in the orthostatic posture or during other functional activities as the performance in ADL [20].

It has been shown that physical activity produces increased range of motion, strength muscle and functional autonomy levels [2,3,6,16]. In addition, other studies analyzed the effects of physical exercise on balance [1,13,17,21]. However, few studies had assessed the effects of physical activities on balance and functional autonomy in elderly by force platform and battery of ADL tests.

Improved balance in elderly women, through participation in a physical activity program, seems to be important for maintaining good performance in ADL and decreasing the chances of physical dependence. Accordingly, the aim of the present study was to evaluate the effects of a physical activity program on static balance and functional autonomy in the performance of ADL in the elderly.

Materials and Methods

Sample

A total of 297 elderly women, aged 60 years or older, retired or not, from any socioeconomic class, and enrolled in the Family Health Program in the Piçarreira I district of Teresina, Brazil were invited to take part in the study. Inclusion criteria were: individuals functionally

independent in their ADL, considered capable, according to medical assessment, of participating in the intervention and test protocols, and having abstained from systematized physical activity for at least six months.

The following exclusion criteria were adopted: subjects with neurological disorders, vestibular disorders, and movement disorders related to cognitive impairment; or those who used drugs that could compromise balance, postural stability and functional autonomy.

After these criteria were applied, 49 women were randomly subdivided into an experimental group (EG), submitted to a physical activity program, and a control group (CG) (Table 1). To form the EG, it was realized a random numeric draw until complete the number of offered place according to the size of exercise classroom (maximum of 30 individuals) [22].

Table 1: Anthropometric characteristics of the sample.

	EG (n=30)		p-value (SW)	CG (n=19)		p-value (SW)
	Mean	SD		Mean	SD	
Age	66.46	4.35	0.052	64.58	3.40	0.057
Height (m)	1.51	0.07	0.349	1.55	0.05	0.395
Body mass (kg)	62.79	13.81	0.497	65.63	9.54	0.698
BMI	26.70	4.08	0.083	27.33	4.38	0.557

SD = standard deviation; BMI = body mass index; p-value (SW) = Shapiro-Wilk's test for normality.

The subjects signed a free and informed consent form according to Resolution 196/96 of the National Health Council and Declaration of Helsinki [23]. The study was approved by the Human Research Ethics Committee of the Universidade Estadual do Piauí-UESPI, Faculty of Medical Sciences - FACIME under protocol number 89/08.

Data collection procedure

Balance assessment

To assess static balance, we used an AM³ Foot Work Pro (Italy) electronic baropodometer with 4096 sensors, polycarbonate coated, measuring 645x520x25 mm, frequency of 200 Hz, in a quiet environment at a temperature between 23 and 25°C, always in the morning. Initially, the subjects remained seated for five minutes. Next, they were placed barefoot on the platform in the orthostatic position with bipedal support, arms alongside the body, calves two centimeters apart, feet at 30° and the individuals looking at a visual target 90 cm away. The

subjects remained in this position for 20 seconds. We observed the mean amplitudes of the center of pressure (COP) in the frontal plane of right (RLD) and left (LLD) lateral displacements, in the sagittal plane of anterior (AD) and posterior (PD) displacements, as well as in the elliptical area (EA) formed by center of gravity (COG) displacement of the body in the platform plane [18].

Functional autonomy assessment

To assess functional autonomy we used the following Latin American Group for the Elderly (GDLAM, Rio de Janeiro, Brazil) autonomy tests: walking 10m (10MW) [24], rising from a sitting position (RSP) [25], rising from a ventral decubitus position (RVDP) [26], rising from a chair and moving about the house (RCMH) [27] and putting on and removing a t-shirt (PRTS) [28,29]. All the tests were performed twice with each individual in a suitable environment, with a minimum interval of 5 minutes between tests. The shortest execution time in seconds was measured with a chronometer (Casio, Brazil). Next, the GDLAM autonomy index (GI) was calculated [30], in which lower scores represented better results, by means of the following formula:

$$GI = \frac{[(10MW + RSP + RVDP + PRTS) \times 2] + RCMH}{4}$$

where:

10MW, RSP, RVDP, PRTS and RCMH = time measured in seconds.

GI=GDLAM index (scores).

Intervention

The physical activity program (PAP) consisted of twice-weekly 60-minute sessions over a 12-week period. The sessions comprised a 10-minute stretching warm-up at submaximal level for the main joint movements, a 20-minute walk, 15 minutes of localized exercises involving the large muscle groups (2 series of 15 repetitions: squats, elbow bending and stretching, knee bends and stretches, horizontal shoulder bends and stretches, plantar flexion and sit-ups), 10 minutes of static stretching at maximal level and a 5-minute cool-down. Intensity of exertion was controlled by the Borg CR-10 scale [31], and maintained at a moderate level (level 2 to 3). All the subjects of EG performed all the program exercises with a minimum frequency of 90% in the exercise sessions.

Statistical analysis

The data were processed by SPSS 14.0 software and presented as mean, standard deviation and percent difference ($\Delta\%$). The Shapiro-Wilk and Levene tests were used to verify the normality and homogeneity, respectively, of sample data variances. Analysis of variance (Two-way ANOVA) was used for intra and intergroup comparisons, followed by the Scheffé post-hoc test to detect possible differences. A value of $p < 0.05$ was adopted for statistical significance.

Results

Figure 1 shows the stabilometric assessment of the sample. It can be seen that the oscillations in center of pressure (COP) amplitudes of anterior ($\Delta\%AD = -30.63\%$, $p = 0.02$) and posterior ($\Delta\%PD = -42.96\%$, $p = 0.0001$) and elliptical area ($\Delta\%EA = -34.41\%$, $p = 0.044$) displacements showed significant reductions ($p < 0.05$) between the pre-test and the post-test in the EG. Intergroup comparisons revealed that the amplitude oscillation of right (RLD), anterior (AD), posterior (PD) lateral and elliptical area (EA) displacements of COP of the EG was significantly ($p < 0.05$) lower than the oscillation reached by the CG in the post-test ($\Delta\%RLD = -25.68\%$, $p = 0.006$; $\Delta\%AD = -36.47\%$, $p = 0.007$; $\Delta\%PD = -44.65\%$, $p = 0.0001$; $\Delta\%EA = -40.74\%$, $p = 0.017$). The other variables showed no significant alterations.

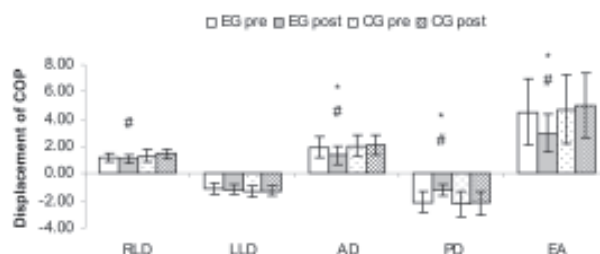


Figure 1: Comparison of oscillation amplitude of the center of pressure (COP) in right (RLD), left (LLD), anterior (AD), posterior (PD) and elliptical area (EA) displacements between the experimental (EG) and control (CG) groups. * $p < 0.05$; EG pre vs EG post. # $p < 0.05$; EG post vs CG post.

Figure 2 shows the results of functional assessment tests. The RSP ($\Delta\% = -36.63\%$, $p = 0.0001$), RCMH ($\Delta\% = -20.27\%$, $p = 0.0001$), 10MW ($\Delta\% = -12.54\%$, $p = 0.038$) and RVDP ($\Delta\% = -25.10\%$, $p = 0.036$) tests showed significant reductions ($p < 0.05$) in execution time in intragroup comparisons in the EG. This result was not found for the CG. Intergroup comparisons demonstrated that the execution times on the RSP, RCMH, 10MW and

RVDP tests of the EG were significantly ($p < 0.05$) lower than the times obtained by the CG in the post-test ($\Delta\%RSP = -40.00\%$, $p = 0.0001$; $\Delta\%RCMH = -20.77\%$, $p = 0.0001$; $\Delta\%10MW = -18.11\%$, $p = 0.002$; $\Delta\%RVDP = -32.40\%$, $p = 0.005$). The PRTS test showed no significant alterations.

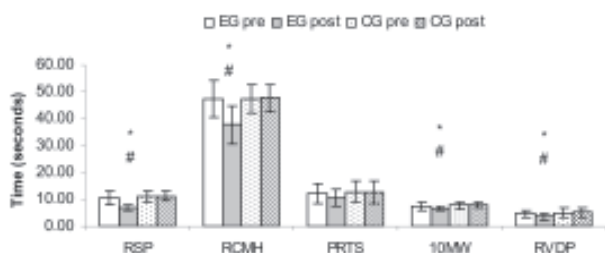


Figure 2: Comparison of execution times on the GDLAM functional autonomy tests between the experimental (EG) and control (CG) groups. 10 MW = walking 10 meters; RSP= rising from a seated position; RVDP= rising from the ventral decubitus position; PRTS= putting on and removing a t-shirt; RCMH= rising from a chair and moving about the house. All the times were measured in seconds. * $p < 0.05$; EG pre vs post. # $p < 0.05$; EG post vs CG post.

Figure 3 shows that the GDLAM index (GI) of functional autonomy for the performance of ADL showed significant reduction ($p < 0.05$) compared to intragroup comparison in the EG ($\Delta\% = -21.37\%$, $p = 0.0001$). This result was not found in the CG. Intergroup comparison shows that the IG scores in the EG were significantly ($p < 0.05$) lower than the scores obtained by the CG in the post-test ($\Delta\% = -24.21\%$, $p = 0.0001$).

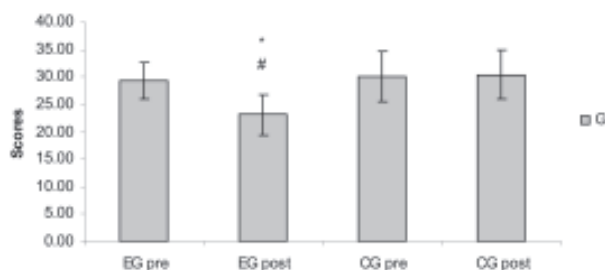


Figure 3: Comparison of GDLAM index (GI) between the experimental (EG) and control (CG) groups. GI= GDLAM index (scores). * $p < 0.05$; EG pre vs EG post. # $p < 0.05$; EG post vs CG post.

Discussion

The results of this study show significant reductions in the mean amplitudes of the center of pressure in right (RLD), anterior (AD), posterior (PD) lateral and elliptical area (EA) displacements, in a battery of tests from the GDLAM protocol and in the GI of the EG. This indicates that the subjects who took part in the physical

activity program obtained improvements in static balance and functional autonomy levels.

These findings are corroborated by Carvalho et al. [21], who compared balance in seniors who practiced regular physical activity ($n = 28$, age = 77.1 ± 7.2 years) and sedentary individuals ($n = 28$, age = 79.4 ± 8.1 years). The results show higher values for the active group in the POMA tests ($p < 0.001$). This suggests that the elderly who engage in regular physical activity may have greater balance and less fear of falling compared to sedentary elderly, and consequently better performance in the ADL. The test used to evaluate balance was different from the one applied here, but these data also indicate that a regular physical activity program may increase self-confidence in the elderly. However, these conclusions must be tempered by the fact that we did not assess falls, fear of falling or self-confidence.

Abreu and Caldas [32] studied the effects of a therapeutic exercise program on balance in the elderly. The results show that the group submitted to therapeutic exercises improved their balance, as measured by the Berg and POMA tests, compared to the ambulatory group. These results corroborate the findings of the EG in the present study, since the balance of the elderly in this group improved with the physical program of general exercises, although the method applied to assess this variable has been the force platform.

Rugelj [13] analyzed performance on the 10MW test and the balance of seniors submitted to functional training composed of 14 functional activities. He found that the experimental group significantly improved execution time on the 10MW test, but found no significant differences in relation to the mean displacement amplitudes of COP in the sagittal and frontal planes and in the elliptical area, using stabilometry. These results partially contradict those of the present study in that we found improvements in the ADL tests, except PRTS, and in mean oscillations in AD, PD and RLD, in the sagittal and frontal planes, respectively, and EA in the EG. These discrepancies may be owing to the differences in exercise programs. Furthermore, these exercises might generate different sensory information, provoking positive adaptations in the sensory motor system [10]. Thus, these stimulations, induced by different movements in the physical activity program may have influenced the improved balance and performance of the ADL in the EG.

Zak et al. [17] investigated a multiple exercise program in the elderly and found that the subjects that engaged in high-intensity exercises at progressive loads,

functional orientations and with nutritional control significantly improved balance and performance on the 6-minute walk test, as measured by POMA. The present study obtained the same result with the 10MW and balance, as assessed by the force platform, using moderate exertion intensity to perform the exercises and without nutritional control. This may have occurred because EG showed a fair level of functional autonomy, as measured by the GI [30].

Mann et al. [33] compared the balance of elderly who engaged in aquatic exercises for between 1 and 5 years and sedentary individuals of the same age, using force platform assessment for 10 seconds. They found that the active elderly only obtained better results ($p < 0.05$) than the sedentary subjects in medium-lateral displacement with feet together and eyes closed. These results differ from the present study in that we found balance improvements in the EG, also in the sagittal plane (AD and PD). These discrepancies between the two studies may be owing to the difference in age of the sedentary groups used as control.

The findings of the present study are corroborated by Aikwa et al. [34], who analyzed postural oscillations in elderly at two different decades of life. The results indicated that posterior postural oscillations were higher in the two groups (from 60 to 70 years, mean = 12.15 ± 12.15^0 and from 71 to 80 years, mean = 11.73 ± 14.42^0). This also occurred in the present study in the pre-test in the EG and at the two moments in the CG, but in the post-test of EG, mean anterior displacement was higher than the posterior mean. These postural oscillations, however, are common in the elderly because they are associated to changes in the base of support or unexpected displacement such as articular instability [7], muscular weakness [16] and elevated BMI, which requires more body displacement to maintain postural balance [35]. But this analysis is limited in the present study because it did not investigate these associations.

In conclusion, the results presented here show a significant improvement in static balance and in the functional autonomy levels of the experimental group. This suggests that a regular physical activity program may contribute to maintaining postural control and performance in ADL. It will be appropriate in the future studies to measure muscle and joint parameters, before and after program of exercise, maybe isokinetically, to investigate the possibilities of their improvement which should be connected with posture balance control and functional improvements.

References

1. Sacco ICN, Bacarin TA, Watari R, et al. Envelhecimento, atividade física, massa corporal e arco plantar longitudinal influenciam no equilíbrio funcional de idosos? *Rev Bras Educ Fís Esp*. 2008;22(3):183-191.
2. Vale RGS, Oliveira RD, Pernambuco CS, Meneses YPSF, Novaes JS, Andrade AFD. Effects of muscle strength and aerobic training on basal serum levels of IGF-1 and cortisol in elderly women. *Arch Gerontol Geriatr* 2009; 49: 343-347. doi:10.1016/j.archger.2008.11.011 PMID:19131122
3. Rebelato JR, Calvo JI, Orejuela JR, Portillo JC. A influência de um programa de atividade física de longa duração sobre a força muscular manual e a flexibilidade corporal de mulheres idosas. *Rev Bras Fisioter*. 2006;10(1):107-132. doi:10.1590/S1413-35552006000100017
4. Salminen M, Vahlberg T, Sihvonen S, et al. Effects of risk-based multifactorial fall prevention on postural balance in the community-dwelling aged: A randomized controlled trial. *Arch Gerontol Geriatr*. 2009;48(1):22-27. doi:10.1016/j.archger.2007.09.006 PMID:17950944
5. Baraúna MA, Barbosa SRM, Canto RST, Silva RAV, Silva CDC, Baraúna KMP. Estudo do equilíbrio estático de idosos e sua correlação com quedas. *Rev Fisioter Brasil*. 2004;5(2):136-141.
6. Tainaka K, Takizawa T, Katamoto S, Aoki J. Six-year prospective study of physical fitness and incidence of disability among community-dwelling Japanese elderly women. *Geriatr Gerontol Int*. 2009;9(1):21-28. doi:10.1111/j.1447-0594.2008.00492.x PMID:19260976
7. Perracine MR, Ramos LR. Fatores associadas às quedas em um coorte de idosos residentes na comunidade [Fall-related factors in a cohort of elderly community residents]. *Rev Saúde Pública*. 2002;36(6):709-716. PMID:12488937
8. Aslan UB, Cavlak U, Yagci N, Akdag B. Balance performance, aging and falling: a comparative study based on a Turkish sample. *Arch Gerontol Geriatr*. 2008;46(3):283-292. doi:10.1016/j.archger.2007.05.003 PMID:17580094
9. Ruwer SL, Rossi AC, Simon LF. Equilíbrio no idoso. *Rev Bras Otorrinolaringol*. 2005;71(3):298-303.
10. Isotalo E, Kapoula Z, Feret PH, Gauchon K, Zamfirescu F, Gagey PM. Monocular versus binocular vision in postural control. *Auris Nasus Larynx*. 2004;31:11-17. doi:10.1016/j.anl.2003.10.001 PMID:15041048
11. Bastos AGD, Lima MAMT, Oliveira LF. Avaliação de pacientes com queixa de tontura e eletro-nistagmografia normal por meio da estabilometria. *Rev Bras Otorrinolaringol*. 2005;71(3):305-310.
12. Jbabdi M, Boissy P, Hamel M. Assessing control of postural stability in community-living older adults using

- performance-based limits of stability. *BMC Geriatrics*. 2008;8(8). [doi:10.1186/1471-2318-8-8](https://doi.org/10.1186/1471-2318-8-8) [PMID:18377646](https://pubmed.ncbi.nlm.nih.gov/18377646/)
13. Rugeleij D. The effect of functional balance training in frail nursing home residents. *Arch Gerontol Geriatr*. 2009. [doi:10.1016/j.archger.2009.03.009](https://doi.org/10.1016/j.archger.2009.03.009) [PMID:19398136](https://pubmed.ncbi.nlm.nih.gov/19398136/)
14. Ragnarsdóttir M. The concept of balance. *Phys Ther*. 1996;82:368-375.
15. Gazzola JM, Muchale SM, Perracine MR, Cordeiro RC, Ramos LR. Caracterização funcional do equilíbrio de idosos em serviços de reabilitação gerontológica. *Rev Fisioter Univ São Paulo*. 2004;11(1):1-14.
16. Wiacek M, Hagner W, Hagner-Derengowska M, *et al*. Correlations between postural stability and strength of lower body extremities of women population living in long-term care facilities *Arch Gerontol Geriatr*. 2009;48:346–349. [doi:10.1016/j.archger.2008.02.019](https://doi.org/10.1016/j.archger.2008.02.019) [PMID:18440656](https://pubmed.ncbi.nlm.nih.gov/18440656/)
17. Zak M, Swine C, Grodzicki T. Combined effects of functionally-oriented exercise regimens and nutritional supplementation on both the institutionalised and free-living frail elderly (double-blind, randomised clinical trial). *BMC Public Health*. 2009;9(39). [doi:10.1186/1471-2458-9-39](https://doi.org/10.1186/1471-2458-9-39) [PMID:19175935](https://pubmed.ncbi.nlm.nih.gov/19175935/)
18. Nordahl SH, Aasen T, Dyrkorn BM, Eldsvik S, Molvaer OI. Static stabilometry and repeated testing in a normal population. *Aviat Space Environ Med*. 2000;71:889-893. [PMID:11001340](https://pubmed.ncbi.nlm.nih.gov/11001340/)
19. Duckworth T, Betts RP, Franks DI, Burke J. The measurement of pressures under the foot. *Foot Ankle*. 1982;3:130-141. [PMID:7152398](https://pubmed.ncbi.nlm.nih.gov/7152398/)
20. Orlin MN, McPoil TG. Plantar pressure assessment. *Phys Ther*. 2000;80:399-409. [PMID:10758524](https://pubmed.ncbi.nlm.nih.gov/10758524/)
21. Carvalho J, Pinto J, Mota J. Actividade física, equilíbrio e medo de cair. Um estudo em idosos institucionalizados. *Rev Port Cien Desp*. 2007;7(2):225-231.
22. Vincent WJ. *Statistics in Kinesiology*. 3rd ed. Champaign: Human Kinetics. 2005.
23. World Medical Association (WMA). Declaration of Helsinki. Ethical Principles for Medical Research Involving Human Subjects. 59th WMA General Assembly, Seoul, 2008.
24. Sipilä S, Multanen J, Kallinen M, Era P, Suominen H. Effects of strength and endurance training on isometric muscle strength and walking speed in elderly women. *Acta Physiol Scand*. 1996;156:457-464. [doi:10.1046/j.1365-201X.1996.461177000.x](https://doi.org/10.1046/j.1365-201X.1996.461177000.x) [PMID:8732251](https://pubmed.ncbi.nlm.nih.gov/8732251/)
25. Guralnik JM, Simonsick EM, Ferruci L, *et al*. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol Med Sci*. 1994;49(2):85-94.
26. Alexander NB, Ulbrich J, Raheja A, Channer D. Rising from the floors in older adults. *J Am Geriatr Soc*. 1997;45(5):564-569. [PMID:9158576](https://pubmed.ncbi.nlm.nih.gov/9158576/)
27. Andreotti RA, Okuma SS. Validação de uma bateria de testes de atividades da vida diária para idosos fisicamente independentes. *Rev Paul Educ Fis*. 1999;13(1):46-66.
28. Dantas EHM, Vale RGS. GDLAM's protocol of functional autonomy evaluation. *Fit Perf J*. 2004;3(3):175-182. [doi:10.3900/fpj.3.3.175.e](https://doi.org/10.3900/fpj.3.3.175.e)
29. Vale RGS, Pernambuco CS, Novaes JS, Dantas EHM. Teste de autonomia funcional: vestir e tirar uma camiseta (VTC). *R Bras Ci Mov*. 2006;14(3):71-78.
30. Vale RGS. Avaliação da autonomia funcional. *Fit Perf J*. 2005;4(1):4.
31. Borg GAV. Physiological bases of perceived exertion. *Med Sci Sports Exerc*. 1982;14(3):377-387. [PMID:7154893](https://pubmed.ncbi.nlm.nih.gov/7154893/)
32. Abreu SSE, Caldas CP. Velocidade de marcha, equilíbrio e idade: um estudo correlacional entre idosas praticantes e idosas não praticantes de um programa de exercícios terapêuticos. *Rev Bras Fisioter*. 2008;12(4):324-30. [doi:10.1590/S1413-35552008000400012](https://doi.org/10.1590/S1413-35552008000400012)
33. Mann L, Kleinpaul JF, Teixeira CS, Rossi AG, Lopes LFD, Mota CB. Investigação do equilíbrio corporal em idosos. *Rev Bras Geriatr Gerontol*. 2008;11(2):155-165.
34. Aikawa AC, Bracciali LMP, Padula RS. Efeitos das alterações posturais e de equilíbrio estático nas quedas de idosos institucionalizados. *Rev Cienc Med*. 2006;15(3):189-196.
35. Greve J, Alonso A, Bordini ACPG, Camanho GL. Correlação entre índice de massa corpórea e equilíbrio postural. *Clinics*. 2007;62(6):717-720. [PMID:18209913](https://pubmed.ncbi.nlm.nih.gov/18209913/)