
POSTURAL BALANCE PROGRAM: VARIABLES RELATED TO FALLS IN ELDERLY

PROGRAMA FÍSICO DE EQUILÍBRIO: VARIÁVEIS ASSOCIADAS ÀS QUEDAS EM IDOSOS

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RESUMO

O objetivo do estudo foi analisar os efeitos de um programa físico de equilíbrio em variáveis associadas às quedas em idosos. Participaram do programa 17 indivíduos com média de idade de 75,73 anos. Foram utilizados os testes de apoio unipodal (AU), Timed Up and Go (TUG), alcance funcional (AF), força (FMI), flexibilidade de membros inferiores (FLEXMI) e o questionário FES-I. Para a análise dos dados utilizou-se o teste de Wilcoxon ($p \leq 0,05$) para comparação entre os dois momentos de avaliação. Para a análise da classificação dos testes de equilíbrio utilizou-se cálculos de distribuição (frequência e percentual) dos períodos pré e pós-treinamento. Os resultados apontaram mudança estatística significativa entre o período pré e pós-treinamento nas variáveis AU, TUG e FLEXMI. A classificação dos resultados indicou melhora no pós-teste, havendo assim uma tendência na melhora do equilíbrio após o treinamento, auxiliando na prevenção de quedas.

Palavras-chave: Idoso. Equilíbrio postural. Acidente. Quedas.

ABSTRACT

The aim of this study was to analyze the effects of a balanced program for preventing falls in the elderly. The sample consisted of 17 subjects (age: 75.73 ± 8.57). The tests used were one foot (AU), Timed Up and Go (TUG), functional reach (AF), strength (IMF) and flexibility of the lower limbs (FLEXMI) of Rikli and 19 Jones (1999) protocol, FES-I questionnaire. For data analysis we used the comparative statistics with the Wilcoxon test ($p = 0.05$) between pre and post-test. For the analysis of the classification of balance tests we used distribution calculations (frequency and percentage). There was no statistically significant change between the pre and post-training in the variables AU, TUG and FLEXMI. The classification of the results showed improved post-test, showing a tendency to improve balance after training and helping to prevent falls

Keywords: Elderly. Postural balance. Accident. Falls.

Introduction

Changes deriving from aging increase the occurrence of falls, which can bring serious consequences. In an analysis involving seniors from 41 municipalities of seven Brazilian states, the prevalence of falls was 34.8%¹. Corroborating with these findings, a survey by the Ministry of Health verified that about 30% of older people fell in a year. This rate rises to 40% among seniors older than 80 years of age². Thus, there is an expressive percentage of elderly individuals falling, which draws attention to the consequences of these falls as well. The same survey mentioned above reports that about 2.5% of the elderly require hospitalization after a fall and only half of them will survive after a year. In addition to these serious consequences, others are more recurrent after a fall, such as incidence of fractures, as well as increased fear of falling³. Such occurrences may lead to reduced independence, autonomy and quality of life⁴. This type of finding, related to the elderly population, has become frequent in recent decades, due to the aging of the population, which stands as a worldwide phenomenon of accelerated demographic transition. In Brazil, for instance, the

elderly population rose from 8.5% in the 2000 Census to 10.8% of the population in the 2010 Census⁵.

The occurrence of falls in this population has a multifactorial etiology, dependent of intrinsic factors (physiological, musculoskeletal and psychosocial aspects related to aging) and extrinsic factors (aspects related to the environment)⁶. In addition to said factors, there are related ones such as: advanced age, individual's gender, decreased balance, impaired vision, diseases, use of medication, environmental factors and decreased muscle strength⁷. Among them, some cannot be changed by any type of external intervention, such as age and sex. However, others can improve with training, including balance⁸, strength and flexibility⁹, and fear of falling¹⁰. Interventions with exercises can reduce the risk and rate of falls; a systematic review study with 54 randomized clinical trials confirmed that exercise, as a single intervention, can prevent falls¹¹.

Balance, in general, is basically founded on three systems: visual, somatosensitive and vestibular¹². The aging process brings some changes to these systems, which reduce the individual's compensatory capacity, increasing his or her instability and, consequently, the risk of falling in individuals of this age group¹³. Thus, balance has been considered one of the variables most associated with falls. This can be stated, because assessments of balance, both dynamic and static, are the most commonly used as predictors of falls¹⁴. Corroborating with this statement, results indicate correlations between falls and results of some of those tests, and seniors with a history of falls present inferior assessment of functional balance compared to those without falls¹⁵.

In addition to balance, strength is an important component related to motor performance, activities of daily living and greater security in relation to falls¹⁶⁻¹⁸. Besides, individuals with poor performance as to lower limb strength are approximately twice as likely to fall when compared to those who performed satisfactorily¹⁹. Another variable associated with falls is flexibility, since seniors go through a reduction in the elasticity of tendons, ligaments and joint capsules⁷. Joint amplitude reduces with age in the lumbar region and in the hip, emphasizing that the flexibility of the hamstring muscles relates to postural balance. Loss of mobility in the hips, knees, ankles and spine produces changes in gait pattern and difficulties in the performance of daily tasks, increasing instability, but training directed to this capacity can reduce the risk of falls²⁰.

Fear of falling has been given attention in some studies^{3,6,21}, and seniors with a history of falls are more likely to report this fear. The greater the concern with falls, the greater the likelihood of their occurrence³; in addition, older people who are more afraid of falling are those with reduced physical fitness²², feeling less secure and more worried. Strength, dynamic balance and flexibility are among physical variables associated with the fear of falling¹.

Given the importance of balance, strength and flexibility in relation to falls, studies have investigated the effect of training on these variables for prevention^{2,11,23}, as well as other associated variables, such as fear of falling^{6,10,24}. Despite similarities with the objectives of our study, those researches used different forms of intervention and assessment. Thus, the aim of this study was to analyze the effects of a postural balance program on variables associated with falls in the elderly population.

Method

The quasi-experimental study was developed from a postural balance program that is part of a university extension project. The sample was composed of some of the program's participants, with the following inclusion criteria: minimum age of 60 years old, physical conditions that allowed participation in the program, and attendance of 75% to classes.

Exclusion criteria were: using some type of prosthesis and/or equipment for displacement (crutch, walker, others), any type of musculoskeletal restriction or neurological problems that compromised the performance of the exercises or the assessment.

Assessments were carried out in two stages: the first stage assessed 29 participants (before the beginning of the program: pre-test), the second stage assessed 17 participants (at the end of the program: post-test), finalizing the sample with 17 people. Several items contributed to this reduction, including: the application of the criteria, specifically regarding attendance lower than 75% and students withdrawing for health or personal reasons.

The data collection plan initially involved training the team through a course on the instruments assessed and the experimental protocol to be developed. The team was composed of four Physical Education undergraduate students who were already working as monitors in the extension project for at least a year, in addition to two professors of the Physical Education and Speech Therapy courses, who developed the study methodology and trained the team for assessment and intervention. The tests were always applied in pairs of assessors, allowing for greater reliability due to supervision in the application of the protocols. After the pre-test application, intervention was developed (by the same team) and the post-test was applied with all the instruments.

The variables analyzed to verify the effects of the balance program were: static, dynamic and recoverable balance, besides two components of physical fitness: strength and flexibility. Several assessments were chosen, because the tests for measuring the risk of falls are complementary, showing different particularities and limitations²⁵.

Static balance is defined as the maintenance of a particular body posture with minimum oscillation²⁶. For assessment, the single leg stance (SLS) test was used, in which the individual should balance on only one leg for 30 seconds, with his or her eyes open. Time was measured in three attempts, and the best of the three was considered (the longest one, limited to the maximum time). The test classification is divided into: shorter than 21 seconds = "change in balance" and longer than 21 seconds = "no change in balance"²⁷.

Dynamic balance refers to posture maintenance during the performance of a motor skill that tends to disturb body orientation²⁶. It was assessed through the Timed Up and Go (TUG)²⁸, in which the individual is asked to stand up from a chair, walk three meters, turn around and sit back in the chair. Results are classified as follows: 0 to 10 seconds = "independent individual without balance issues"; 11 to 20 seconds = "dependence for basic transfers"; 21 to 30 seconds = "dependence for many activities of daily living and mobility".

Recoverable balance, which is required in tasks in which individuals need to reach for distant objects and return to their initial position, was assessed through backward functional reach (FR)²⁹, in which the individual was asked to stand with one shoulder close to a wall and perform a shoulder flexion (90°); in this position, the starting point is marked. Afterwards, a trunk flexion was requested, up to the maximum limit, maintaining the initial position, without executing any compensatory strategy. The distance from the first marking to the second one is measured. Subjects who reached between 15.2 centimeters and 25.4 centimeters of displacement = "twice as likely to fall", higher values = "no risk of falls", less than 15.2 centimeters = "four times more likely to fall"²⁹.

Among physical fitness components, lower limb strength (LLS) was assessed through the "sit and stand" test (Senior Fitness Test)³⁰, in which the individual stands up from and sits in the chair as often as possible during 30 seconds. The higher the number of repetitions, the greater the strength of the individual. For lower limb flexibility (LLFLEX), the "sit and reach"³⁰ test was used, in which the individual, in the sitting position, flexes one knee while the other is extended, flexing the trunk to the joint limit, trying to reach or go beyond the tip of the foot without flexing the knee. For the classification of these results, the normative table

proposed by the authors was used, which establishes whether the value obtained is within an expected limit for the age and sex.

In order to measure the individual's perception of his or her fear of falling, the FES-I³¹ was used. The FES-Brazil test is a scale with questions related to a senior's concern with falling. The questions refer to activities of daily living, in which the individual indicates his or her degree of concern about performing the activity. Each answer is equivalent to a score that varies from 1 to 4 points; the result is obtained from the sum of all questions, being classified as: higher than or equal to 23 points = "sporadic falls", higher than 31 points = "recurrent falls"³¹.

The objective of the physical program was to improve balance capacity and other physical fitness components, aiming at reducing the fear of falling in daily activities. The modality that proved most efficient for reducing the risk of falls is the combination of strengthening, stretching and coordination³².

Currently, studies^{33,34} advocate the implementation of multifaceted interventions for prevention of falls in the elderly population, which work mainly on the strength of the lower limbs, especially feet and ankles, static and dynamic balance, in addition to reinforcing that physical exercise programs that offer a greater challenge as to balance, often offered, including intensity progression over time and without interruption, are more effective in preventing falls. The literature has indicated strategies for better postural control, defined as ankle, hip and stepping strategies¹⁶. Exercises that focus on the strength and flexibility of the muscles of the feet and ankles have been considered as important components to a successful fall prevention strategy.

The contents of the program were: a) balance (movement of the center of mass, reduced base of support, decreased support of the upper limbs, stimulation of the somatosensory, visual and vestibular sensory systems); b) strength (emphasis on the lower limbs with ankle movements (dorsiflexion and plantar flexion), knee movements (knee flexion and extension), hip movements (abduction, adduction, flexion and extension), c) flexibility (hips, knees, ankles and spine); d) gait (different directions, steps and paces, Tandem gait, reaction speed). Functional exercises were proposed, whenever possible, due to similarities with activities of daily living, such as standing and sitting, climbing stairs, transfers.

The program, created by the researchers and adjusted to the sample, consisted of two weekly classes lasting 50 minutes, divided into: warm-up, exercises for adjustment control (plantar grasp; variation of supports, heights and types of floor; proprioceptive training; displacement in different directions), strength exercises with emphasis on lower limb muscles, stretching and relaxation exercises. The class methodology used was in the form of a circuit composed of 6 exercise stations, with an average duration of 3 minutes each, which could vary. The stations were planned so as to encompass the following variables: lower limb strength (1 station), lower limb flexibility (1 station), balance (2 stations), reaction speed (1 station) and vestibular system (1 station). Gait was present in the stations, being inherent to the course of the circuit, but also directed. The volume and intensity of the program were incremented, based on the difficulty progression that happened according to how the elderly adapted to the course, using: increase in loads, increase in the course and height of steps, use of more difficult postures (reduced base of support, movements that disturbed the center of gravity), reduction of sensorial stimuli. The exercises used, in addition to approaching the abilities mentioned, simulated the seniors' daily activities, such as climbing stairs, standing up from chairs, walking on uneven surfaces, single leg stance exercises, static, dynamic and recovered balance, among others.

The project was approved by the Research and Ethics Committee of the Institute of Psychology of the UFRGS, under protocol No 21629, complying with all recommendations of

the National Health Council resolution 466/12. All participants signed a free and informed consent form.

Statistical analysis was adopted, starting from data normality assessment, using the Shapiro Wilk test. After the absence of normality in all analyzed variables was checked, comparative statistics with the Wilcoxon test ($p \leq 0.05$) was chosen for comparison between pre and post-test. To analyze the classification of the tests, distribution calculations (frequency and percentage) of pre and post-training periods were used, as well as variation delta calculation. The statistical software IBM-SPSS 20.0 was used. Limitations of the study include the fact that previous experience in physical exercises or use of medication were not controlled.

Results

The study sample consisted of 17 people (1 man and 16 women) aged on average 75.53 ± 8.57 years old, with minimum age of 62 years old and maximum of 89 years old.

Table 1. Comparative statistics of balance assessment in seniors, before and after balance training, by the Wilcoxon test (Z) ($p \leq 0.05$).

Variable	n	PRE Md±sd	POST Md±sd	Z	Sig
Single Leg Stance	17	17.00±11.7	22.25±10.8	-3.059	.002
Timed Up and Go	17	6.15±2.39	6.82±2.29	-2.391	.017
Functional Reach	17	34.18±6.5	36.0±7.4	-1.225	.220
Lower limb strength	17	15.71±6.2	17.24±5.7	-1.510	.131
Lower limb flexibility	17	-2.35±9.2	2.41±10.7	-2.775	.006
FES-I-BRAZIL	17	22.82±4.8	23.47±4.7	-.626	.531

Legend: n: sample; Md ± sd: mean and standard deviation; Z: Wilcoxon test; Sig: level of significance; units of measure = single leg stance: seconds, Timed Up and Go: seconds, functional range: centimeters, lower limb strength: repetition, lower limb flexibility: centimeters, FES-I-Brazil: score.

Source: The authors.

The results presented in Table 1 show an improvement in four of the six variables assessed (SLS, FR, LLS, LLFLEX), based on the means of both assessments. The TUG obtained a higher mean in the post-test, indicating that the participants took longer to execute the test, revealing worse results. The FES also had a higher post-test result, which evidences a greater fear of falls. Comparative statistics indicated a significant statistical change between pre and post-training periods as to the SLS, TUG and LLFLEX variables, reflecting an improvement of the variables. On the other hand, the TUG obtained significantly lower scores in the post-test when compared to the pre-test.

Table 2. Descriptive statistics of the risk of fall, based on the assessment of seniors before and after balance training.

Variable	Classification	Pre		Post		Δ pre-post %
		N	%	n	%	
Single Leg Stance	No changes	8	47.1	12	70.6	23.5
	Changes	9	52.9	5	29.4	23.5
Timed up and go	Low risk	15	88.2	16	94.1	5.9
	Medium risk	2	11.8	1	5.9	5.9
Functional Reach	No risk	16	94.1	15	88.2	5.9
	2x higher	1	5.9	2	11.8	5.9
Lower limb strength	Superior	7	41.2	8	47.1	5.9
	Inferior	1	5.9	1	5.9	0
	Limit	9	52.9	8	47.1	5.8
Lower limb flexibility	Superior	3	17.6	7	41.2	23.6
	Inferior	8	47.1	4	23.5	23.6
	Limit	6	35.3	6	35.3	0
FES-I-BRAZIL	No falls	9	53	10	59	6
	Sporadic falls	7	41	5	29	12
	Recurrent falls	1	6	2	12	6

Legend: Δ pre-post= variation delta for pre-post; n= frequency; %= percentage.
Source: The authors.

Results evidence that there was a change in the risk of fall, based on the assessment of balance, in the SLS. However, in the TUG and FR, the risk of fall increased. In the FES, the no risks and sporadic risks categories increased, indicating improvement in prevention, but recurrent fall increased as well. In the TUG, FR, LLS and FES variables, among possible classifications, the majority of the sample was in the best pre-test category already: low risk (88%), no risk (94.1%), upper limit and limit (41.2% and 52.9%), no falls (53%), respectively. In the post-test, most of these classifications continued, with the majority increasing, except for FR. About LLFLEX and SLS, a more significant difference was observed between pre and post-test, highlighting the positive percentage of the variation delta of 23.5% and 23.6%, respectively.

Discussion

Regarding the results of the present study, significant statistical differences were found after intervention in the SLS and LLFLEX tests, in addition to the TUG. However, in the latter the post-test mean was less effective than in the pre-test. The different results found for the SLS and TUG tests coincide with statements of another study²⁵ that reports that the tests used for assessing body balance in the elderly are complementary, since each one has its own different particularity and limitation. Results indicated an improvement in static body balance. Similarly, elderly women who underwent a progressive functional balance training showed significant improvement in functional balance, evidencing the efficacy of the proposed exercises³⁵. Besides, proprioceptive and kinesiotherapy training³⁶ also seem to be effective in improving body balance. However, it should be noted that in the findings of the present research the results were effective only for the static balance test.

We can consider that these results relate to the content developed in the intervention. Static balance exercises in various situations (suppression of senses and support on irregular surfaces), as well as flexibility stimuli, such as joint mobility in the lower limbs, are examples of activities developed in the intervention that induced the improvement of results in the SLS and LLFLEX. On the other hand, lack of improvement in the TUG can be explained by the low level of stimulus for exercises focused on variables such as agility, reaction time and explosive strength, which are more present components in the test. It is important to stress that variables such as level of physical activity and use of medication were not controlled in the research and could interfere with test results.

Specific interventions as to falls and flexibility have not been explored in researches; nonetheless, they are deemed important for balance maintenance. Regarding flexibility, it is believed that a decrease in it with aging may be related to risk of falls, mainly due to reduction in joints such as hip, knees and ankles, which directly influence the gait pattern of seniors⁷. Thus, we consider that our positive results, in this variable, seem to be effective in reducing concern with falls.

The variables that did not indicate statistical difference were FR, LLS and FES. Regarding FR, in a study³⁷ with this type of assessment after intervention of strength, flexibility and balance exercises, effective results were found. In this way, it is indicated that exercises can be effective in improving performance in this test. Although strength is associated with body balance^{26,27}, few studies have subjected seniors to a specific program for balance improvement and measured this variable after training. In a program that had individualization as characteristic, those with less satisfactory results received 10 minutes of extra activities in specific variables³⁸. Thus, after six months of intervention, the individuals had improved their strength and vision, but there was no significant improvement in the assessment of risk of falls. In this case, individuals raised their strength levels, which was not found in our results.

Fear of falling can have a protective effect when elderly individuals are more careful so as to expose themselves to the risk⁵, but can cause limitation and insecurity and thus restrict activities of daily living. In our FES results, the subjects' means did not change after the intervention. Opposing the findings of the present research, it is verified that physical exercises are effective in lessening the fear of falling seniors have, according to a systematic review¹⁰.

Regarding the classification of the variables, as indicated in the protocols of the tests, it was possible to perceive an improvement or maintenance of the variables throughout the intervention period. Due to changes associated with the aging process, which become more

evident at more advanced ages, the maintenance of results is considered a positive fact³⁹ and was evidenced in all variables.

Final considerations

From the results, we can conclude that the postural balance program brought positive effects in relation to falls in the elderly population, as well as reflections as to training progression (objective, volume, intensity). It should be noted that not all variables were given the same emphasis at all of the circuit stations, which may be an influence factor in the different results – for instance, reaction speed may be associated with the TUG, not being a priority in the training.

The multifactorial etiology of falls hinders a work aimed at preventing them, and identifying the source of the fall proves to be a priority condition to subsidize physical programs. Fear of falling has been taken as an important aspect when the issue of falling in the elderly population is addressed; in this way, investigations with this variable are important, though still incipient. Based on our results, as well as other studies, we have found that balance training is capable of improving an individuals' body stability. However, it is necessary to investigate the definition of the training methodology, and further studies with experimental designs and hybrid methodology should be conducted. Greater emphasis must be given to muscle strength work, reaction speed, among other variables that need to be identified and assessed.

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