DOI: 10.1590/1809-2950/16953224012017

Association of balance and cardiorespiratory conditioning techniques reduces risk of falls and improves functional capacity in women

A associação de técnicas de equilíbrio e condicionamento cardiorrespiratório diminui o risco de quedas e melhora a capacidade funcional em mulheres

La asociación de ejercicios de equilibrio con el acondicionamiento cardiorrespiratorio disminuye el riesgo de caídas y mejora la capacidad funcional de mujeres

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ABSTRACT | This study aimed to test the effectiveness of the association of balance training on the ground with cardiorespiratory training in the water on the functional capacity and risk of falls on adult women. This single-blind uncontrolled clinical trial was formed by 24 women (60.79±5.51), subjected to three months of training. Instruments: Short Physical Performance Battery (SPPB), QuickScreen Clinical Falls Risk Assessment (QSCFRA) and Six-Minute Walk Test (6mwt). Balance improvement was noticed, although without statistical significance. Significant improvement occurred for risk of falls (p<0.001) and 6mwt (p=0.049), with a 39.58±95.5 mean increase of distance covered. Significant correlations happened between 6mwt and pre-training SPPB (r=0.56, p=0.008), age and QSCFRA (r=0.538, p=0.012), and comorbidities and QSCFRA (r=0.696; p=0.006). Effectiveness was observed in association with the proposed training on reduction of risk of falls and functional capacity improvement.

Keywords | Accidental Falls; Aging; Physical Therapy Modalities.

RESUMO | Verificou-se a efetividade da associação do treino de equilíbrio no solo com o treino cardiorrespiratório na água sobre a capacidade funcional e o risco de quedas em mulheres adultas. Esse ensaio clínico não controlado unicego foi composto por 24 mulheres (60,79±5,51), submetidas a três meses de treinamento. Instrumentos: Short Physical Performance Battery (SPPB), Quick Screen Clinical Falls Risk Assessment (QSCFRA) e Teste de Caminhada de Seis Minutos (TC6). Houve melhora dos índices de equilíbrio, mas sem significância estatística. Ocorreu melhora significativa para o risco de quedas (p<0,001) e TC6 (p=0,049), com aumento médio de 39,58±95,5 m na distância percorrida. Houve correlações significativas entre TC6 e SPPB pré-treinamento (r=0,56, p=0,008), idade e QSCFRA (r=0,538, p=0,012) e comorbidades e QSCFRA (r=0,696; p=0,006). Verificou-se efetividade na associação dos treinos propostos sobre a diminuição do risco de quedas e melhora da capacidade funcional.

Descritores | Acidentes por Quedas; Envelhecimento, Modalidades de Fisioterapia.

RESUMEN | Se estudia si hay eficacia la asociación de los ejercicios de equilibrio en el suelo con el acondicionamiento cardiorrespiratorio en el agua en la capacidad funcional y en el riesgo de caídas de mujeres mayores. De este estudio clínico no aleatorizado a ciegas participaron 24 mujeres (60,79±5,51), evaluadas durante tres meses. Se emplearon las siguientes: Short Physical Performance Battery (SPPB), Quick Screen Clinical Falls Risk Assessment (QSCFRA) y la Prueba de Caminata de

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6 minutos (PC6). Aunque los índices de equilibrio presentaron mejoras, no fueron estadísticamente significantes. El riesgo de caídas (p<0,001) y la PC6 (p=0,049) tuvieron mejoras significativas, con un promedio de aumento de 39,58±95,5 m en la distancia cumplida. Presentaron correlaciones significativas la PC6 y la SPPB preejercicio (r=0,56; p=0,008), la edad y la QSCFRA (r=0,538; p=0,012) y las comorbilidades y la QSCFRA (r=0,696; p=0,006). Se concluye que la relación entre los ejercicios propuestos es eficaz para disminuir caídas y mejorar la capacidad funcional.

Palabras clave | Accidentes por Caídas; Envejecimiento; Modalidades de Fisioterapia.

INTRODUCTION

In 2025, Brazil will reach 33 million older adults[1]. Aging comes with physical-functional disorders and increased risk of falls[3], a major health problem among older people[4]. To Maintain an active lifestyle prevents the development of functional disability[3], cardiorespiratory capacity reduction[5,6], and occurrence of falls in older people[7].

Therapeutic programs that include strength training, flexibility and cardiorespiratory conditioning[8], applied on the ground or in the water, decrease risk of falls and imbalances in older adults and are associated with better quality of life and prevention of functional disability[7,9].

Few studies verify efficiency of combined therapies – that is, activities on the ground with activities in the water. This study aims to verify the effect of balance training carried out on the ground, associated with cardiorespiratory training in the water, regarding risk of falls and functional capacity of middle-aged and older women.

METHODOLOGY

Uncontrolled clinical trial, single-blind, approved by the Research Ethics Committee of the Pontifícia Universidade Católica de Goiás, with protocol number 968,807, approved by the Brazilian Clinical Trials Registry, with registration number RBR-8kvgy3. All participants signed the Informed Consent Form.

Sample was formed by 24 women aged 55 or older, participants of the UNATI (Universidade Aberta à Terceira Idade) of the Pontifícia Universidade Católica de Goiás (PUC – Goiás), without cognitive changes, according to the Mini-Mental State Examination (MMSE), whereas 17 as minimum score[11].

Tools used are described below.

Mini-Mental State Examination (MMSE): assesses cognitive parameters in seven categories, which are temporal and spatial orientation, registration of three words, attention and calculation, recall of the three words, language and visual construction. Score ranges from 0 to 30 points[10]. This is a tracking test for dementia.

International Physical Activity Questionnaire (IPAQ): assesses physical activity level, covering activities carried out at work, to go from one place to another, leisure, sports or activities at home. It classifies activities into vigorous or moderate, following recommendations of the consensus achieved between the CELAFICS and the Center for Disease Control (CDC) of Atlanta 2002[11].

Physical health questionnaire: verifies the presence of heart disease, systemic arterial hypertension, stroke, diabetes mellitus, cancer, rheumatic diseases, pneumopathy, depression, osteoporosis, urinary and fecal incontinence, and use of medicines.

Short Physical Performance Battery (SPPB): verifies the levels of functionality through three tests: static standing balance (standing with feet together, one foot partially forward and the other foot forward, for 10 seconds in each posture), gait speed in a three-meter track with usual step, measured in two times on a round-trip route and muscle strength of lower limbs with the sitting-rising test without using the arms[12].

Quick Screen Clinical Falls Risk Assessment (QSCFRA): assesses the risk of falls in eight items: history of falls, medicines currently used, use of psychotropic medicines, visual acuity, plantar cutaneous sensitivity, by applying the esthesiometer in the lateral malleolus, balance in the posture with the feet laterally separated, alternate step test, and transfer from sitting to standing. Respective classification is: zero to one, risk factor indicates 7% probability of falling, two to three 13%, four to five 27%, and six or more 49% risk of falls[13].

Six-Minute Walk Test (6mwt): assesses aerobic capacity of individuals who walk during six minutes the longest distance they can[14]. The test must be carried out in a track with at least 30 meters. The 6mwt was performed twice, with a 30-minute interval between them, to avoid learning effect. To analyze the predicted value, we used the formula: predicted distance 6mwt = 356,658–(2,303×age)+(1,704×height)+(1,365×ΔHR)[16].

Before the 6mwt, the older people remained 10 minutes at rest. During the rest, two measurements of vital signs were performed, in the tenth minute and a minute before the walk. Blood pressure (BP), Heart Rate (HR), Respiratory Rate (RR), Oxygen Saturation (SpO2), and dyspnea level were measured by the Borg Scale. After that, they walked in the 20-meter track for six minutes. Then, the Borg scale was applied to assess PA, FR, FC, and SpO2 under the following circumstances: immediately after, 5 minutes and 10 minutes after the test.

After the aforementioned assessments, the combined therapy of activities on the ground was started followed by water activities on the same therapy day. The exercise program lasted 60 minutes a day, twice a week, during three months. The program consisted of two stages, starting with the balance training practice formed by three phases. In the first phase, individuals carried out a two-minute warm-up with frontal and lateral walk and then exercises for balance; the second phase kept the same warm-up with motor coordination and waist dissociation exercises; the third phase also kept the warm-up but with exercises involving motor coordination and rotational movements.

Afterwards, participants entered the pool and warmed up for 10 minutes, 15 to 20 minutes of muscular strength and motor coordination exercises associating trunk, upper and lower limbs activities, then ending with 5 to 10 minutes of breathing exercises and trunk, upper and lower limb stretching.

By the end of this period, women were reassessed in the same sequence of the functional physical tests described.

Data were analyzed in the Statistical Package for the Social Sciences (SPSS version 22.0). The quantitative variables were presented in absolute numbers, means, standard, minimum and maximum deviations. The qualitative variables were presented in absolute numbers and proportions. The Shapiro-Wilks test was used to assess normality. Wilcoxon test was performed to compare means. For correlation, Spearman correlation coefficient was used. In the whole analysis, a 95% confidence interval and a 5% significance level ($p<0.05$) were considered.

RESULTS

Twenty-seven women enrolled in the UNATI were assessed. Of these, three women were excluded for not fulfilling all the study assessments, so 24 women were included. Table 1 and Chart 1 show characteristics of the sample.

Therapeutic program did not cause significant modifications in the SPPB scores, but the balance test mean increased from 3.92±0.28 to 3.96±0.20, as well as the sitting-rising test from 2.75±1.19 to 2.79±0.93. In addition, there was also an improvement in the total test classification. After training, 79.2% of the sample achieved a good performance in their functional capacity, whereas before training, only 75% obtained this result.

Regarding the risk of falls, there was significant improvement after training ($p<0.001$) Before training, 29.2% presented 7% risk of falls; 66.7% presented 13% risk, and 4.2% presented 27% risk. After training, 79.2% reached 7% risk of falling, 20.2% showed 13%, and none obtained 27% risk of falls (Table 2).

In the assessment before training, participants walked a mean of 430.46±103.39 meters in the 6mwt and 95.5% was sufficient, according to what was predicted[12]. After the three-month period of training, they walked 470.04±83.25 meters and 100% managed to achieve sufficiency, according to what was predicted. Therefore, there was a 39.58±95.54 meter increase after training, which represents significant improvement ($p=0.049$) on the cardiorespiratory capacity. However, in the dyspnea level assessment with the Borg scale, no significant difference was found. The difference between the means of covered distances before and after training are demonstrated in the graph below (Graph 1).

Correlation analysis between the variables verified moderate correlation between the 6mwt and the SPPB before training ($r=0.56$, $p=0.008$) and between age and the QSCFRA before training ($r=0.0538$ and $p=0.012$). In addition, comorbidities were also associated with increased risk of falls before training ($r=0.696$ and $p=0.006$) (Table 3).

Table 1. Mean, maximum, minimum and standard deviation of age, weight, height and BMI of the volunteers

	Mean	SD	Minimum	Maximum
Age (years)	60.79	5.51	54.00	77.00
Weight (kg)	69.93	10.94	54.00	94.00
Height (m)	1.54	0.05	1.45	1.65
BMI (km/m^2)	29.70	5.01	23.06	41.23

SD: standard deviation; BMI: Body Mass Index.

Chart 1. Profile of the study's participants (n=24)

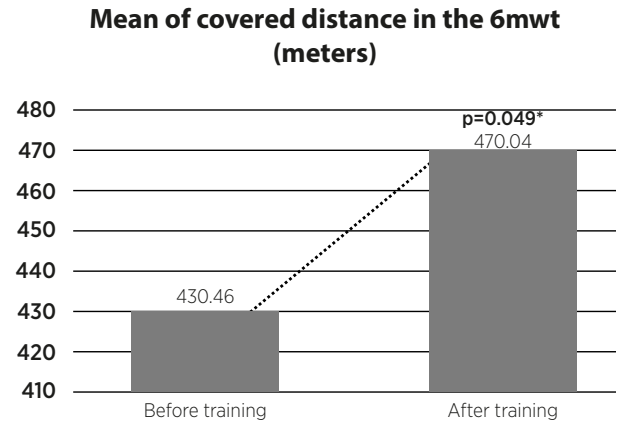
	n	%
Race		
White	6	25.0
Brown	13	54.2
Black	5	20.8
Marital Status		
Single	2	8.3
Married	11	45.2
Widow	5	20.8
Divorced	6	25.0
Educational Background		
Elementary or middle school	2	8.3
Some elementary or middle school	5	20.8
High school	2	8.3
Some high school	7	29.2
College degree	7	29.2
Some college	1	4.2
BMI Classification		
Eutrophic	5	20.8
Overweight	9	37.5
Obesity degree 1	7	29.2
Obesity degree 2	2	8.3
Obesity degree 3	1	4.2
Comorbidities		
Arthritis/arthrosis	13	54.2
SAH	9	37,5
CVA	2	8.3
Diabetes mellitus	2	8.3
Cancer	1	4.2
Lung disease	2	8.3
Osteoporosis	7	29.2
Urinary incontinence	3	12.5
Fecal incontinence	2	8.3
Depression	3	12.5
Life habits		
Smoker	1	4.2
Drinker	5	20.8
IPAQ		
Very active	4	16.7
Active	14	58.3
Irregularly active	3	12.5
Sedentary	3	12.5

n: frequency, % percentage; BMI: Body Mass Index; SAH: Systemic Arterial Hypertension; CVA: Cerebrovascular Accident; DM: Diabetes mellitus; IPAQ: International Physical Activity Questionnaire.

Table 2. QSCFRA results in the participants (n=24)

% risk of falls	Before training		After training		P value
	N	%	N	%	
7%	7	29.2	19	79.2	<0.001**
13%	16	66.7	5	20.8	
27%	1	4.2	0	0	

n: frequency; %: percentage; * Wilcoxon test; ** p<0.05.



TC6: 6-minute walk test; *p<0.05.

Graph 1. Mean of covered distance in the 6mwt before and after training.

Table 3. Spearman's correlation among the variables studied (n=24)

	r*	p**
Age versus QSCFRA 1	0.538	0.012
Commorbities versus QSCFRA 1	0.696	0.006
6mwt versus SPPB 1	0.560	0.008

* Spearman's correlation coefficient; **Wilcoxon test
1: before training; 2: after training; QSCFRA: Quick Screen Clinical Falls Risk Assessment; IPAQ: International Physical Activity Questionnaire; 6mwt: 6-minute walk test; SPPB: Short Physical Performance Battery.

DISCUSSION

This study tested efficiency of combined therapies, that is, balance training on the ground, associated with cardiorespiratory training in the water, on risk of falls and functional capacity of middle-aged and older women.

No significant improvement of the participants' functional capacity was found. What can explain this fact is that the sample is predominantly active, being 58.3% active and 16.7% very active. Participants presented good and moderate functional capacity even before the intervention. Bastone and Jacob Filho[17] verified the functional capacity of individuals undergoing an exercise program and found

significant improvement in the group submitted to the exercise. The program used lasted 1 hour, twice a week for 6 months. Sessions included ankles, knees, hips, spine and shoulders mobility exercises, strengthening exercises with weights on ankles and hands, closed kinetic chain exercises, 15-minute walk, and 5- to 10-minute relaxation. Carrying out the program for a longer time and higher impact exercises may have contributed to this functional capacity improvement.

Risk of falls of the sample studied significantly decreased in response to the therapeutic program. This reveals the importance of the proposed exercise program for reducing risk of falls. This result corroborates the ones by Gardner, Robertson and Cambpell[7] in a review of clinical trials that used diverse exercise programs in older people for prevention and reduction of risk of falls, which may be related to possible improvement of reaction time, as studied by Lajoie and Gallagher[18], who confirmed that faster reactions relate to lower occurrence of falls in older women.

This study revealed significant improvement of functional capacity after the training period, with Δ6mwt of 39.58 (±95.54). The study by Bastone and Jacob Filho[17], which compared older adults who took part in a regular exercise program with those who did not, found similar results. Physical exercise practice improves functional capacity in adults and older people. Cavani et al.[19] submitted a sample of older people to a resistance training combined with stretching. The authors used a battery of tests to verify the physical ability of the participants and found no improvement in the 6-minute walk test. Cardiorespiratory training in the water appears to be more suitable to improve cardiorespiratory and functional capacity, associated with better cardiovascular responses, increased strength and muscle resistance[20]. Studies suggest an average increase of 30 meters in the Δ6mwt is enough to obtain clinical improvement of the cardiorespiratory capacity deficit[21].

Despite the improvement in cardiorespiratory and functional capacity, there were no positive results on the dyspnea subjective sensation during the 6mwt, as assessed by the Modified Borg Scale[22].

Among the correlations found, the 6mwt correlated with the SPPB, suggesting a good functional capacity correlates with better functionality, therefore, physically active women have a better performance in daily activities. The study by Bastone and Jacob Filho[17] also correlated the 6-minute walk with functionality, showing highly significant correlation between better performance on the obstacle track (qualitative score) with best time in the 6-minute walk, and moderate correlation between the 6-minute walk and the isometric strength of knee extensor, the lower limb function, and with the obstacle quantitative score.

There was moderate correlation between age and the QSCFRA in the stage before training, showing that the higher the age, the higher the risk of fall percentage, confirming age effects on the risk of falls. This study found no correlation between age and functional capacity. Pires et al.[23] verified that with aging also comes declines on functionality and found inverse correlation between age and distance covered in the 6mwt. The study was conducted with young people, adults and older people. Higher ages and functional decline also influenced the increased risk of falls[24].

Higher numbers of comorbidities relate to the increased risk of falls. This study found significant correlation between comorbidities and the QSCFRA before training. Lima and Cezario[25] studied the risk factors associated with falls in older people. They were cardiovascular, neurological, musculoskeletal, endocrinologic, urinogenital, sensory and psychiatric comorbidities, which can cause functional capacity reduction.

Results reinforced the importance of maintaining an active lifestyle during aging and the direct link between independence levels and performance quality of daily life activities.

As limitations of the study, we should highlight the small sample used. Besides, the 6-minute walk test was performed on a 20-meter track, which is inferior to what is recommended. Research with greater number of participants must be conducted using a track with at least 30 meters.

CONCLUSION

We verified effectiveness of association of balance training on the ground with cardiorespiratory training in the water on risk of fall reduction, as well as improvement of functional capacity and functionality levels in middle-aged and older women.

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