Original Article

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The effect of 8-week multicomponent intervention on physical fitness in trained older women

Agata Horbacz ABCDE, **Ladislav Kručanica** 1D, **Zuzana Kováčiková** 1ACD

Institute of Physical Education and Sport, Pavol Jozef Šafárik University in Košice, Slovakia

Authors' Contribution: A – Study Design, B – Data Collection, C – Statistical Analysis, D – Manuscript Preparation, E – Funds Collection

Abstract: *Introduction:* A sufficient level of aerobic endurance, strength and balance is an important precondition for performing almost all activities of daily living with advancing age. Multimodal physical interventions seem to be an effective tool to improve overall fitness for of elderly. However, it is not known to what extent such interventions are effective in healthy and physically active elderly people. Therefore, this study aims to assess the effect of an 8-week multimodal training programme focused on aerobic endurance, strength and dynamic balance in physically active elderly females. *Methods*: A total of 25 physically active women over 60 years of age completed and 8-week multimodal training programme with two 60-minute sessions a week. Their functional performance before and after the intervention was evaluated with the Chair stand test, Arm curl test, 2-minute step test, Chair sit-and-reach test, Back scratch test and Foot up and go test. A program STATISTICA was used for data analyses (TIBCO Software Inc., 2018; version 13). *Results:* An 8-week multicomponent training programme resulted in a statistically significant performance in 2-minute step test. Moreover, training resulted in a significant reduction of BMI. Surprisingly, training resulted in the significantly prolonged time in the Foot up and go test. No other significant changes have been observed. The training programme resulted in a statistically significant improvement in the 2-minute step test (p=0.007). Moreover, the BMI index significantly decreased after the programme (p=0.037). Surprisingly, training resulted in the significantly prolonged time in the Foot up and go test (p=0.011). No other significant changes have been observed. *Conclusion:* The 8-week multimodal training programme seems to be an effective tool for increasing aerobic endurance in physically active elderly women. This training does not contribute to more pronounced improvements of other abilities.

Keywords: aerobic endurance, lower limb strength, balance, flexibility, Senior Fitness Test

Corresponding author: Zuzana Kováčiková, email: zuzana.kovacikova@upjs.sk

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INTRODUCTION

It is known, regular physical activity improves not only physical but also mental health as well as reverse certain adverse effects of chronic diseases [1,2]. Despite that, a low level of physical activity is an ongoing problem in the aging population [3,4]. Physical inactivity in the older adults increases the risk of all-cause mortality: it doubles the risk of cardiovascular diseases, obesity, diabetes; increases the risk of colon cancer, high blood pressure, osteoporosis, and even mental health [5].

The World Health Organization [6] recommends for people over 60 years of age to exercise 2-3 times a week with an emphasis on aerobic endurance (75-300 minutes depending on intensity), strength (exercises that involve all major muscle groups performed with moderate or greater intensity) and balance. Training programmes should include attractive, secure, and mainly effective exercises. However, training practice often shows that the physical interventions are too short to invoke the desired training effects [7,8]. Moreover, they are focused on the development of one or two abilities and are mainly intended for older adults with various types of diseases or health restrictions [9]. Recently, more and more attention is being paid to multicomponent training programs due to their effectiveness in case improved physical performance and health benefits to older adults [3,4,10,11-13]. The advantage is that they are focused on the development of various fitness components simultaneously. Compared to standard training regimens, multicomponent interventions allow the same training effect with a lower training volume [12]. Timmons et al. [11] found that a 12-week aerobic-strength training programme for the older adults effectively improved not only walking parameters and lower limbs strength but also selected somatic and complex health related parameters. In addition, programmes containing balance, function and strength exercises have been shown to reduce the incidence of falls by 34% [14]. On the other hand, Ebner et al. [15] concluded in their meta-analytic study that multicomponent interventions produce only small to moderate effects in the areas of physical fitness in people over 65 years of age.

Controversy findings published in scientific literature can be attributed to the great variability of the exercises used and the different duration of multicomponent interventions. In terms of the development of individual components such as balance, strength, aerobic endurance, flexibility etc., volume and intensity are also important factors. Moreover, very few studies have been conducted in healthy and physically active older adults. It is we found no study conducted in trained and relatively healthy older adults. It is very important to pay attention to this group as well. It has been observed that physically active older adults fall more often than [16]. Limited physical activity due to the fall-related injuries in physically active older adults could increase a wide array of deleterious social, emotional, and physical changes that can be describe as a downward spiral of health [17].

This study evaluates the effect of an 8-week multicomponent training intervention on aerobic endurance, strength, flexibility, and dynamic balance in relatively healthy and physically active women over 60 years of age with the aim to extend knowledge in the female population, which is more prone to age-related diseases and injuries than men.

MATERIAL AND METHODS

Participants

The inclusion criteria were as follows: (1) women over 60 years of age; (2) women without orthopaedic, neurological and/or cardiovascular disorders; (3) women participating in organized physical activities in minimum of twice a week (60 min/session). The exclusion criterion was any existing medical condition that would compromise participation in our multicomponent exercise training. Forty-three women over 60 years of age in apparently good state of health (age 71.7 ± 6.5 years; height 162.1

± 6.1 cm; weigh 70.4 ± 10.4 kg; BMI 26.8 ± 3.3 kg/m^2) were recruited, but only data of those women who completed entry evaluation, more than 14 training sessions, and post-training evaluation were analyzed. A total of 18 women did not meets these criteria. The final analysis includes data of twenty-five women who completed the required number of trainings and with no missing pre-and post-training data. Their baseline characteristics are shown in Tabele 2. Medical and fitness status of all women were screened via standardized anamnestic questionnaire. The study was approved by the Ethics Committee of the University. Each woman was informed about the purpose of the study, protocol, and possible risks, and then she was asked to sign an informed consent. All procedures were in accordance with the ethical standards on human experimentation according with the Helsinki Declaration of 1975 and its later amendments.

Study protocol

The study protocol included two visits – prior to and after the intervention. During the entry visit, women completed a standardized questionnaire, which was aimed at identifying health variables and changes in the implementation of physical activities - developed by Jones, Rose [18]. Then participants completed anthropometric screening followed by functional testing. Functional fitness performance of older women was evaluated using by The Senior Fitness Test battery developed by Rikli and Jones [19,20]. Six tests were performed in the following order: Chair stand test (number of repetitions), Arm curl test (strength of upper limbs), 2-minute step test (aerobic step test), Chair sit-and-reach test (lower body flexibility), Back scratch test (upper limbs flexibility) and 8 Foot up and go test (balance, strength, and speed). Each test was explained in detail to the participant. One training trial was given to each participant before the one trial was recorded. The rest interval between individual tests was adjusted individually, while the time never exceeded 3 minutes. Entry visit takes 90 minutes. Post-intervention visit lasted 60 minutes and included anthropometric screening and functional testing. Tests were performed in the same order. The study design is depicted in Figure 1.

Training protocol

An 8-week multicomponent training programme (2 training sessions/week with 48 hours' time interval between the sessions) was designed to improve aerobic capacity, dynamic balance, lower limb strength a flexibility in physically active older women. Each training session lasted a total of 60 minutes (10 minutes warm up, 40 minutes of main activity and 10 minutes of cool- down phase) and was performed before noon (8:30 a.m. – 9:30 a.m.). Training protocol included combination of exercises of different components such as cardiorespiratory, muscular strength, balance, and flexibility (Tabele 1). Exercises were performed to music with different beats per minutes (125- 130 BPM). Participants were required to undertake at least 14 from 16 training sessions during the program. Exercises were carefully selected with respect to age, health, and fitness status of our participants.

Statistical analysis

The assumption of normal distribution was verified using the Shapiro-Wilk test. The parametric dependent t-test was used for normally distributed data and non-parametric Wilcoxon test was used if the data do not follow a normal distribution. A program STATISTICA was used for data analyses (TIBCO Software Inc., 2018; version 13). Normally distributed data are presented as mean ± standard deviation (SD), and the data showing deviation from normal distribution are presented as median and interquartile range. According to Cohen 18 (1998), the effect size was calculated and interpreted as follows: large effect $d>0.8$, medium effect $0.5<d<0.8$, small effect $d<0.5$. The effect size was calculated by dividing the difference between the mean post-test score and the mean pre-test score by the standard deviation of the post-test score.

1st VISIT		**2nd VISIT**
90 minutes 	**8-week multimodal training**	**60 minutes** 
Study protocol explanation **Informed consent form** **Medical and physical activity questionnaire** **Anthropometric screening** **Senior Fitness Test** (Rikli, Jones, 2001) *Chair stand test* *Arm curl test* *2-minute step test* *Chair sit-and-reach test* *Back scratch test* *Foot up and go test*		X X X **Anthropometric screening** **Senior Fitness Test** (Rikli, Jones, 2001) *Chair stand test* *Arm curl test* *2-minute step test* *Chair sit-and-reach test* *Back scratch test* *Foot up and go test*

Figure 1. Study design.

Table 1. An 8-week multimodal training program of selected exercise groups.

Week/ session	Aerobic				Dynamic balance				Strength				Flexibility			Combination of exercises			
	ACH	R	S	RI	N	R	S	RI	N	R	S	RI	N	R	S	N	R	S	RI
1/1	1	4	2	30	2	8	1	30	3	8	1	60	3	8	1	2	8	1	20
	2	8	4	90					4	8	1	60	3	4	1	2	8	1	30
1/2	1	4	2	30	3	8	1	30	4	8	1	60	3	8	1	3	8	1	20
	1	8	4	90					4	8	1	60	4	4	1	2	8	1	30
2/1	1	4	2	30	2	8	2	30	3	8	1	60	3	8	1	3	8	1	20
	2	4	4	90					4	8	1	60	2	4	1	2	8	1	20
2/2	1	4	2	30	3	8	1	30	3	8	1	60	2	8	1	3	8	1	30
	1	8	4	90					4	8	1	90	4	4	1				
3/1	1	4	2	30	2	8	1	30	3	8	2	60	3	8	1	4	8	1	30
	2	4	4	90					4	8	2	60	3	4	1				
3/2	1	4	2	30	4	8	1	30	4	8	1	60	2	8	1	3	8	1	20
	1	8	4	90					4	8	1	60	2	4	1	2	8	1	30
4/1	1	4	2	30	2	8	2	30	4	8	1	60	3	8	1	4	8	1	20
	2	4	4	90					4	8	1	60	2	4	1	2	8	1	20
4/2	1	4	2	30	4	8	1	30	4	8	1	60	2	8	1	3	8	1	30
	1	8	4	90					5	8	1	90	4	4	1				
5/1	1	8	2	30	2	8	1	30	4	8	2	60	3	8	1	4	8	1	30
	2	8	4	90					4	8	2	60	3	4	1				
5/2	1	4	2	30	4	8	1	30	4	8	1	60	2	8	1	3	8	1	20
	1	8	4	90					4	8	1	60	4	4	1	3	8	1	20
6/1	1	8	3	30	2	8	2	30	4	8	1	60	2	8	1	2	8	1	30
	2	8	4	90					4	8	1	60	3	4	1	4	8	1	20
6/2	1	4	3	30	4	8	1	30	4	8	1	60	2	8	1	2	8	1	20
	1	8	4	90					4	8	2	60	2	4	1	3	8	1	30
7/1	1	8	3	30	2	8	1	30	5	8	1	90	4	8	1				
	2	8	4	90					4	8	2	90	3	4	1	4	8	1	30
7/2	1	8	3	30	4	8	1	30	4	8	2	90	3	8	1				
	2	8	4	90					4	8	2	60	2	4	1	3	8	1	20
8/1	1	8	3	30	3	8	2	30	4	8	1	60	2	8	1	2	8	1	30
	2	8	4	90					4	8	2	60	3	4	1	3	8	1	20
8/2	1	8	3	30	4	8	2	30	4	8	2	60	2	8	1	2	8	1	20
	2	8	4	90					4	8	2	90	3	4	1				

ACH = (aerobic choreography); N = number of exercises; R = repetitions; S = sets; RI = rest interval (in seconds). Each aerobic choreography included 4 individual exercises which were always performed on both sides.

RESULTS

Table 2 contains Pre- and post-training characteristics of women that have met criteria. An 8-week multicomponent training programme resulted in a statistically significant performance in 2-minute step test. Moreover, training resulted in a significant reduction of BMI. Surprisingly, training resulted in the significantly prolonged time in the Foot up and go test. No other significant changes have been observed.

A G*Power software (version 3.1.9.4) was used to conduct post-hoc power analysis. An alpha error probability was set at 0.05, mean difference ± SD and effect size (Cohen's d) of the 2-minute step test were used to determine power. The post-hoc analysis revealed a power of 81%.

Table 2. Pre- and post-training characteristics of women (n=25) that have met criteria.

Characteristic	Indicator	Pre-training	Post-training	p	Cohen's d
Baseline characteristics	Age (years)	70.6 ± 5.1	71.0 ± 4.9	0.798	0.10
	Height (cm)	161.4 ± 7.0	161.1 ± 7.3	0.852	0.04
	Weight (kg)	67.5 ± 9.0	65.3 ± 9.2	0.402	0.25
	BMI (kg/m2)	25.9 ± 3.3	25.3 ± 3.7	0.037*	0.17
Functional tests	Chair stand test (n)	18.9 ± 3.4	17.8 ± 3.6	0.070	0.31
	Arm curl test (n)	25.0 (23.0–27.0)	26.6 ± 4.2	0.154	0.13
	2-minute step test (n)	114.4 ± 10.9	121.4 ± 13.4	0.007*	0.52
	Chair sit-and-reach test (cm)	5.0 (2.0–12.0)	9.2 ± 7.7	0.191	0.20
	Back scratch test (cm)	-0.54 ± 5.7	-1.2 ± 6.0	0.776	0.11
	Foot up and go test (s)	5.2 ± 0.5	5.5 ±0.5	0.011*	0.50

Normally distributed data are presented as mean ± standard deviation. Non-normally distributed data are presented as median and interquartile range, * statistical significance

Our training programme designed for physically active women over 60 years of age induced a statistically significant improvement in aerobic endurance in the 2-minute step-test (p=0.007). The exercises for the development of aerobic endurance prevailed in this programme. This fact might have resulted in a significant improvement in the 2-minute step-test after the completion of the programme in our subjects.

Our training managed to induce significant anthropometric changes – it statistically significantly improved the BMI values (p=0.037), which is most often associated with endurance training and consequently decreases the risk of health problems.

This programme did not result in a statistically significant improvement in strength and balance skills and flexibility. Surprisingly, the training programme caused a decline in the results of the Foot up and go test.

DISCUSSION

Our 8-week multicomponent training programme resulted in a statistically significant improvement in the 2-minute step performance in older women. Moreover, the BMI index significantly decreased after the programme. Surprisingly, significantly longer time to complete Foot up and go test has been observed after the intervention.

The 2-minute step test has been developed as a diagnostic tool to measure aerobic endurance of older adults [21]. Women in our group were physically active, performed regular low-intensity aerobic activities such as walking, cycling and swimming lasting from 30 to 90 minutes a week and organized physical activities twice a week/60 minutes. In other words, they had built a certain level of aerobic capacity before training. Despite this fact, training has led to a significant improvement in 2-minute step test. Aerobic exercises in our programme accounted for approximately 1/3 of all training exercises. Older adults in particular are recommended to perform aerobic exercises to prevent cardiovascular diseases, high blood pressure, diabetes and obesity [22,23]. The WHO recommends to people aged 60 years and above at least 150–300 minutes of moderate-intensity aerobic physical activity; or at least 75–150 minutes of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout the week [6].

Results of our study revealed that 8 weeks of multicomponent training (2 times/week, 60 minutes), was not sufficient to elicit significant changes in strength, balance and flexibility in physically active older women. A review of the research in this field indicates that the length of such programmes ranges from 8 to 16 weeks, with a frequency of 1 to 3 training sessions per week [25-28]. According to Farinatti et al. [28], training length and frequency are important variables in multicomponent interventions. They observed that training programme performed 1 to 3 times a week for 16-weeks improved strength, dynamic balance, flexibility and walking pace in older adults. Fernández-Lezaun et al. [26] found that 3-month multicomponent training with the frequency from 1 to 3 training units/week led to increased maximal strength in older adults. Toraman, Erman and Agyar [27] observed a significant positive effect of their 9-week multicomponent exercise programme on lower and upper limb strength, aerobic endurance and dynamic balance. DiBrezzo et al. [29], found significant changes in the Chair Stand Test, Arm Curl Test, Back Scratch Test, Foot Up and Go Test after a 10-week exercise programme. Timmons et al. [11] concluded that 12 weeks of mixed exercise training is effective in improving a variety of health-related parameters and in increasing walking pace and lower limb strength in older adults. However, it seems that these findings are not universal for drawing conclusions about the effectiveness of multicomponent interventions in terms of the length and the weekly frequency of training units. Except of intervention length and training sessions frequency, studies differ also in training duration, volume, intensity, nature of exercises and training tools used [26-28,30]. It is therefore difficult to compare the results of our study with those observed in other studies.

Interestingly, the comparison of our results with the age-normative score for the individual tests according to Rikli, Jones [19,20] suggests that our participants achieved above average score in most tests before and also after training programme. This can be attributed to the overall good level of physical fitness of our participants. Logically, it is more difficult to achieve significant training gains in trained individuals. This could explain the non-significant changes in most functional test after the training. Therefore, coaches and ageing experts should consider using of more demanding exercises, higher volume, intensity, and/or number of training units, longer duration of the intervention, and/or a combination of these factors when designing interventions for physically active participants.

This study has several limitations. First limitation of this study is a relatively small sample size. Second, our participants completed only one attempt of each test. Third, a control group was not included.

CONCLUSION

The results of our study revealed that 8-week multicomponent training programme with a frequency of 2 training sessions per week improved aerobic endurance and BMI. However, this training did not reveal the significant improvements in other functional and/or anthropometric variables.

Ethics: The study was approved by the Ethical committee of Pavol Jozef Šafárik University in Košice (no. PJSU-0825). Informed consent was obtained from all subjects involved in the study.

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