Research Article

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Effects of multicomponent exercise on metabolic health parameters in elderly

Abstract

Sedentary lifestyle combined with aging is associated with the genesis and development of cardiovascular diseases, Evidence for prescribing exercise in metabolic disorders in young and middle age individuals is overwhelming, but little is known regarding the effect of multicomponent exercise programs on the elderlies' metabolic health. The aim of this study was to analyze changes in blood pressure, lipid profile and cardiorespiratory fitness in a group of sedentary older adults following a two-days weekly multicomponent training (MCT) program (60 min/session). Thirteen elderly (70.77±3.72 years; 72.38±14.39 kg; 8 female) completed 15 weeks of MCT. Tryglicerydes (TG), Total cholesterol (TC), High Density Lipoprotein Cholesterol (HDL-c), Low Density Lipoprotein Cholesterol (LDL-c), blood pressure, and cardiorespiratory fitness were evaluated before and after training. Pre-post results showed significant improvements in cardiorespiratory fitness and blood pressure ($p<0.05$), and a trend to significance ($p=0.06$) for TC. A 2-days MCT short intervention improves metabolic health in sedentary old adults, although this dose (duration and time of training) seems not enough to impact blood lipid profile in this kind of training.

Keywords: aging; cardiovascular health; lipid profile; intervention; physical activity

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Abbreviations: CVD; cardiovascular disease, MCT; multicomponent Training, BMI; body mass index, SBP; systolic blood pressure, DBP; dyastolic blood pressure, TG; triglycerides, TC; total cholesterol, HDL-c; high density lipoprotein cholesterol, LDL-c; low density lipoprotein cholesterol, 6MWT; 6 minute walk test, HR; heart rate

Introduction

The World Health Organization (WHO) revealed that 60–85% of people in the world lead sedentary lifestyles.[1] This is a particularly important problem in the elderly because sedentary lifestyle combined with aging is associated with the genesis and development of cardiovascular diseases (CVD), as well as an increased risk of death from such chronic diseases.[2] This is, indeed, one of the current most serious public health concerns in western countries. On the other hand, there is strong evidence that regular physical activity is associated with improvements in cardiovascular health among older adults,[3,4] becoming an essential tool in providing health and quality of life. There is also evidence with regard to its role in improving functional mobility and reducing risk of disability.[5,6]

In this context, it is interesting to know how the exercise modality can influence the change of different variables. Specifically, some reviews have shown that aerobic training improves cardio-respiratory fitness, metabolic outcomes, blood pressure and the lipid profile.[7,8] But multicomponent training (MCT) has been proposed as an alternative to those traditional walking or endurance training programs, particularly due to its higher impact on functional and neuro-psychological outcomes in older adults.[9] MCT combines aerobic and strength physical exercises, with balance and sometimes cognitive tasks, to reap multiple benefits along with a multisystemic physical activation.[10,11] Notwithstanding, little is known regarding the impact of MCT on blood lipid profile and blood pressure. Some authors[12,13] investigated the effect of this kind of programs on blood lipid profile, and reported a significant reduction in triglycerides (TG) and high-density lipoprotein (HDL-c) serum levels, but none showed significant changes in total cholesterol (TC) or low-density lipoprotein level LDL-c). Likewise, MCT has shown conflicting results when its effect on blood pressure has been studied.[14,15]

Therefore, the aim of this study was to analyse the effect of a multicomponent training program in a population of sedentary older adults on blood pressure, lipid profile and cardiorespiratory fitness. Given the relevance of starting physical activities in sedentary elderly, and the benefits associated with MCT programs in this population, we expect improvements in all these cardiovascular parameters.

Material and methods

Participants and experimental procedure

This quasi-experimental and longitudinal study was carried out in Spain. Twenty-five sedentary elderly people volunteered to participate in this intervention, led and conducted by the local authorities, the general practitioners at the primary health care centre and a team of sport sciences researchers. Inclusion criteria were: (1) ≥65 years old; (2) fit to participate in a regular exercise program according to the medical referral; and (3) currently sedentary (no participation in a regular exercise program or intentional activities beyond normal daily habits within the previous 4 months). After the first screening, 11 individuals didn't meet the inclusion criteria, so 14 sedentary older adults (8 female) took part in the pre-intervention assessments. 1 of them dropped out before the post-test evaluation, so 13 participants finished the 15 weeks of a multicomponent training (7+7 with a week of rest between weeks 7th and 8th). All individuals were previously informed and signed their written consent to participate in this study approved by the ethic committee of the University of Valencia. Health status and medications were stable during the intervention, as monitored by the doctors of the Local Health Center.

Exercise intervention

Exercise intervention consisted of 15 weeks of EFAM-UV© program, based on the *Cognitive Neuromotor Functional Training* Methodology by Blasco-Lafarga et al.[16] This periodized program aims to re-train the main basic skills affected by aging, looking to maintain or even improve the so-called elderlies' *physical literacy* (Whitehead, 2010). EFAM-UV© training sessions integrate mobility, balance, strength, coordination exercises, and aerobic circuits, evolving through the physical exercise continuum from neuromuscular demands to bioenergetics, with cognition as a permanent target. Based on Blasco-Lafarga et al.,[16] participants in the EFAM-UV© program trained twice a week, which was time enough to improve physical and executive function in a similar sample.[11] EFAM-UV© neuromotor training methodology aims to improve two basic skills in the neuromotor re-training of the elderlies: postural control and gait patterns. Manipulative and cognitive skills are also included in a primary level of training (i.e. rough coordination). Later, to increase the demands on executive function and motor control, technicians introduce rhythm and motor skills tasks (complex domains), looking for a more adaptive and precise coordination. EFAM-UV© also sets methodological guidelines to increase the load through the three main directions (bioenergetics, neuromuscular and cognitive) of the re-training/learning process. Other characteristics about this program have been described previously,[10,11,17]

Measurements

Before and after the intervention, weight was evaluated by bioimpedance (TANITA, model BC-545N, Tokyo, Japan), controlling the food intake in the previous hours to reproduce the evaluation conditions. Height was measured using a stadiometer (SECA 222) and body mass index (BMI) was calculated from weight (in kg) divided by height (in meters) squared.

Blood pressure was measured two times on the left arm with the arm tensiometer Omron M3 Intellisense (HEM-7051-E). Systolic and diastolic blood pressure (SBP and DBP, respectively) were retained for further analysis. Blood for biochemical assays was withdrawn from the antecubital vein after an overnight fast. Routine biochemical methods were used for the determination of Total Cholesterol (TC), Triglycerides (TG), High Density Lipoprotein (HDL), Low Density Lipoprotein (LDL) and glucose. All of the analyses were performed using plasma samples.

In order to evaluate cardiorespiratory fitness, participants performed the 6-minute walk test (6MWT).[18,19] They were encouraged to walk following a linear corridor of 30 meters long, with indicator cones every 5 m. They were advised of the remaining time once after 1 minute.[18]

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences, SPSS v24 for Windows. (IBM Inc. Chicago, USA). After testing for normality (Shapiro-Wilk test), variables that did not meet the assumption of normality were analyzed with non-parametric statistics. Paired Student's t-test was used to compare means of continuous variables before and after the training period (BMI, SBP, DBP, TC, HDL, Ratio TC/HDL and glucose); when the variables departed from normality, the Wilcoxon rank test was used instead (TG, LDL and 6MWT). Statistical significance set at the level of $p \leq 0.05$. Finally, the effect size was calculated by means of the Cohen´s d, where the effect was considered small (d =.20-.40), medium (d =.50-.70) or large (d =.80–2.0) according to Cohen.[20]

Results

Table 1 presents the descriptive characteristics of the participants at the beginning of the intervention. Regarding the main effect of the intervention (Table 2), the Student t-test showed a moderate and significant decrease in diastolic blood pressure (T=5.15; p=0.040) and a large and significant decrease in systolic blood pressure (T=2.30; p<0.001). No-significant differences were found for BMI table 2 after the intervention.

Table 1 Sample characteristics

N=13 (8 women)	Mean±SD
Age (years)	70.77±3.72
Weight (kg)	72.38±14.39
Height (cm)	159.31±8.52
SaO_2 (%)	97.31±1.11
HR (bpm)	74.31±10.75

Table 2 Effects of the MCT on blood pressure and BMI

N=13 (8 women)	PRE	POST	Effect size
	Mean± SD	Mean±SD	
BMI (kg/cm²)	28.32±4.14	28.22±3.76	-0.02
SBP (mmHg)	141.46±18.14	122.69±13.57*	-1.17
DBP (mmHg)	81.85±7.57	77.31±9.19*	-0.54

*p<0.05

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Table 3 shows plasma lipid and lipoprotein concentrations before vs. after the training period. Comparisons showed no significant differences in any of the biochemical parameters with the exception of TC that showed a trend to significance with a small effect size.

As illustrated in figure 1, the multicomponent exercise program resulted in a significant (p=0.003) improvement in aerobic endurance capacity as evidenced by 6MWT performance with a moderate effect size (504.77±46.75 vs 548.62±68.89; d=0.69).

Table 3 Effects of the MCT on blood lipid profile

N=13 (8 women)	PRE	POST	Effect size
	Mean±SD	Mean±SD	
TG (mg/dl)	128.77±74.02	124.31±71.41	-0.06
TC (mg/dl)	191.00±24.37	180.24±36.40¥	-0.35
HDL (mg/dl)	61.00±15.79	57.77±13.83	-0.22
LDL (mg/dl)	104.25±21.67	97.6±26.93	-0.27
Ratio TC/HDL	3.34± 1.01	3.25±0.89	-0.09
Glucose (mg/dl)	92.15±16.48	91.31±4.58	-0.07

¥p=0.065

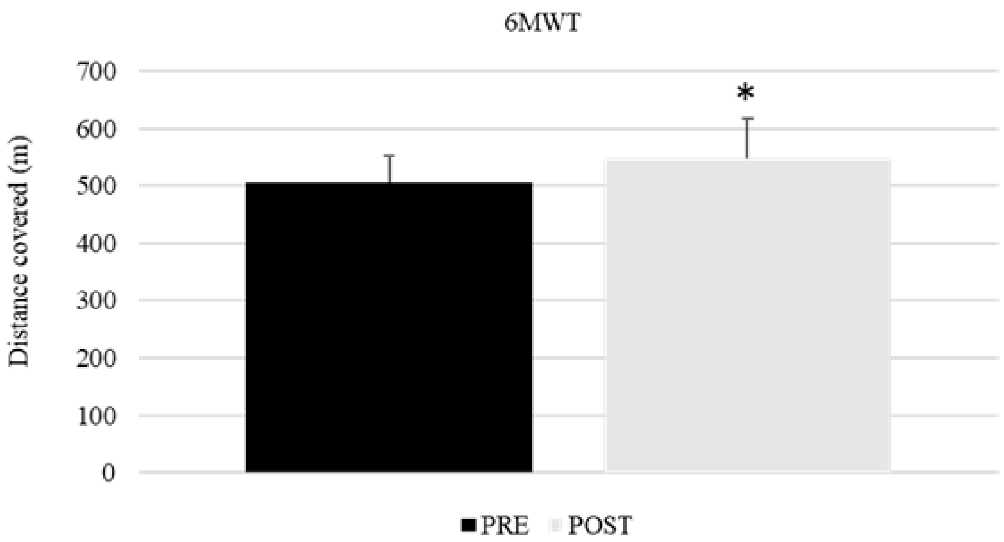

Figure 1 Pre-post changes in the 6 minutes walking test.

Discussion

Specifically, this study analyses the effect of a multicomponent training program carried out by professional physicians in sedentary elderly. Our results suggest that tailored and properly periodized physical practice improves blood pressure and cardiorespiratory fitness. However, we did not find any significant change of the intervention in blood lipid profile and BMI. Likewise, BMI results alone should be interpreted with caution because this variable does not distinguish between lean mass and fat mass and may not fully reflect produced changes in body composition.[21]

On the one hand, we found a significant reduction in SBP and DBP. Moraes and others[15] found out significant improvements after 12 weeks of MCT (twice weekly), both in SBP (3.6%) and DBP (1.2%), whilst enhancements in EFAM-UV© were 13% in SBP and 6% in DBP, with the same weekly training frequency. Conversely, Leite and others (14) did not show changes neither SBP nor DBP after 12 weeks of MCT, although this intervention had less endurance training. These greater percentage reductions could be explained by the effect of exercise on groups with high level of blood pressure before the training, as Moraes and others (15) pointed out. Exercise prescription guided to the prevention or treatment from hypertension need endurance and strength exercises,[22] and a fundamental aspect from EFAM-UV© training is its periodization: from the strength requirements (initial mesocycles) to bioenergetic tasks in the last mesocycles,[16] thus helping to get greater improvements on blood pressure outcomes. Importantly, these changes have occurred with a relatively short exercise intervention as compared to others. For example, Rosa et al.,[23] also found out significant improvements in sedentary older adults, but after 6 months of concurrent training.

On the other hand, in the present study no changes in blood lipids levels were found after the MCT program, despite other authors have shown a decrease in triglycerides and an increase in HDL,[12,13] with changes between 2% and 9%. In our case, only TC diminished about 5% (with a trend to significance), with no impact on BMI. Other studies have also reported such a lack of change in blood lipids levels.[14] It's possible that a key for improving metabolic parameters can be resided in the intensity of exercise, since high intensity interventions promote more accentuated changes than moderate intensity interventions.[24] Although physical exercise produces hormonal changes that contribute to lipolitical activity, large amounts of adipose tissue appear to blunt this metabolic response (circulating levels).[25] In this sense, although beneficial effects from our intervention about lipidic balance can seem scarce, any small reduction from these markers (joint to the reduction of blood pressure values) should be taking into account, because it could contribute to minimize the risk of mortality and comorbidity in this population.[8]

Regarding results of 6MWT, we found significant and important improvements in cardiorespiratory fitness, in line with previous interventions. For example, Heubel et al.,[26] found out improvements close to 6%, after 16 weeks of multicomponent training; Taguchi et al.,[27] achieved enhancements of 18% but in 12 months; and Vaughan et al.,[28] obtained improvements with a greater effect size (d=1.7) compared to EFAM-UV©, with similar training weeks (16 weeks). One of the reasons of these differences could be the fact that Vaughan et al.[28] dedicated more minutes to endurance training from the start of the intervention, whilst bioenergetic domain appears in EFAM-UV© in the late mesocycles (when participants are able to maintain a correct postural and a certain level of cognitive motor control). In addition, the use of cognitive constraints in EFAM-UV© dual tasking methodology might be reducing the metabolic intensity and thus its impact on these cardiovascular parameters in the short term.

Study limitations include the lack of nutrient intake assessments and a small sample size. Although subjects were instructed to maintain their normal dietary routines throughout the protocol period, this was not strictly controlled. Besides, we did not include a control group who did not exercise. This was intentional from an ethical point of view because we considered the evidence of physical exercise impact on physical function in sedentary older adults. On the other hand, this was the first exercise training intervention in the Local Health Centre, and the sanitary staff was not trained in the recruitment of elderly individuals. In addition, and as already mentioned, the dose of this intervention (60 min x 2 days weekly) may be insufficient to impact on the lipids profile for a cognitive MCT such as EFAM-UV© in the short term (15 weeks). Further studies are thus needed in order to ascertain whether the observed changes were mostly due to exercise rather than due to other possible concurrent factors.

In summary, MCT improved blood pressure and cardiorespiratory fitness in sedentary old adults. However, limited significant changes were observed in lipid biochemical markers. Some studies have indicated that as age increases, the improvements caused by physical exercise are less evident for programs that have a single task-orientation.[29] In this sense, multicomponent interventions, which are aimed simultaneously at the improvement of several aspects of the function without losing sight of the physiological and psychological perspective of the changes, are key in the beginning of the physical practice to later move on to work on more specific deficits.

Conclusion

In conclusion, 15 weeks of a cognitive MCT failed to have an impact on markers of metabolic health in healthy older adults, regardless the positive effects observed on blood pressure and cardiorespiratory fitness.

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Conflicts of interest

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