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Effects of a Moderate-intensity Walking Program on Blood Pressure, Body Composition and Functional Fitness in Older Women: results of a pilot study

Flávia Accioly Canuto Wanderley[1], José Oliveira[1], Jorge Mota[1] and Joana Carvalho[1]

[1]CIAFEL, Faculty of Sport, University of Porto, Porto, Portugal

Objective: The positive impact of regular physical activity among older adults is well recognized. However, few studies have assessed the effectiveness of walking exercise programs in older women with regard to their impact on physical fitness, body composition and resting blood pressure. Therefore, the aim of this pilot study was to evaluate the effects of a moderate-intensity walking program on the physical fitness body composition and resting blood pressure of older women. ***Design:*** Twenty-two older women (71.4±5.9 years; BMI= 27.7±2.6) not in the habit of regularly exercising volunteered to participate in this study. Subjects were evaluated at three distinct points in time: at baseline, after four months with no exercise, and after participating in a four month walking program. Habitual physical activity, blood pressure, heart rate, body composition (DXA) and physical fitness (Senior Fitness Test) were assessed each time. Training consisted of a 10 minute warm up, 30 minutes of walking at an intensity corresponding to 50-70% $HR_{Reserve}$ and ending with a 10 minute cool-down. ***Results:*** After walking, data demonstrated: i) a mean reduction of 12mmHg ($p = 0.001$) in the women's systolic blood pressure; ii) improvements of 5 repetitions ($p < 0.001$) on the muscular endurance of the lower limbs; iii) however, there were no significant alterations after the walking program on body composition variables. ***Conclusion:*** These findings suggest that a four month's walking program with progressive duration and moderate intensity is able to improve the blood pressure of older women and the muscular endurance of the lower limbs.

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Key Words: older adults, risk factors, functional fitness, aerobic training

INTRODUCTION

The likelihood of having a cardiovascular disease (CVD) is substantially higher in older individuals compared to younger ones, reflecting the effect of age as a cardiovascular risk factor and the increased prevalence of other antecedents of CVD in this age group (25). Despite the fact that cardio-respiratory fitness is not considered as an independent risk factor for CVD, it has been consistently reported that the risk for CVD is greater for the least fit individuals (6, 11, 15, 26, 30). Moreover, impairments to fitness are responsible for the inability to carry out activities of daily living which can lead to a loss of independence, reinforcing sedentary behaviours (14). Therefore, sustaining older adults' ability to live independently as well as reducing blood pressure (BP) and body weight via healthy lifestyle interventions are very important goals of public health, geriatrics, and gerontology.

To promote general health, guidelines and recommendations (3, 13, 40) for physical activity encourage adults to meet or exceed thirty minutes of moderate-intensity physical activity "most" days of the week. Unfortunately, the majority of older adults do not meet this recommendation. In Women's Health and Aging Studies I and II, just 12.7% of the women, aged 70-79 years, met the recommended guidelines for activity (21). Alarmingly, the Centre for Disease Control and Prevention (12) reported that 39.2% of women aged 70 and older have no leisure time physical activity.

Walking is an accessible form of physical activity and is a means of transportation for the vast majority of

Corresponding author:
Flávia A. C. Wanderley: Faculty of Sport, University of Porto, Portugal, Rua Dr. Plácido Costa, 91, 4200-450 Porto, Portugal • Phone: 00351225074785 • Fax: +351 225 500 689 • Email: flaviacanuto@gmail.com

people regardless of age, gender and social status (36, 46). Furthermore, habitual walking (20, 31), brisk walking and walking programs (16, 42) seem to be effective in improving overall functional fitness and the profile for cardiovascular risk factors (CRF). However, the duration and intensity of walking needed to achieve optimal health-related benefits has not always been well controlled in the studies using interventional programs aiming to modify health-related outcomes, including cardiovascular risk factors and/or functional fitness associated with daily-living activities. In some of these studies, the interventional programs were home-based and lacking close control of walking intensity or duration (31). On the other hand, walking programs conducted in laboratory environment (18-19, 33) may not correspond to a natural walking pattern that could be incorporated in lifestyles of older women.

In this way, while the positive impact of regular physical activity among older adults is well recognized, the effects of supervised exercise programs, based mainly on walking with a progressive duration at a moderate intensity are less well known. Considering all the arguments mentioned above, the aim of this pilot study was to evaluate the effects of a moderate-intensity walking program on older women's physical fitness, body composition and resting BP. We hypothesized that a supervised walking-based exercise program with a progressive duration and moderate-intensity would be effective in improving physical fitness, body composition and resting BP of older women.

MATERIAL AND METHODS

Participants and Study Design

The study design is presented in figure 1. Community-dwelling and independent older women were recruited in the Porto area through advertisements in newspapers. At the screening, participants completed a health history questionnaire to record past and present conditions and medications.

The selection criteria of the sample were the following: (i) older than 64 years; (ii) not have participated in regular exercise training in the previous six months, which means not having been involved in supervised exercise of moderate to vigorous intensity for 20 minutes or more at least twice a week; (iii) no present acute or terminal illness; (iv) no severe or uncontrolled hypertension or any cardiovascular and/or respiratory disorder; (v) no neurological, skeletal-muscular or joint disorder or disturbance that precludes participation in exercise; (vi) not be under pharmacological therapies that could compromise safety during exercise or influence the responses of cardiovascular function.

Thirty-one women volunteered to participate in the study. From these, nine subjects were excluded because they didn't fully meet the selection criteria. Thus, only twenty-two women (aged 71.4 ± 5.9 years, BMI= 27.7 ± 2.6) initiated the study protocols.

Those included in this longitudinal study acted as their own control by taking part in a four month control period followed by the four month walking program, comprising 48 sessions. An attendance rate of at least 80% of the previewed walking sessions had to be accomplished by the subjects in order to consider the training program complete. Additionally, older women who were absent for eight or more consecutive sessions were also excluded.

Data were collected for all variables at baseline (M1), after the four month control period (M2), and finally, at the end of the four month walking program (M3).

In order to characterise participants' habitual physical activity and to identify possible changes in this potential confounder during the study period, a questionnaire based on the Baecke questionnaire (4) and validated for older populations (45) was applied to all the subjects at three points in time. Participants were instructed not to change their daily physical activity routines or dietary patterns during the course of the study.

According to the Helsinki Declaration, the nature, benefits, and risks of the study were explained to the volunteers, and their written informed consent was obtained. All methods and procedures were approved by the Institutional Review Board.

Training Protocol

The length of the walking program was three times/week for four months, with each exercise session lasting approximately fifty min. Training workouts consisted of a ten minute warm-up, thirty minutes of walking at an intensity corresponding to 50-70% HRreserve, and ending with a ten minute cool-down.

In order to raise the subject's functional fitness so that they were able to sustain thirty minutes of continuous walking at the targeted intensity, the training load was gradually increased during the first four weeks. The walking duration in the first session was fifteen minutes at 50-70% HRreserve, and it was increased by five minutes each week until subjects were able to walk continuously for thirty minutes (week 4). In order to be sure that the subjects were exercising at the targeted intensity, Polar Heart Rate Monitors (Polar Team System, Finland) were used.

Measurements

During assessment, the test administrator and the time of day used for collection remained constant.

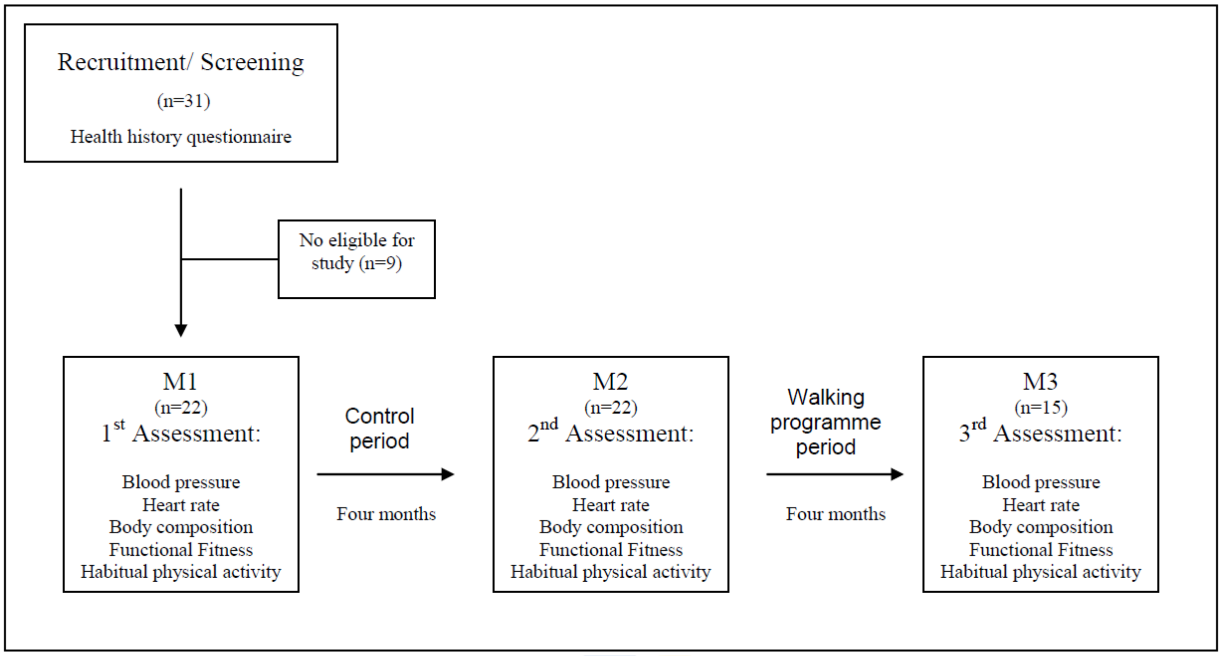

Figure 1. Study Design.

Anthropometrics and Body Composition

Body weight was measured to the nearest 0.1kg with an electronic weight scale (SECA 708). Subjects were weighed barefoot wearing light clothing. Height was measured to the nearest 1mm with a standard stadiometer.
Body Mass Index (BMI) was determined as weight divided by height squared (kg/m2).
Whole body lean mass (LM), percentage of total body fat (%BF) and trunk fat were determined by whole body scan using a Dual-energy X-ray Absorptiometry (DXA – Hologic QDR-4500, software for Windows XP, version 12.4) with subjects in the supine position. All scans were analyzed by the same investigator. The rationale of body composition analysis with DXA is described elsewhere (22).

Blood Pressure and Heart Rate

Resting BP and heart rate (HR) were measured in the right arm with an automated blood pressure monitor (Colin, DP 8800). After being at rest for fifteen minutes in an upright seated position in a quiet, temperature-controlled room, BP measurements were taken with the subjects seated in an upright position with the arm comfortably placed at heart level. The average of three measurements for SBP, DBP, and HR were entered as data. The measurements were performed between 8:00 am and 11:00 am, by the same investigator.

Questionnaire (Habitual Physical Activity)

Daily Physical activity (PA) levels were assessed using the Baecke modified physical activity questionnaire (45), which has been shown to generate valid and reliable classification scores for activity in older subjects. The questionnaire evaluates and generates scores of household activities, sporting activities and other physically active leisure time activities, altogether resulting in a physical activity score. The questionnaires were completed by the same researcher during a personal interview.

Physical Fitness Assessment

The Senior Fitness Test (SFT) (the eight foot up and go to) was used to assess physical fitness (39). This battery consists of 6 assessment items, designed and validated ($0.77 \leq r \leq 0.83$) to assess the physiological parameters that support physical functionality and mobility in older adults (39). The test items include lower body muscular endurance (thirty second chair stand), upper body muscular endurance (thirty second arm curl), aerobic endurance (six minute walk test), lower body flexibility (chair sit-and-reach), and dynamic balance and agility (the eight foot up-and-go to assess) (14). In our laboratory, the test-retest reliability for SFT was established in 15 subjects (68.6 ± 5.8 years; BMI=27.6 ± 3.0 Kg/m2) tested in two sessions separated by 12 days; all tests showed good reliability ($0.92 \leq ICC \leq 0.96$).
All test stations were organized in a circuit, and the

Table 1. Weight, Percent Body Fat (%BF), Trunk Fat, Lean Mass (LM), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Heart Rate (HR): Mean ± SD on different moments (M1, M2, and M3).

Outcomes	M1	M2	M3	Overall *F* values	Overall *p* values
Weight (kg)	66.1 ± 7.4	64.3 ± 6.1	63.4 ± 6.6	0.111	0.895
%BF	38.9 ± 4.1	40.2 ± 3.9	39.5 ± 4.2	0.077	0.926
Trunk Fat (kg)	11.63 ± 3.02	13.01 ± 3.30	13.06 ± 3.23	0.860	0.431
LM (kg)	39.96 ± 3.70	38.86 ± 3.55	39.64 ± 3.78	0.354	0.704
SBP (mmHg)	142.8 ± 11.1	136.1 ± 14.0	124.1 ± 12.4†‡	7.964	0.001
DBP (mmHg)	75.1 ± 4.8	70.5 ± 3.9*	65.3 ± 4.8†‡	8.418	0.001
HR (bpm)	66 ±10	68 ±12	68 ± 9	0.250	0.780

* Significant difference from M1 to M2 (p<0.05); †Significant difference from M1 to M3 (p<0.05); ‡Significant difference from M2 to M3 (p<0.05).

same conditions were maintained for each test at all testing periods. On the testing days, subjects first completed an eight to ten minute warm-up led by a physical education instructor and then completed all the test items.

Statistical Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS, version 16) for Windows. The Shapiro-Wilk test was used to ascertain the normality of data distributions on all variables. One-Way ANOVA for repeated measures was used to compare means across time. The Tukey test was used for Post-hoc comparisons. The 0.05 level of probability was accepted as significant. Post hoc power analyses were performed to verify the effect size f on dependent outcomes included in this study, using G Power 3 for Windows (17).

RESULTS

Of the 22 participants who underwent the initial assessment, two subjects were excluded from the study because they exceeded a 20% rate of absence and one subject failed the post-training assessment. Therefore, compliance was 86.4%, meaning that 19 individuals with a mean age of 71.4 ± 5.9 years completed the program.

Of the 19 women, three have diagnosed osteoporosis, six are hypertensive (controlled by angiotensin-1 converting enzyme inhibitor – n=3, and diuretics – n=3), three have controlled dislipidaemia (under statins), and one is diabetic (controlled). Two are taking medication for depression, and one is undertaking hormone replacement therapy.

At baseline, the women presented 142.8 ± 11.1/ 75.1 ± 4.8mmHg for SBP and DBP, respectively (table1). Considering their mean baseline BMI (27.7 ± 2.9 Kg/cm²) values they are classified as overweight. At the fitness assessment, they had performed at or above normative values (38) in the greater part of the tests (table 2). No significant changes were observed in body weight, %BF, trunk fat, LM or HR across the eight months, but significant decreases in SBP and DBP were detected (table 1). The mean SBP at the end of the program (M3) was significantly lower than the SBP at M1 and M2. A different pattern was observed for the mean DBP, which lowered across the three time points (table 1).

Physical fitness performance was maintained or significantly decreased (upper body muscular endurance) between M1 and M2 (table 2). On the contrary, between M2 and M3, significant improvements were found on lower body muscular endurance.

Physical activity patterns did not change between M1 (2.77 ± 1.59) and M2 (3.23 ± 2.56). As was expected, between M2 and M3 (5.61 ± 1.64) a significant increase (2.38; p<0.001) in the total amount of older women's physical activity was observed. However, when we subtracted the walking program score of each participant's total score, the physical activity score differences disappeared, which means that the observed increase in total physical activity corresponds to the addition of the walking program to the women´s routine.

Table 2. Physical Fitness: Mean ± SD on different moments (M1, M2, and M3).

Physical Fitness Components	M1	M2	M3	Overall *F* values	Overall *p* values
Lower body muscular endurance (reps)	13.6 ± 2.2	13.9 ± 2.7	18.3 ± 2.3†,‡	16.465	<0.001
Upper body muscular endurance (reps)	21.1 ± 3.8	16.7 ± 1.4*	18.3 ± 2.3	5.929	0.006
Lower body flexibility (cm)	-9.5 ± 9.1	-4.8 ± 11.1	-0.88 ±4.7	2.414	0.103
Upper body flexibility (cm)	-6.32 ± 12.1	-6.4± 12.4	-5.4 ± 8.6	0.036	0.964
Dynamic balance and agility (sec.)	5.76 ±1.0	6.62 ± 1.1	6.3 ± 0.9	0.515	0.602
Aerobic endurance (m)	471.9 ± 51.2	493.2 ± 56.8	485.7 ± 58.1	0.072	0.931

* Significant difference from M1 to M2 (p<0.05); †Significant difference from M1 to M3 (p<0.05); ‡Significant difference from M2 to M3 (p<0.05).

Post hoc power analysis for a sample size of 19 subjects, setting α as 0.05, with a power of 1.0 obtained an effect size f of 1.45; 1.52; 0.41; 0.65; 0.95; 0.85; 1.14; 2.20; 1.31, for SBP, DBP, weight, %BF, trunk fat, lean mass, lower-body flexibility, lower-body strength, and upper-body strength, respectively. Adopting α=0.05 with a power of 0.99 agility/balance demonstrated an effect size f of 0.557. Adopting α=0.05 with a power of 0.191, upper-body flexibility demonstrated an effect size f of 0.20. Finally, adopting α=0.05 with a power of 0.54 aerobic fitness obtained an effect size f of 0.24. These results from the post hoc power analysis demonstrate that this sample size of 19 subjects (adopting α=0.05) was large enough to detect medium to large effects in almost all outcomes (with the exception of Upper-body flexibility and Aerobic fitness).

DISCUSSION

The main findings of this pilot study are that a simple and feasible moderate-intensity walking program has beneficial and significant effects on older women's lower body muscular endurance and blood pressure (SBP and DBP). Walking is a popular form of moderate-intensity physical activity that has been linked with many health benefits (34). Despite the epidemiologically strong evidence, only a few experimental studies have observed the effects of moderate-intensity walking on older women's functional fitness, body composition and resting blood pressure.

Similar to other investigations (42), the present study demonstrated that thirty minutes of moderate-intensity walking, three times/week was able to improve important components of physical fitness, namely, muscular endurance in the lower limbs. This is of importance since greater age-related declines in muscle strength of the lower extremities compared to the upper extremities have been described in previous studies (9, 27). Moreover, deficits in lower limb strength, muscular endurance and power are closely related to functional limitations (10), such as impairments to the ability to walk (5), getting in and out of a chair, the speed of climbing steps, and the number of falls in older adults (10). Besides this important fitness improvement, no statistically significant differences were found in the other physical fitness components evaluated.

Many studies have demonstrated that endurance training is effective in improving fitness (19, 34, 37, 47). However, these studies differ from the present one in many aspects such as the subjects' age (34, 47) and gender (41), volume and/or intensity of training (19, 34, 37) and the type of exercise (47). In this way, the lack of significant improvements in those functional fitness components after walking training could be due to different reasons: (i) lack of specificity of the stimulus for these components and (ii) the relatively high conditioning of the sample before the start of the training period. Moreover, concerning aerobic fitness, Kervio et al. (23) observed a learning effect (increase of ~21m) between the first and second six minute walk test trials. These authors highlighted the necessity of a familiarization to the six minute walk test, intending to limit the skill effect in healthy elderly subjects. The American Thoracic Society also suggested in its Institutional Guidelines for the six minute walk test an extra trial to minimize intraday variability (2). The authors strongly believe that this was the main reason besides the improvement (non significant) in the six minute walk test between M1 and M2 and the lack of significant improvement between M2 and M3. Unfortunately, extra trials were not performed in this pilot study. But, authors strongly recommend that next researchers adopt at least an extra trial before the real six minute walk test has been conducted.

Results show a gradual decrease in SBP and DBP across the eight months. The not expected (and non significant) differences observed in blood pressure between M1 and M2 could be attributed to the "White coat effect". This term refers to an alert reaction which increases basal blood pressure in some individuals (43). The white coat hypertension is a common finding in the population at large (35) but the difference between clinic and ambulatory blood pressure seems to be more pronounced in older patients (1). Generally, the white coat effect occurs in clinical settings but it also happens in response to the environment of the measurement (35). Once, since the subjects did not know the place and the evaluators at baseline, it is not uncommon to observe some kind of nervous and anxiety. Finally, we want to reinforce that the difference in SBP between M2 and M3 was about -12mmHg, almost twice the difference observed between M1 and M2 (7mmHg). The authors do not believe that such a decrease in blood pressure (12mmHg) would happen if no interventions (i.e., exercise, diet or medication change) were implemented. Subjects did not refer any change in medication during the eight months and they attested that they did not alter their nutritional habits. Thus, their changes in exercising habits seem to be the plausible mechanism to lower blood pressure levels between M2 and M3. In agreement with this idea, previous studies (21, 42) described a decrease in SBP and DBP after training. Increased SBP and decreased DBP are characteristic of an aging population (8). On the other hand, as observed in our study, exercise seems to counter-act these age-related alterations, especially on SBP (32-33). Although the mechanisms underlying the lowering effect of exercise on SBP are not fully understood, neuro-hormonal (7, 36), structural (vascular remodelling and angiogenesis) and functional vascular adaptations were recently proposed as possible mechanisms (36). As functional adaptations, it was suggested that aerobic training may possibly: (i) reduce sympathetic nervous activity and the subsequent release of norepinephrine (7), (ii) lower endothelin-1 levels (28), and (iii) increase nitric oxide production (38, 40), together, therefore, reducing vasoconstriction and peripheral vascular resistance (7, 29).

However, despite the fact that the depressor effect of exercise on BP has been attributed to factors such as body composition, many studies (32-33), such as the present study, suggest that, independent of body weight and/or adiposity changes, exercise is effective in lowering BP. Nevertheless, some studies have found significant weight or body fat reductions (19, 41); the majority of them found, as in the present study, minimal (18, 37) or no changes at all (24, 33). These studies, which reported significant changes in body composition, had a greater training volume (≥3 hours/week) and duration (28-52-weeks) than ours. Furthermore, although subjects were instructed to maintain their normal dietary routines throughout the protocol period, this was not strictly controlled. So, it is possible that the participants in our study increased their energy intake in response to the energy demands of exercise training. Although the walking program could not improve body composition, upper body muscular endurance, aerobic endurance, upper and lower body flexibility, dynamic balance and agility in a statistical way, the fact that it could potentially attenuate the decrease in fitness and the increase in body fat mass observed in normal aging merits attention.

The major limitations of this pilot study are: (i) the lack of extra trials before the “true” six minute walk test; (ii) the lack of concurrent measures of dietary habits and food consumption; (iii) self-reported physical activity is a subjective measure that may have been influenced by cognitive status and perceived mastery (44); (iv) our study population was small and limited to healthy old women and thus cannot be considered representative of a normal aging population; and finally (v) there was no separate or randomized control group. Hence the change in the outcomes cannot be fully attributed to the walking intervention.

Considering the above-mentioned limitations, the findings of this pilot study lead us to conclude that a moderate-intensity walking program can improve lower limb muscular endurance and can lower blood pressure. However, for future research, we recommend a larger sample, the use of different intensities and duration protocols, and an investigation of other outcomes related to CVD risk factors in order to make a stronger relationship between exercise and more favourable cardiovascular health in community-dwelling older women possible.

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