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SHORT REPORT

Cardiovascular program to improve physical fitness in those over 60 years old – pilot study

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Background: In Spain, more than 50% of 60-year-olds are obese. Obesity is a disease with serious cardiovascular risks. The mortality rate for cardiovascular disease in Spain is 31.1%.

Objectives: To improve aerobic fitness, strength, flexibility and balance, and body composition (BC) in persons over 60 years old.

Materials and methods: A clinical intervention study of 24 participants was carried out over a period of 3 months. Aerobic fitness was assessed using the Rockport 1-Mile Walk Test. Upper-body strength was evaluated with an ad hoc test. Flexibility and balance were evaluated using the Sit and Reach Test and the Stork Balance Stand Test, respectively. Anthropometric measurements were taken by bioelectrical impedance.

Results: After 3 months of training, aerobic fitness was improved, as demonstrated by improved test times (pretest 13.04 minutes, posttest 12.13 minutes; $P<0.05$). Body composition was also improved, but the results were not statistically significant (fat mass pretest 31.58%±5.65%, posttest 30.65%±6.31%; skeletal muscle mass pretest 43.99±9.53 kg, posttest 46.63±10.90 kg).

Conclusion: Our data show that in subjects over 60 years old, aerobic fitness was improved due to program intervention. However, these results should be treated with caution, because of the limited sample size and the brief time period of this pilot study. A more rigorous study would include a sample of at least 100 participants.

Keywords: Rockport 1-Mile Walk Test, IPAQ, Sit and Reach Test, Stork Balance Stand Test, bioelectrical impedance and strength

Introduction

Obesity is the second-leading cause of preventable death. It has been shown that inactivity and obesity have a positive correlation with certain health problems, ie, hypertension, hypercholesterolemia, diabetes mellitus, heart disease, and other chronic degenerative diseases (eg, metabolic syndrome, cancer, arthrosis).[1] Clinical intervention programs address these problems by reducing obesity and inactivity. In Spain, older people have become more aware of the benefits of the continued practice of physical activity (PA).

Aging is accompanied by a gradual and inevitable deterioration of physical capacities. In addition, certain degenerative diseases, which manifest themselves over a period of years,[2] are more commonly seen in the elderly, and also result in decreased physical capacities. These physical capacities are related to body composition (BC), ie, fat mass (FM) and skeletal muscle mass (SMM).[3,4] For example, with obesity, we see an increase in FM, and with sarcopenia, a loss of SMM. Both phenomena result in decreased strength and aerobic capacity.[5,6]

PA such as aerobic and resistance exercises, prevent the ordinary reduction in the size and number of muscle fibers (sarcopenia).[7–9] Regular, vigorous PA also prevents

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loss of bone mass and thus osteoporosis.[10–13] Finally, PA improves quality of life due to the reduction of FM and obesity,[10] and as a result allows the individual to enjoy a more independent lifestyle.[2,11]

The aim of this study was to assess the loss of weight and FM, and the gain of SMM, strength, aerobic fitness, flexibility, and balance in Spanish people over 60 years old during a 3-month pilot intervention study.

Materials and methods

Participants

Twenty-four participants (nine men and 15 women) volunteered for this pilot study. They were from the south of Spain (Malaga). Subjects were briefed on the experimental procedures, completed a medical history form, and signed an informed consent statement. Participants were recruited through advertisements at Malaga University. Inclusion criteria were the age of the participants – more than 60 and less than 70 years old – because for this age-group, it is very important to gain health benefits and to improve life quality. Exclusion criteria were having a chronic disease, taking medications, and limited functional mobility. The aim of the participants was to lose FM and improve cardiorespiratory endurance. Six participants dropped out due to continued absence in the program. Power calculations showed that the sample size necessary was 52 participants (0.80 coefficient intraclass). Our sample was 24 participants, so the conclusions obtained in this pilot study should be considered with caution.

Instruments and tests

Instruments

An SC-330 portable BC analyzer (Tanita Corporation, Tokyo, Japan) was used to measure BC (by bioelectrical impedance), FM, SMM, bone mass, fat-free mass, waist circumference, and basal metabolism.[14] Waist circumference was measured with an inelastic plastic-fiber tape measure (Prym Consumer USA Inc., Spartanburg, SC, USA) placed directly on the skin while the subject stood balanced on both feet, with the feet touching each other and both arms hanging freely. The measurement was taken at the end of expiration. Before a reading was taken, specific attention was given to placing the tape perpendicular to the long axis of the body and horizontally to the floor. All participants performed this test under the following pretest restrictions:

- Do not eat or drink for at least 4 hours prior to testing.
- Do not practice any PA for at least 4 hours prior to testing.
- Do not consume alcohol for at least 24 hours prior to testing.
- Empty bladder 30 minutes before testing.
- Remove any metal objects, such as jewelry, watches, etc.

International Physical Activity Questionnaire

The International Physical Activity Questionnaire (IPAQ) assesses the level of PA according to the intensity of exercise and the number of training days per week.[15] The questionnaire is recommended for people between 15 and 69 years old. It contains seven questions (short version), and quantifies all activities (such as work, leisure time, home activities) in metabolic equivalent of tasks (METs). A MET is the unit of measurement of metabolic rate, and is defined as the amount of heat emitted by a person in a sitting position per square meter of skin. We followed the test protocol to calculate results, which are shown in Table 1.[16] This questionnaire has been validated for older Spanish people.[17]

Rockport 1-Mile Walk Test

This is a submaximal aerobic-capacity test to estimate maximal oxygen consumption (VO_{2max}). The successful performance of this test requires a fast walk (not run) for 1 mile (1,609 m) in the shortest time possible.[18] The test has been validated by Kline et al.[19] To calculate the effort variable, it is necessary to note the age (years), height (centimeters), weight (kilograms), maximum heart rate (HR; beats per minute, measured at the end of the test), and total test time. The complete equation differs according to sex: women, $VO_2 = 154.899 - (0.0947 \times 2.2046 \times \text{weight}) - (0.3709 \times \text{age}) - (3.9744 \times \text{time}) - (0.1847 \times \text{HR})$; men, $VO_2 = 116.579 - (0.0585 \times 2.2046 \times \text{weight}) - (0.3885 \times \text{age}) - (2.7961 \times \text{time}) - (0.1109 \times \text{HR})$.

Sit and Reach Test

The Sit and Reach (SR) Test quantifies the degree of elasticity of the lower back and hamstring muscles (Table 2). This test has been validated by Jones et al.[20] The SR Test was performed following the procedures specified in the American College of Sports Medicine (ACSM) manual.[9] The participant sits on

Table 1 Test-calculation short-form International Physical Activity Questionnaire in metabolic equivalent of tasks (METs)[15]

Activity	Calculation
Walking	3.3 METs × minutes × number of days
Moderate PA	4 METs × minutes × number of days
Vigorous PA	8 METs × minutes × number of days
Total PA	Sum of walking + moderate + vigorous MET-minute/walk scores

Abbreviation: PA, physical activity.

Table 2 Categories of the Sit and Reach Test data

Category	Men (cm)	Women (cm)
High excellent	>27	>30
Excellent	17–27	21–30
Good	6–16	11–20
Mean	0–5	1–10
Regular	–8 to –1	–7 to 0
Poor	–20 to –9	–15 to –8
High poor	<–20	<–15

the floor with the right leg fully extended and the right foot flat against a box that is 30.5 cm high by 60 cm long by 27 cm wide. The left knee is bent, with the sole against the medial border of the extended knee. The participant extends their arms forward, with palms down sliding down the measuring scale as far as possible.

Ad hoc strength test

This test required participants to perform 15 repetitions on the quadriceps extension machine (men, 30 kg; women, 25 kg). After completing the test, subjects were asked to rate their perceived exertion (RPE) according to the category ratio 10 scale.[21]

Stork Balance Stand Test

This test measures balance on one foot. With the subject barefoot on a carpet and hands at the waist, one foot is placed on the inside of the knee of the other leg (support). Time begins when the participant lifts one foot off the ground.[22] The time ends when one or both hands separate from the waist, the support foot changes position (moves), or the foot resting on the opposite knee loses contact. Categories of the Stork Balance Stand Test are explained in Table 3.

Procedure

This study was initiated in October 2010. The execution of the test battery proposed in this study was carried out in three sessions. The program duration was 90 days (3 months), with the requirement to attend three times a week for 60 minutes each workout.

Table 3 Categories of the Stork Balance Stand Test

Category	Seconds
Excellent	>50
Good	40–50
Mean	25–39
Regular	10–24
Poor	>10

Session 1

In this session, we explained to the subjects the aim of our research and that participation was voluntary. Informed consent was signed, and we explained the protocol for the assessment of BC. Participants completed the IPAQ (short) and performed the SR Test preceded by a formal warm-up (10 minutes of cycling).

Session 2

During the second training session, we proceeded with the assessment of BC, Stork Balance Stand Test, and ad hoc strength test (preceded by the same warm-up).

Session 3

During the last session, we performed the Rockport 1-Mile Walk Test (preceded by the same warm-up). After the assessment sessions, we started the intervention-training program. We followed the protocol prescribed in the ACSM manual.[9] Contents were treated as upper- and lower-body strength exercises, flexibility, and aerobic capacity. The frequency of sessions was three times a week in the afternoon, lasting 60 minutes per session. The intervention-training program was planned by the same trainer/researcher. The program had a 90% attendance rate during this period. This rate was very important in this first phase to achieve the objective of the study. This study was approved by the Ethics Committee of the University of Malaga and the participants signed informed consent forms agreeing to participate in the study.

Statistical analyses

Analysis of results was performed with SPSS 17.0 for Windows (SPSS Inc., Chicago, IL, USA). We checked the abnormality of the data distribution using the Kolmogorov–Smirnov test and ran descriptive tests (mean, standard deviation, and confidence interval to 95%). We also performed paired samples through the Wilcoxon test, Spearman coefficient correlations, and stepwise linear regressions. The level of significance was $P<0.05$.

Results

Firstly, basal metabolism was calculated pretest (men 1,789.2±244.4 cal, women 1345.0±123.1 cal; $P<0.05$). Results of the intervention program are shown in Table 4. Participants (both men and women) reduced their waist measurements ($P<0.05$). FM was reduced and SMM was increased, although not to a statistically significant degree ($P>0.05$).

Table 4 Characteristics of body composition according to sex

	Men (n=9)			Women (n=15)			*P*
	Pretest	Posttest	*P*	Pretest	Posttest	*P*	
Weight (kg)	80.84±9.89	79.14±7.69	NS	61.33±5.86	61.62±6.01	NS	**
Height (cm)	168.6±7.67	167.1±6.89	NS	156.8±2.32	156.8±2.52	NS	**
Age (years)	63.80±5.45	64.14±5.31	NS	63.50±5.47	64.25±4.52	NS	NS
Waist (cm)	102.4±5.98	101.6±8.04	†	91.00±6.07	87.77±7.40	†	*
FM (%)	27.00±5.29	25.32±3.36	NS	35.10±4.29	34.25±3.98	NS	**
Water (%)	51.29±2.50	51.96±2.19	NS	44.53±2.84	44.75±2.38	NS	**
SMM (kg)	54.99±6.55	57.10±6.39	NS	37.40±2.02	38.14±1.88	NS	***

Notes: $^{*}P<0.05$; $^{**}P<0.01$; $^{***}P<0.001$; $^{\dagger}P<0.05$ (pre/post).
Abbreviations: FM, fat mass; SMM, skeletal muscle mass; NS, not significant.

The average time spent sitting between men and women was 6.2±2.39 and 2.0±1.41 hours per day, respectively. This difference was not significant ($P>0.05$). Women demonstrated higher performance than men in the walking variable (940.5±70.0 versus 458.6±240.3 MET × minutes/week, $P<0.05$; Figure 1).

The Rockport 1-Mile Walk Test resulted in lower posttest times for both men and women (Table 5). However, the improvement was significant only for men ($P<0.05$). RPE in the ad hoc upper-body strength test was lower posttest. Posttest times for the Stork Balance Stand Test were improved, although again these differences were not significant ($P>0.05$). No improvements were seen in the SR Test.

Spearman coefficient correlations were calculated to demonstrate the relationship between BC, the IPAQ, and the physical fitness test. Pretest mean HR showed a high correlation with vigorous PA ($\rho=-0.84$, $P<0.01$) and was also related to the time of the Rockport test ($\rho=-0.51$, $P<0.05$). Table 6 shows the relationship between the IPAQ, the physical fitness test (Rockport, strength, and balance) and BC.

Discussion

The aim of this study was to assess the loss of weight and FM and gains in SMM, strength, aerobic fitness, flexibility, and balance in Spanish people over 60 years old during a 3-month pilot intervention study. PA results in health benefits for those who practice it. This has been demonstrated in published studies of previous healthy-intervention programs, where tests were performed to evaluate BC and such physical abilities as aerobic capacity, strength, and balance.[23]

It has also been shown that motivation has a positive correlation with the continued practice of PA.[24] Participants were motivated in this longitudinal study, so the practice of PA was done on a daily basis.[25] It has been found that persons with higher body weight have a lower motivation toward PA.[26] The ACSM,[9] as part of a guide on basic exercises, recommends that the elderly use training programs

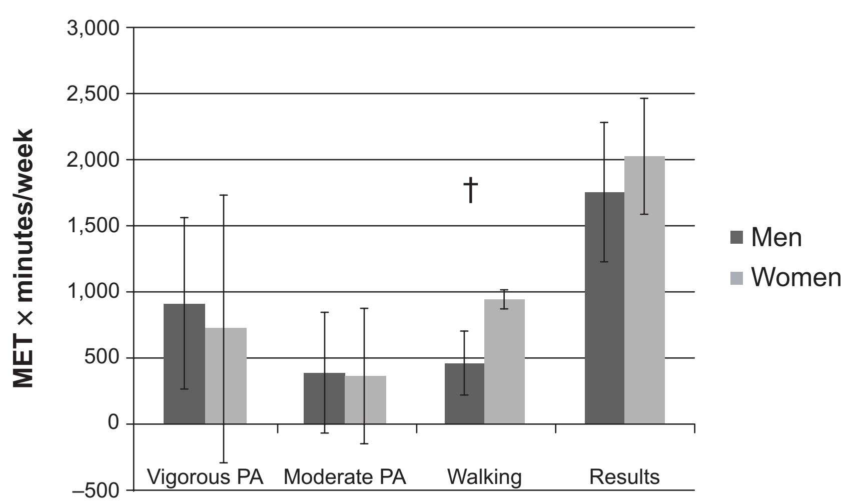

Figure 1 International Physical Activity Questionnaire results between men and women.
Note: $^{\dagger}P<0.05$.
Abbreviations: MET, metabolic equivalent of task; PA, physical activity.

Table 5 Physical fitness variables before and after the interventional physical activity program

	Men (n=9)			Women (n=15)			*P*
	Pretest	Posttest	*P*	Pretest	Posttest	*P*	
Max HR (bpm)	150.7±16.7	150.6±17.81	NS	128.9±19.0	138.0±27.2	NS	*
VO_{2max} (cm)	37.50±2.95	37.95±3.19	NS	28.82±5.55	35.76±6.10	NS	NS
Time (years)	14.33±1.03	14.00±0.71	†	16.64±1.29	14.39±3.77	NS	NS
RPE (points)	4.40±1.34	3.80±1.64	NS	6.60±2.51	4.60±2.19	NS	*
Balance (seconds)	33.00±20.79	39.00±10.39	NS	22.50±17.41	26.75±19.96	NS	*

Notes: $^*P<0.05$; $^†P<0.05$ (pre/post).
Abbreviations: Max HR, maximum heart rate; VO_{2max}, maximal oxygen consumption; RPE, rating of perceived exertion (ad hoc strength test); NS, not significant.

that focus on resistance, strength, aerobic capacity, and flexibility exercises.

From the age of 30 years, the body begins to show signs of decreasing physical abilities. This decrease in biological capacities and metabolic rates also extends to other aspects, such as neuromuscular capacity, flexibility, FM, SMM, and density of bone cells.[27,28]

This pilot intervention study was performed over a period of 3 months following the guidelines found in the ACSM.[9] Pretest and posttest readings were recorded and compared to assess improvements in physical fitness. Posttest, subjects improved the time of the Rockport 1-Mile Walk Test. The same success occurred in the study of Pazoki et al.[29] This test has been used to assess the VO_2 by some studies. Rockport is an excellent test for older people.[30–32]

In addition, BC was improved due to decreased FM and increased SMM. However, these differences were not significant. This was anticipated, as the intervention program was limited to a time period of 90 days, too short to manifest definitive improvements in BC. Dias et al[33] and Lim et al[34] did not find any improvements in their participants either. The reason for this is thought to be due to the short duration of the course (6 weeks). Natural physical deterioration and decreasing physical fitness as part of the aging process must also be taken into account, even for a period of 3 months.[6,35] When there is an increase in FM, there is a reduction in muscle strength, physical capacity, and quality of life, along with a loss of fat-free mass.[36]

In the second phase, we used a larger sample, necessary to verify the results obtained in this pilot study. Future research should test how this clinical intervention affects each of the capacities measured with two types of instruments. Therefore, the differences will be more reliable.

Conclusion

As a result of the healthy-intervention program performed for 90 days (3 months), persons 60 years or older were able to increase their physical fitness, as demonstrated by the specific tests performed. They also showed improved FM and SMM. These results should be considered with caution, due to the limited sample size of this pilot study.

Table 6 Spearman coefficient correlation between the International Physical Activity Questionnaire, physical fitness test, and body composition

	Pretest						Posttest					
	Weight	Height	Waist	% FM	% H_2O	SMM	Weight	Height	Waist	% FM	% H_2O	SMM
Mean HR	0.39	0.33	0.36	−0.61*	0.63*	0.37	0.08	0.10	−0.04	−0.38	0.38	0.32
Max HR	0.48	0.33	0.25	−0.52*	0.59*	0.42	−0.08	−0.05	−0.17	−0.29	0.22	0.13
Time	−0.42	−0.56*	−0.36	0.68**	−0.73**	−0.63**	−0.36	−0.29	−0.52	0.33	−0.29	−0.35
Mean VO_2	0.11	−0.05	0.30	−0.07	0.23	0.07	0.51	0.39	0.67*	−0.23	0.24	0.37
VO_{2max}	0.50*	0.56*	0.52*	−0.50	0.60*	0.68**	0.53	0.40	0.70*	−0.21	0.22	0.39
RPE	−0.02	0.10	−0.26	0.08	−0.15	−0.18	−0.37	−0.35	−0.31	0.47	−0.50	−0.68*
Balance	0.44	0.56*	0.40	−0.27	0.39	0.52*	0.24	0.08	−0.09	0.08	0.06	0.16

Notes: $^*P<0.05$; $^{**}P<0.01$.
Abbreviations: Max HR, maximum heart rate; HR, heart rate; VO_{2max}, maximal oxygen consumption; RPE, rating of perceived exertion (ad hoc strength test); FM, fat mass; SMM, skeletal muscle mass.

Disclosure

The authors report no conflicts of interest in this work.

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