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Effects of Brisk Walking on Physical Performance and Muscle Function in Community Dwelling Elderly Women

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Abstract

Aim: To examine the impact of a 12-week brisk walking program on physical performance and muscle function in community-dwelling healthy elderly women.

Methods: The study was conducted in a group of 27 women with mean age 68.6 ± 5.5 years and mean BMI 28.2 ± 4.37 Kg/m^2. Anthropometric variables (BMI, weight, height, waist circumference), body composition measured by Dual Energy X-ray Absorptiometry (DXA), the 400 meters walking test, the short physical performance battery, the physical activity level with the PASE questionnaire, handgrip, isometric strength and power of the lower limbs with dynamometer were evaluated at baseline and three months follow-up.

All subjects were involved in brisk walking sessions, 1 and ½ h per day on 2 days each week under the supervision of a qualified physical education instructor for 12 weeks. The physical activity intensity has been calculated on the basis of the Borg Scale (RPE scale=13 "somewhat hard").

Results: At 3 months of follow-up, a reduction in waist circumference, total and percentage fat mass, an improvement of peak torque and power of lower limbs and in all the performance test administered was observed.

In addition, dividing the population into two sub-groups based on the frequency to walking groups, it was observed that the group with higher attendance presented a significantly greater increase of muscle peak torque, power and specific power values. Moreover subjects with greater attendance showed significantly higher reduction of the time to perform the 400 meters test.

Conclusions: Moderate aerobic exercise can improve muscle strength, physical performance and body composition. Dividing the study population into two groups on the basis of greater or lesser participation in the walk groups, the group with frequency percentage higher than 70% showed a significantly greater improvement in peak torque, power and the specific power, suggesting a dose-dependent effect.

Introduction

The human aging process is accompanied by a significant decline in neuromuscular function and performance characterized by the inevitable reduction in skeletal muscle mass and strength [1,2]. Studies have shown that isometric, concentric, and eccentric muscle strength declines with advancing age [3,4].

Muscle quality (strength per unit cross-sectional area or muscle mass) also declines with age [5,6]. These factors contribute to the loss of functional mobility and independence present in many older adults. Muscle strength and muscle quality are important predictors of incident mobility limitations in older adults [7].

Age-related changes in muscle mass and muscle "quality", defined by strength per unit muscle size, may each contribute separately to the loss of muscle function as well as increased risk for mortality [8].

Several studies have examined the effects of exercise on muscle mass and strength in older adults [9]. Far fewer studies have examined the effects of exercise on muscle quality. Moreover, little objective data exists concerning the potential of walking to prevent the loss of muscle mass, muscle quality and strength with age. Moreover, no studies have examined whether regular walking may prevent the decline in physical performance that normally occurs with age. Sipila et al. found that there was a trend for aerobic exercise training to improve the specific torque, i.e., muscle quality [10] but with no effect on the amount of lean tissue [11]. These interventions, however, were conducted over a relatively short (18 week) period. Thus, the effects of increased physical activity on age-associated loss of muscle strength increase in skeletal muscle lipid accumulation and diminished function requires further investigation.

Aging is also associated with a decline in physical function and performance that negatively impacts quality of life and may compromise independence. The assessment of physical function is a critical component of the assessment of older persons and some physical performance tests, such as walking speed, ability to rise from a chair or maintain balance, have been shown to be useful in the prediction of institutionalization, disability, and mortality [12].

Walking is a form of exercise that is very acceptable to many people [13] and may be integrated easily into daily routines. It does not require any formal training or specialist equipment and can be undertaken in an individual's own locality and time [13].

This was a population based intervention study, conducted to examine whether or not a modest exercise program, consisting in regular walking groups 2 days/week for 90 minutes under the supervision of a qualified physical education instructor, could prevent some of the deleterious effects of aging on body composition and physical performance in older women with moderate functional capacity.

Methods

Design

Independently living, community-dwelling older women aged 60-80 years were recruited from the Verona city area by newspaper or flyer advertisement. When potential participants made contact (n=47), a short telephone interview took place to establish their eligibility for the study.

Clinical status, body composition, strength assessments and performance tests were evaluated at baseline in 30 females aged 68.6 ± 5.5, with a BMI of 28.4 ± 4.7. Women were eligible to take part in the study, if they were older than 60 years of age, could walk 0.8 km (0.5 mi) without difficulty and were free of cognitive impairment on the basis of a Mini-Mental State Examination (MMSE) score>24. None of the subjects engaged in regular physical exercise more than once a week before the study. The exclusion criteria included severe chronic liver or kidney disease, disabling knee osteoarthritis, heart failure (New York Heart Association class 2 or higher), arrhythmias or COPD (as defined by clinical records). Individuals who had lost more than 5% of their body weight in the year preceding the study were also excluded. All the subjects involved in the study were retired and completely independent at the Activities of Daily living (ADL) scale at the baseline evaluation. The Physical Activity Scale for the Elderly has been performed in the study population at baseline and at 3 months follow-up.

During the 3-months follow up, 1 participant (3.3%) refused to give her consent to continue to participate at the study; 2 participants (6.6%) could not visit the clinic due to onset of illnesses such as cancer and hospitalization for pneumonia. A total of 27 women, resident in Verona with body mass indexes (BMIs; in kg/m2) ranging from 20.2 to 41.3 underwent DXA, muscle strength determinations and performance test at baseline and again after a 3 month follow up and were thus included in the present analysis.

No significant differences were observed for any of the variables considered between women who were excluded (n=3) and those included in the present analysis.

Anthropometry

With the subjects wearing light indoor clothes and no shoes, body weight was measured to the nearest 0.1 kg on a scale (Salus, Milan, Italy) and height to the nearest 0.5 cm with a stadiometer (Salus). BMI was then calculated as body weight adjusted for stature. Circumferences were measured to the nearest 0.5 cm with the use of a 1 cm wide metal measuring tape while subjects were standing. Waist circumference (WC) was measured as the minimum abdominal circumference between the xyphoid process and the umbilicus. All subjects were examined in a flat standard hospital bed.

Body composition

Total body fat (FM) and total fat free mass (FFM) were determined using DXA Hologic QDR 4500 fan beam densitometer with software version 8.21.

The characteristics and physical concepts of DXA measurements have been described elsewhere. All metal objects (jewellery, snaps, and belts) were removed. Measurements were taken with the subject positioned supine on the scanning table. Radiation exposure was less than 8 Millis everts and the mean measurement time was six minutes. Daily quality-assurance tests were performed per the manufacturer's instructions. All scans were subsequently analysed by a single trained investigator. The percentage of fat was calculated as fat mass (kg) measured by DXA divided by body weight (kg) measured by scale.

Physical performance tests

400 m walking test

Participants received instructions to walk 400 m in a track on a 100 m per segment course for 2 laps (200 m per lap) with standard encouragement given at each minute. Instructions were to "walk as quickly as you can, without running, at a pace that you can maintain." (Newman JAMA 2006).

4 and ½ meters test

Volunteers walked a 4 and ½ meters course at their usual pace. Timing began when subjects initiate foot movement and stopped when 1 foot contacted the ground after completely crossing the 8-foot mark. The best time of 2 attempts was recorded [12].

Chair rises

Volunteers sat with arms folded across the chest in a 17-inch armless chair. Five rises were performed as rapidly as possible, and were reported as seconds [12].

Single leg stand

Volunteers attempted to stand on their preferred leg for as long as possible with eyes open; a maximum of 30 sec was recorded [12].

Assessment of physical activity

Physical activity was evaluated with the Physical Activity Scale for the Elderly (PASE). The total PASE score was computed by multiplying the amount of time spent in each activity (h/day) or participation (yes/no) in an activity by the empirically derived item weights and summing over all activities. The item weights are based on comparison with physical activity derived by regressing a component score developed from a three-day physical activity diary and global activity assessment [14].

Health status

The presence of chronic conditions was determined using standardized questionnaires previously used in the Italian Longitudinal Study on Aging [15]. Chronic conditions assessed included cardiovascular disease, lipid abnormalities, lung, liver and renal disease, degenerative joint disease, and hypertension.

Physical activity intervention

All exercise sessions included a warm-up, pre-exercise stretches, an assigned walking period, a cool-down and post-exercise stretches supervised by two qualified physical education instructor. Subjects were instructed to walk at a self-regulated intensity.

Isometric strength testing

Isometric strength and power of the knee extensors was determined using a isometric dynamometer (Dynatronic 100, Milano) and grip strength using an handheld isometric strength dynamometer (Jaymar. Bolingbrook, IL).

Knee extension strength was measured isometrically with subject seated and the angles of the hip and knee joints at 90°.

Two practice trials were performed at 50% effort to familiarize the participant with the procedure and to provide a warm-up period.

Participants were given a "go" command and instructed to undertake the contraction "as fast as possible" and to maintain maximal torque for 3 sec. During the test, subjects were again given strong verbal encouragement ("Kick hard! Go! Go! Go!") exhorting subject for the entire duration of the contraction. Each contraction was followed by a 2-sec rest. At least three maximal efforts were performed by each volunteer. Participants were not asked to perform more than six trials. Maximal torque production was recorded as the mean peak torque production from three similar trials [16]. The intra-tester reliability in our laboratory expressed as the ICC is 0.914 for peak torque and 0.816 for muscle power, with a CV values respectively of 9.69% and 11.08%.

Statistical analysis

The results are presented as mean ± standard deviations (SD). To evaluate the modifications of the main variables of the study during the follow up to the baseline and three months was used as t-test for paired data.

The study population was divided into two groups considering as cut-off the median percentage of the frequency of path groups (70%).

The comparison between the changes of the main variables of the study in the two groups at frequencies>70% and<70% during follow up of 3 months was evaluated by analysis of variance for repeated measures (ANOVA).

The probability of detecting significant changes resulting from the intervention was set at an alpha level of p=0.05.

All statistical analyzes were performed using SPSS statistical program (version 21 for Macintosh).

Statement and ethics

We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during this research. The study protocol was approved by our ethical committee.

Results

The characteristics of the study population and the main body composition variables measured at baseline and after three months of follow-up are presented in (Table 1). We studied 27 female subjects with mean age of 68.29 ± 1.10 years and BMI of 28.5 ± 4.88 kg/m2. 75% of subjects were suffering from hypercholesterolemia, 30% were obese and 45% had hypertension.

Women (n=27)	X ± SD (baseline)	X ± SD (12 weeks follow-up)	Δ ± SD
Age (y)	68.29 ± 1.10		
Weight (kg)	69.11 ± 10.93	68.77 ± 10.92	-0.34 ± 1.23
BMI (kg/m^2)	28.50 ± 4.88	28.36 ± 4.86	-0.14 ± 0.50
Waist circumference (cm)	88.75 ± 10.93	87.55 ± 10.93	-1.20 ± 1.94[3]
Lean mass (kg)[1]	40.74 ± 4.59	40.88 ± 4.89	0.14 ± 1.03
Legs lean mass (kg)[1]	12.58 ± 1.49	12.51 ± 15.63	-0.69 ± 5.34
Fat mass (kg)[1]	25.42 ± 6.91	24.78 ± 6.73	-0.64 ± 1.03[2]
Fat mass percent (%)	36.89 ± 5.21	36.23 ± 4.97	-0.66 ±1.30[2]
PASE	154.99 ± 23.53	160.78 ± 34.27	5.76 ± 37.44

[1]Measured by dual-energy X-ray absorptiometry; [2]P <0.05; [3]P <0.01; [4]P <0.001. BMI: Body Mass Index; PASE: Physical Activity Scale Elderly

Table 1: Anthropometric, Body composition, Dynamometric and Performance Test variables at baseline and after 12-week program of regular walking.

The level of physical activity estimated by the PASE has not changed significantly during the study. Adherence to the brisk walking program at the end of the three months follow-up was 66.2% ± 19.13 (14.81%-92.59%).

Weight and BMI did not change significantly during the follow-up period. After three months, a significant reduction in waist circumference (p=0.003), total fat mass (p=0.003) and percentage fat mass (p=0.014) was observed. Conversely total and lower limbs lean body mass didn't change significantly.

The mean ± SD of the dynamometric and physical performance variables was evaluated with Short Physical Performance Battery and 400 meters test at baseline and after three months of follow-up are presented in (Table 2).

Women (n=27)	X ± SD (baseline)	X ± SD (12 weeks follow-up)	Δ ± SD
Peak Torque Legs (Nm)	150.68 ± 59.12	167.45 ± 60.19	16.77 ± 21.11[2]
Work Legs (J)	387.30 ± 146.64	415.71 ± 151.93	28.40 ± 70.80
Power Legs (W)	107.19 ± 39.59	117.28 ± 40.07	10.09 ± 16.63[1]
Specific legs torque (Nm/kg)	12.29 ± 4.99	13.62 ± 4.89	1.33 ± 1.74[2]
Specific legs power (W/kg)	8.77 ± 3.49	9.55 ± 3.36	0.79 ± 1.33[1]
Handgrip (kg)	23.50 ± 4.85	23.39 ± 5.02	-0.10 ± 2.37
400-meter walk time (s)	247.88 ± 20.34	234.69 ± 19.24	-13.19 ±10.59[1]
4 and ½ meter walk time (s)	2.55 ± 0.31	2.50 ± 0.28	-0.05 ± 0.16
Chair stand x 5 time (s)	9.09 ± 1.25	8.50 ± 1.17	-0.58 ± 0.60[1]
One leg stand time (s)	22.94 ± 9.08	24.60 ± 8.03	1.65 ± 3.08[1]
[1]P <0.05; [2]P <0.01; [3]P <0.001			

Table 2: Dynamometric and Performance Test variables at baseline and after 12-week program of regular walking.

A significant improvement in muscle peak torque and muscle power of the femoral quadriceps evaluated dynamometer, was observed (p=0.002 and p=0.12, respectively), while the dominant arm handgrip did not change significantly.

A significant improvement in lower limb specific peak Torque and specific Power was observed, p=0.002 and p=0.013, respectively.

A significant reduction in time to perform the 400 meters test (p<0.001) and chair-stand test (p<0.001) and a significant increase in the Single leg stand test of the dominant leg (p=0.011) was also observed. In contrast, the time to perform the 4 ½ meters test was not significantly reduced (p=0.144).

The Study population has been divided on the basis of the attendance rates at physical activity sessions, using 70% as cutoff.

14 subjects showed an average attendance to brisk walking sessions>70% (average 79.79 ± 7.77%), while 13 had a frequency<70% (average 51.57 ± 16.72%).

The mean values ± standard deviations of body composition variables, dynamometer tests and physical performance at baseline and after 12 weeks of follow-up in different attendance groups are presented in Figures 1 and 2, respectively.

At baseline the main body composition characteristics, dynamometry and performance were not statistically different between the two groups, except for waist circumference, that was significantly higher in subjects with higher attendance (data not shown in the figure).

The group with attendance> 70% presented a significantly greater increase of the Peak Torque (p=0.027), Power (p=0.009) and the Specific Power values (p=0.045). Moreover subjects with greater attendance showed significantly higher reduction of the time taken to perform the 400 meters test (p=0.033).

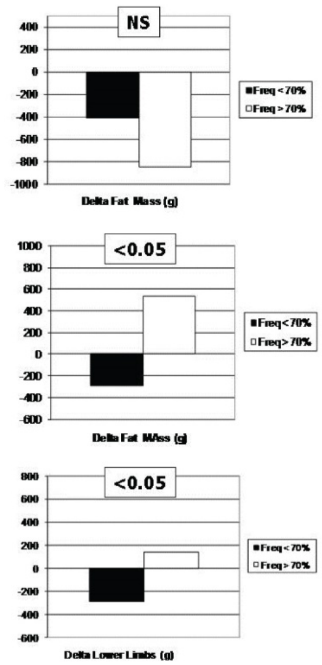

Figure 1: Changes in body composition variables in subjects with attendance to walking program ≥70% (n=14) and <70% (n=13).

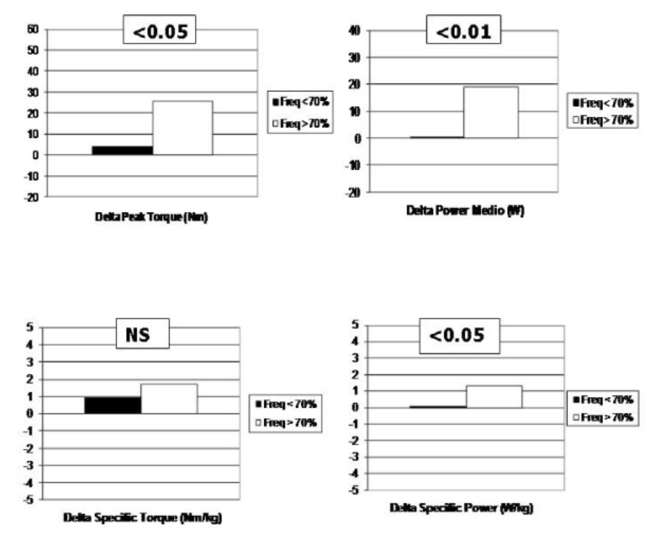

Figure 2: Changes in dynamometry variables in subjects with attendance to walking sessions ≥70% (n=14) and <70% (n=13).

Discussion

The results of this study show that, in a group of elderly women in good health conditions, a mild to moderate degree of aerobic exercise program, based on supervised walking groups, has beneficial effects on body composition, muscle function and physical performance.

In particular, a significant reduction of total fat mass and central adiposity was observed, without concomitant changes of total and lower limbs lean body mass. These results are consistent with previous studies on the effects of aerobic exercise on body composition [17-19]. It is known that aging is associated with loss of lean body mass and a decrease in muscle strength [2,20].

Our study confirms that a moderate intensity exercise program has no effects on lower limbs lean mass. This observation confirms the results of the LIFE study [21] that has documented, after 6 months of exercise program based on the combination of aerobic, strength, balance and flexibility exercises, an increase in lower limbs isokinetic strength, not accompanied by an increase of total lean mass.

Although numerous studies have documented that a structured exercise program has positive effects on skeletal muscle function, considerably less well known is the effect of a mild to moderate physical activity program in the prevention of sarcopenia and the progressive decrease of muscle strength associated with aging. In particular, only few studies have previously pointed out the effect of intervention based on supervised walking groups on body composition, dynamometer and performance testing [22,23].

Our study documented significant improvement in the values of Peak Torque and Power lower limbs measured by dynamometer, even after adjustment for lean mass of the lower limbs.

In addition, the literature is full of studies that assess the impact of resistance exercise programs in elderly individuals [24,25]. Conversely, more rare are those evaluating the impact of aerobic exercise on body composition, muscle strength and physical performance.

Interestingly, dividing the study population into two groups on the basis of greater or lesser participation in the walking groups, the improvement in peak torque, muscle power and the specific muscle power was significantly greater in the group with higher attendance (above 70%). We can therefore assume that an intervention of moderate physical activity has a dose-dependent effect.

A significant improvement in physical performance as evaluated with the Short Physical Performance Battery (SPPB) and 400 meters test after three months of intervention was also observed.

By dividing the study population into two groups on the basis of greater or lesser participation at the walking groups, the group with higher attendance showed greater improvement at the 400 meters walking test.

Longitudinal observational studies suggest that regular physical activity cannot only extend life expectancy, but also to reduce the incidence of disability associated with aging [26-28].

The results of this study showed an improvement in 400 meters test and in the Short Physical Performance Battery test (SPPB), in line with the results from the LIFE study [29] in which it was evaluated the effect at 6 months follow-up of an intervention based on the combination of aerobic, strength, balance and flexibility exercises on physical performance.

Preserving mobility is essential to maintain a high quality of life and the activities required to maintain complete independence. The limited movement expressed by the score of the Short Physical Performance Battery (SPPB) and in particular the 400 meter tests are predictors of several adverse events, such as comorbidities, worsening disability, institutionalization and mortality [14,30,31].

Interventions based on physical activity programs, including resistance exercise, have been shown to improve a variety of performance measures, such as walking speed, speed in climbing a flight of stairs, balance, and to rise up from a sitting position [32,33]. Other intervention studies with short follow-up suggest that physical activity can increase the score of SPPB [34,35].

Our study show that an intervention based only on supervised walking groups has benefits on physical performance and can be useful for preventing or delaying the mobility deficit in elderly subjects.

Some limitations of the present study should be recognized. First, the study sample was relatively small and limited to relatively healthy elderly women and thus cannot be considered representative of a normal aging population. It is known that the incidence of cardiovascular events is higher in men [36]. For this reason the presence of a group of male subjects would be useful to better understand the benefits of supervised walking groups in both sexes.

It is also possible that a longer intervention or follow-up period would have allowed us to observe significant effects of exercise to prevent the loss of muscle mass.

Second, the level of physical activity of subjects enrolled in the study was at higher limit of the PASE normal range. The choice of more sedentary individuals would probably have allowed to obtain even more significant results.

In conclusion, the results of this study demonstrate that an intervention based on walking groups organized and supervised by qualified instructor can prevent the negative consequences associated with aging on body composition, muscle function and physical performance, determines the reduction of total fat mass, of central adiposity, as well as improving strength and muscle power and physical performance assessed in the 400 meters and Short physical performance Battery test.

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