Effect of Ecological Walking Training in Sedentary Elderly People: Act on Aging Study

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Received August 11, 2012; Accepted April 5, 2013
Decision Editor: Rachel Pruchno, PhD

Purpose of the Study: This study aims to investigate the effects of a walking program on aerobic endurance and function in a sample of sedentary elderly people. Design and Methods: For this study, 126 sedentary individuals were recruited: 63 individuals (mean age = 74.1 ± 6.0 years) for the control group and 63 (mean age = 72.0 ± 4.5 years) for the intervention group. The intervention consisted of walking training including balance exercises and lower limb strength activities twice a week for 4 months. We collected baseline and post-test measurements of aerobic endurance, lower limb strength, and mobility. We also measured aerobic endurance at increments of 4, 8, and 12 weeks between the baseline and the post-test. We used analyses of covariance with baseline value, gender, age, and body mass index scores as covariates (p < .05) and calculated the effect size for the effects of the intervention. The changeover time of aerobic endurance was also analyzed with the repeated analysis of variance (p < .05).

Results: The intervention group showed steady and significant improvements with respect to the 6-min walk (aerobic endurance) from 447.89 m (SD 73.87) to 561.51 m (SD 83.96), as well as the 30-s chair stand (lower limb strength) from 10 (SD 3) to 13 (SD 3) number of times and the Timed Up and Go Test (mobility) from 8.53 s (SD 2.86) to 7.13 s (SD 1.76) at the post-test, whereas the control group showed significant decrease in all measurements. Implication: These results underline that an ecological walking training program can be used to improve physical functioning among sedentary elderly people.

Key Words: Physical activity, Intervention

Population in developed countries are getting older. Aging is considered a primary risk factor for the progression of most chronic degenerative diseases and is associated with an increase in disability and frailty (Stenzelius, Westergren, Thorneman, & Hallberg, 2005; WHO, 2002). Furthermore, reduced physical function in elderly people is a risk factor relating to comorbidities, physical and psychosocial health problems, environmental and social frail conditions, inadequate nutrition, and unhealthy lifestyles (Beswick et al., 2008). Therefore, one of the priorities of risk prevention among the elderly people is to delay or to avoid risks related to aging by structuring specific interventions that aim at maintaining physical function, limiting disability, and promoting independence for as long as possible.

In particular, advancing age is associated with physiological changes that result in the reductions of functional and motor ability and skills, such as strength, endurance, and mobility (Shea, Park, & Braden, 2006). These age-related physiological changes can have an impact on activities of daily living (ADLs) and undermine the preservation of the elderly people’s physical independence (Guralnik et al., 2000; Spirduso & Cronin, 2001).
For example, aging is accompanied by a progressive loss of muscle mass that has been associated with both lower muscle force production capacity and an inability to perform ADL (Rockwood et al., 2004; Wallerstein et al., 2012).

These impairments can affect walking, one of the most common and important human movements related to living an active and independent life. With aging, walking performance starts to decline in terms of a decrease in speed and shorter stride length, whereas the double-limb support duration increases (Chodzko-Zajko et al., 2009). Walking difficulties result in reduced activity, loss of independence, and an increased number of falls and other injuries (Van Swearingen et al., 2009).

Such walking difficulties are also associated with weakness in the lower extremity muscles, poor balance, and deconditioning from lack of muscle use (Chodzko-Zajko et al., 2009). In general, leg weakness is associated with impaired gait function in terms of slow speed and small steps (Barrett, Mills, & Begg, 2010). In particular, a decrement in lower extremity strength may be associated with the occurrence of falls. Besides this, declines in gait speed might be seen as a relevant component of preclinical disability (Guralnik et al., 2000; Protas & Tissier, 2009). We know that the maintenance of walking skills can be obtained by promoting regular physical activity (Chodzko-Zajko et al., 2009).

Generally speaking, regular physical activity increases the average life expectancy by decreasing the chance of chronic disease development and progression (Olshansky, Hayflick, & Carnes, 2002). In fact, regular physical activity can mitigate the effects of age-related biological changes (Huang, Shi, Davis-Brezette, & Osness, 2005) and the decline in health and well-being (Darren, Crystal, & Shannon, 2006). Moreover, regular physical activity affects the physical and psychological capabilities of elderly people (Colcombe & Kramer, 2003). This is part of a healthy lifestyle that contributes toward successful aging (Nelson et al., 2007).

Traditionally, walking improvement training focuses on walking practice and the remediation of deficits in strength, balance, and endurance, under the assumption that gains in physiological capacity will contribute to improved walking performance (LIFE Study Investigators et al., 2006; Mian et al., 2007). Furthermore, an increase in the walked distances indicates an overall improvement of the functional capacity that can be used as a relevant indicator of the efficacy of an intervention and/or of a rehabilitation program (Poole-Wilson, 2000). The elderly people’s walking performance can be improved by enhancing the strength of lower extremity muscles (Protas & Tissier, 2009). The improvements in gait speed are associated with the improvements in the strength of lower extremity muscle and an increased mobility function (Binder et al., 2002; Liubicich, Magistro, Candela, Rabaglietti, & Ciairano, 2012). Moreover, a moderate walking training may result in the increments of muscle thickness and strength in the elderly people’s lower limb muscles (Liu & Latham, 2009).

The problem is that most of the aforementioned studies investigate the effects of physical training organized in traditional gyms with sports equipment (i.e., bike and treadmill) and/or in a laboratory. However, it is well known that promoting the participation of sedentary elderly people in physical trainings implemented in places such as traditional gyms with specific facilities can be problematic, particularly in Italy (National Institute of Statistics, 2010). There are two important factors affecting the initiation and maintenance of physical activity: social and structural barriers (Dunlap & Barry, 1999). Social barriers include societal stereotypes regarding activity in aging, social isolation, and judgment from younger people. Structural barriers include access to appropriate venues for activities, neighborhood safety, transportation, and socio-economic disadvantage (Dunlap & Barry, 1999). For these reasons, many elderly people remain sedentary.

Sedentary living is defined as a way of living or a lifestyle that requires minimal physical activity and that encourages inactivity through limited choices, disincentives, and/or structural or financial barriers (Chodzko-Zajko et al., 2009). Furthermore, according to Wahl, Iwarsson, and Oswald (2012), many elderly people desire to “age in place” by remaining in their familiar home environment or in an environment of their choice for as long as possible. An ecological intervention signifies a health promotion program at the community level that is based on emphasizing the individual and contextual systems and the interdependent relations between the two. It also consists of a combination of educational, organizational, regulatory, and economic components aimed at achieving specific objectives for a given population (McLaren & Hawe, 2005).

In this study, we focused our attention on a different kind of physical training that is based on
the ecological perspective of health promotion at the community level. To do so, we created a new ecological walking training program that includes balance and strengthening exercises. These can be performed not only in a gym but also in other environments without specific facilities for physical activity. Our walking training can be, in fact, practiced in such places as any meeting point, club, or public environment already attended by elderly people in their daily life. The advantage of these spaces is that they are within the elderly people’s own neighborhood and easily accessible, especially for those sedentary elderly people who are not willing to put a great deal of effort into a gym. Moreover, the participants can practice this physical activity in a familiar social context with other elderly people. This training combines function-focused aerobic endurance and resistance lower limb training including specific tasks commonly performed in daily life among sedentary elderly people aged more than 65.

In sum, the first objective of this research is to test the effects of an ecological physical activity program on walking function, particularly with regards to endurance, mobility, and lower limb strength, which are strictly related to walking. We hypothesized that our ecological walking training would improve aerobic endurance, lower limb strength, and mobility performance among sedentary elderly people. The second aim of the study was to monitor the change of aerobic endurance of the elderly people who participated in the training. In fact, we wanted to detect the time required to observe a first significant change in aerobic endurance. These data could be useful to improve the protocol of the training for future intervention. The proposed intervention is addressed at specific subgroup of the population: elderly people who are at high risk of loss of autonomy and/or diseases because of their sedentary lifestyle.

**Design and Methods**

An experimental research design was utilized in this study in which one experimental group and one control group were used to determine the effects of walking training on aerobic endurance, mobility, and strength of lower limbs. The experimental condition consisted of the participation in an ecological 16-week physical training implemented in halls of elderly people residential centers. All participants were tested before and after the 16-week training. Aerobic endurance was also tested every 4 weeks during the 16 weeks of training, but only within the experimental group. Control group participants were advised to maintain their normal daily routines. This research belongs to a larger in-progress longitudinal “Act on Ageing” project of Piedmont Region, Italy, the main aim of which is to evaluate the effect of various physical and cognitive interventions on the physical and cognitive status of sedentary elderly people.

**Participants**

The sedentary elderly people were recruited from a list of 400, offered by the Health Office of the Piedmont Region and general medical practitioners. The participants were recruited by phone and did not receive any incentive for participation. The Consolidated Standards of Reporting Trials (Figure 1) summarizes the recruitment and attendance information of our study sample.

First, participants were classified as leading a sedentary lifestyle if they did not report participating in regular moderate or vigorous physical activity for the last 5 years. Second, the eligibility criteria for participation were being 65 years or older, having an ability to walk 500 m without assistance and a Mini-Mental State Examination (MMSE) score higher than 25 (a score ≥25 of 30 indicates the absence of cognitive impairment). People were excluded if they had a myocardial infarction and/or coronary bypass surgery within 1 year, uncontrolled diabetes or hypertension, orthopedic impairment, or upper or lower extremity fracture within the past 6 months and/or if they were currently participating in another study, even if of a different scope. Such conditions were thought to present a potential negative effect on the participant’s participation in our intervention and potentially impend on his/her health and safety. Elderly people meeting the inclusion criteria (126 of the 400 from the original list) received written approval from their primary-care physician to be eligible for the study.

After baseline testing, participants were randomly assigned to the walking training or the control group using a computerized randomization. Descriptive characteristics of the participants are presented in Table 1. All the participants were retired and independent. A total of 126 elderly people participated in the study: 42 (33%) men (16 in the control group and 26 in the experimental group) and 84 (67%) women (47 in the control group and 37 in the experimental group).
The mean age was 74.1 years (SD = 6.0) for the control group and 72.0 years (SD = 4.5) for the experimental group.

At the beginning of the 16-week study, one participant from the experimental group withdrew after the introductory training session, and subsequent attempts to contact him for an explanation were unsuccessful. Besides this, two women in the experimental group and two men and five women in the control group were dropped from the analyses because they were unable to attend the final data collection. In sum, we had an 8% attrition rate for the study. The remaining 60 experimental group participants attended 90% of the total possible workouts. Data were also collected at both waves from the 56 remaining control participants. All the elderly people completed every session of training.

The Ethical Committee of the University of Torino approved the study, and all participants were informed that participation in the study was voluntary and confidential. All the selected individuals agreed to participate and gave their written informed consent in accordance with Italian law and the ethical code of the American Psychological Association (2002).

**Measures**

The demographic data (age, gender, family condition, and level of education) were self-reported. Each participant was assessed at the baseline for height, weight, body mass, and cognitive function (MMSE, Folstein, Folstein, & McHugh, 1975). Height was assessed by anthropometer (International Standard ISO/TR 7250-2, 2010). Weight and body mass index (BMI) were assessed by Tanita Body Composition Analyzer BF-350.

We tested for aerobic endurance, strength of lower limb, and mobility. All tests were performed in the same day, with an hour break between each test.
Aerobic endurance is defined as the capacity to perform large-muscle activity over an extended period of time (Weineck, 2007). Aerobic endurance was assessed using a 6-min walk (Rikli & Jones, 2001). The test involves walking around a course covering as much distance (m) as possible within 6 min. On a timed test such as the 6-min walk, scores were obtained for individuals of all levels of ability starting with frail participant who can only walk a few meters to the highly able individual who can cover several hundred meters within the allocated time. We also tested aerobic endurance at increments of 4, 8, and 12 weeks between the baseline and the post-test. The test was performed 1 hr before the beginning of the training session.

Strength is the ability to generate force to overcome inertia or a load (Zatsiorsky, 2008). Lower limb strength is an important aspect of fitness in elderly people because of its role in daily activity. It was assessed using a 30-s chair stand (Jones, Rikli, & Beam, 1999), consisting in counting the number of times a person could stand up from a sitting position with arms folded across the chest within a 30-s time frame. Chair-stand performance has also been found to be effective in detecting normal age-related declines (Bohannon, Shove, Barreca, Masters, & Sigouin, 2007) and the effect of physical training in older adults (Carvalho, Marques, & Mota, 2004).

Mobility is defined as the ability to independently move around in one’s environment (Webber, Porter, & Menec, 2001; WHO, 2001) and is a fundamental expression of an individual’s autonomy. This capacity was assessed using Timed Up and Go Test (Rees, Murphy, & Watsford 2007), which involves counting the number of seconds required to stand from a seated position, walk as quickly and as safely as possible across a line located 3 m away, turn around, and finally return to the initial sitting position. This test was completed twice and the best score was recorded.

**Training Protocol**

The training consisted of a twice-weekly intervention of 75 min each session. The training was organized in six groups composed of 10–11 participants and conducted by two qualified instructors. The instructors had a university degree in

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<th>Table 1. Sociodemographic and Baseline Characteristics of Study Participants</th>
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<td>Level of education (N)</td>
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<td>Married</td>
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<td>Widow</td>
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<td>Divorced</td>
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<td>Past job</td>
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<td>Manual labor</td>
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<td>Nonmanual labor</td>
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Note: Level of education: low—corresponding to compulsory education (primary school); high—corresponding to additional noncompulsory education.
physical education and sports-related fields and specialized in physical activity for the elderly people. Every training session was supervised by the first author. For each intervention session, the instructors followed a specific protocol that was specifically designed for our research. The protocol specified the duration and the recovery time between each exercise. It also gave the instructor the instructions for each sequence of every exercise and the time of execution and rest. For managing all the activity sections, the instructors followed an instruction sheet where all the sequences and times of the exercises were specified. Also, the instructors used a stop watch to manage the times of the exercises correctly. All participants of the various groups performed the same sequences and same times of the exercises. Moreover, the instructor was asked to show the exercise during the activity until all the participants learned the correct execution of the exercise. For the safety of all participants, heart rates were monitored during the training with a personal heart rate system. The safety limit was determined by calculation the maximum heart rate following the method of Tanaka, Monahan, and Seals (2001); the formula to predict the maximum heart rate is 208 – 0.7 × age.

The first 10 min of the exercise consisted of a warm-up activity of walking around an indoor track (a track was built along the perimeter of the hall) at a slow pace/rhythm of low intensity, followed by four accelerations of stride for 30 s, which were interspersed with 1 min of slow strides up to 40%–45% of maximum heart rate. A 50-min progressive endurance exercise period followed the warm-up, consisting primarily in walking with direction changes, accelerations and decelerations, and changes of gait. More specifically, during the walk, two series of six accelerations of the gait speed were provided where participants were walking at their maximum speed. Between accelerations, there was a recovery time where participants were walking at a slower pace. After every acceleration, the participants changed the direction of their walk. The walk’s intensity increased with the time of acceleration (from 30 s in the first month to 120 s in the fourth month). The recovery time between accelerations also decreased (from 180 s in the first month to 90 s in the fourth month). Moreover, after the first and second series of accelerations, six balance exercises were included during the walk (at a slow speed). Our protocol specifically provided three series of three different exercises (toe walk, balance walk, heel walk, tandem forward walk, heel-to-toe walk, and cross-over walk). Each exercise had a duration of 30 s and for each session the sequence of these exercises changed. The sequence of balance exercises had previously been defined in the protocol of activity.

During this period, the heart rate ranged between 45% and 60% of the maximum heart rate. During the 16 weeks of training exercise, intensity was increased to a 70% of the maximum heart rate. After, in the same place, 10 min of strength training provided closed kinetic chain exercises using body weight as resistance for all major muscle groups of the lower extremity (half squat—knee flexion around 90°; quarter squat—knee flexion around 120°; lunge—during the lunge, the knee does not touch the floor; side lunge; and calf raise). The participants did not use any exercise equipment (i.e., free weights and elastic bands) during these exercises. However, if they felt or seemed insecure during the exercises, the participants were able to use handrails or chairs in order to support themselves. Overall, the participants performed three sets for each exercise. Their intensity was increased with the number of repetition (from 8–10 for the first month to 22–24 for the fourth month), whereas the recovery time between series was decreased (from 90 s in the first month to 30 s in the fourth month). The last 5 min were used for cool down and rest.

**Statistical Analyses**

First, we performed a *t*-test analysis for each test score at the baseline between the experimental and control group to see if there were any differences in the baseline values. Second, following the work of Van Breukelen (2006), we tested the differences between experimental and control groups by a series of analyses of covariance for each outcome (aerobic endurance, lower limb strength, and mobility) with group as main effect (experimental vs control) and the baseline value, gender (coded as 0 for women and 1 for men), age, and BMI scores as covariates. As a dependent variable, we used the post-test scores for each outcome variable. In addition, we tested the effect size (Cohen’s *d*) of walking training in order to quantify the effectiveness of an intervention (Derzon, Sale, Springer, & Brounstein, 2005). The Cohen’s *d* was computed with the following formula: training group (TG),
control group (CG), pretest (t1), post-test (t2), sample (N), standard deviation, and range:

$$ES = \frac{(M_{TG,t2} - M_{TG,t1}) - (M_{CG,t2} - M_{CG,t1})}{SD_{pool}};$$

$$SD_{pool} = \sqrt{\frac{(N_{TG} - 1)SD^{2}_{TG} + (N_{CG} - 1)SD^{2}_{CG}}{N_{TG} + N_{CG} - 2}}$$

Range: negligible effect ($\geq -0.15$ and $< .15$), small effect ($\geq .15$ and $< .40$), medium effect ($\geq .40$ and $< .75$), large effect ($2.75$ and $< 1.10$), very large effect ($\geq 1.10$ and $< 1.45$), and huge effect ($> 1.45$).

With respect to aerobic endurance, we checked at which time point the change was statistically significant by repeated measures analyses of variance (ANOVA) for which we introduce the five waves as the within-factor. We also used the Bonferroni post hoc test to determine whether the difference between each pair of waves was significant at $p$ value less than .05. In order to highlight the change in experimental and control groups, we computed the percentage of change by dividing the average gain by the pretest mean of our measures (Thomas, Nelson, Silverman, & Silverman, 2010). All data were analyzed using the SPSS computer package (SPSS V. 18.0; Chicago, IL).

**Results**

There were no baseline differences between the two groups with respect to age ($t(124) = 1.89; p = .06$), BMI score ($t(124) = .62, p = .54$), and MME score ($t(124) = .98, p = .33$). At the pretest, the intervention group and the control group did not differ in a statistically significant way with respect to aerobic endurance ($t(124) = -1.38, p = .18$), as well as lower limb strength ($t(124) = -1.56, p = .12$), and mobility ($t(124) = 1.77, p = .08$) (Table 1).

All participants attended 90% of the total possible workouts and reached the intensity range required by the exercise program for each session. Furthermore, all participants were able to complete every set of strength training exercises without difficulties.

Table 2 presents mean scores and standard errors for the experimental and control groups at pre- and postintervention. As for the effects of the intervention (Figure 2), the difference between the experimental and control group was statistically significant for aerobic endurance ($F(5, 116) = 253.59, p < .0001, \eta^2 = .697$) with a huge effect size ($d = 3.39$). In fact, aerobic endurance
decreased between the pre- and post-test in the control group (from 432.46 to 330.84 m), whereas it increased in the experimental group (from 447.70 to 561.51 m). Considering the baseline aerobic endurance score, the data of the experimental group showed a relative increase of 26%, whereas the control group showed a relative decrease of 24%.

Regarding lower limb strength (Figure 3), the difference between the experimental and control groups was statistically significant \((F(5, 115) = 96.80, p < .0001, \eta^2 = .470)\) together with a huge effect size \((d = 1.56)\). A small decrease between the pre- and post-test was observed in the control group (from 10 to 9 times). However, the lower limb strength increased in the experimental group (from 10 to 13 times). Based on the baseline lower limb strength score, the data of the experimental group showed a relative increase of 33%, and the control group showed a relative decrease of 6%.

Finally, the difference between the experimental and control groups was statistically significant for mobility \((F(5, 115) = 42.85, p < .0001, \eta^2 = .282)\) with a large effect size \((d = .75)\). The control group (Figure 4) remained stable in mobility performance (from 9.25 to 9.84 s), whereas the intervention group’s increased (from 8.47 to 7.13 s). The baseline mobility score data of the experimental group showed a relative increase of 13% and the control group showed a relative decrease of 7%.

Figure 5 presents mean scores and standard errors for the experimental groups at pretest, three midwaves, and post-test. Regarding aerobic endurance (Table 3), the Bonferroni post hoc test of the ANOVA revealed a significant statistical difference for every five waves of measures \((F(1, 59) = 157.11, p < .0001, \eta^2 = .920)\).

**Discussion**

The aim of this study was to investigate the effects of an ecological walking training, which includes balance and strengthening exercise among a group of sedentary elderly people in terms of aerobic endurance, lower limb strength, and mobility.

As for aerobic endurance, we wanted to demonstrate whether participating in an ecological physical activity training could improve this in elderly people. Consequently, the data showed a huge effect size of intervention. We found that the participants of the experimental group increased their aerobic endurance from the baseline by 26%. This improvement is similar to changes reported in other studies that trained participants in comparable tasks (Harber et al., 2009; LIFE Study Investigators et al., 2006). Also noteworthy is the fact that no physical or medical problems occurred during training or aerobic endurance testing, which is consistent with the literature and confirms the idea that moderate aerobic training is safe and effective even in the elderly people (Bischoff & Roos, 2003; Garber et al., 2011). In accordance with American College of Sports Medicine (2000) (Chodzko-Zajko et al., 2009), aerobic physical activity training can significantly increase aerobic capacity and performance in older adults. This finding is relevant because an adequate level of aerobic endurance, which is the ability to sustain large-muscle activity over time, is necessary to perform many everyday activities (Garber et al., 2011). In relation to aerobic endurance, our study...
demonstrated that sedentary elderly people who participated in walking training had a regular and continuous increase in performance during the 16-week training. For each measurement at weeks 4, 8, 12, and 16, the participants improved steadily (respectively by 9%, 10%, 4%, and 3%). The participants of the control group, who remained sedentary, decreased their aerobic endurance by
24% during the same period. Therefore, our study suggests that even in the shorter term physical activity training can trigger positive and continuous changes on individual physical functions that are essential for maintaining independence and reducing fatigue in daily activities.

A further outcome of our study was that we found that our ecological training would specifically improve the lower limb strength of sedentary elderly people. The participants in the experimental group increased lower limb strength by 33% with respect to the baseline. The data show, also in this case, a huge effect size. Our results, similar to those reported in the meta-analysis by Liu and Latham (2009), confirm that given a stimulus of sufficient intensity, muscle strength may increase in older adults. Moreover, the meta-analysis showed that strength training had a significant benefit compared with aerobic training on strength in elderly people. Also, we found a similar positive effect that was reported after a progressive resistance strength training (Latham, Bennett, Stretton, & Anderson, 2004). However, physical activity based on walking and resistance strength training does help to preserve and even improve the lower limb strength of sedentary elderly people (Lovell, Cuneo, & Gass, 2010). Limb strength is directly related to one’s autonomous walking ability. Indeed, lower limb strength declined by 6% among the control group participants. Moreover, the ability to repeatedly produce muscular strength through an extended period of time determines the travel range and the functional independence of the elderly people; the lack of strength is a reliable predictor of the onset of disability in later years of life.

The third outcome this study demonstrated was that a physical activity program based on walking exercise that includes balance and strengthening exercise can improve performance related to mobility. In particular, the participants of the experimental group registered an intermediate-high improvement (13%) compared with the sedentary participants of the control group where mobility decreased (7%). These results are similar to changes reported by Malatesta, Simar, Saad, Préfaut, and Caillaud (2010) who demonstrate that walking training may be an effective way to improve walking performance and delay mobility impairment among elderly people. Indeed, maintaining a good level of mobility is very important for elderly people with regards to walking and managing dynamic balance, even in situations that require speed, such as getting in and out of a bus and/or car (Rikli & Jones, 2013). Mobility includes the ability to perform complex motor tasks, such as ambulatory supporting weights, changing direction, and overcoming obstacles. Shumway-Cook, Ciol, Yorkston, Hoffman, and Chan (2005) already showed that older persons, even if independent in mobility, have limitations in the way they express themselves in complex situations. Moreover, a good level of mobility can promote an active lifestyle and participation at recreational activities in the elderly people (Webber et al., 2010).

Moreover, we want to highlight that these positive results can be affected by the interaction of walking training with lower body strength exercises and balance exercises. In fact, as already shown by the literature, a combination of activities (i.e., aerobic and strength training) seems to be more effective than training alone in counteracting the detrimental effects of a sedentary lifestyle on health and physical function (Chodzko-Zajko et al., 2009). Also, multimodal exercise, usually including strength and balance exercises, has been shown to be effective in reducing the risk of

### Table 3. Repeated Measures Analyses of Variance

<table>
<thead>
<tr>
<th>Wave 1 (baseline)</th>
<th>Wave 2 (4 weeks)</th>
<th>Wave 3 (8 weeks)</th>
<th>Wave 4 (12 weeks)</th>
<th>Wave 5 (16 weeks)</th>
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<tr>
<td><strong>M (SD)</strong></td>
<td><strong>M (SD), p</strong></td>
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<td><strong>Percentage of change</strong></td>
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<tr>
<td>Six-minute walk test</td>
<td>(baseline)</td>
<td>(73.87)</td>
<td>9</td>
<td>534.13</td>
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<td></td>
<td>(74.15), &lt;.0001</td>
<td>(79.10), &lt;.0001</td>
<td>(81.20), &lt;.0001</td>
<td>(83.96), &lt;.0001</td>
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</table>

**Main effect time**

\[ F = 157.11; p < .0001; \eta^2 = .920 \]

**Notes:** The statistical significance of the difference between the waves was calculated by the Bonferroni post hoc test. Relative percentage of improvement from baseline is the difference between post-test and baseline in percent with respect to baseline.
falling over and promote safer mobility (Pereira, Vogelaere, & Baptista, 2008).

There are limitations to consider in this study, especially regarding the age of participants and duration and the frequency of activity. Concerning the age of participants in our study between experimental and control groups, there is no difference ($p = .06$). If we take in account the sample size, however, we cannot exclude that the magnitude of our result is, in part, due to some difference in the age of two groups. Moreover, literature regarding training duration and frequency suggests that in order to achieve more effective results, training should be introduced three times a week and last for 24–32 weeks.

In our study, it was not possible to use such a protocol. In Italy, the majority of the elderly population (National Institute of Statistics, 2006), although sedentary, is very socially active. In fact, Italian elderly people are usually very much involved in the care of their grandchildren and voluntary and cultural activities. There is often little time left for other activities such as physical training. The literature focuses on interventions carried out in northern European and North American countries. These are not representative of the Italian social context that is characterized by a different social and health care system. Furthermore, the present generation of elderly people has not developed the habit of participating in structured physical activity and therefore to convince them to participate in a training longer than the one we used would have been virtually impossible. Finally, we only measured lower limb strength and mobility before training and after the 16-week training. Consequently, our results reflect only the amplitude of the final change and not the rate of change over the weeks of training. We think it is important to continuously monitor the process of change during the activity, as we did for aerobic endurance, because all changing aspects must be measured in order to plan training phases and meet the elderly people’s needs. Furthermore, future studies should investigate the effects of our ecological walking training on psychosocial and cognitive adjustment and compare its effects with those of a different kind of physical activity (i.e., strength training and walking training with treadmill).

Despite these limitations, our study highlights the importance of identifying protective factors for health and independence among elderly population. Considering their involvement in physical activity, many elderly individuals must confront barriers to initiation and maintenance. These barriers are not only chronic diseases, disability, or fear of doing new activities (Bruce, Devine, & Prince, 2002) but also social and structural. We think that physical activity programs for elderly people have to take into account environmental conditions during the design of the intervention. Our ecological training was designed to meet these social and structural barriers.

Most importantly, our study shows that it is possible to obtain positive results through implementing a physical training without any specific facility or structure. According to Wiles, Leibing, Guberman, Reeve, and Allen (2012), the elderly people wanting to be “aging in place” need health-promoting services inside their daily community, such as physical trainings. The increasing proportion of the elderly population demands urgent implementation and evaluation of the effectiveness of preventive programs that can reduce the costs of health care in a frail population at risk of disability. Our findings suggest that a physical activity program may play a protective role in elderly people autonomy. Even ecological training can slow the aging process and preserve motor abilities that are critical for independent livelihood. In addition, our walking training, owing to the possibility of implementing this program within elderly residential communities, combined the organizational, regulatory, and economic components representing an example of an effective ecological intervention (McLaren & Hawe, 2005).

We point out that, despite its ecological characteristics, our intervention was based on professional exercises recognized by literature (American College of Sports Medicine, 2000; Weineck, 2007). For this reason, it required a qualified instructor in order to ensure the proper conduct of the activity and the safety of the participants. Finally, the study supports the possibility of introducing healthy lifestyles at older ages, that is, lifestyles in which movement becomes a relevant part of the elderly people’s everyday life.

Conclusions

In summary, we found that 16 weeks of our ecological walking training, which includes balance and strengthening exercise, for sedentary elderly people resulted in a significant increase in aerobic endurance, lower limb strength, and mobility. The decline of these parameters usually has significant implications for the quality of life.
and health of this age bracket. Physical training is one of the most important instruments to combat these declines. The study demonstrated that an ecological training conducted by qualified trainers could be used to improve physical functioning in sedentary elderly people. Setting a training, which reproduces movements of daily life, bearing realistic goals, and taking scientific evidence into consideration (with respect to type, intensity, and frequency of the physical training) can allow for active and successful aging.

Funding

Research presented in this article has been supported by Regione Piemonte, Direzione e Innovazione Ricerca e Università, Bando Scienze Umane e Sociali 2008 (ID 59), for their contribution to ACT ON AGEING study.

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