Effectiveness of a Lifestyle Physical Activity Versus a Structured Exercise Intervention in Older Adults

Evelien Van Roie, Christophe Delecluse, Joke Opdenacker, Katrien De Bock, Eva Kennis, and Filip Boen

Two groups of sedentary older adults, participating in either a lifestyle physical activity intervention (LIFE, \(n = 60\)) or a structured exercise intervention (STRU, \(n = 60\)), were compared with a control group (CO, \(n = 66\)) in terms of physical fitness and cardiovascular risk factors. Participants in LIFE were stimulated to integrate physical activity into their daily routines and received an individualized home-based program. Participants in STRU completed 5 supervised training sessions every 2 wk in a fitness center. Both interventions lasted 11 months and focused on endurance, strength, flexibility, and postural/balance exercises. The results revealed that the interventions were equally effective in improving functional performance. STRU was more effective than LIFE in improving cardiorespiratory and muscular fitness. Limited effects emerged on cardiovascular risk, with STRU improving in total cholesterol and HDL. Consequently, interventions aiming at reducing cardiovascular risks among sedentary elderly should focus on long-term changes in physical activity behavior.

Keywords: functional performance, cardiovascular fitness, muscular fitness, home-based program, public health

Over the last century, life expectancy in North America and Western Europe has increased by more than 30 years, up to 75 years for men and 80 for women (National Center for Health Statistics, 2006). This increase has an enormous impact on the health-care cost in these societies, given that 88% of their inhabitants over age 65 have at least one chronic health condition (Hoffman, Rice, & Sung, 1996). Moreover, low functional capacity and muscle weakness are more common in the elderly and contribute to a loss of independence (Doherty, 2003). As a consequence, large numbers of older adults suffer from impaired functioning and well-being (Crews & Zavotka, 2006).

Regular physical activity decreases the risk of developing chronic diseases such as cardiovascular disease, diabetes, hypertension, obesity, and osteoporosis (Warburton, Nicol, & Bredin, 2006). Furthermore, it delays the onset of functional
Van Roie et al. decline (LaCroix, Guralnik, Berkman, Wallace, & Satterfield, 1993). Although these benefits of regular physical activity are widely known, most elderly in North America and Europe do not reach the recommended level of 30 min of physical activity each day (Whaley, Brubaker, Otto, & Armstrong, 2006). For example, in the United States more than 70% of older adults do not meet these recommendations (Kruger, Carlson, & Buchner, 2007).

Several studies have shown that older adults benefit from a supervised, center-based exercise program in terms of improved functional performance and fitness (Binder et al., 2005; Delecluse et al., 2004; Dunn et al., 1998; Fahlman, Morgan, McNevin, Topp, & Boardley, 2007; Fahlman, Topp, McNevin, Morgan, & Boardley, 2007; Stewart, 2005; Toraman, Erman, & Agyar, 2004). However, such programs are expensive, which limits the implementation possibilities and hence the public health impact. Moreover, for sedentary older adults in particular, there are a number of important barriers to attending these supervised center-based exercise programs, such as lack of access or transportation to the facilities, financial considerations, and a lack of affinity with the culture of fitness centers (Schutzer & Graves, 2004).

To deal with these barriers, home-based and lifestyle interventions were developed. Home-based interventions extend the supervision of the exercise program to participants’ home environment (e.g., by telephone counseling), and lifestyle interventions focus on integrating physical activity in the daily routines of the participants instead of restricting it to isolated exercises. It should be noted that home-based and lifestyle interventions are often combined (e.g., Pahor et al., 2006; Nelson et al., 2004). Several studies have revealed positive effects of such interventions compared with an assessment-only or attention control group on fitness and functional performance (Campbell, Robertson, Gardner, Norton, & Buchner, 1999; Jette et al., 1999; Nelson et al., 2004; Pahor et al., 2006). However, it is not yet clear whether the effects of such home-based and lifestyle interventions equal the effects of supervised center-based exercise interventions.

To our knowledge, two large studies have compared the effects of a structured intervention with a lifestyle intervention (Dunn et al., 1999) and a home-based intervention (King, Haskell, Taylor, Kraemer, & DeBusk, 1991) in middle-aged adults. Those studies suggested that lifestyle and home-based interventions can produce effects on physical fitness that equal those of structured center-based interventions. Up to now only one such study has been performed among older adults. Caserta and Gillett (1998) compared the effects of a 16-week health-education group, in which elderly were instructed to exercise aerobically on their own three times per week, with a 16-week structured exercise group that consisted of three supervised aerobic sessions per week. No effects on physical fitness or cardiovascular risk factors were found in either of their interventions. However, it should be noted that these exercise interventions only included aerobic exercise, whereas research has indicated that strength training, flexibility exercises, and balance training are important to preserve physical function and health with advancing age (Toraman & Sahin, 2004). Moreover, their sample consisted only of obese older women and their design did not include a control group.

Therefore, the current study aimed to evaluate the effects of a structured center-based exercise intervention and a home-based lifestyle physical activity intervention on fitness and cardiovascular risk factors in sedentary older adults in comparison with an assessment-only control group. We hypothesized that both interventions
would produce significant increases in all fitness components and decreases in cardiovascular risk factors compared with the control group. Because the structured exercise intervention group had access to a fitness center and thus to specialized equipment, we expected larger gains in muscle strength for these participants.

Method

Participants

A flowchart of the study is provided in Figure 1. Recruitment took place through personal letters and advertisements on local radio stations and in local newspapers. Letters were sent to retired university employees and members of sociocultural organizations for seniors.

All candidates participated in an information session that focused on different components of healthy aging. A number of those information sessions were randomly selected to constitute a control group of volunteers and did not include information regarding the benefits of physical activity. Other volunteers were randomized into either a structured exercise intervention or a lifestyle physical activity intervention. At the end of these sessions, 235 community-dwelling adults more than 60 years of age volunteered to participate in a randomly selected physical activity intervention by signing an informed consent. One hundred one people volunteered for the control group and participated in a “checkup of fitness/health status” program for older adults. All volunteers were asked to report their current level of physical activity in hours per week and their previous participation in endurance or strength training in the 2-year period preceding the study. If more than 2 hr of physical activity per week were reported, volunteers were excluded from medical screening.

The inclusion criteria for all participants were as follows:

- Being over 60 years old
- Not having participated systematically in any endurance or strength training in the 2-year period preceding the study
- Not being physically active at moderate intensity for more than 2 hr/week at the time of recruitment

The exclusion criteria were

- Any pathologies with contraindications for involvement in a training program, such as stroke, cardiovascular disease, coronary bypass or stent placed at least 5 years ago, peripheral neuropathologies, serious rheumatism or osteoarthritis, tumors, diabetes, severe migraine, and pathological ECG abnormalities
- Intake of medication known to affect exercise capacity or bone density less than 1 year before the initiation of the study
- All neurodegenerative or neuromuscular disorders such as Parkinson’s disease or multiple sclerosis

A power calculation on the basis of the expected increase in peak oxygen uptake ($V_{O_{2peak}}: \text{ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$) was performed to determine the sample size.
The estimation of the required sample size was based on a meta-analysis (Green & Crouse, 1995) in which the characteristics of the participants, as well as the mean training parameters, were very similar to those of the current study. Those authors found an average increase of 14% in VO$_{2peak}$. It was decided that 22 participants of each sex were needed to reach a power of 80%. Because 25% dropout was expected, 30 participants per sex and per condition were recruited.
The first 60 male and female volunteers for the physical activity intervention who passed the medical screening were numbered in sequence and alternately allocated to the structured exercise or lifestyle physical activity intervention, based on equal gender distribution. Participants who came with a partner were allocated to the same intervention to avoid confounding between the conditions. The allocation sequence was concealed until the interventions were assigned. The first 60 controls who passed medical screening were accepted. Between-groups differences were tested for age, education, body-mass index (BMI), and VO2peak. At the end of recruitment, a significant difference was found for age and VO2peak between the 30 male controls and the males for the interventions. Therefore, the control group was enlarged by 6 (i.e., + 20%) men. After adding these participants to the sample, no significant between-groups differences remained for age, education, BMI, and VO2peak at the beginning of the study. The study was approved by the commission of medical ethics of Leuven Catholic University. All participants gave their written informed consent before participation.

Procedure

Participants were tested in March (pretests), and the interventions started in April. Midtests were performed at the end of September after 6 months of intervention, and posttests were performed in March of the next year after 11 months of intervention. The programs were guided by two female instructors. Both had master’s degrees in kinesiology and one had an additional master’s degree in rehabilitation sciences. They were responsible for planning the measurements and were therefore not blinded to group assignment.

Interventions

Structured Exercise Group. The participants in the structured exercise group (STRU) had the opportunity to engage in a supervised training session of 60–90 min, organized three times a week in a fitness center that was only open for participants in the study. They were asked to attend five sessions every 2 weeks and exercised in groups of 10, supervised by an instructor. The program included four training components: endurance (10–40 min), strength (25 min), flexibility (10 min), and postural/balance (15 min) training. Endurance training consisted of walking or jogging on a treadmill, exercising on a cycle ergometer, or stepping. Training intensity was verified by heart-rate registration. Training progression included gradual increase of exercise duration from 10 to 40 min over a 24-week period, and training intensity varied between 70% and 80% of the individual heart-rate reserve (HRR; Karvonen formula). During the last 20 weeks of training, participants continued to perform 40 min of endurance exercise. In that period, continuous exercise (70–80% of HHR) was alternated with interval-type exercise consisting of high-intensity blocks (85% of HRR, 10–15 min) and blocks at a lower intensity (70% of HRR). During each training session, participants subse- quently performed 9 of 13 strength exercises: abdominal crunch, back extension, arm curl, vertical row, vertical traction (similar to lateral pull-down), chest press, shoulder press, leg press, leg curl, leg extension, hip abductor, hip adductor, and standing gluteus. The initial training load (20 RM) was individually determined by the instructor. All exercises were performed with the objective to complete the
number of repetitions with the highest possible load. Training intensity gradually increased from moderate (20 RM) to high (8 RM). The number of sets per exercise, varying between one and two, was clearly stated before training. Participants were encouraged to increase the load in the next set or in the next session if they felt capable of performing more than the prescribed number of repetitions. At the end of each training session, 10 min of static stretching and 15 min of postural and balance training were performed.

**Lifestyle Intervention.** In the home-based lifestyle intervention (LIFE), participants were stimulated to integrate physical activity into their immediate environment during daily routines. In a collective session, general information concerning endurance, strength, flexibility, and postural/balance training was offered. Participants received a brochure and were taught how to use a pedometer and how to check their heart rate. This was followed by an individual session with the instructor, in which an individualized program was set up, adapted to the participant’s needs, preferences, and experiences. Participants received a booklet with illustrated strength, flexibility, and balance exercises, from which appropriate exercises were chosen. For strength training, they had to use elastic tubes and their own weight. Depending on the preference of the participants, the endurance training included activities such as walking, jogging, cycling, swimming, or other cardiovascular exercises. Participants were encouraged to perform their endurance activities at an intensity that resulted in an increased heart rate but still enabled them to have a talk with their partner while exercising. During a consecutive individual session with an exercise psychologist, the individual program was integrated into the daily routines of the participant (e.g., active transportation). The psychologist gave information on how to persist in being physically active and how to anticipate possible barriers.

Participants were supported through phone calls, initially every 2 weeks and later once a month (16 phone calls in total). During these booster phone calls, they were asked to which part of their individual program they had adhered, based on an activity log they kept daily. Collective sessions (five in total) were organized to ensure correct performance of the exercises.

**Control Group.** Participants in the control group (CO) only underwent the measurements and did not receive any feedback or information on the results until the end of the study. Each participant was asked to report changes in lifestyle regarding physical activity, diet, or medication.

**Fitness Components**

Cardiorespiratory capacity was determined by means of a maximal exercise test on an electrically braked Lode Excalibur cycle ergometer (Lode, Groningen, The Netherlands) with gradually increasing intensity (20 W + 20 W/min). Oxygen consumption was measured directly with breath-by-breath respiratory-gas-exchange analysis, using a Cortex Metalyser 3B analyzer (Cortex Biophysic GmbH, Leipzig, Germany). VO\(_{2 \text{peak}}\), defined as the highest 20-s value during the end of the exercise test; peak work load (W); and time till exhaustion (s) were used for statistical analysis.

Muscular fitness was evaluated on the right leg with the Biodex System III isokinetic dynamometer (Biodex Medical Systems, Shirley, NY, USA). Maximal
isometric torque of knee extensors was determined as the peak torque recorded during two isometric contractions in a knee-joint angle of 120° (static strength, Nm). Maximal dynamic torque was determined as the peak torque recorded by means of six isokinetic contractions at 240°/s (dynamic strength, Nm). Finally, a strength endurance test consisting of 25 knee extensions and flexions at 180°/s was performed. Total work (J) was recorded.

Functional strength of the upper and lower extremities was measured with the arm-curl test (number of biceps curls completed in 30 s) and chair-stand test (number of full stands from a seated position completed in 30 s), respectively (Rikli & Jones, 2001). Explosive strength of the lower extremities was assessed by a vertical jump. Jump height (h) was recorded on an electronic contact mat, by means of the flight time (t): \( h = gt^2/8 \), where \( g = 9.81 \text{ m/s}^2 \).

**Cardiovascular Risk Factors**

**Systolic and Diastolic Blood Pressure.** On arrival at the laboratory, fasted participants were placed in a supine position for 10 min, after which blood pressure was measured and subsequently a blood sample was taken. Blood pressure was measured on the right arm with a fully automatic blood-pressure manometer (Omron M4-I, Bannockburn, IL, USA). Systolic and diastolic blood pressure were measured three times at 1-min intervals, and the mean of these three measurements was used in the analysis.

**Glucose, Insulin, and Blood Lipids.** A fasting blood sample was taken from an antecubital vein. Glucose (mg/dl), insulin (\( \mu \text{U/ml} \)), triglycerides (mg/dl), total cholesterol (mg/dl), high-density lipoprotein cholesterol (HDL, mg/dl), and low-density lipoprotein cholesterol (LDL, mg/dl) were determined according to standard laboratory procedures. The ratio of total cholesterol to HDL was calculated.

**Body Composition.** Body weight was recorded to the nearest 0.1 kg with a digital scale (Seca alpha 770, Hamburg, Germany), and standing height was measured to the nearest millimeter using a Harpenden stadiometer (Holtain, Crymych, UK). BMI was calculated (kg/m\(^2\)). Waist and hip circumference were measured to the nearest millimeter, using a metal tape (Rosscraft, Surrey, BC, Canada), according to the ACSM’s guidelines for exercise testing and prescription (Whaley et al., 2006), and waist:hip ratio was calculated.

Percent body fat was measured on the right side of the body with a tetrapolar bioelectrical-impedance analyzer (Bodystat 1500, Bodystat Ltd., Isle of Man, UK) in participants who had been supine for 5 min with arms and legs in abduction.

**Statistical Analyses**

One-way analysis of variance (ANOVA) was used to test for differences between groups at baseline. Effects of the interventions on fitness and cardiovascular risk factors were analyzed by means of linear mixed-models analyses with an unstructured covariance structure, time as repeated factor, and group and gender as fixed factors. Because the Time \( \times \) Group \( \times \) Gender interaction was not significant for any of the variables, the reported analyses were performed with only time and group as factors. Contrast analyses were used to assess between- and within-group differences.
All analyses were executed using SPSS 16.0. Significance level was set at $p < .05$. Unless noted otherwise, significant effects of the intervention groups are similar to those of the control group. All observed measurements were included in the analyses regardless of the participants’ adherence to the program (intention-to-treat analyses).

**Results**

**Compliance and Dropout**

The number of and reasons for dropout, as well as the number of adherers to the intervention programs, are shown in Table 1. The most important reasons to drop out were health problems not related to the study. One participant in LIFE was withdrawn from the study because he complained of being continuously fatigued; this may have been related to the exercise intervention. Participants who completed 80% of their exercise program were considered adherers.

There were no significant differences between the three groups at pretest in age, body mass, height, and gender distribution (Table 2).

**Fitness Components**

At baseline, no significant differences were found between the groups for cardiorespiratory fitness, muscle strength, and functional performance. For all these variables, Group $\times$ Time interactions were found (Table 3).

### Table 1  Number of Dropouts

<table>
<thead>
<tr>
<th>Reason</th>
<th>LIFE $(n = 60)$</th>
<th>STRU $(n = 60)$</th>
<th>CO $(n = 66)$</th>
<th>Total $(N = 186)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal or medical reasons, not related to the study</td>
<td>7</td>
<td>8</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>Medical reasons, probably related to the study</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>&lt;80% present at training sessions</td>
<td>5</td>
<td>7</td>
<td>—</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>15</td>
<td>3</td>
<td>31</td>
</tr>
</tbody>
</table>

*Note. LIFE = lifestyle intervention; STRU = fitness intervention; CO = control group.*

### Table 2  Baseline Characteristics for the Lifestyle Intervention (LIFE), the Structured Exercise Intervention (STRU), and the Control Group (CO)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>LIFE $(n = 60)$</th>
<th>STRU $(n = 60)$</th>
<th>CO $(n = 66)$</th>
<th>$p^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, $M \pm SD$, years</td>
<td>66.11 $\pm$ 4.05</td>
<td>66.75 $\pm$ 4.47</td>
<td>67.79 $\pm$ 5.26</td>
<td>.13</td>
</tr>
<tr>
<td>Body mass, $M \pm SD$, kg</td>
<td>75.65 $\pm$ 11.42</td>
<td>75.15 $\pm$ 12.99</td>
<td>75.52 $\pm$ 10.86</td>
<td>.97</td>
</tr>
<tr>
<td>Height, $M \pm SD$, cm</td>
<td>166.65 $\pm$ 8.52</td>
<td>166.92 $\pm$ 9.63</td>
<td>167.53 $\pm$ 8.49</td>
<td>.85</td>
</tr>
<tr>
<td>Gender, % male</td>
<td>50</td>
<td>50</td>
<td>54.5</td>
<td>.81</td>
</tr>
</tbody>
</table>

*aResults of one-way ANOVA comparing the three groups at pretest.*
<table>
<thead>
<tr>
<th></th>
<th>LIFE (n = 60)</th>
<th>STRU (n = 60)</th>
<th>CO (n = 66)</th>
<th>( p^a ) (Group × Time)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VO(_{\text{peak}}) (ml · kg(^{-1}) · min(^{-1}))</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>22.0 ± 0.66</td>
<td>21.4 ± 0.66</td>
<td>22.3 ± 0.63</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>PM</td>
<td>+ 2.3†</td>
<td>+ 3.1†</td>
<td>+ 0.9</td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>+ 0.7</td>
<td>+ 1.4</td>
<td>+ 1.1</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>+ 3.0</td>
<td>+ 4.5‡</td>
<td>+ 2.0</td>
<td></td>
</tr>
<tr>
<td><strong>T(_E) (s)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>464.1 ± 17.8</td>
<td>478.0 ± 17.9</td>
<td>483.5 ± 16.9</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>PM</td>
<td>+ 30.9†</td>
<td>+ 32.3†</td>
<td>− 4.6</td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>+ 2.9</td>
<td>+ 36.4‡</td>
<td>+ 7.9</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>+ 33.8†</td>
<td>+ 68.7‡</td>
<td>+ 3.3</td>
<td></td>
</tr>
<tr>
<td><strong>WL(_p) (W)</strong></td>
<td></td>
<td></td>
<td></td>
<td>.002</td>
</tr>
<tr>
<td>Pre</td>
<td>163.7 ± 5.89</td>
<td>167.7 ± 5.90</td>
<td>168.9 ± 5.67</td>
<td></td>
</tr>
<tr>
<td>PM</td>
<td>+ 11.2†</td>
<td>+ 17.2†</td>
<td>+ 2.3</td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>+ 2.6</td>
<td>+ 6.3</td>
<td>+ 4.8</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>+ 13.8</td>
<td>+ 23.5‡</td>
<td>+ 7.1</td>
<td></td>
</tr>
<tr>
<td><strong>F(_{\text{STA}}) (Nm)</strong></td>
<td></td>
<td></td>
<td></td>
<td>.001</td>
</tr>
<tr>
<td>Pre</td>
<td>137.7 ± 5.75</td>
<td>139.6 ± 39.1</td>
<td>137.3 ± 5.41</td>
<td></td>
</tr>
<tr>
<td>PM</td>
<td>+ 4.3</td>
<td>+ 23.3‡</td>
<td>+ 1.5</td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>+ 2.8</td>
<td>− 6.2‡</td>
<td>+ 0.0</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>+ 7.1</td>
<td>+ 17.1‡</td>
<td>+ 1.5</td>
<td></td>
</tr>
<tr>
<td><strong>F(_{\text{DYN}}) (Nm)</strong></td>
<td></td>
<td></td>
<td></td>
<td>.002</td>
</tr>
<tr>
<td>Pre</td>
<td>70.0 ± 2.93</td>
<td>70.5 ± 2.93</td>
<td>68.6 ± 2.76</td>
<td></td>
</tr>
<tr>
<td>PM</td>
<td>+ 1.2</td>
<td>+ 5.2‡</td>
<td>− 0.6</td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>+ 0.4</td>
<td>+ 1.0</td>
<td>+ 0.6</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>+ 1.6</td>
<td>+ 6.2‡</td>
<td>+ 0.0</td>
<td></td>
</tr>
<tr>
<td><strong>W(_T) (J)</strong></td>
<td>1,864.0 ± 86.2</td>
<td>1,871.3 ± 86.1</td>
<td>1,844.1 ± 81.1</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>PM</td>
<td>+ 94.1</td>
<td>+ 238.3‡</td>
<td>+ 34.4</td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>− 30.0</td>
<td>+ 5.6</td>
<td>− 19.6</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>+ 64.1</td>
<td>+ 243.9‡</td>
<td>+ 14.8</td>
<td></td>
</tr>
<tr>
<td><strong>ACT (number)</strong></td>
<td>18.7 ± 0.52</td>
<td>18.9 ± 0.53</td>
<td>18.2 ± 0.50</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>PM</td>
<td>+ 1.8</td>
<td>+ 2.8†</td>
<td>+ 1.0</td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>+ 2.5†</td>
<td>+ 1.6†</td>
<td>− 0.4</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>+ 4.3†</td>
<td>+ 4.4†</td>
<td>+ 0.6</td>
<td></td>
</tr>
<tr>
<td><strong>CST (number)</strong></td>
<td>14.4 ± 0.40</td>
<td>14.9 ± 0.40</td>
<td>14.7 ± 0.38</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>PM</td>
<td>+ 2.1†</td>
<td>+ 2.5†</td>
<td>+ 0.5</td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>+ 0.†</td>
<td>− 1.4‡</td>
<td>− 1.2</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>+ 2.2†</td>
<td>+ 1.1†</td>
<td>− 0.7</td>
<td></td>
</tr>
<tr>
<td><strong>VJ (cm)</strong></td>
<td>14.4 ± 5.0</td>
<td>13.8 ± 0.65</td>
<td>14.3 ± 0.63</td>
<td>.002</td>
</tr>
<tr>
<td>PM</td>
<td>+ 0.8</td>
<td>+ 1.9‡</td>
<td>+ 0.5</td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>+ 0.8</td>
<td>− 0.1‡</td>
<td>+ 0.2</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>+ 1.6†</td>
<td>+ 1.8†</td>
<td>+ 0.7</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* LIFE = lifestyle intervention; STRU = fitness intervention; CO = control group; VO\(_{\text{peak}}\) = peak oxygen uptake; T\(_E\) = time to exhaustion; WL\(_p\) = peak work load; F\(_{\text{STA}}\) = static strength; F\(_{\text{DYN}}\) = dynamic strength; W\(_T\) = total work; ACT = arm-curl test; CST = chair-stand test; VJ = vertical jump.

*Linear mixed-models analyses, significance level *\( p < .05 \).*

†Significant difference from CO. ‡Significant difference from LIFE.
After 6 months, both interventions realized significant increases in VO$_{\text{2peak}}$ time till exhaustion, and peak work load. After 11 months STRU increased VO$_{\text{2peak}}$ time till exhaustion, and peak work load more than CO and LIFE.

STRU increased more on all three variables of muscular fitness (static strength, dynamic strength, and total work) after 6 months, as well as after 11 months, of intervention than CO and LIFE. LIFE had no significant effects on muscular fitness in comparison with CO.

In the first 6 months STRU improved more on all functional tests (arm-curl test, chair-stand test, and vertical jump) than CO, whereas LIFE only improved on the chair-stand test. However, in the following 5 months LIFE continued increasing on all functional tests, while STRU only increased on the arm-curl test and showed slight decreases on chair-stand test and vertical jump. Consequently, after 11 months of intervention, both LIFE and STRU showed significant and quite similar improvements on all functional tests.

### Cardiovascular Risk Factors

At baseline, no significant differences were found between the groups for the different cardiovascular risk factors (Table 4).

Irrespective of group, systolic and diastolic blood pressure gradually decreased during the intervention period (i.e., significant time effect). However, no significant changes were found for any of the two intervention groups compared with the control group.

Total and LDL cholesterol decreased from pretest to midtest and from pretest to posttest (significant time effect). There was only an intervention effect for the ratio of total cholesterol to HDL, wherein STRU showed a significant decrease compared with LIFE and CO from midtest to posttest and only compared with LIFE from pretest to posttest.

No time or interaction effect was found for waist:hip ratio. A time effect was found for BMI, percent body fat, waist circumference, and hip circumference; significant improvements were found during the time of the intervention. An intervention effect was found only for hip circumference—STRU decreased significantly after 6 months, as well as after 11 months, of intervention compared with CO and after 11 months compared with LIFE (see Table 5).

### Discussion

This study aimed to compare the effects of a year-round lifestyle physical activity intervention (LIFE) with a structured exercise intervention (STRU) on older adults’ cardiorespiratory fitness, muscular fitness, functional performance, and cardiovascular risk. Both interventions resulted in significant gains in cardiorespiratory fitness compared with the control group (CO), but the increases were more prominent in STRU than in LIFE. Furthermore, only STRU improved significantly on muscular fitness, and there was no effect in LIFE. The improvements in functional performance were significant and quite similar in both intervention groups. In contrast, with respect to cardiovascular risk factors, only few improvements were observed in STRU and none in LIFE.
Table 4  Mean ± SE for Pretest and Changes from Pre- to Midtest (PM), Mid- to Posttest (MP), and Pre- to Posttest (PP) for Blood Pressure, Glucose, Insulin, and Blood Lipids for the Three Groups

<table>
<thead>
<tr>
<th></th>
<th>LIFE (n = 60)</th>
<th>STRU (n = 60)</th>
<th>CO (n = 66)</th>
<th>( p ) (time)</th>
<th>( p^a ) (Group × Time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP (mmHg) Pre</td>
<td>148.6 ± 2.29</td>
<td>144.8 ± 2.31</td>
<td>142.9 ± 2.18</td>
<td>&lt;.001</td>
<td>.39</td>
</tr>
<tr>
<td></td>
<td>PM – 5.8</td>
<td>– 3.1</td>
<td>– 3.2</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MP – 3.5</td>
<td>– 1.8</td>
<td>– 0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PP – 9.3</td>
<td>– 4.9</td>
<td>– 4.1</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>DBP (mmHg) Pre</td>
<td>87.9 ± 1.30</td>
<td>86.7 ± 1.31</td>
<td>84.6 ± 1.24</td>
<td>&lt;.001</td>
<td>.99</td>
</tr>
<tr>
<td></td>
<td>PM – 4.7</td>
<td>– 4.3</td>
<td>– 4.5</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MP – 1.7</td>
<td>– 1.2</td>
<td>– 1.3</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PP – 6.4</td>
<td>– 5.5</td>
<td>– 5.8</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Gluc (mg/dl) Pre</td>
<td>95.6 ± 1.5</td>
<td>95.9 ± 1.5</td>
<td>93.5 ± 1.5</td>
<td>.070</td>
<td>.26</td>
</tr>
<tr>
<td></td>
<td>PM – 1.9</td>
<td>+ 0.1</td>
<td>– 1.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MP + 1.6</td>
<td>– 0.3</td>
<td>+ 2.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PP + 0.3</td>
<td>– 0.2</td>
<td>+ 0.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ins (μU/ml) Pre</td>
<td>6.8 ± 0.75</td>
<td>9.4 ± 0.74</td>
<td>7.2 ± 0.73</td>
<td>.55</td>
<td>.43</td>
</tr>
<tr>
<td></td>
<td>PM 0.0</td>
<td>– 0.5</td>
<td>– 0.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MP + 0.5</td>
<td>– 0.6</td>
<td>– 0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PP + 0.5</td>
<td>– 1.1</td>
<td>– 0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TG (mg/dl) Pre</td>
<td>134.4 ± 8.2</td>
<td>130.6 ± 8.1</td>
<td>122.2 ± 8.0</td>
<td>.13</td>
<td>.46</td>
</tr>
<tr>
<td></td>
<td>PM – 6.5</td>
<td>– 6.8</td>
<td>– 5.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MP + 3.9</td>
<td>+ 2.2</td>
<td>+ 13.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PP – 2.6</td>
<td>– 4.6</td>
<td>+ 8.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chol (mg/dl) Pre</td>
<td>240.7 ± 5.5</td>
<td>251.6 ± 5.3</td>
<td>237.8 ± 5.3</td>
<td>&lt;.001</td>
<td>.20</td>
</tr>
<tr>
<td></td>
<td>PM – 9.4</td>
<td>– 12</td>
<td>– 13.1</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MP + 5.3</td>
<td>– 3.6</td>
<td>+ 5.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PP – 4.1</td>
<td>– 15.6</td>
<td>– 7.8</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>HDL (mg/dl) Pre</td>
<td>53.5 ± 1.6</td>
<td>53.6 ± 1.5</td>
<td>54.1 ± 1.5</td>
<td>.14</td>
<td>.59</td>
</tr>
<tr>
<td></td>
<td>PM + 0.1</td>
<td>– 0.5</td>
<td>– 1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MP + 0.3</td>
<td>+ 1.6</td>
<td>+ 1.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PP + 0.4</td>
<td>+ 1.1</td>
<td>– 0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDL (mg/dl) Pre</td>
<td>149.4 ± 4.1</td>
<td>158.8 ± 4.0</td>
<td>147.7 ± 4.0</td>
<td>&lt;.001</td>
<td>.18</td>
</tr>
<tr>
<td></td>
<td>PM – 6.5</td>
<td>– 9.1</td>
<td>– 9.5</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MP + 3.7</td>
<td>– 2.9</td>
<td>+ 3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PP – 2.8</td>
<td>– 12.0</td>
<td>– 6.0</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>RATIO</td>
<td>4.48 ± 0.14</td>
<td>4.79 ± 0.14</td>
<td>4.60 ± 0.14</td>
<td>.051</td>
<td>.034</td>
</tr>
<tr>
<td></td>
<td>PM + 0.04</td>
<td>– 0.17</td>
<td>– 0.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MP + 0.09</td>
<td>– 0.19 †‡</td>
<td>+ 0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PP + 0.13</td>
<td>– 0.36 ‡</td>
<td>– 0.13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. LIFE = lifestyle intervention; STRU = fitness intervention; CO = control group; SBP = systolic blood pressure; DBP = diastolic blood pressure; Gluc = glucose; Ins = insulin; Chol = cholesterol; TG = triglycerides; HDL = high-density lipoprotein; LDL = low-density lipoprotein; RATIO = total cholesterol:HDL; \( p \) values are from linear mixed-models analyses, significance level \( p < .05 \).

*Significant time effect. †Significant difference from CO. ‡Significant difference from LIFE.
When taking a closer look at the results for cardiorespiratory fitness, participants in LIFE improved significantly, but only during the first 6 months of the intervention, and less than participants in STRU. This difference is probably related to the well-controlled training intensity and training volume in STRU compared with LIFE. Although it seems easy to integrate endurance exercise into the daily routines of the elderly, participants in LIFE had no direct supervision and were therefore less committed to reach a specific training intensity.

It should be noted that our STRU participants obtained gains in VO$_{2peak}$ after 6 months identical to those of the participants in the structured intervention of Dunn et al. (1998; i.e., 14.5% vs. 14%). Moreover, our LIFE participants improved more than participants in Dunn et al.’s (1998) intervention (i.e., 6% vs. 10.5%). A possible explanation for the smaller improvements in the study by Dunn et al. is that their participants were on average 20 years younger and started at a higher fitness level (26.8 ml · kg$^{-1}$ · min$^{-1}$ for the lifestyle intervention and 26.5 ml · kg$^{-1}$ · min$^{-1}$ for the structured intervention).

### Table 5

Mean ± SE for Pretest and Changes from Pre- to Midtest (PM), Mid- to Posttest (MP), and Pre- to Posttest (PP) for Body Composition for the Three Groups

<table>
<thead>
<tr>
<th></th>
<th>LIFE (n = 60)</th>
<th>STRU (n = 60)</th>
<th>CO (n = 66)</th>
<th>p (time)</th>
<th>p (Group × Time)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMI (kg/m$^2$)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>26.5 ± 0.51</td>
<td>27.1 ± 0.48</td>
<td>26.8 ± 0.45</td>
<td>&lt;.001</td>
<td>.26</td>
</tr>
<tr>
<td>PM</td>
<td>− 0.2</td>
<td>− 0.5</td>
<td>− 0.1</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>0.0</td>
<td>+ 0.2</td>
<td>+ 0.1</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>− 0.2</td>
<td>− 0.3</td>
<td>0.0</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td><strong>%BF</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>33.3 ± 1.1</td>
<td>33.9 ± 1.0</td>
<td>33.8 ± 0.98</td>
<td>.032</td>
<td>.75</td>
</tr>
<tr>
<td>PM</td>
<td>+ 0.2</td>
<td>− 0.3</td>
<td>− 0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>− 0.4</td>
<td>− 0.5</td>
<td>− 0.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>− 0.2</td>
<td>− 0.8</td>
<td>− 0.7</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td><strong>WHR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>0.89 ± 0.012</td>
<td>0.90 ± 0.011</td>
<td>0.91 ± 0.011</td>
<td>.062</td>
<td>.32</td>
</tr>
<tr>
<td>PM</td>
<td>− 0.01</td>
<td>0.0</td>
<td>− 0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>− 0.01</td>
<td>0.0</td>
<td>− 0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>WC (mm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>906.0 ± 1.5</td>
<td>928.3 ± 1.4</td>
<td>921.7 ± 1.4</td>
<td>&lt;.001</td>
<td>.86</td>
</tr>
<tr>
<td>PM</td>
<td>− 14.0</td>
<td>− 17.7</td>
<td>− 12.6</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>+ 0.7</td>
<td>+ 1.9</td>
<td>+ 3.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>− 13.3</td>
<td>− 15.8</td>
<td>− 6.0</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td><strong>HC (mm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>1,024.1 ± 0.95</td>
<td>1,031.0 ± 0.91</td>
<td>1,011.8 ± 0.87</td>
<td>.002</td>
<td>.005</td>
</tr>
<tr>
<td>PM</td>
<td>− 11.0</td>
<td>− 18.3†</td>
<td>− 1.2</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>MP</td>
<td>+ 7.2</td>
<td>− 2.8</td>
<td>+ 2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>− 3.8</td>
<td>− 21.1†‡</td>
<td>+ 0.8</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

*Significant time effect. †Significant difference from CO. ‡Significant difference from LIFE.
Lifestyle vs. Structured Exercise in Older Adults

for the structured intervention). Overall, the gains in VO$_2$peak of both our interventions were substantial and further increased after 11 months to 21.0% for STRU and 13.6% for LIFE.

With respect to muscular fitness, STRU improved in the first 6 months, followed by a status quo in the following 5 months. These quick improvements can partially be attributed to neural adaptations that take place in the initial stage of strength training. Numerous studies have shown dramatic improvements in strength, even in advanced age, using targeted exercise programs (Fiatarone et al., 1990; Frontera, Meredith, O’Reilly, Knuttgen, & Evans, 1988; McCartney, Hicks, Martin, & Webber, 1996).

It has also been shown that strength-training interventions help improve physical performance and reduce falls (Campbell et al., 1997; Fiatarone et al., 1990). However, until now it remained unclear to what extent a lifestyle intervention in older adults could result in increased strength after 1 year. Jette et al.’s (1996) study demonstrated that a 12- to 15-week home-based strengthening intervention designed for nondisabled, community-dwelling older adults did achieve positive, albeit modest, improvements in lower extremity strength. These findings were not confirmed in our study because we did not find significant changes in LIFE. Moreover, the longer period of intervention in our study did not result in larger gains in strength.

Several things could account for the differences in strength gain between our two intervention groups. First, STRU met the ACSM’s guidelines and was supervised by fitness professionals every training session. In contrast, because of practical considerations, it was very difficult to set up an exact training load, volume, and intensity to obtain efficient strength gains for LIFE participants. Second, motivating older adults to perform home-tailored strength exercises proved to be very difficult, because the exercises were hard to integrate in a natural way into their daily activities. Participants experienced these strength exercises as a chore and felt insecure without the supervision of a professional. In contrast with the cardiovascular exercises that could be performed with friends, strength exercises had to be performed individually. Therefore, in future studies lifestyle interventions should pay more attention to implementing strength exercises if they aim to improve muscular fitness.

In contrast with the results on muscular fitness, both intervention groups showed similar improvements in functional performance after 11 months of intervention. It should be noted that although there was no difference between the two intervention groups at the end of the programs, LIFE increased more for the chair-stand test and arm-curl test during the last months of the intervention. This different result can be explained by the specificity of the exercises in LIFE, which was more linked to the daily functioning of the participants than in STRU.

Our results on functional performance are consistent with the findings of Nelson et al. (2004) and Pahor et al. (2006). Nelson et al. found positive results on functional performance with an exercise program that focused on strength and balance training with encouragement to increase overall physical activity. Pahor et al. reported improvements on functional performance after a physical activity program that consisted of a combination of aerobic, strength, balance, and flexibility exercises and that started in a fitness center but gradually moved to the home environment. Combined with our findings, these results suggest that a lifestyle
physical activity intervention consisting of specific exercises at home can improve functional performance as much as a more costly and time-consuming structured exercise intervention in a specialized fitness center.

Because previous studies reported positive effects of physical activity interventions on cardiovascular risk factors (Boardley, Fahlman, Topp, Morgan, & McNevin, 2007; de Jong et al., 2006; Dunn et al., 1997), we had expected a beneficial effect of our interventions on these risk factors. Surprisingly, only limited effects were found. This lack of results could be related to the fact that most of our participants were not showing a risk profile for cardiovascular disease to begin with. Consequently, a floor effect might explain the limited effects of our interventions on cardiovascular risk factors. On the other hand, previous research has indicated that low fitness is an important precursor of cardiovascular disease and all-cause mortality in men and women (Blair et al., 1996; Blair et al., 1995). Individuals who do not have a high risk profile for cardiovascular disease but are physically unfit, like our participants, should be encouraged to improve their fitness level to prevent cardiovascular disease in the future.

Although both STRU and LIFE showed a decrease in blood pressure (systolic and diastolic), a similar but unexpected decrease was established in CO. Both the information session on healthy aging and participation in an extensive set of measures regarding health may have had a positive effect on the health behavior of the control group, even without further intervention.

The mean group value for total and LDL cholesterol decreased, and HDL cholesterol increased significantly from baseline to midtests and further to posttest, but there were no differences between the three groups. The only group difference with regard to blood cholesterol levels was found for total cholesterol:HDL ratio, with positive changes for STRU compared with LIFE after 1 year of intervention. Kinosian, Glick, and Garland (1994) found that total-cholesterol:HDL ratio is a better measure of risk for coronary heart disease than either total cholesterol or LDL cholesterol. The results of our study with regard to cardiovascular risk factors confirm the findings of King et al. (King et al., 1991; King, Haskell, Young, Oka, & Stefanick, 1995), who also observed no or only limited changes in cardiovascular risk factors. By contrast, in the study by Dunn et al. (1998), 6 months of intervention did result in a decrease of total cholesterol, total cholesterol:HDL ratio, and systolic and diastolic blood pressure. However, those authors did not include a control group in their study. The significant time effects on these variables in our study indicate that we would also have obtained positive results on cardiovascular risk factors without the comparison of a control group. The finding that total cholesterol:HDL ratio only improved in STRU does not confirm the hypothesis of King et al. (1991) that frequency of exercise may be a more critical factor to affect cholesterol levels than exercise intensity, because we may expect that in the current study STRU realized on average a higher exercise intensity than LIFE.

Finally, with respect to body composition, hip circumference was somewhat reduced in STRU compared with both other groups. No group differences were found for the other body-composition parameters. This study solely focused on the effects of a physical activity intervention; no specific dietary advice was given to the participants. Greater improvements in body composition would probably be attained with a combination of physical activity and a specific diet.
Our nonsignificant results for body composition are consistent with the findings of King et al. (1995), who also observed no significant changes in BMI, waist-to-hip ratio, or body-fat percentage for any of their training conditions across a 2-year period. Other studies reported mainly weak changes in body composition and other health-related indicators (de Jong, Lemmink, King, Huisman, & Stevens, 2007; King et al., 1991). In contrast, Dunn et al. (1999) observed significant decreases in percentage body fat for both interventions. However, as previously mentioned, their study did not include a control group. In our study we can only conclude that changes in body composition were weak and limited to STRU.

Two methodological limitations of this study should be considered. First, the medical screening of the participants resulted in the inclusion of mainly healthy older adults, whereas a significant proportion of older adults suffer from at least one chronic health condition (Hoffman et al., 1996). This limits the external validity of some of our findings. On the other hand, the average initial VO$_{2\text{peak}}$ of our participants (i.e., 22.0 ml · kg$^{-1}$ · min$^{-1}$ in LIFE and 21.4 ml · kg$^{-1}$ · min$^{-1}$ in STRU) was rather low compared with previous studies that investigated the effects of endurance training in elderly (Dunn et al., 1999; Green & Crouse, 1995). These findings indicate that participants in our study had a relatively low fitness level at baseline. We therefore believe that the selected group of participants did represent a potential target population for physical activity programs that aim to prevent chronic diseases. A second limitation is the fact that the control group was recruited through separate information sessions, because it would be unethical to randomize participants who are striving for more physical activity into a control group. Given that the controls participated in a fitness and health assessment study, this may have had a positive impact on their lifestyle.

Despite these limitations, the findings of this study add new information regarding the effects of physical activity interventions on physical fitness and health in older adults. Both LIFE and STRU were effective in improving cardiorespiratory fitness and functional performance. Although STRU increased more than LIFE on cardiorespiratory fitness, LIFE increased as much as STRU for functional performance. On the other hand, only STRU resulted in significant improvements in muscular fitness. Moreover, a year-round physical activity intervention seemed not very effective in reducing cardiovascular risk parameters in older adults, although STRU showed a limited effect on body composition and total cholesterol:HDL ratio. Although large beneficial effects of physical activity have been reported in different epidemiologic studies (Blair et al., 1996; Blair et al., 1995; Dipietro, 2001; Pate et al., 1995), it seems that 1 year of intensive structured exercise or lifestyle integrated physical activity is not sufficient to improve all cardiovascular risk factors in older healthy adults who have been sedentary for many years. Therefore, interventions for sedentary older adults should focus on long-term changes in physical activity behavior and on dietary changes.

Acknowledgments

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