

The Longitudinal Effects of a Lifestyle Physical Activity Intervention and a Structured Exercise Intervention on Physical Self-Perceptions and Self-Esteem in Older Adults

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The objectives of this study were (1) to evaluate the long-term effects of a lifestyle physical activity intervention ($n = 60$) and a structured exercise intervention ($n = 60$) on physical self-perceptions and self-esteem in older adults compared with a control group ($n = 66$), and (2) to test the longitudinal fit of the exercise and self-esteem model (EXSEM). Immediately after the 11-month interventions, the lifestyle group showed significant improvements in self-perceived physical condition, sport competence, body attractiveness, and physical self-worth. In the structured group, significant effects were found on physical condition and sport competence. One year later, the lifestyle program had significant effects on body attractiveness and global self-esteem, while the structured group showed significant improvements in physical condition, sport competence, and body attractiveness. Path analyses revealed a good fit for the EXSEM across the 2-year period.

Keywords: aged, psychological models, self concept, structured equation modeling

The physical health benefits of regular physical activity in older age are well established. Physically active older adults have a decreased risk for all-cause mortality, cardiovascular disease, diabetes, and fractures caused by falling, and an increased ability to perform their daily activities and maintain their mobility (e.g., Singh, 2002; Taylor et al., 2004). In addition, an increasing number of studies have been documenting the psychological benefits of regular physical activity in advanced age. More specifically, regular physical activity is associated with improved mood and psychological well-being, a reduction in depressive symptoms, and a decrease in the risk of developing cognitive impairment, dementia, and Alzheimer's disease (e.g., Barbour & Blumenthal, 2005; Netz, Wu, Becker, & Tenenbaum, 2005; Rovio et al., 2005).

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Concepts that have received less attention as outcomes of physical activity interventions in older adults are self-esteem and self-perception. In a comprehensive review on the effects of exercise interventions on self-perception and self-esteem, Fox (2000a) identified 37 randomized studies, but none of these studies focused on older adults. More recently, two studies did assess these effects, and revealed an increase in physical self-perception and self-esteem after a Tai Chi and a walking intervention respectively (Li, Harmer, Chaumeton, Duncan, & Duncan, 2002; McAuley, Blissmer, Katula, Duncan, & Mihalko, 2000). Nevertheless, the evidence for the relationship between physical activity and self-esteem in older adults remains scarce and long-term results are lacking (Fox, 2000b).

Moreover, to our knowledge the effects of a home-based lifestyle intervention on self-esteem in older adults have not been studied yet. Lifestyle interventions are receiving more and more attention in the health promotion literature for several reasons: (1) they require fewer resources, which facilitates large-scale implementation; (2) they are more accessible, which is especially important for the sedentary population; (3) they are believed to facilitate the long-term maintenance of physical activity behavior (Perri, Martin, Leermakers, Sears, & Notelovitz, 1997); and (4) older adults seem to prefer to be physically active outside formal class groups (Mills, Stewart, Sepsis, & King, 1997).

A model that links physical self-perceptions to physical activity and global self-esteem is the *exercise and self-esteem model* (EXSEM; Sonstroem & Morgan, 1989). The EXSEM posits that changes in physical activity resulting from physical activity interventions or free-living activity have an influence on changes in self-efficacy (i.e., the belief in one's capabilities to become or remain physically active). In turn, these changes in self-efficacy are proposed to have an effect on physical self-perceptions, in particular physical condition, sport competence, body attractiveness, and physical strength. Changes in these physical self-perceptions would then influence physical self-worth, which is ultimately associated with global self-esteem (Sonstroem, Harlow, Gemma, & Osborne, 1991). Several tests of this model led to a revision of the EXSEM in which self-efficacy no longer acts as a mediating variable, but rather in parallel to physical activity (McAuley et al., 1997; Sonstroem, Harlow, & Josephs, 1994).

Until now, few studies have examined the EXSEM in experimental designs (Alfermann & Stoll, 2000; Caruso & Gill, 1992; McAuley et al., 2000). To our knowledge, only one study has used the model to evaluate the relationship between exercise and self-esteem in older adults (McAuley et al., 2000). These authors reported support for most of the hypothesized relationships of the revised version of the EXSEM over a 6-month exercise intervention (McAuley et al., 2000). Subsequently, a longitudinal test of the model was performed in the same sample and the relationships were found to be consistent across a 4-year period (McAuley et al., 2005).

The lack of studies evaluating the long-term effects of physical activity interventions, in particular lifestyle interventions, on self-esteem in older adults, and the lack of evidence for the longitudinal relationships of the EXSEM resulted in the two main objectives of the current study. The first objective was to evaluate the short- and long-term effects of a home-based lifestyle intervention and a structured exercise intervention on physical self-perceptions and self-esteem in older adults, in comparison with an assessment-only control group. The second objective was

to examine the structure of the EXSEM in older adults for short-term as well as long-term changes in physical activity and self-esteem.

Methods

Participants

Participants were recruited through advertisements in local newspapers and on local radio, and via letters to retired university employees and members of sociocultural organizations for seniors. Two hundred and thirty-five community-dwelling adults volunteered to participate in a physical activity program.

The control group was recruited separately for a “checkup of fitness/health status” program. Given the scientific evidence that physical activity has a positive influence on health and well-being, we decided that it would be unethical to randomize older adults who are willing to participate in an exercise program into a control group and ask them to continue their usual, sedentary lifestyle. One hundred and one older adults volunteered for the control group.

Inclusion criteria for all three groups were as follows: being over 60 years old, not having participated systematically in any endurance or strength training in the 2 years preceding the study, and not being physically active at moderate intensity for more than 2 hr per week at the moment of recruitment. Exclusion criteria for all groups were as follows: being diagnosed with any pathology with contraindications for involvement in a training program; having taken medication known to affect exercise capacity or bone density less than 1 year before the initiation of the study; being diagnosed with a neurodegenerative or neuromuscular disorder.

Procedure

The study was part of a larger research project by order of the Flemish government. It was approved by the commission of medical ethics of the Katholieke Universiteit Leuven. A power calculation on the basis of the expected increase in peak oxygen uptake ($\text{VO}_{2\text{peak}}$, $\text{mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$), which was the main outcome for other parts of the project, was performed to determine the sample size.

Before participation, the purpose and procedures of the study were explained and participants gave their written informed consent. After medical screening, the participants who volunteered for the physical activity programs were randomized into the structured exercise intervention or the lifestyle intervention. The first 30 men and the first 30 women who volunteered for the “checkup of fitness/health status” program and passed the medical screening formed the control group. Next, we checked for significant between-group differences on age, education, BMI, and peak oxygen uptake ($\text{VO}_{2\text{peak}}$). The results showed that the control group was older and had a lower $\text{VO}_{2\text{peak}}$. Because we did not have a randomized control group, we wanted to match the control participants as much as possible to the intervention participants. Therefore, six male candidates were additionally allocated to the control group to make the baseline differences disappear.

To rule out seasonal effects, all measurements took place in March—that is, in March 2004 (pretest), March 2005 (posttest), and March 2006 (follow-up). Consequently, the intervention programs lasted 11 months, from April 2004 to

March 2005. The programs were guided by the same two instructors. Both had a master's degree in kinesiology and one had an additional degree in rehabilitation sciences. They were responsible for the planning of the measurements and were thus not blinded to group assignment.

Interventions

The structured exercise intervention consisted of three sessions of 60–90 min each week in a fitness center that was only open to participants of the study. Participants exercised in groups of 10 and were supervised by the two instructors. Each participant received an individualized program that included endurance, strength, flexibility, and balance training. Endurance training consisted of walking or jogging on a treadmill, exercising on a cycle ergometer, or stepping. Training progression included a gradual increase of exercise duration from 10 min to 40 min over a 24-week period, and training intensity varied between 70 and 80% of the individual heart rate reserve. In each training session, participants performed 9 out of 13 strength exercises (25 min). The training intensity gradually increased from moderate (20 RM) to high (8 RM). At the end of each training session, the participants performed 10 min of static stretching and 15 min of posture and balance training.

In the home-based lifestyle intervention, participants were stimulated to integrate physical activity into their daily routines. In cooperation with each participant, an individualized physical activity program was designed, which consisted of home-based endurance, strength, flexibility, and balance exercises and which was adapted to the participants' needs, preferences, experiences, and time schedules. The endurance training comprised activities like walking, jogging, cycling, and swimming, of which walking and cycling were the most popular activities. For strength training at home, the participants used elastic tubes and their own weight. During a session with an exercise psychologist, the individual program was integrated into the participants' daily routines. Special attention was given to active transportation. The psychologist gave information on relapse prevention and on the anticipation of barriers. Participants in the lifestyle group were supported through booster phone calls (10–15 min) from the instructors, initially every 2 weeks and later once a month (16 phone calls in total). An important focus of the lifestyle program was to make the participants self-supportive by gradually increasing their autonomy and decreasing the support.

A more-detailed description of the intervention programs is reported elsewhere (Opdenacker, Boen, Coorevits, & Delecluse, 2008). The control group participated only in the measurements and did not receive any feedback on their health status or any information on physical activity until the end of the study (April 2006).

Measurements

The *demographic variables* age and level of education were included in a short questionnaire. 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). Body mass index (BMI) was calculated (kg/m^2). $\text{VO}_{2\text{peak}}$ was determined by means of a maximal exercise test on an electrically braked Lode Excalibur cycle ergometer

(Lode, Groningen, the Netherlands) with gradual increasing intensity (20 W + 20 W·min⁻¹).

Self-esteem can be defined as an overall evaluation of one's self-worth or value and was measured with a Dutch version of the Rosenberg Self-Esteem Scale (Helbing, 1982; Rosenberg, 1965). The scale consists of 10 items (e.g., "On the whole, I am satisfied with myself"), which are measured on a 7-point Likert scale ranging from *strongly agree* to *strongly disagree*, and has proven to be a reliable and valid measurement of global self-esteem (Helbing, 1982; Rosenberg, 1965). Cronbach's α of the scale in the current study was .87.

Physical self-perception was measured with a Dutch version of the Physical Self-Perception Profile (PSPP) (Fox & Corbin, 1989; Van de Vliet et al., 2002). This questionnaire is used to assess multidimensional hierarchical physical self-esteem. The PSPP includes five subscales: a general physical self-worth scale and four scales that represent the underlying subdomains of perceived sport competence, physical condition, body attractiveness, and physical strength. Each scale consists of six items that are presented in a 4-point structured-alternative response format. This format had shown to reduce socially desirable responding (Fox & Corbin, 1989). The result is a score of 1 to 4 per item, with higher scores representing more positive perceptions. The PSPP has proven to be reliable and valid across different populations (Fox, 1997; Page, Ashford, Fox, & Biddle, 1993; Sonstroem, Speliotis, & Fava, 1992). Alpha estimates proved that the scales were internally consistent in the current study ($\alpha = .83$ for sport competence; $\alpha = .82$ for physical condition; $\alpha = .76$ for body attractiveness; $\alpha = .87$ for physical strength; and $\alpha = .79$ for physical self-worth).

Self-efficacy was assessed with a Dutch version of the five-item Self-Efficacy Questionnaire (Marcus, Selby, Niaura, & Rossi, 1992). Participants indicated how confident they were that they would be physically active in each of five adverse situations on a 5-point Likert scale ranging from 1 = *not at all confident* to 5 = *very confident*. Marcus and Owen (1992) reported adequate internal consistency (Cronbach's $\alpha = .80$) and test-retest reliability ($r = .90$) for this questionnaire. Cronbach's α for the current study was .75.

Physical activity was measured objectively with the RT3 Triaxial Research Tracker (Stayhealthy Inc., Monrovia, CA). The RT3 is an accelerometer that measures motion in three dimensions and provides triaxial vector data in activity units. It has shown to be a reliable and valid physical activity monitor (Powell & Rowlands, 2004; Rowlands, Thomas, Eston, & Topping, 2004). The accelerometer was worn for five consecutive days, starting on Thursday so as to include both week and weekend days.

Self-reported physical activity was measured with the Flemish Physical Activity Computerized Questionnaire (FPACQ). The FPACQ has proved to be a reliable and valid questionnaire for the assessment of physical activity (Matton et al., 2007). In retired people, the 2-week test-retest reliability for total physical activity was excellent (ICC = .96) (Matton et al., 2007). In this questionnaire, the participants had to indicate how much time they spent performing different physical activities during a usual week. Several physical activity indices were calculated by multiplying the different physical activities with their MET values (Ainsworth et al., 2000) and subsequently multiplying appropriate sums of these multiplications (e.g., for different leisure-time activities) with the reported body

weight. Consequently, the indices were expressed the average energy expenditure per week (kcal/week). The indices that were used in this study were leisure-time physical activity, active transportation, physical activity during household/garden activities, and total physical activity.

Statistical Analyses

The analyses were performed with SPSS 15.0 and AMOS 16.0. Between-group differences at pretest were assessed with one-way ANOVAs and chi-square analyses. Between-group differences in change over time were analyzed with linear mixed models analyses with an unstructured covariance structure, time as repeated factor and group and gender as fixed factors. When the Time $\times$ Group interaction was significant, contrast analyses were conducted to determine differences in changes over time between separate groups. *P*-values of 0.05 were considered as statistically significant, except for the contrast analyses where a *p*-value of $0.05/3 = 0.016$ was considered significant. This correction was made because three contrasts were computed for each variable.

All participants, regardless of their adherence, were included in the mixed model analyses, as is required for an intention-to-treat analysis. A mixed model analysis has the advantage of being able to deal with missing values. It is a likelihood-based approach that models jointly all the actual observations, with no attempt at imputation or adjustment for the missing-value mechanism. A recent study showed that mixed model analyses are more reliable and better grounded statistically for handling missing data in longitudinal trials compared with imputation methods such as the last-observation-carried-forward method (Lane, 2008). By consequence, the observed measurements of all participants were included in the analyses, regardless of any missing values at posttest or follow-up.

To test the revised EXSEM model we performed path analyses with a maximum likelihood estimation procedure. Residualized change scores were computed for all variables to be used as measurements of change. Change scores were used in the path analyses because the EXSEM posits that changes in physical activity and changes in self-efficacy have an effect on changes in physical condition, changes in sport competence etc. Because no change was expected in the control group, the path analyses were based only on the participants in the two intervention groups who had complete data for the posttest ($n = 95$) and follow-up scores ($n = 78$). The fit of the model was assessed with multiple indices: the chi-square, which should be nonsignificant for a good-fitting model; the comparative fit index (CFI), which should approximate unity; the root mean square error of approximation (RMSEA), which should be smaller than 0.06; and the goodness of fit index (GFI), which should be larger than .90 for a good-fitting model (Hu & Bentler, 1999; Sivo, Fan, Witta, & Willse, 2006).

Results

Adherence and Dropout

A detailed flow diagram of the study is shown in Figure 1. For the structured group, it was decided that participants who followed 5 out of 6 training sessions in two

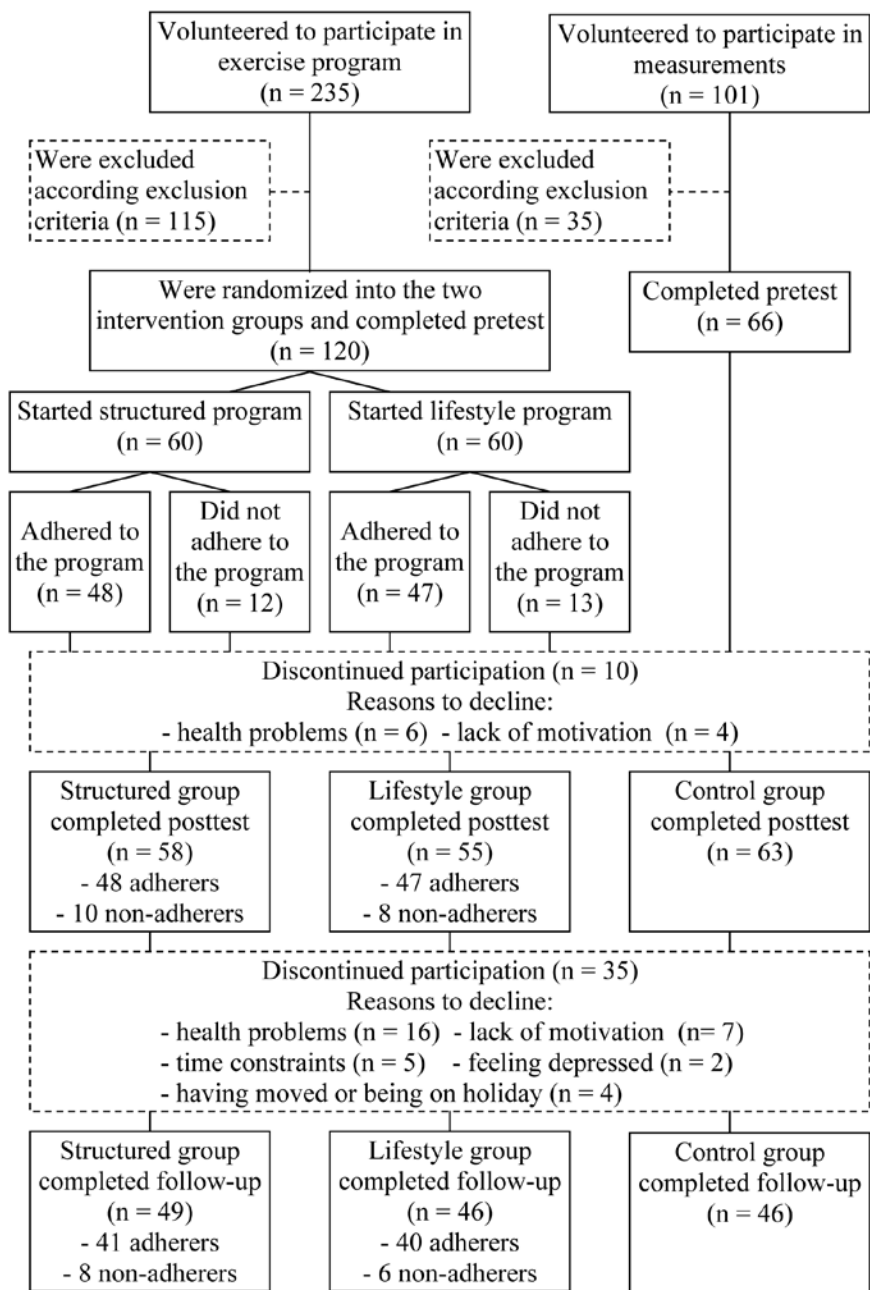


Figure 1 — Flowchart of the study.

consecutive weeks had adhered to the program. The lifestyle participants reported their adherence to the different components of their program during the phone calls. If they performed at least 80% of their program, they were considered adherers. Eighty percent of the participants in the structured exercise group and 78.3% of the lifestyle participants adhered to their program. For the measurements, there was 3.3%, 8.3%, and 4.5% dropout at posttest, and 18.3%, 23.3%, and 31.8% dropout at follow-up in the structured exercise group, the lifestyle group, and the control group, respectively. Dropout rates did not differ significantly between the groups.

Demographic Variables

There were no significant differences between the three groups at pretest in age, body mass index, years of education, gender distribution, or VO_{2peak} (Table 1).

Table 1 Demographic Characteristics for the Three Groups at Pretest

Characteristic	Structured Group <i>n</i> = 60	Lifestyle Group <i>n</i> = 60	Control Group <i>n</i> = 66
Age	66.99 (4.32)	66.30 (3.99)	67.86 (5.32)
Body Mass Index	26.82 (3.54)	27.33 (3.74)	26.91 (3.36)
Education (years)	13.22 (3.29)	12.68 (4.26)	13.86 (3.34)
VO_{2peak}	21.27 (4.64)	22.02 (5.14)	22.32 (5.60)
Gender (% males)	50%	50%	54.5%

Effects of Interventions on Fitness and Physical Activity Behavior

Changes in fitness and physical activity behavior are reported elsewhere (Opdenacker et al., 2008, Delecluse, Bogaerts, Coorevits, & Boen, 2008). In brief, the structured group increased significantly more than did the control group from pretest to posttest for leisure-time physical activity, total self-reported physical activity, and VO_{2peak} . All these differences disappeared at follow-up. In the lifestyle group, there were significant improvements from pretest to posttest for active transportation, daily steps, and total physical activity. From pretest to follow-up, the lifestyle group still showed significantly larger increases in active transportation and daily steps than did the control group and structured group respectively.

Effects of Interventions on Physical Self-Perceptions and Self-Esteem

A significant pretest difference between the groups was found for body attractiveness ($p = .022$). The control group scored significantly higher on this variable than the lifestyle group (Table 2). There were no significant group differences at pretest for the other effect variables.

The Time $\times$ Group $\times$ Gender interaction was not significant for any of the variables. Therefore, subsequent analyses were performed with time and group as factors. There was a significant Time $\times$ Group interaction for physical condition ($p = .001$), sport competence ($p = .016$), body attractiveness ($p = .001$), physical self-worth ($p = .024$), and self-esteem ($p = .036$) (Table 2).

Contrasts showed that the structured group increased significantly more from pretest to posttest than the control group on physical condition and sport competence (Table 3). These differences in change over time remained from pretest to follow-up.

Table 2 Estimated Means (SE) at Pretest, Posttest (11 Months), and Follow-Up (23 Months) for the Three Groups for all the Effect Variables

	Pretest	Posttest (11 months)	Follow-up (23 months)	Time <i>F</i>	Time x Group <i>F</i>
Physical Condition					
Structured group	2.25 (0.07)	2.63 (0.07)	2.59 (0.07)	19.220***	4.829**
Lifestyle group	2.18 (0.07)	2.43 (0.07)	2.42 (0.08)		
Control group	2.32 (0.07)	2.32 (0.07)	2.38 (0.07)		
Physical Strength					
Structured group	2.29 (0.07)	2.36 (0.07)	2.46 (0.08)	5.720**	1.686
Lifestyle group	2.13 (0.07)	2.33 (0.07)	2.33 (0.08)		
Control group	2.29 (0.07)	2.33 (0.07)	2.33 (0.08)		
Body Attractiveness					
Structured group	2.34 (0.06)	2.52 (0.07)	2.59 (0.06)	20.094***	4.887**
Lifestyle group	2.27 (0.06)†	2.52 (0.07)	2.51 (0.07)		
Control group	2.49 (0.06)†	2.54 (0.06)	2.45 (0.06)		
Sport Competence					
Structured group	2.03 (0.07)	2.20 (0.07)	2.20 (0.08)	2.806	3.163*
Lifestyle group	1.98 (0.07)	2.10 (0.07)	2.11 (0.08)		
Control group	2.04 (0.07)	1.96 (0.07)	1.97 (0.08)		
Physical Self-Worth					
Structured group	2.36 (0.06)	2.51 (0.07)	2.59 (0.07)	19.221***	2.895*
Lifestyle group	2.24 (0.06)	2.56 (0.07)	2.51 (0.07)		
Control group	2.43 (0.06)	2.52 (0.07)	2.51 (0.07)		
Self-Esteem					
Structured group	5.31 (0.12)	5.42 (0.12)	5.43 (0.11)	6.663**	2.630*
Lifestyle group	5.23 (0.12)	5.52 (0.12)	5.45 (0.12)		
Control group	5.56 (0.11)	5.60 (0.11)	5.45 (0.11)		

* $p < .05$, ** $p < .01$, *** $p < .001$; PSPP = Physical Self-Perception Profile.

†Significant difference ($p < .05$) between these groups at pretest.

Table 3 Group Differences Changes From Pretest to Posttest and From Pretest To Follow-Up

	Change							
	Posttest ('11 months)				Follow-up (23 months)			
	Contrast estimate	95% CI	P	Effect Size	Contrast estimate	95% CI	P	Effect Size
Physical condition								
Structured vs. control	0.38	0.21 to 0.55	.000*	0.66	0.28	0.09 to 0.47	.004*	0.45
Lifestyle vs. control	0.25	0.07 to 0.42	.006*	0.42	0.19	−0.01 to 0.38	.057	0.30
Lifestyle vs. structured	−0.13	−0.31 to 0.04	.139	−0.23	−0.09	−0.29 to 0.10	.331	−0.16
Body attractiveness								
Structured vs. control	0.14	0.01 to 0.27	.038	0.32	0.29	0.14 to 0.44	.000*	0.59
Lifestyle vs. control	0.20	0.07 to 0.33	.003*	0.45	0.27	0.12 to 0.43	.001*	0.55
Lifestyle vs. structured	0.06	−0.07 to 0.19	.361	0.14	−0.02	−0.17 to 0.14	.845	−0.03
Sport competence								
Structured vs. control	0.25	0.10 to 0.40	.001*	0.50	0.24	0.06 to 0.41	.009*	0.41
Lifestyle vs. control	0.21	0.05 to 0.36	.008*	0.40	0.21	0.03 to 0.39	.023	0.35
Lifestyle vs. structured	−0.05	−0.20 to 0.11	.558	−0.09	−0.03	−0.21 to 0.15	.746	−0.05
Physical self-worth								
Structured vs. control	0.06	−0.10 to 0.21	.478	0.11	0.14	−0.03 to 0.32	.113	0.25
Lifestyle vs. control	0.23	0.08 to 0.39	.004*	0.44	0.19	0.01 to 0.38	.035	0.33
Lifestyle vs. structured	0.18	0.02 to 0.33	.028	0.34	0.05	−0.13 to 0.23	.575	0.09
Self-Esteem								
Structured vs. control	0.07	−0.13 to 0.28	.475	0.11	0.23	0.00 to 0.46	.047	0.32
Lifestyle vs. control	0.25	0.05 to 0.46	.017	0.37	0.32	0.09 to 0.55	.007*	0.43
Lifestyle vs. structured	0.18	−0.03 to 0.38	.089	0.26	0.09	−0.14 to 0.32	.431	0.13

* $p < .05/\beta = 0.016$.

In addition, the increase from pretest to follow-up on body attractiveness was significantly larger in the structured group than in the control group.

For the lifestyle group, the increase from pretest to posttest was significantly larger than the control group for physical condition, body attractiveness, sport competence, and physical self-worth (Table 3). Only the increase in body attractiveness remained significant from pretest to follow-up. An additional difference between the lifestyle and control group was found from pretest to follow-up for global self-esteem.

The effect sizes for all significant changes over time between the intervention groups and the control group ranged between .40 and .66 (Table 3). There were no significantly different changes over time between intervention groups.

Model Fit

Figure 2 shows the relationships among residualized change scores in physical activity, self-efficacy, and physical self-perceptions and self-esteem from pretest

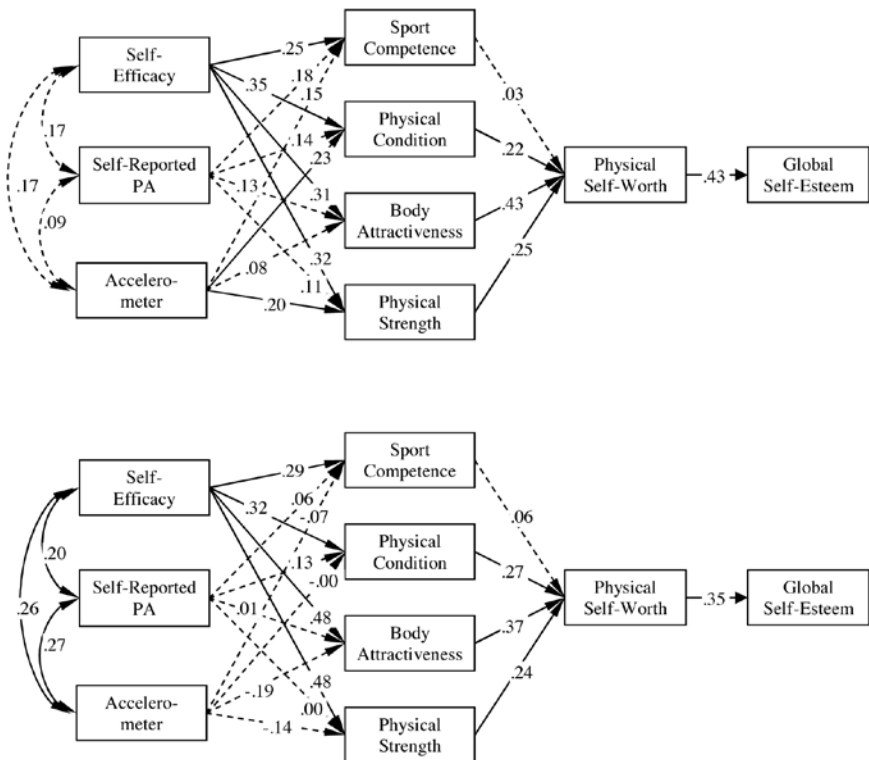


Figure 2 — Path diagram of the EXSEM for residualized changes scores from pretest to posttest (above) and from pretest to follow-up (below). All reported path coefficients and correlations are standardized estimates.

to posttest (above) and from pretest to follow-up (below). The path analyses were based only on the participants in the two intervention groups who had complete data for the posttest ($n = 95$) and follow-up scores ($n = 78$). The percentage of missing data in the intervention groups at posttest and follow-up were, respectively, 2.5% and 25% of self-reported physical activity, 8.3% and 22.5% of accelerometer data, 6.7% and 20.8% of self-efficacy, 6.7% and 20.8% of physical self-perceptions, and 5.8% and 20.8% of global self-esteem. The correlation matrix, which served as input for these model fittings, is displayed in Table 4.

Both models provided an excellent fit for the data: $\chi^2(10) = 6.87, p = .737$, CFI = 1.00, RMSEA = .00, and GFI = .99, for the changes from pretest to posttest, and $\chi^2(10) = 9.09, p = .523$, CFI = 1.00, RMSEA = .00, and GFI = .98, for the changes from pretest to follow-up. The full (solid) lines in Figure 2 are significant effects or correlations, the dashed lines are nonsignificant. For the changes from pretest to posttest, 18% of the variance in global self-esteem was accounted for by the model. For the changes from pretest to follow-up, 13% of the variance in global self-esteem was explained by the model. In both models, there were also significant correlations (range $r = .20$ to $r = .47$) between the disturbances of changes in the four subdomain levels of physical self-esteem. For the sake of clarity, these correlations are not depicted in the path diagram.

The differences between the two models were the following: (1) the changes in physical activity measured with the accelerometer were significantly related to physical condition and physical strength in the pre- to postmodel, but not in the pre- to follow-up model; (2) the correlations between self-reported physical activity, accelerometer measured physical activity, and self-efficacy were significant in the pre- to follow-up model but not in the pre- to postmodel.

Discussion

The results of the current study showed that compared with a nonrandomized control group, both a lifestyle intervention and a structured exercise intervention had significant positive effects on physical self-perceptions and self-esteem in older adults, both in the short and the long term. With respect to the short term (i.e., directly after the 11-month interventions), the lifestyle group showed significant improvements in physical condition, sport competence, body attractiveness, and physical self-worth. In the structured exercise group, there were significant short-term effects on physical condition and sport competence. The effect sizes for all significant effects ranged between .40 and .66, which are regarded as medium effects (Cohen, 1988). These effect sizes are comparable to the effect sizes reported in studies that evaluated the effects of physical activity interventions on physical self-perceptions and global self-esteem in other age groups (McAuley et al., 1997; Spence et al., 2005).

The present results confirm the previous findings that short-term effects on physical self-perceptions and self-esteem can be achieved with different physical activity interventions, such as a walking intervention or a Tai Chi intervention (Alfermann & Stoll, 2000; Li et al., 2002; McAuley et al., 2000). However, these interventions were all structured given that they consisted of two to three weekly sessions guided by an instructor. To our knowledge, the current study is the first to

Table 4 Correlations Among Residualized Change Scores From Pretest to Posttest and From Pretest to Follow-Up in Physical Activity, Self-Efficacy, and Physical Self-Perceptions and Self-Esteem for Participants of the Intervention Groups With Complete Data

	1	2	3	4	5	6	7	8	9
	Pretest to Posttest (<i>n</i> = 95)								
1 Accelerometer	—								
2 Self-reported PA	.09	—							
3 Self-efficacy	.17	.17	—						
4 Sport competence	.20	.24	.31	—					
5 Physical condition	.31	.22	.41	.54	—				
6 Body attractiveness	.15	.19	.35	.42	.52	—			
7 Physical strength	.26	.18	.37	.41	.33	.33	—		
8 Physical self-worth	.25	.24	.33	.43	.54	.64	.47	—	
9 Global self-esteem	.16	.14	.15	.24	.16	.32	.33	.43	—
	Pretest to Follow-up (<i>n</i> = 78)								
1 Accelerometer	—								
2 Self-reported PA	.27	—							
3 Self-efficacy	.26	.20	—						
4 Sport competence	.02	.10	.28	—					
5 Physical condition	.12	.19	.35	.51	—				
6 Body attractiveness	-.06	.06	.43	.38	.47	—			
7 Physical strength	-.01	.07	.45	.53	.52	.44	—		
8 Physical self-worth	.07	.15	.48	.46	.60	.63	.58	—	
9 Global self-esteem	.04	.22	.15	.09	.25	.31	.24	.35	—

Note. All correlation coefficients $\geq .20$ were significant at $p < .05$.

demonstrate the beneficial effects of a home-based lifestyle intervention on physical self-perceptions and self-esteem in older adults, who were on average 67 years old.

Two previous studies also found support for (a part of) the structure of the revised EXSEM in the short term (Li et al., 2002; McAuley et al., 2000; McAuley et al., 2005). The results of the path analysis in the current study with the participants with complete data of both intervention groups combined, confirmed these findings. These results indicate that the short-term effects of our interventions on physical self-perceptions and self-esteem were partly mediated by changes in objectively measured physical activity and self-efficacy. However, not all of the proposed relationships were significant. More specifically, there were no significant direct effects from changes in self-reported physical activity on changes in physical self-perceptions, whereas short-term changes in physical activity measured with the accelerometer did have significant direct effects on short-term changes in physical condition and physical strength. These findings once again highlight the discrepancy between subjective (i.e., self-reported) and objective measurements of physical activity (Dishman, Darracott, & Lambert, 1992).

With respect to the long-term effects (i.e., 1 year after the end of the intervention), the lifestyle program had significant effects on body attractiveness and global self-esteem. The structured exercise intervention had long-term effects on physical condition, sport competence, and body attractiveness. These long-term changes were apparently not dependent on long-term changes in physical activity because the path analysis did not reveal a direct effect from long-term changes in self-reported or objectively measured physical activity to long-term changes in physical self-perceptions. Despite these nonsignificant effects, we did find an excellent fit for the longitudinal relationships of the EXSEM.

Only one other study evaluated these long-term effects in older adults of a comparable age (i.e., mean age of 67). Consistent with the present results McAuley et al. (2000, 2005) found support for the longitudinal structure of the EXSEM. In contrast to our results, (1) they did not find long-term effects of their interventions on multidimensional self-esteem yet (2) they did find significant direct effects from changes in self-reported physical activity to changes in physical condition and physical strength. Possible explanations for the contrasting results might be differences in the physical activity interventions (e.g., length of the interventions, physical activity modes) and differences in the measurement instruments. Therefore, more research is necessary to determine the long-term influence of physical activity interventions on self-esteem in older adults.

Another issue that deserves attention in future studies with older adults is the role of sport competence. Previous authors have omitted the sport competence subscale of the PPSP because they did not consider it relevant to the population of sedentary older adults (Li et al., 2002; McAuley et al., 2000; McAuley et al., 2005). We decided to include this subscale because we hypothesized that our interventions could have an influence on sport competence, which was indeed the case in the current study. However, the results of the path analysis showed that the subdomain of sports competence did not significantly contribute to the explanation of physical self-esteem in our sample of older adults. This could be seen as a validation for the decision of previous authors to omit the sport competence subscale in research with older adults. However, post hoc analyses without sport competence did not lead to a better fit of the EXSEM model in the current study.

Although for both the short-term and the long-term results, there were no significant differences between the two intervention conditions in the current study, only the lifestyle program had significant effects on physical self-worth and global self-esteem in comparison with the control group. The significant effects of the structured exercise intervention were all on the specific physical self-perceptions. The effects of the lifestyle program on the more global dimensions of self-esteem might be a result of the autonomy-supporting focus of this intervention.

Finally, we have briefly examined whether the significant results in each group were related to the improvements in fitness and physical activity behavior. In the lifestyle group, the short-term effects on body attractiveness and physical self-worth were associated with the significant improvements in active transportation in this group ($r = .39, p = .005$ and $r = .37, p = .008$ respectively), but not with the improvements in daily steps or total physical activity. The long-term improvement in self-esteem in the lifestyle group was also associated with the long-term improvement in active transportation in this group ($r = .446, p = .003$). None of the short-term or long-term effects of the structured group on physical self-perceptions were related to the improvements in fitness or physical activity behavior in this group.

It is remarkable that only the improvements in active transportation were associated with improvements in the physical self and in global self-esteem. A possible explanation might be that changes in active transportation are more visible in daily life and require a stronger motivation because it concerns the replacement of an effortless behavior with a physically active behavior (e.g., taking the bicycle instead of the car to go to the mall). This visibility and extra effort may lead to a more positive perception of the self. On the other hand, it should be noted that the abovementioned results mainly indicate that the majority of our psychological outcomes were not related to changes in physical activity and fitness.

Overall, the results of the current study lend additional support to the use of home-based lifestyle interventions in older adults. Previous studies with home-based programs already found positive effects on physical activity, physical fitness, strength, depression, and quality of life (e.g., Croteau, Richeson, Farmer, & Jones, 2007; King, Haskell, Taylor, Kraemer, & DeBusk, 1991). However, this is the first study that reports the positive effects of a home-based lifestyle intervention on physical self-perceptions and self-esteem in adults, who were on average 67 years old. Previous studies have found a positive link between self-esteem and well-being (e.g., Elavsky & McAuley, 2005). Consequently, the results of the current study—combined with the previously mentioned advantages of lifestyle programs—indicate that such interventions could have an important public health impact on both the quantity and the quality of life in old age. Future studies should try to confirm these positive effects of lifestyle interventions in different samples of older adults (different age, race, health status, etc.).

Some limitations of the current study should be considered. First, because of ethical reasons, the control group was recruited separately. Although we ensured that this group was equivalent to the intervention groups on a number of physiological parameters, the control group may not have been fully equivalent with respect to behavioral and psychological parameters. This may have caused the significant pretest difference on body attractiveness that was found between the lifestyle and the control group. In the analyses, possible differences at pretest were accounted for by comparing only the changes over time between the groups. Although we

feel that the inclusion of a nonrandomized control group was preferable to a study without a control group, we acknowledge that the separate recruitment of the control group is a methodological weakness of our study. A second limitation of our control group was that we did not provide an alternative attention-control program to rule out possible placebo effects. The comparisons between the intervention groups and the control group should therefore be interpreted with caution.

Third, we included only healthy older adults, whereas approximately 88% of adults over the age of 65 suffer from at least one chronic health condition (Hoffman, Rice, & Sung, 1996). This limits the external validity of the present findings. Finally, we could not evaluate the structure of the EXSEM as a function of the differences between the interventions because the separate intervention groups were too small for structural equation modeling.

In summary, both a structured exercise intervention and a home-based lifestyle intervention had positive short and long-term effects on physical self-perceptions and self-esteem in older adults in comparison with an assessment-only control group. In addition, evidence was found for the longitudinal fit of the EXSEM. These findings enhance our understanding of the longitudinal relationships among physical activity, self-efficacy, physical self-perceptions, and self-esteem in older adults.

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