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Six-month effects of the Groningen active living model (GALM) on physical activity, health and fitness outcomes in sedentary and underactive older adults aged 55–65

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Abstract

Objective: To determine the effects on energy expenditure, health and fitness outcomes in sedentary older adults aged 55–65 after 6-month participation in the GALM program.

Methods: In three Dutch communities, subjects from matched neighbourhoods were assigned to an intervention ($n = 79$) or a waiting-list control group ($n = 102$). The GALM program consisted of fifteen 60 min sessions once a week emphasising moderate-intensity recreational sports activities.

Results: The intervention group showed significant increases in energy expenditure for recreational sports activities, other leisure-time physical activity, health indicators, and perceived and performance-based fitness. Contrary to our expectations, the same increases were found for the control group. Consequently, only significant between-group differences, favouring the intervention group, were obtained for sleep, diastolic blood pressure, perceived fitness score and grip strength.

Conclusion: The increases in energy expenditure for physical activity from the GALM program, especially for the more intensive recreational sports activities, look promising and are in line with the expected amounts necessary to improve health. Further research is needed to evaluate long-term effects of participation in the GALM program.

Practice implications: These results underline that GALM can be considered successful in stimulating leisure-time physical activity and improving health and fitness in older adults.

Keywords: Physical activity; Health; Fitness; Community-based strategy; Sedentary older adults

1. Introduction

Despite evidence that regular physical activity contributes substantially to health, functioning and quality of life of older adults [1–3], a large segment of the Dutch older adult population does not participate regularly in leisure-time physical activity [4–5]. Approximately 60% of Dutch adults aged 55–65 can be considered physically inactive, according to the 1998 American College of Sport Medicine (ACSM) recommendations for exercise and physical activity for older adults [3].

The Groningen active living model (GALM) was designed to recruit and stimulate leisure-time physical activity in sedentary and underactive older adults aged 55–65 [6]. After the recruitment phase, participants start with what can be characterised as a leisure-time physical activity program with an emphasis on recreational sports activities [2]. To assist the maintenance of physical activity in the

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GALM groups, it was assumed that the activities conducted should be tailored to participants' preferences and needs [7–9]. To this end, the GALM physical activity program was based on insights from social cognitive theory [10] and evolutionary-biological play theory [11]. The social cognitive mediating variables of self-efficacy, social support, perceived fitness and enjoyment were influenced through the structure and versatile content of the GALM program and the instructors' actions [6,12,13]. Evolutionary-biological play theory suggests that programs that fit the genetic potential of humans are most likely to succeed in developing a lifelong, physically active lifestyle.

Another reason for the versatility of the GALM program was that in this way several dimensions of fitness–like cardiorespiratory, muscular fitness and flexibility, all of which are important to older adults living independently–were addressed [3,14]. We assumed that by providing a versatile leisure-time physical activity program of moderate-intensity on average [15], participants would gain or regain enjoyment during leisure-time physical activities and develop preferences towards certain activities. When the GALM program succeeds in its role as a trigger, it can cause a transfer in participants becoming physically active more frequently outside the program [16,17].

Many studies have focused on the impact of physical activity programs on indicators of health and fitness in older adults, resulting in a large variety of reported effects [1,18]. Several factors that may account for this variation are diversity of program and subject characteristics, outcome measures and methodological issues. The purpose of this study was to determine the effects of 6-month participation in the GALM program on physical activity level and indicators of health and fitness in sedentary older adults aged 55–65. Based on the low initial levels of physical activity of the GALM participants [19], together with the characteristics of the GALM leisure-time physical activity program, we hypothesised that increased physical activity could lead to significant improvements in health and fitness outcomes [20,21].

2. Methods

2.1. Study design and subjects

A group-randomised trial was used. Based on urbanisation degree, number of persons in the 55–65 age category and population distribution, three municipalities were selected. In every municipality, the recruitment phase took place in four neighbourhoods that were assigned as intervention or control neighbourhoods. These 12 neighbourhoods were matched on number of older adults aged 55–65 living in that neighbourhood and socioeconomic status, and randomly assigned to study condition within matched pairs. Older adults from the six intervention neighbourhoods automatically became intervention group participants (IG). Correspondingly, older adults from the six control neighbourhood became control group participants (CG). The IG received the regular GALM strategy [6] and the CG started with the intervention after being placed on a waiting-list for 6 months.

The trial was designed to include 144 and 192 subjects in the intervention and control groups, respectively, taking into account corresponding expected dropout percentages of 20 and 40% with an alpha of 5% and a power of 80%. Based on experiences from former GALM projects, a total of 8504 potential participants were recruited using a special strategy to reach the calculated numbers of subjects in the IG and CG. All older adults received a written invitation and were visited at home by trained personnel. During this visit, potential participants were screened using a short questionnaire based on the 1998 ACSM recommendations on exercise and physical activity for older adults [3,22]. Older adults who were not sufficiently active according to these criteria were invited to participate in the study. Based on estimates of available demographic data, about 60% ($n = 5102$) of the older adults invited could be considered underactive according to the 1998 ACSM recommendations [3]. Half of this 60% ($n = 2551$) qualified for GALM. The other half was not interested in leisure-time physical activity or was unable to participate for reasons that included illness and personal circumstances [6].

A total of 315 older adults aged 55–65, i.e. 12% of the qualified individuals, participated in the baseline measurement; 181 of them (57%) also participated in the 6-month follow-up measurement (Fig. 1). Intervention group participants were distributed over 12 different GALM groups led by six different GALM instructors. Before starting measurements, a written informed consent was obtained from each participant. The study protocol was approved by the Medical Ethics Committee of Groningen University Hospital.

2.2. The GALM program

The GALM program can be characterised as a leisure-time physical activity program emphasising moderate-intensity recreational sports activities and consists of fifteen 60 min sessions at a frequency of once a week [15]. After the first 15 sessions participants are able to continue with a subsequent series of 15 GALM sessions. The recreational sports activities of the GALM program are based on national survey results on preferences of older adults towards certain recreational sports activities. The 15 most favourite recreational sport activities were incorporated into the GALM program (e.g. softball, dance, self-defence, swimming and athletics). The physical activities conducted were tailored by type, format, intensity and frequency to meet the wishes and needs of participants [6]. The structure of each GALM session was as follows: (1) a 5–10 min warm-up period; (2) 20–25 min of skills-practicing in which the exercises offered were differentiated for the level and needs

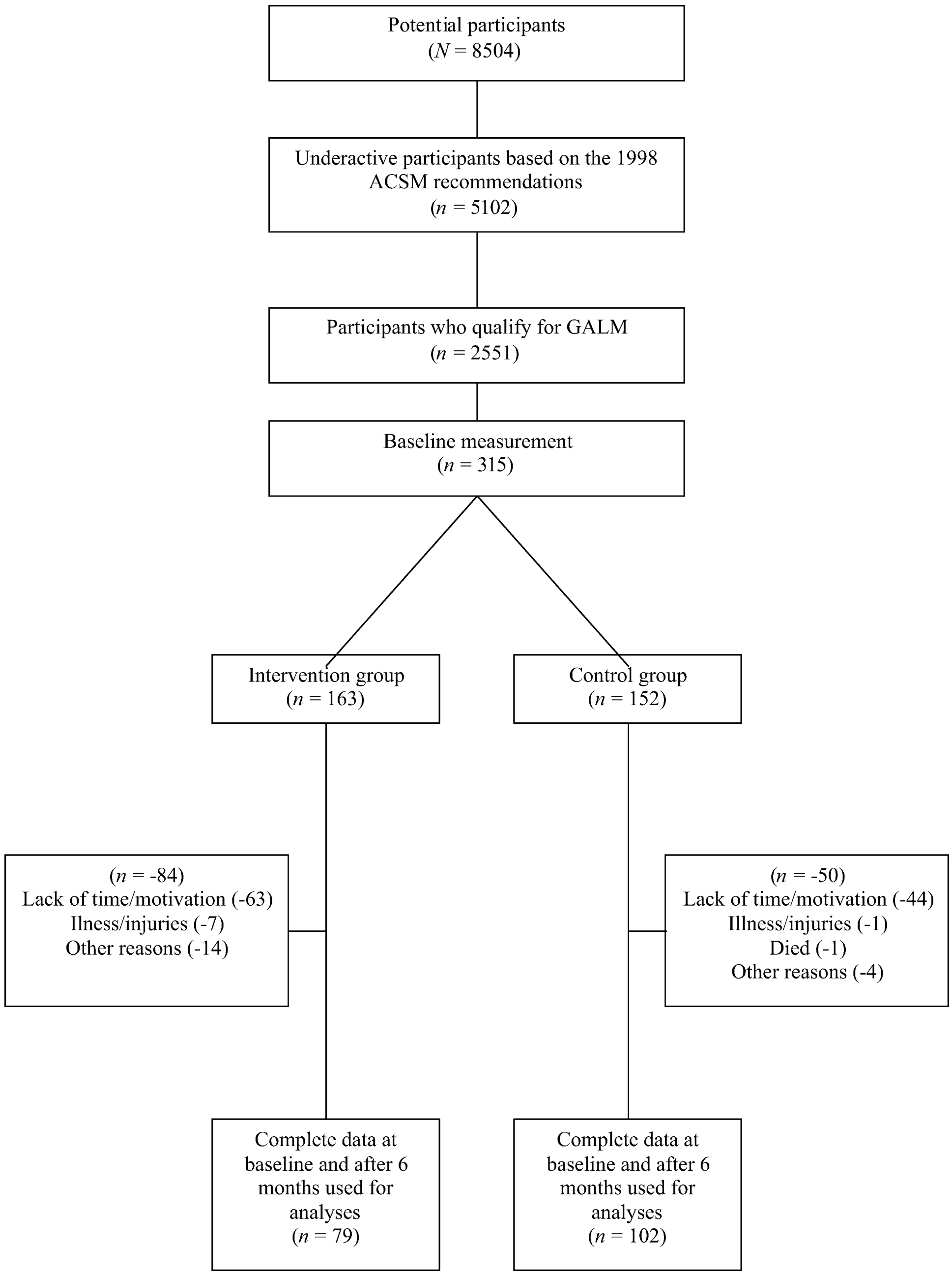

Fig. 1. Participants flow.

of the participants, using adapted materials when necessary (e.g. foam balls); (3) 20–25 min of playing in which the skills learned and practiced were applied in the context of a game or other activities; (4) 5–10 min of cooling-down consisting of flexibility and relaxation activities. All sessions were conducted in groups of 15–24 participants and held in a gymnasium located in or near neighbourhoods participants lived in to avoid barriers like travelling distance. For reasons of convenience, the GALM sessions were scheduled at different times and days so participants could choose among the options offered. Once the participants made their choice, they were obligated to join that group for the rest of the program. The sessions were led by trained instructors who, besides having a professional sports education, completed a 3-day course to learn to teach the GALM sessions.

2.3. Measures

Baseline and follow-up measurements consisted of a questionnaire that had to be completed at home and a fitness test session. By way of the questionnaire, information about indicators of energy expenditure for physical activity, perceived health and perceived fitness was collected. The questionnaire data were collected at the end of the GALM program. Within 1 week after the participants finished their last GALM session, the fitness test sessions were held which took place in a local sports accommodation. During the test session indicators of health and performance-based fitness were assessed objectively. All test examiners were students and personnel with a medical or scientific background who completed a 1-day course on administering the correct test procedures.

2.3.1. Estimated energy expenditure

Two categories of the Voorrips physical activity questionnaire [23] combined with the compendium of physical activities by Ainsworth et al. [24] were used to estimate the energy expenditure for recreational sports activities (EE_{RSA}: i.e. swimming, volleyball, cycling, brisk walking, etc.) and other leisure-time physical activities (EE_{LTPA}: i.e. gardening, doing odd jobs, walking and cycling for transportation purposes). Spearman's correlation coefficient between the Voorrips questionnaire and 24 h physical activity recall and a pedometer (Fitty, Kasper and Richter, Uttenreuth, Germany) was 0.78 and 0.72, respectively. Test–retest reliability coefficient for the questionnaire was 0.89 [23,24].

2.3.2. Perceived health

Perceived health was measured with a Dutch translation of the vitality plus scale (VPS) [25], and the TNO-AZL adult quality of life questionnaire (TAAQOL) [26]. The VPS was assessed to measure potential health-related benefits of exercise. The reliability of the scale (test–retest reliability: ICC = 0.87, 95% confidence interval [CI] = 0.76–0.93) and convergent and discriminant validity were reported to be sufficient [25]. The TAAQOL was used to measure quality of life and originally consisted of 12 subscales. We used nine subscales that were related mostly to physical activity. Scale reliability was reported to range from 0.72 to 0.90. Convergent validity between the TAAQOL and corresponding SF-36 scales showed correlations from 0.50 to 0.70 [26].

2.3.3. Perceived fitness

Two measures of the perceived fitness questionnaire of the Groningen Fitness Test for the Elderly (GFE) were used: a perceived fitness score and a comparative fitness rating using peers as a frame of reference entitled comparative fitness rating [27,28]. The original test–retest reliability of the perceived fitness score was satisfactory for older men and older women (ICC = 0.76, 95% CI = 0.57–0.87 versus ICC = 0.78, 95% CI = 0.66–0.86). The test–retest reliability coefficient of the comparative fitness rating was reported to be 0.94 for older men (95% CI = 0.88–0.97) and 0.84 for older women (95% CI = 0.76–0.90) [27].

2.3.4. Health indicators

Prior to the test session, all participants had their blood pressure measured and completed a modified version of the physical activity readiness questionnaire (PAR-Q) [29]. Participants who had a systolic blood pressure >160 mmHg and/or a diastolic blood pressure >100 mmHg, and/or who answered one or more questions of the PAR-Q affirmatively, had to consult the attending physician. Systolic and diastolic blood pressure were assessed electronically (Omron M4, Omron Corporation, Tokyo, Japan) [30]. Body fat was predicted using leg-to-leg bioelectrical impedance analysis (Tanita TBF-300, Tanita Corporation, Tokyo, Japan). This method proved to be reliable to measure body fat percentage, and results correlated highly with body fat percentages as measured with underwater weighing and dual-energy X-ray absorptiometry in healthy adults [31]. Body mass index (BMI) was calculated by dividing body mass in kilograms by height in meters [1].

2.3.5. Performance-based fitness

Six test items of the Groningen Fitness Test for the Elderly were used [27]. Manual dexterity was measured using the block transfer test. Reaction time was assessed by measuring simple reaction time. The grip strength test was used to measure maximum isometric strength of hand and arm muscles. The sit-and-reach test was conducted to measure flexibility of the hamstrings and lower back. The circumduction test measured shoulder flexibility. The walking test with increasing speed measured aerobic endurance. All test items have proven to be reliable and valid [27,32–34]. Additionally, the functional reach and the

Table 1
Main characteristics at baseline

Characteristics	Intervention group ($n = 79$)	Control group ($n = 102$)	F/χ^2	P
Age (year)				
Mean (S.D.)	59.6 (2.4)	58.8 (2.7)	4.02	0.05
Range	55–65	55–65		
BMI (kg/m^2)				
Mean (S.D.)	26.9 (3.2)	26.8 (3.6)	0.03	0.86
Range	19.9–35.9	20.2–35.8		
Women (%)	54.4	56.9	0.11	0.74
Living alone (%)[a]	17.7	19.8	0.13	0.72
Educational Level (%)[b]				
Elementary	43.6	33.7	5.02	0.08
Secondary	28.2	44.5		
Higher/University	28.2	21.8		
Number of chronic diseases (%)				
0	37.2	30.4	2.04	0.36
1 or 2	34.6	45.1		
>2	28.2	24.5		
Smoker (%)	19.0	14.9	0.55	0.46
Glasses of alcohol per day (%)				
0	20.3	19.6	1.21	0.55
1 or 2	72.2	76.5		
≥3	7.5	3.9		

[a] Missing $n = 1$ in control group.
[b] Missing $n = 1$ in intervention group.

Table 2
Estimated energy expenditure, perceived health, perceived fitness, health indicators and performance-based fitness per study group at baseline

Characteristics	Intervention group (n = 79), mean (S.D.)	Control group (n = 102), mean (S.D.)	F-value	P
Estimated energy expenditure for physical activity				
EE_{RSA} (kcal/week)	657 (789)	715 (1008)	0.18	0.68
EE_{LTPA} (kcal/week)	1820 (1934)[a]	1520 (1465)	1.40	0.24
Perceived health				
Vitality plus scale (sum score 10–50)	39.5 (7.0)[b]	39.5 (5.8)[c]	0.00	0.95
TAAQOL subscales				
Gross motor functioning (1–100)	79.5 (21.8)	83.7 (21.8)[b]	1.60	0.21
Fine motor functioning (1–100)	92.9 (19.8)	92.3 (16.2)[c]	0.06	0.82
Cognition (1–100)	82.0 (20.2)	82.9 (21.6)[a]	0.09	0.76
Sleep (1–100)	73.2 (25.4)[a]	74.8 (25.0)[a]	0.19	0.66
Social contacts (1–100)	91.3 (16.4)[d]	89.5 (17.1)[d]	0.51	0.48
Daily activities (1–100)	88.2 (20.6)[d]	89.0 (18.9)[d]	0.07	0.80
Vitality (1–100)	67.5 (22.6)[b]	68.9 (19.3)[d]	0.18	0.68
Positive moods (1–100)	64.3 (21.5)[a]	65.0 (19.0)	0.05	0.83
Depressive moods (1–100)	81.2 (16.0)[b]	81.7 (18.0)[a]	0.03	0.85
Perceived fitness				
Fitness score (1–10)	6.3 (1.1)	6.4 (1.2)	0.55	0.46
Comparative fitness rating (10–50)	28.6 (5.6)[a]	28.3 (4.2)[a]	0.16	0.69
Health indicators				
RDBP (mmHg)	84.8 (12.4)	84.1 (11.7)	0.14	0.71
RSBP (mmHg)	144.8 (23.0)	144.2 (21.6)	0.03	0.86
BMI (kg/m^2)	26.9 (3.2)	26.8 (3.6)	0.03	0.86
Body fat (%)	32.3 (8.4)	32.4 (8.2)	0.00	0.99
Performance-based fitness				
Manual dexterity (s)	46.6 (5.4)	47.0 (5.3)	0.35	0.56
Reaction time (ms)	219 (30)	227 (42)	2.04	0.16
Functional reach (cm)	38.6 (5.5)	36.8 (5.8)	4.93	0.03*
Grip strength (kgf/kg)	0.497 (0.113)	0.493 (0.133)	0.03	0.86
Leg strength (s)	20.0 (5.3)	20.5 (5.7)	0.32	0.57
Sit-and-reach (cm)	29.3 (9.5)	26.1 (10.7)	4.53	0.04*
Shoulder flexibility (°)	48.7 (6.3)	48.9 (7.9)	0.03	0.86
Walking (×16 2/3 m)	50.8 (14.5)	51.4 (13.6)	0.07	0.78

RSA, recreational sports activities; LTPA, leisure-time physical activities; RDBP, resting diastolic blood pressure; RSBP, resting systolic blood pressure; BMI, body mass index.

[a] Missing $n = 1$.
[b] Missing $n = 4$.
[c] Missing $n = 2$.
[d] Missing $n = 3$.
* Statistically significant $P < 0.05$.

timed chair-stand test were administered to measure dynamic balance and leg strength, respectively. Both tests have also proven to reliable and valid [35–37]

2.4. Analysis

Data were analysed using SPSS version 10.0 (SPSS Inc., Chicago IL, 1999) and MLwiN (2004, 2.01). Analysis of variance (ANOVA) and χ^2 procedures were used to evaluate between-group differences for the general characteristics and main outcomes at baseline. To assess effectiveness of GALM after 6 months, we first checked if neighbourhood and municipality were of influence using a multilevel analysis. Since the results of this multilevel analysis demonstrated there was no such influence, repeated measure analysis of covariance (ANCOVA) procedures were used with baseline values, sex and age as covariates. The analyses were conducted by intention-to-treat, with participants analysed according to the initial randomised assignment. Secondary analyses were performed including only those subjects who attended at least 50% of the GALM sessions. For both analyses, a one-tailed test of significance was applied for the between-group differences because we had directional hypotheses for the change in these outcomes. Adjusted change scores for each outcome measure and 95% confidence intervals were reported. To determine whether the calculated within-group changes over time were significant, paired t-test procedures were conducted. For all test procedures a probability value of less than 0.05 was considered statistically significant.

Table 3
Adjusted mean changes in estimated energy expenditure, perceived health, perceived fitness, health indicators and performance-based fitness per study group after 6 months

Characteristics	Control group (n = 102), mean change[a] (95% CI)[b]	Intervention group intention-to-treat (n = 79), mean change[a] (95% CI)[b]	P^{c}	Intervention group 50% of sessions (n = 73), mean change[a] (95% CI)[b]	P^{d}
Estimated energy expenditure for physical activity					
EE_{RSA} (kcal/week)	151 (−9, 312)	325 (179, 471)[**]	ns	323 (169, 476)[**]	ns
EE_{LTPA} (kcal/week)	662 (510, 813)[*]	664 (455, 872)[e,**]	ns	770 (544, 997)[e,**]	ns
Perceived health			ns		ns
Vitality Plus Scale	−0.17 (−0.61, 0.27)[f]	0.18 (−0.44, 0.80)[g]	ns	0.18 (−0.46, 0.81)[g]	ns
TAAQOL subscales					
Gross motor functioning	−0.57 (−2.97, 1.82)[g]	2.74 (0.47, 5.02)[*]	ns	2.54 (0.24, 4.83)[*]	ns
Fine motor functioning	−0.50 (−1.57, 0.57)[f]	0.32 (−1.14, 1.78)	ns	0.32 (−1.35, 1.98)	
Cognition	−2.10 (−3.81, −0.40)[e,*]	−1.42 (−3.17, 0.32)	ns	−0.76 (−2.72, 1.20)	
Sleep	−3.36 (−5.49, −1.24)[e,*]	2.64 (0.35, 4.94)[e,*]	0.04	2.50 (0.11, 4.90)[e,*]	0.04
Social contacts	−0.95 (−2.68, 0.79)[h]	0.63 (−1.34, 2.60)[h]	ns	−0.11 (−1.95, 1.74)[h]	ns
Daily activities	0.76 (−1.46, 2.97)[h]	−1.15 (−3.87, 1.57)[h]	ns	−0.95 (−3.68, 1.77)[h]	ns
Vitality	0.87 (−1.08, 2.82)[h]	−0.61 (−3.02, 1.80)[f]	ns	−0.92 (−3.45, 1.61)[f]	ns
Positive moods	0.05 (−1.59, 1.70)	−1.18 (−3.28, 0.93)[e]	ns	−1.12 (3.38, 1.14)[e]	ns
Depressive moods	0.99 (−0.67, 2.65)[e]	−0.04 (−1.53, 1.46)[f]	ns	0.09 (−1.50, 1.67)[f]	ns
Perceived fitness					
Fitness score	0.10 (−0.04, 0.23)	0.55 (0.41, 0.68)[**]	$P < 0.01$	0.58 (0.43, 0.73)[**]	$P < 0.01$
Comparative fitness rating	−0.24 (−0.49, 0.006)[e]	−1.34 (−1.71, −0.97)[e,**]	0.02	−1.38 (−1.72, −1.03)[e,**]	0.02
Health indicators					
RDBP (mmHg)	−0.15 (−1.41, 1.12)	−2.67 (−4.15, −1.19)[**]	0.04	−2.34 (−3.83; −0.85)[**]	0.03
RSBP (mmHg)	0.25 (−1.98, 2.47)	−2.05 (−4.69, 0.59)	ns	−2.26 (−5.04; 0.53)	ns
BMI (kg/m^2)	0.05 (0.02, 0.08)[**]	−0.12 (−0.15, −0.096)[**]	ns	−0.11 (−0.14; −0.08)[**]	ns
Body fat (%)	−0.65 (−0.75, −0.55)[**]	−1.01 (−1.10, −0.91)[**]	ns	−1.02 (−1.12; −0.92)[**]	ns
Performance-based fitness					
Manual dexterity (s)	−2.58 (−2.99, −2.17)[**]	−2.10 (−2.59, −1.62)[**]	ns	−2.21 (−2.72; −1.70)[**]	ns
Reaction time (ms)	−11.3 (−15.5, −7.0)[**]	−8.9 (−12.2, −5.5)[**]	ns	−9.3 (−12.9; −5.6)[**]	ns
Functional reach (cm)	2.06 (1.22, 2.89)[**]	1.15 (0.22, 2.07)[*]	ns	1.16 (0.20; 2.12)[*]	ns
Grip strength (kgf/kg)	−0.013 (−0.017, −0.0086)[**]	0.0034 (−0.0005, 0.0072)	$P < 0.01$	0.0056 (0.0015, 0.0096)[**]	$P < 0.01$
Leg strength (s)	−3.05 (−3.61, −2.50)[**]	−2.94 (−3.53, −2.36)[**]	ns	−2.44 (−2.84, −2.05)[**]	ns
Sit-and-reach (cm)	3.17 (2.81, 3.54)[**]	1.57 (1.19, 1.95)[**]	ns	1.53 (1.12, 1.94)[**]	ns
Shoulder flexibility (°)	−0.52 (−1.70, 0.66)	−2.04 (−3.11, −0.96)[**]	ns	−2.02 (−3.20, −0.84)[**]	ns
Walking (×16 2/3 m)	2.49 (1.35, 3.63)[**]	4.40 (3.17, 5.64)[**]	ns	3.56 (2.55, 4.58)[**]	ns

RSA: recreational sports activity; LTPA: leisure-time physical activity; RDBP: resting diastolic blood pressure; RSBP: resting systolic blood pressure; BMI: body mass index; ns: not significant.

[a] Adjusted for baseline measurement, sex and age.
[b] 95% Confidence interval (adjusted for baseline measurement, sex and age).
[c] *P*-value for difference between control group and intervention intention-to-treat group, one-sided.
[d] *P*-value for difference between control group and intervention group consisting of participants who followed more than 50% of the GALM sessions, one-sided.
[e] Missing $n = 1$.
[f] Missing $n = 2$.
[g] Missing $n = 4$.
[h] Missing $n = 3$.
[*] Statistical within-group difference paired t-test, $P < 0.05$.
[**] Statistical within-group difference paired t-test, $P < 0.01$.

3. Results

One hundred and eighty-one out of 315 participants at baseline also completed all measurements after 6 months, producing an overall dropout rate of 43% (IG, 52% versus 33%, CG). Main characteristics of the 181 participants who completed all measures at baseline and after 6 months are shown in Table 1. The study participants who dropped out were not significantly different with respect to sex, age, stage of change, EE_{RSA}, EE_{LTPA}, and all health and fitness outcomes measures. The percentages of women in the IG (54.4%) and CG (56.9%) were nearly the same. The IG subjects demonstrated an average attendance to the GALM program of 12 of the 15 GALM sessions (80%, standard deviation = 19).

3.1. Baseline characteristics

Table 2 shows the results of the ANOVA for between-group differences for outcome measures at baseline, and demonstrates that energy expenditure, health and fitness of the IG were not significantly different from the CG except for two measures in the performance-based fitness domain. The mean scores on the functional reach test showed a significant difference between the IG and CG in favour of the IG (38.6 cm, S.D. = 5.5 versus 36.8 cm, S.D. = 5.8) ($F = 4.93$, $P < 0.05$). The IG also demonstrated a significantly higher score on the sit-and-reach test than the CG (29.3 cm, S.D. = 9.5 versus 26.1 cm, S.D. = 10.7) ($F = 4.53$, $P < 0.05$).

3.2. Intention-to-treat analysis

IG as well as CG participants show many positive changes in energy expenditure for physical activity and health and fitness outcomes after 6 months. Especially the health and fitness outcomes as measured objectively changed positively (i.e. health indicators and performance-based fitness). The mean change for EE_{RSA} in the IG was larger than in the CG (325 kcal/week versus 151 kcal/week), but did not reach statistical significance. Similar increases in EE_{LTPA} (664 kcal/week versus 662 kcal/week) occurred in both groups (Table 3). For the indicators of perceived health, the sleep subscale of the TAAQOL demonstrated a significant difference between the IG and the CG at 6 months ($F = 3.07$; $P < 0.05$). All indicators of health showed favourable results for the IG, with the between-group difference in diastolic blood pressure reaching statistical significance ($F = 3.35$; $P < 0.05$). Perceived fitness characteristics also showed significant 6-month between-group differences. The fitness score increased by 0.55 in the IG and 0.10 in the CG ($F = 7.06$; $P < 0.01$). By contrast, the mean score on the comparative fitness rating decreased 1.34 in the IG compared to 0.24 in the CG ($F = 4.50$; $P < 0.05$). Performance-based fitness scores showed a significant between-group difference in mean change for grip strength ($F = 7.64$; $P < 0.01$).

3.3. Subgroup analysis

We performed post-hoc analyses to examine the effects of the intervention group including only those subjects who attended at least 50% of the sessions ($n = 73$) (Table 3). After adjustment for baseline measure, sex and age, comparable within and between-group differences were observed as for the intention-to-treat group.

4. Discussion and conclusion

4.1. Discussion

We evaluated the effects of 6-month participation in the GALM program at the level of physical activity, health and fitness outcomes in sedentary older adults aged 55–65. Participant flow showed high attrition rates (IG, 52% versus 33%, CG), which could be a threat to the internal validity of our study. The main characteristics at baseline however showed that the recruited older adults were still representative of the average GALM participants [12,19]. Comparison between GALM participants' performance-based fitness and normative data of an average group of Dutch adults aged 55–65 revealed that GALM participants scored on average below mean values of the normative dataset. The average score of the GALM participants on the walking test was clearly below the average norm score, which underlines that our study group was less fit [27]. Comparison between participants who dropped out and those who stayed verified no significant differences in age, sex and all of the outcome measures at baseline. A major reason for the high attrition rate was that this research was conducted in a real community setting and depended highly on practical issues like change of instructors and changes in group size, making it necessary for local project managers to combine groups from different days or times into a new group to make the project feasible. Many of these practical issues were reasons for participants to drop out of the GALM program, and consequently out of the study. From the process evaluation no selective mechanism could be found for the attrition, since 95% of the participants enjoyed the content of the program activities, 89% valued the intensity of the sessions, 87% thought the level of difficulty of the sessions was good and 97% appreciated the instructor [17]. The ecologic validity and generalisability of our study results are high, given that we conducted this study in a real community setting (i.e. the individuals' neighbourhoods).

Increased levels of energy expenditure in RSA and LTPA in both study groups during the initial 6-month period were found. The increase in total energy expenditure (EE_{RSA} and EE_{LTPA} together) of approximately 1000 kcal/week (walking briskly approximately 188 min per week) in the IG and 800 kcal/week (walking briskly approximately 156 min per week) in the CG is an increase of physical activity that equals promoted amounts of 2 kcal/kg/day for enhancement of health [20,21]. The Community Healthy Activities Model Program for Seniors (CHAMPS II) is one of the few programs that shares similarities with GALM, in that it focuses on older adults, uses a population-based recruitment approach, is lifestyle-oriented and individualised for each person's physical activity interest and abilities (i.e. several physical activities options during one session, adapted materials if necessary). Although baseline estimated caloric expenditures for physical activity were higher in our study, the 6-month changes in estimated energy expenditure for physical activity were comparable with the 12-month changes found in that study [16]. Dunn et al. (1998) reported a significant increase in energy expenditure for moderate-to-hard physical activity (approximately 1.4 kcal/kg/day) after 6 months of participation in a lifestyle or a structured physical activity program for adults (Project Active) [38]. Although these studies show similar responses, caution must be used in comparing their energy expenditure changes with our findings, given that they classified physical activity differently.

The estimated energy expenditure data seem to indicate that the participants on the waiting-list (CG) were motivated and prepared to participate in GALM. Although the CG participants were instructed to maintain their regular physical activity pattern, we clearly did not succeed in this intention and they became more active than expected. There are several possible reasons for this: first, the intensive door-to-door recruitment strategy and other forms of attention could have primed CG participants to make changes across the 6-month period. The baseline assessments may have increased participants' knowledge of healthy behaviour and artificially influenced behaviour, thus confounding results [39,40]. Second, while the IG had more than double the increase in energy expenditure for recreational sports activities relative to the CG, the response variability in both groups made such differences difficult to detect. Third, with the 6-month study period starting in the winter and ending in the summer, seasonal variation may have influenced general physical activity patterns and consequently the absolute changes in estimated energy expenditure [41,42]. The results suggest that control groups other than wait-listed groups–involving e.g. attention-control conditions that provide participants with appealing, non-physical activity information–may be preferred when studying older adults, from an intervention as well as a retention perspective [43]. We recommend the use of a control arm in future studies of this type offering individuals something other than physical activity (e.g. nutrition, general health education) that will satisfy them and prevent them from making gains in the behaviour of interest.

The impact of the increase in physical activity level in both groups was reflected in an increase of most of the health and fitness outcomes. The increases in the health and fitness outcomes in our study are in line with other studies. Similar positive effects of 6–24 months of exercise on systolic and diastolic blood pressure as well as body fat percentage as indicators of health are reported [38,44]. Positive effects of exercise interventions on aspects of physical fitness among older adults are also reported in other studies, i.e. gait, balance and mobility [18,45,46], walking parameters [45–47], strength, flexibility [46,47] and endurance [38]. The comparison between control group and intervention group resulted in relatively few significant between-group differences favouring the intervention group (i.e. sleep, diastolic blood pressure, perceived fitness score and grip strength). A logical explanation of why our study did not succeed in finding more significant between-group differences is the increase in total energy expenditure for physical activity for the intervention, but also the control group as described before.

A remarkable result was found for the comparative fitness rating. CG participants showed significantly less deterioration than IG participants; the opposite was true for the perceived fitness score measure at follow-up. The fitness score measured a more general perception of health and fitness without an explicit comparison with age-group peers. Participation in the GALM program seemed to influence this general self-perception of health and fitness condition positively. On the other hand, the comparative fitness rating included a comparison with peers, i.e. older adults of the same sex and age. By participating in the GALM program, the reference group may have changed from neighbours, friends and family members to active and motivated GALM participants. The change in reference group accompanied by a more realistic view may have influenced the comparative fitness rating in the IG negatively. In other words, participating in the GALM physical activity program corrected the participants' "optimistic bias" which has been reported to increase with age in other older adult populations [48].

4.2. Conclusion

The increases in total energy expenditure for physical activity from the GALM intervention, especially for the more intensive recreational sports activities, look promising and are in line with the expected amounts necessary to improve health [20,21]. Six-month results show significant effects on health and fitness indicators in both groups. Between-group differences are limited though, probably as a result of the significant increase in energy expenditure in the control waiting-list group. Knowing that studies with short follow-up have limitations, as older adults may take longer adaptation time to gain optimal benefit from exercise programs, a longer study follow-up is needed [21]. Further research will be conducted to evaluate how changes in physical activity outcomes and other variables develop after 12 months of participation in GALM and to correct for possible seasonal variations. An additional effectiveness study in which the costs of implementing GALM are compared with effects on morbidity and public health resources would be valuable to determine how effective GALM is in producing health gains at a community-based level.

5. Practice implications

Our study sheds light on the effects of participation in GALM on the level of physical activity, health and fitness in sedentary and underactive older adults. GALM distinguishes itself from other community-based strategies by way of the neighbourhood-oriented recruitment phase and the recreational sports activity program which is based on behavioural change and evolutionary-biological play theories. Since 1997, over 420,000 older adults have been approached using the GALM recruitment strategy, and approximately 41,000 sedentary and underactive older adults participate in the recreational sports programs. The increases in energy expenditure for physical activity from the GALM intervention, especially for the more intensive recreational sports activities, look promising and are in line with the expected amounts necessary to improve health. Six-month results show significant effects on most health and fitness outcomes. The results underline the fact that GALM can be considered successful in stimulating leisure-time physical activity and improving health and fitness in older adults.

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