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Feasibility and Effectiveness of a Walking Program for Community-Dwelling Older Adults With Mild Cognitive Impairment

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This study examined the feasibility and effect on aerobic fitness of a 1-yr, twice-weekly, group-based moderate-intensity walking program (MI-WP, $n = 77$) compared with a low-intensity activity program (LI-AP, $n = 75$) for community-dwelling older adults with mild cognitive impairment (MCI). Thirty participants did not start a program; median attendance in the other 122 participants was 71%. Small but significant associations were observed between attendance and memory in the MI-WP and general cognition in the LI-AP. Associations were no longer significant when both groups were analyzed together. Intensity, assessed using percentage of heart-rate reserve and the Borg scale, equaled intended intensity for both programs. Aerobic fitness improved significantly in participants in the MI-WP. In conclusion, cognition was not clearly associated with attendance in the 62 participants starting the MI-WP, and average attendance was good. The intensity was feasible for participants who continued the MI-WP. The findings support the proposal that regular moderate-intensity walking improves aerobic fitness in adults with MCI.

Keywords: cognition, exercise, aerobic fitness, randomized controlled trial

Older adults are encouraged to pursue active lifestyles (Nelson et al., 2007). In the long term, physical activity, and more specifically aerobic exercise, can prevent the development and progression of age-related chronic diseases such as cardiovascular disease and diabetes (Nelson et al.; Peel, McClure, & Bartlett, 2005; Taylor et al., 2004). Other benefits of regular aerobic exercise include improvements in overall functioning because of enhanced physiologic capacity (Bean, Vora, & Frontera, 2004), better mental health (Netz, Wu, Becker, & Tenenbaum, 2005), and improved cognitive function (Colcombe & Kramer, 2003).

Most studies on the benefits of physical activity and exercise for older adults have focused on those who are cognitively healthy (Bean et al., 2004; Taylor et al.,

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2004). Attention to the effects of exercise programs for adults with cognitive impairment, however, is also important, given the increasing prevalence of cognitive decline and dementia. According to the World Health Organization, there will be almost 29 million people with dementia by the year 2020 (Haan & Wallace, 2004). Dementia of the Alzheimer's type is often preceded by mild cognitive impairment (MCI; Petersen et al., 1999). People with MCI experience memory loss to a greater extent than is expected for their age and education but do not meet criteria for Alzheimer's disease (Petersen et al.). Prevalence reports of MCI in the general population range from 3% to 19%, varying according to the specific definition of MCI (Bischkopf, Busse, & Angermeyer, 2002; Ganguli, Dodge, Shen, & DeKosky, 2004; Low et al., 2004), and are expected to increase. Improved aerobic fitness has been shown to result in increased brain volume in healthy older adults (Colcombe et al., 2006). In addition, aerobic exercise shows promising effects on cognitive function in both cognitively healthy adults and adults with dementia (Colcombe & Kramer, 2003; Heyn, Abreu, & Ottenbacher, 2004). Therefore, it is important to address the feasibility and effectiveness of aerobic-exercise programs in older adults with memory complaints.

Most studies on the effect of exercise in people with cognitive impairment are carried out with residents of long-term-care facilities. It has been shown that exercise interventions can improve aerobic fitness in institutionalized adults with dementia and related cognitive impairments (meta-analysis, 13 randomized controlled trials [RCTs], effect size [95% confidence interval] =.62 [.45–.78]; Heyn et al., 2004). Unfortunately, none of the 13 studies on the effects of exercise on aerobic fitness achieved a high score for methodologic quality. Therefore, Heyn et al. advocated for larger RCTs based on a robust design with long-term follow-up.

The effect of exercise on cognitive function in these institutionalized cognitively impaired adults (Heyn et al., 2004) was also promising. McAuley, Kramer, and Colcombe (2004) mentioned that the beneficial effects of aerobic exercise on cognition depend on successful adherence to exercise programs (McAuley et al.), involving both compliance with exercise intensity and session attendance. In Heyn et al.'s meta-analysis, exercise intensity was defined as minutes per session. Information about the attendance at the exercise programs was not reported. For most studies it was not clear whether the results were based on an intention-to-treat or a per-protocol analysis. In general, exercise adherence in older adults is not optimal (van der Bij, Laurant, & Wensing, 2002), and it may be even poorer in cognitively impaired adults because several cognitive functions, such as memory and executive function, are required to participate without problems in an exercise program. To our knowledge, studies in community-dwelling older adults with cognitive impairment examining adherence to these programs, the association between cognitive function and session attendance, and the effect of exercise programs on aerobic fitness are scarce.

The current study was carried out in community-dwelling older adults with MCI. This RCT was developed to examine the effect of a 1-year moderate-intensity walking program (MI-WP), aimed at improving aerobic fitness, on cognitive function (van Uffelen, Chinapaw, van Mechelen, & Hopman-Rock, 2008). For that purpose the walking program was compared with a low-intensity activity program (LI-AP) serving as a control group. Because MCI is associated with poor physical health and higher risk of not being able to perform activities of daily living (Frisoni et al., 2000; Gill, Richardson, & Tinetti, 1995), not all adults with MCI will be able to participate in aerobic exercise programs, so the feasibility of the LI-AP is also addressed in the current study. From a public health perspective, participation in an LI-AP could help prepare people for participation in moderate-intensity aerobic activities, for example, by improving balance, flexibility, and strength (Nelson et al., 2007).

The aim of the current article is twofold. The first aim is to compare the feasibility of a group-based MI-WP with the feasibility of a group-based LI-AP in community-dwelling adults with MCI in terms of session attendance, the association between cognitive function and session attendance, and compliance with exercise intensity. The second aim is to examine the effect of the walking program on aerobic fitness compared with the LI-AP.

Methods

Study Design and Randomization

The study is based on an RCT with a factorial design originally designed to examine the effect of walking and vitamin supplementation on cognition (van Uffelen, Hopman-Rock, Chin A Paw, & van Mechelen, 2005). The study protocol was approved by the TNO-VU University Medical Center medical ethics committee. Randomization was stratified for baseline physical activity level as measured by the LASA Physical Activity Questionnaire (Stel et al., 2004), using the SPSS statistical program. The median physical activity level was used to separate the participants into a relatively active and relatively inactive group. These two groups were then separately randomized to the two exercise programs. Written informed consent was obtained from all participants.

Participants

Participants were recruited from the general population from September 2003 to January 2004. The criteria for MCI proposed by Petersen et al. (1999) were used. The operational criteria for MCI and additional inclusion criteria are described in Figure 1. These criteria were checked using a postal questionnaire and a subsequent telephone interview (van Uffelen, Chin A Paw, Klein, van Mechelen, & Hopman-Rock, 2007). See Figure 2 for the flow of participants during recruitment and intervention.

Intervention

Both exercise programs were group based and consisted of two 60-min sessions per week for 1 year (June 2004 to June 2005). The training groups were supervised by qualified and trained exercise instructors who were experienced in working with older adults.

MI-WP. The MI-WP was based on Sportive Walking, an aerobic walking program aimed at improving aerobic fitness (Stahl & Laukkanen, 2000). Moderate intensity

- Memory complaints: answer yes to question "Do you have memory complaints?" or at least twice sometimes at cognition scale of Strawbridge
- Objective memory impairment: 10 WLT delayed recall ≤5 and percentage savings ≤100
- Normal general cognitive functioning: TICS ≥19 and MMSE ≥24
- Intact daily functioning: no report of disability in activities of daily living on GARS-scale, except on the item "taking care of feet and toenails"
- Absence of dementia: TICS ≥19 and MMSE ≥24
- Being able to perform physical activities of moderate intensity, without making use of a walking device, e.g., rollator or walking frame
- Not using vitamin supplements, vitamin injections, or drinks with high dose of vitamin B6, B11, or B12
- Not suffering from epilepsy, multiple sclerosis, Parkinson's disease, kidney disorder requiring hemodialysis, or psychiatric impairment
- No depression: GDS ≤5
- Not using medication for rheumatoid arthritis or psoriasis interfering with vitamin supplement
- No alcohol abuse: men <21 drinks a week, women <15 drinks a week)
- Not currently living in a nursing home or on a waiting list for a nursing home

Figure 1 — Operationalization of Petersen criteria for mild cognitive impairment (1–5) and additional inclusion criteria for participation in the study (6–12). *Note*. 10 WLT = 10-word learning test; TICS = telephone interview for cognitive status; MMSE = Mini Mental State Examination; GARS = Groningen Activity Restriction Scale; GDS = Geriatric Depression Scale. See van Uffelen et al. (2005) for references of tests.

was operationalized as walking at an intensity >3 MET (Ainsworth et al., 2000). The instructors monitored exercise intensity subjectively during the classes according to the following criteria: Participants were still able to talk and also showed signs of moderate-intensity physical activity (increased breathing frequency, turning red, perspiration). Each session consisted of a warm-up, moderate-intensity walking, and a cooldown. The walking exercises were designed in such a way that participants were able to exercise at their own level, without losing contact with the group. They were taught to walk at four walking paces. Pace 0 corresponded to quiet walking, and Pace 3, to brisk walking. Intensity of the MI-WP was increased gradually during the program by increasing the time participants spent walking at Pace 3. Sessions took place outdoors in municipal parks and were only cancelled when it was slippery because of snow or freezing rain.

LI-AP. Intensity of the LI-AP was operationalized as activity at <3 MET (Ainsworth et al., 2000). Participants were taught to recognize signs of becoming too intensely active and instructed to decrease intensity if they experienced these

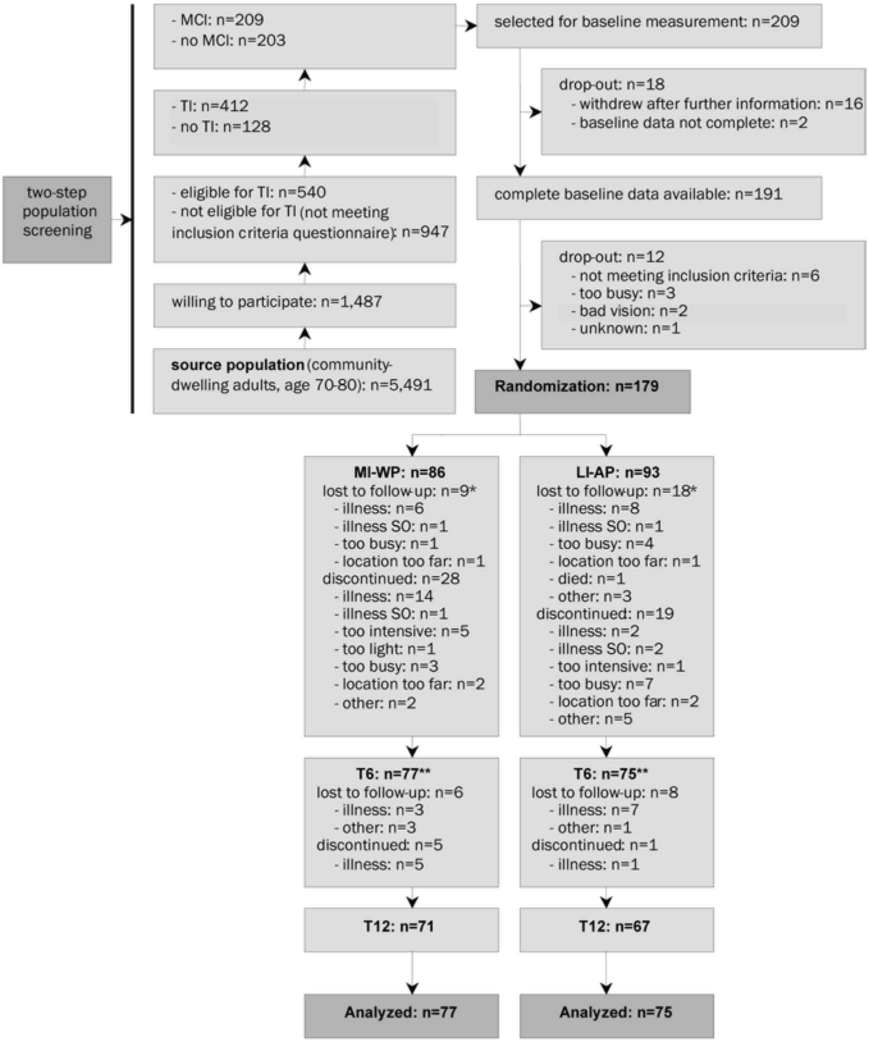

Figure 2 — Flowchart of recruitment and intervention. MCI = mild cognitive impairment; TI = telephone interview; MI-WP = moderate-intensity walking program; LI-AP = low-intensity activity program; SO = significant other; T6 = follow-up after 6 months; T12 = follow-up after 12 months. See van Uffelen et al. (2007) for detailed description. *Excluded from analysis (only baseline data). **Included in analysis.

signs. The instructors subjectively monitored this. The program consisted of an introduction, low-intensity nonaerobic group exercises, and a closing. Sessions were divided into five themes: relaxation, activities of daily living, balance, flexibility, and posture. Three sessions were developed for each theme, with an additional three sessions of combined themes. The entire series of 18 sessions was then repeated. The program was carried out in community centers.

Measurements

The measurement of baseline variables is described elsewhere (van Uffelen et al., 2005). Time spent per day in moderate physical activity was assessed using the LASA Physical Activity Questionnaire (Stel et al., 2004). For all outcomes except attendance, data were collected at the start and after 6 and 12 months intervention. Data on aerobic fitness and performance on cognitive tests were collected by examiners blinded to group allocation. Blinded collection of data on attendance and intensity was not possible.

Feasibility

Session Attendance. Attendance was defined as the percentage of sessions attended during the intervention in participants who attended at least one session. The number of participants attending zero sessions was reported separately. The supervisors also systematically and accurately registered adverse events during the exercise sessions.

Association Between Cognitive Function and Attendance. Five cognitive tests were performed during a standardized interview at baseline. They are described in detail elsewhere (van Uffelen et al., 2008; van Uffelen et al., 2005).

- General cognitive function was assessed by the Mini Mental State Examination (Folstein, Folstein, & McHugh, 1975). The maximum score is 30, and a score below 24 is considered abnormal. Participants with a score below 24 were excluded, because this does not comply with the Petersen criteria for MCI as operationalized in this study (van Uffelen et al., 2007).
- Memory was assessed by the Auditory Verbal Learning Test (AVLT; Rey, 1964). Scores ranged from 0 to 75 and from 0 to 15 words for immediate and delayed recall, respectively.
- Executive function was assessed by the Verbal Fluency Test (Lezak, 2004). Participants were asked to name words starting with a particular letter during a 1-min period. In each administration of the test, three letters were given. The score was the total number of named words.
- Information-processing speed was assessed by the Digit Symbol Substitution Test (Uiterwijk, 2001). The participant was asked to draw symbols corresponding to nine digits below numbered boxes during a 90-s period. The score was the number of correctly drawn symbols.
- Attention was assessed with the Abridged Stroop Color Word Test (Klein, Ponds, Houx, & Jolles, 1997), which consists of three tasks: reading eight rows of five written colors; naming the colors of eight rows of five red, green, blue, or yellow rectangles; and naming the color of ink for the words *red, green, blue,* or *yellow*. The third task is also a measure of executive function (response inhibition) and was used for analysis in the current article. The score was the time needed to complete the task.

Compliance With Program Intensity. Heart rate and RPEs were measured during an exercise session at the start of the exercise programs and after 6 and 12 months. Resting heart rate (HR_{rest}) was recorded using heart-rate monitors (Polar, Vantage, NV) after 10 min rest preceding the session. During the session, heart rate was recorded every minute. From these data, the mean heart rate (HR_{mean}) during moderate-intensity walking in the MI-WP and the nonaerobic group exercises in the LI-AP was calculated. Maximum heart rate (HR_{max}) was estimated by the following equation: $HR_{max} = 208 - (0.7 \times \text{age})$ (Tanaka, Monahan, & Seals, 2001). Finally, percentage of heart rate reserve (%HRR) was calculated using the following formula: $\%HRR = (HR_{mean} - HR_{rest})/(HR_{max} - HR_{rest})$ (Warburton, Nicol, & Bredin, 2006). Exclusion criteria for heart-rate measurement were use of beta blockers, having a pacemaker, or having current heart problems. During the sessions in which heart rate was recorded, subjective program intensity was assessed immediately after the most intensive part of the program by administering the Borg scale (Borg, 1982). This is an RPE based on a 15-item scale from 6 (*no exertion at all*) to 20 (*maximum exertion*). The values obtained for %HRR and RPE were compared with cutoff points for aerobic-exercise intensity published by Warburton et al. (2006), being a %HRR of less than 39 for very light to light effort and 40–59 for moderate effort, and an RPE of 10–11 for light effort and 12–13 for moderate effort (Warburton et al.).

Effect on Aerobic Fitness: The Groningen Walking Test

The Groningen Walking Test (GWT) is a graded submaximal test of aerobic endurance for the elderly (Lemmink, 1996). Participants in the GWT walked distances of 16.6 m between pylons in a large rectangle. For every covered distance, a score of 1 point was acquired. Walking speed started at 4 km/hr, increasing every 3 min by 1 km/hr to a maximum of 7 km/hr. The test was finished when a participant failed twice to reach the next pylon in time before the next beep. The maximum score was 66 points, which corresponded to a walking distance of 1.1 km. Before participation in the GWT or the interventions, participants completed the Physical Activity Readiness Questionnaire (Thomas, Reading, & Shephard, 1992) and consulted their general practitioner about participation in case of doubt.

Statistical Analysis

Data were analyzed using SPSS (release 12.0.1). A significance level of 5% was used. Differences in baseline characteristics between participants randomized to the MI-WP and participants randomized to the LI-AP were identified with independent *t* tests, Mann–Whitney *U* tests, or chi-square tests.

Feasibility

Session Attendance. Between-groups differences in session attendance were assessed using Mann–Whitney *U* tests.

Association Between Cognitive Function and Attendance. Spearman's correlation coefficients were calculated to determine the association between performance on the cognitive tests at baseline and session attendance.

Compliance With Program Intensity. %HRR and RPE were compared between the MI-WP and the LI-AP at the start of the programs and after 6 and 12 months, using Mann–Whitney *U* tests and independent *t* tests, respectively.

Effect on Aerobic Fitness

To examine the effect of the MI-WP on aerobic fitness, longitudinal-regression analysis was conducted. This was a modified intention-to-treat analysis, including data of participants with at least one postbaseline GWT assessment. The two follow-up measurements were defined as dependent variables, and multilevel analysis with two levels was used: time of follow-up measurement (values corresponding with performance after 6 and 12 months intervention) and individual. Reported regression coefficients indicate the differences between the MI-WP and the LI-AP. Data were analyzed using a crude model and an adjusted model. In the crude model, the independent variable was exercise intervention, and baseline GWT score was added as a covariate. Because half the participants took vitamin pills (van Uffelen et al., 2005), vitamin intervention was also added as a covariate. In the adjusted model, gender, education, body-mass index, and attendance at the exercise programs were also added as covariates. These covariates were included in the model because they have previously been shown to be associated with aerobic fitness.

Results

One hundred seventy-nine subjects were randomized, of whom 27 decided immediately after randomization that they did not want to further participate in the study. Therefore, data for these people were not included in the analysis. Baseline cognitive-test performance did not differ between these 27 people and the remaining 152 participants who continued study participation (data not reported). We had data on cognitive performance at baseline and at least one follow-up measurement, as well as data on session attendance, for these 152 participants, and this number also includes study participants who never started or who discontinued an exercise program. Baseline variables are described in Table 1. The MI-WP included significantly fewer men than the LI-AP (48% vs. 64%) and significantly more participants with hypertension (27% vs. 14%).

Feasibility

Session Attendance. Session attendance is reported in Table 2. Thirty participants did not attend a single session. Baseline cognitive-test performance did not differ significantly between the 30 participants who attended zero sessions and the remaining 122 participants, who attended at least one session. In these 122 participants, median attendance (25th–75th percentile) was 70% (25–79) in the MI-WP ($n = 62$) and 71% (50–88) in the LI-AP ($n = 60$). Attendance at the LI-AP was significantly higher than attendance at the MI-WP, $p = .03$. No adverse events during the MI-WP or LI-AP sessions were reported.

Table 1 Baseline Characteristics of the Participants (N = 152)

Characteristic	Program	
	MI-WP (n = 77)	LI-AP (n = 75)
Age, years, M (SD)	75 (2.9)	75 (2.8)
Gender, % male	48*	64
Marital status, % living together	75	68
Education, % low/middle/high[a]	61/22/17	52/29/19
MMSE, median (10th–90th percentile)	29 (26–30)	29 (27–30)
AVLT direct recall, M (SD)	33.7 (8.0)	31.8 (7.6)
AVLT delayed recall, M (SD)	6.1 (2.5)	5.6 (2.3)
Moderate-intensity physical activity, min/day, median (10th–90th percentile)	54 (13–135)	46 (13–141)
Blood pressure, % hypertension[b]	27*	14
Body-mass index, kg/m^2, M (SD)	26.8 (3.2)	27.4 (3.5)
Smoking, % smokers	13	15
Number of self-reported diseases, % 0,1,2[c]	52/42/6	69/27/4

Note. MI-WP = moderate-intensity walking program; LI-AP = low-intensity activity program; MMSE = Mini Mental State Examination; AVLT= Auditory Verbal Learning Test.

[a]Low = no education, primary education, lower vocational training; intermediate = intermediate-level secondary education, intermediate vocational training; high = higher level secondary education, higher vocational training, university training. [b]Diastolic ≥90 and systolic ≥160. [c]Cardiovascular disease, chronic obstructive pulmonary disease, diabetes, epilepsy, multiple sclerosis, Parkinson's disease, psychiatric disease, renal failure requiring dialysis, and/or rheumatoid arthritis.

*Significantly different from LI-AP (p < .05).

Table 2 Distribution of the Participants over Five Categories of Attendance (N = 152)

	Sessions Attended					
	0%	1–24%	25–49%	50–74%	75–100%	Total
MI-WP, n	15	15	8	16	23	77
LI-AP, n	15	6	9	17	28	75
Total, n	30	21	17	33	51	152

Note. MI-WP = moderate-intensity walking program; LI-AP = low-intensity activity program.

Association Between Cognitive Function and Attendance. The correlations between baseline performance on the cognitive tests and attendance in participants attending at least one session are reported in Table 3. Small but statistically significant associations were observed between AVLT delayed-recall score and attendance at the MI-WP (Spearman's r = .28, p = .03) and between general cognition and attendance at the LI-AP (Spearman's r = .29, p = .03). These associations were no longer significant when both groups were analyzed together (Table 3).

Table 3 Correlation Between Cognitive Performance at Baseline and Session Attendance in Participants Attending at Least One Session

	MI-WP, *n* = 62		LI-AP, *n* = 60		Total, *N* = 122	
	R (Spearman)	*p*	*R* (Spearman)	*p*	*R* (Spearman)	*p*
MMSE[a]	.02	.88	.29	.03	.16	.08
AVLT direct recall, words[a]	.24	.07	.02	.91	.08	.38
AVLT delayed recall, words[a]	.28	.03	.11	.40	.15	.11
SCWT-A task 3, s[b]	−.04	.77	.05	.72	.00	.97
DSST, symbols[a]	−.09	.50	.00	.98	−.04	.70
VFT, words[a]	.02	.88	−.05	.73	−.04	.65

Note. MI-WP = moderate-intensity walking program; LI-AP = low-intensity activity program; MMSE = Mini Mental State Examination; AVLT = Auditory Verbal Learning Test; SCWT-A = Stroop Color Word Test-Abridged; DSST = Digit Symbol Substitution Test; VFT = Verbal Fluency Test,

[a]Higher score indicates better performance. [b]Lower score indicates better performance.

Compliance With Program Intensity. RPE and heart-rate data were available for participants who attended the exercise sessions at which they were measured (Table 4). At baseline, participants who provided RPE (n = 74) differed from participants without RPE (n = 78) with respect to AVLT delayed recall (M [SD] = 6.3 [2.6] vs. 5.4 [2.2], p = .04) and minutes spent per day in moderate-intensity physical activity (median [10th –90th percentile] = 45 [10–118] vs. 56 [18–164], p = .03). Participants with heart-rate recordings (n = 54) reported significantly fewer chronic diseases than participants without heart-rate recordings (n = 98; percentages reporting one, two, and three diseases were 72, 20, and 7, respectively, in those with heart-rate recordings and 54, 42, and 4 in those without heart-rate recordings, p = .03). Both self-rated intensity and %HRR were significantly higher in the MI-WP than in the LI-AP at the start of the exercise programs and after 6 and 12 months intervention. According to the cutoff points published by Warburton et al. (2006), RPE corresponded with moderate intensity (Borg score 12–13) in the MI-WP at all three measurements and with low intensity (Borg score 10–11) in the LI-AP at the start of the exercise programs and at 6 months follow-up. Average %HRR in the LI-AP corresponded with very light effort (<20% HRR) at all three measurements. In the MI-WP, average %HRR nearly reached the lower cutoff for moderate intensity (range 40–59% HRR) at 6 months follow-up and reached it at 12 months follow-up.

Effect on Aerobic Fitness

No significant baseline differences were observed between participants with (n = 89) and without GWT data (n = 63), including the 30 participants who did not attend a single session. Baseline distance walked in meters (median [10th–90th

Table 4 Values of Percentage of Heart Rate Reserve (% HRR) and Borg Scales at the Start of the Programs and After 6 and 12 Months

	Moderate-Intensity Walking Program						Low-Intensity Activity Program					
	T0	*n*	T6	*n*	T12	*n*	T0	*n*	T6	*n*	T12	*n*
% HRR, median (10th–90th percentile)	27 (13–54)*	21	37 (19–69)*	21	40 (25–67)*	12	14 (8–27)	33	16 (9–27)	29	19 (10–34)	24
Borg scale, *M* (*SD*)	11.6 (1.5)*	31	13.1 (1.4)*	31	12.6 (1.4)*	18	10.8 (1.5)	43	11.1 (1.6)	40	11.7 (1.7)	33

Note. T0 = baseline; T6 = 6-month follow-up; T12 = 12-month follow-up. In participants with data on these measures at the start of the programs and at least one follow-up measurement.

*Significantly different from LI-AP ($p < .05$).

percentile]) was 614 (448–863) in the MI-WP (n = 43) and 498 (249–930) in the LI-AP (n = 46) and did not differ significantly between groups. In the longitudinal-regression analysis, a significant beneficial main effect of the MI-WP was found on the distance walked compared with the LI-AP: Crude-model beta (95% CI) = 63 (1–125) m, and adjusted-model beta (95%CI) = 71 (8–136) m.

Discussion

Addressing the feasibility and effectiveness of exercise interventions for adults with MCI is important, given the increasing prevalence of age-related cognitive impairments and the promising association between aerobic fitness and cognitive function in both cognitively healthy and demented older adults (Colcombe & Kramer, 2003; Heyn et al., 2004).

Feasibility

Session Attendance. Overall session attendance including all randomized study participants was not good. Actual dropout rate was higher than the a priori assumed rate of 25% (van Uffelen et al., 2005). Fifty-seven of 179 randomized participants (32%) did not attend a single session. Of these 57 participants, 27 decided after randomization that they did not want to participate in the study after all, and they did not provide data at the 6- and 12-month follow-up measurements. Baseline cognitive-test performance did not differ between these 27 people and the 152 participants who were included in this study, and reasons for not further participating in the study after baseline measurement varied from illness to being too busy to participate (Figure 2). Therefore, it seems unlikely that dropping out had to do with feasibility of the exercise programs for these 27 people. The other 30 participants did attend the follow-up measurements but did not attend an exercise session. A frequently mentioned reason for not starting an exercise program was lack of interest. The percentage of 32% is consistent with a review on group-based physical activity interventions in older adults that reported that 21–90% of participants never participated in the intervention (van der Bij et al., 2002). These results indicate that researchers planning exercise interventions for older adults should prioritize recruitment of participants and make the effort to include a larger number of participants than actually needed to prevent lack of power in the analysis.

Attendance in participants who attended at least one session (n = 122) was good and corresponded to the attendance among older adults of 63–84% reported by van der Bij et al. (2002). The slightly, but significantly, higher attendance at the LI-AP was in line with another review reporting that adherence tends to be higher in flexibility programs than in aerobic-exercise programs (Martin & Sinden, 2001). This may be explained by the lower intensity of flexibility programs, which make them suitable for a higher proportion of the older population. Indeed, in the current RCT, the number of participants who discontinued because they found the program too intense was higher in the MI-WP than in the LI-AP. Another reason for the difference in attendance in this specific RCT may be the weather. The MI-WP took place outdoors, even when it rained, whereas the LI-AP was carried out in community centers.

The proportion of all randomized participants ($n = 179$) who discontinued the MI-WP was considerably larger than the proportion who dropped out of the LI-AP (33/86 = 38% vs. 20/93 = 22%). The possibility that participants who had difficulties walking were more prone to dropout from the MI-WP than from the LI-AP cannot be excluded. This may have resulted in an overestimation of the actual effect of the MI-WP on aerobic fitness, as measured with the walking test. According to Figure 2, this difference can be mainly attributed to a higher number of participants in the MI-WP reporting illness as a reason for dropping out. A potential explanation may be that during the intervention two outbreaks of the flu took place, and several participants did not want to come back to the outdoors MI-WP after having had the flu. A small number of participants also reported aggravation of existing joint pain, causing them to discontinue. Only 5 participants in the MI-WP mentioned the intensity of the walking program as the primary reason to drop out. It is important to keep up to date with participants' perceptions of the program and how they are coping with the intensity, to make potential adjustments to prevent them from dropping out.

Thus, in line with the literature (Rhodes et al., 1999; Schutzer & Graves, 2004), health-related problems were the main reason for not continuing with either program. Future research should focus on effective methods to increase exercise adherence in an older population. Determinants of exercise adherence that have been reported in previous studies range from psychological factors such as self-efficacy to environmental factors such as unsafe neighborhoods (Brawley, Rejeski, & King, 2003; Hui & Rubenstein, 2006; King, 2001). Brawley et al. reported that behavior-change strategies are a promising tool to increase adherence to exercise programs in community-dwelling older adults (Brawley et al.). They also advocate flexibility in programming, individual tailoring, and implementing social problem solving in the intervention.

Association Between Cognitive Function and Attendance. The number of studies focusing on the association between cognitive function and session attendance in exercise programs for community-dwelling older adults is small. Previous studies were carried out in demented adults attending day care (Netz, Axelrad, & Argov, 2007) and residential care (Littbrand et al., 2006). Netz et al. (2007) studied the feasibility of a 12-week, twice-weekly, group-based physical activity program in 29 demented older adults. They found that severely cognitively impaired individuals could participate in the exercise program and improve their functional status. Littbrand et al. found that session attendance at a 13-week high-intensity weight-bearing program was not significantly correlated with Mini Mental State Examination score in 91 institutionalized adults with and without dementia living in residential care. In the current study, memory was significantly related to session attendance in the Mi-WP, and general cognitive function, to session attendance in the LI-AP, but the associations were small. None of the other cognitive tests were significantly associated with session attendance, although these other cognitive functions would be equally important for participating in the programs. Moreover, it seems unlikely that the cognitive abilities required for attending the MI-WP would differ from the abilities required for attending the LI-AP. When analyzing the association between cognition and session attendance in all participants together, the associations between cognition and session attendance were no longer significant. Therefore, a likely explanation is that the significant associations in the MI-WP and the LI-AP were based on chance.

Compliance With Program Intensity. Subjective monitoring of exercise intensity by the instructors and participants themselves appeared to be a feasible method for reaching the intended intensity, because intensity of the LI-AP corresponded with very low intensity and intensity of the MI-WP was about the lower limit of moderate effort (Warburton et al., 2006). Even though the achieved intensity of the WI-WP was not consistently within the target range of 40–59% HRR for moderate intensity, the MI-WP was effective in improving aerobic fitness. Heart-rate monitors may be a useful tool to further increase the proportion of participants in walking programs that reach moderate intensity. Especially in the first weeks of an exercise program, it may be helpful for the participants to get direct feedback on their exercise intensity. This may also help them relate physiological signs, such as increased breathing frequency and perspiration, to moderate-intensity physical activity. To do this, the use of heart-rate monitors should be implemented in the program. Unfortunately, this was not possible in the current study.

Participants who did not provide RPEs (i.e., were not present at these sessions) reported being more physically active than participants who did provide RPEs. This may be explained by the fact that more than one fifth of those who discontinued the programs cited being too busy as the reason (see Figure 2). More specific explanations for being too busy included taking care of grandchildren and volunteer work. These activities may have required a lot of physical activity, thereby explaining why participants without RPEs reported being more active. Participants without RPEs also had poorer memory scores than participants with RPEs. A possible explanation could be that participants with poorer memory were more prone to drop out of the program and thus not provide RPE data. Indeed, a significant small association between delayed-recall score and session attendance was observed. This was only the case in the MI-WP, however, and this association was not present in the total population.

Effect on Aerobic Fitness

In the current RCT, regular participation in a group-based MI-WP improved aerobic fitness in community-dwelling adults with MCI, compared with an LI-AP. Even though the proportion of participants with hypertension differed significantly between the MI-WP and the LI-AP, hypertension was not added to the adjusted model for examining the effect of the programs on aerobic fitness. Participants who had high blood pressure during the baseline interview were seen by a geriatrician to confirm the existence of hypertension. Participants with confirmed hypertension were treated. Furthermore, the results did not differ after adjusting for hypertension, except for a small change in the estimates of meters walked in the MI-WP compared with the LI-AP. This change was less than 10%, which is generally considered a rule of thumb for confounding, so hypertension was not considered a confounder.

Strengths and Limitations

The relatively high numbers of participants with missing data regarding program intensity and aerobic fitness are a limitation of the study. Potential methods for improving data collection in future studies may be to measure RPE more often and to use an average score in the analysis. Heart rate could also be measured more often to calculate an average and more accurate percentage of HRR. The proportion of missing data for the fitness test could be reduced by testing on multiple days, so that participants can take the test on a date that is convenient for them. Unfortunately it was not feasible to do this in the current study because of logistical and financial constraints.

A particular strength of the current study is its design. The use of an LI-AP as a control program made it possible to exclude the Hawthorn effect of attention. Moreover, including this control program offered the possibility to blind both exercise instructors and participants to group allocation, thereby reducing bias. A limitation of this study is that because of dropout from the exercise programs, only a subgroup of the randomized participants could be included in the analyses. Furthermore, only participants who reported being able to participate in moderate-intensity physical activity were eligible for inclusion in the trial. These issues limit generalization of the results. A more specific issue with respect to generalizability is the operationalization of the concept of MCI. MCI originates from a clinical setting, in which the fulfillment of criteria is determined through clinical judgment after clinical examination, including in-depth neuropsychological testing (Winblad et al., 2004). However, in most epidemiological studies MCI is determined on the basis of neuropsychological testing only. Consequently, the characterization of people with MCI is likely to differ between MCI populations in epidemiological research and clinical populations (Petersen, 2004). Therefore, the results of this RCT may be generalizable to physically healthy community-dwelling older adults with memory complaints in general but are probably less generalizable to older adults with MCI according to clinical criteria.

To conclude, cognition was not clearly associated with session attendance in community-dwelling older adults with MCI who started the MI-WP, and average session attendance was good. The intensity was feasible for participants who continued the program. The findings of this study indicate that regular moderate-intensity walking is beneficial for aerobic fitness in adults with MCI.

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