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Original Study

Walking Aids Moderate Exercise Effects on Gait Speed in People With Dementia: A Randomized Controlled Trial

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Residential facilities  
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Rehabilitation  
Frail elderly

ABSTRACT

Objectives: To investigate the effects of exercise on gait speed, when tested using walking aids and without, and whether effects differed according to amount of support in the test.

Design: A cluster-randomized controlled trial.

Setting: The Umeå Dementia and Exercise (UMDEX) study was set in 16 nursing homes in Umeå, Sweden.

Participants: One hundred forty-four women and 45 men (mean age 85 years) with dementia, of whom 145 (78%) habitually used walking aids.

Intervention: Participants were randomized to the high-intensity functional exercise program or a seated attention control activity.

Measurements: Blinded assessors measured 4-m usual gait speed with walking aids if any gait speed (GS), and without walking aids and with minimum amount of support, at baseline, 4 months (on intervention completion), and 7 months.

Results: Linear mixed models showed no between-group effect in either gait speed test at 4 or 7 months. In interaction analyses exercise effects differed significantly between participants who walked unsupported compared with when walking aids or minimum support was used. Positive between-group exercise effects on gait speed (m/s) were found in subgroups that walked unsupported at 4 and 7 months (GS: 0.07, \( P = 0.009 \) and 0.13, \( P < 0.001 \); and GS test without walking aids: 0.05, \( P = 0.011 \) and 0.07, \( P = 0.029 \), respectively).

Conclusions: In people with dementia living in nursing homes exercise had positive effects on gait when tested unsupported compared with when walking aids or minimum support was used. The study suggests that the use of walking aids in gait speed tests may conceal exercise effects.

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While exercise appears to improve gait in people with dementia in community settings, results are inconsistent in nursing home populations where severity of physical and cognitive impairments is greater. To further evaluate effects of exercise in randomized controlled trials would, therefore, be of value in this setting. In addition, many older people with dementia living in nursing homes use walking aids that can improve gait performance through alleviating impaired balance or pain. Subsequently, gait speed measured using a walking aid could limit detection of gait deficits, thus, reduce responsiveness of the test. Furthermore, in people with dementia the impact may be pronounced given the cognitive demand of walking aid use.

Fig. 1. Flow of participants. SD, standard deviation.
We have previously reported positive exercise effects on balance in people with dementia living in nursing homes. With the notion that leg strength and balance are important components of gait, the hypothesis of this study was therefore that the exercise program would improve gait speed, and that the use of a walking aid could conceal the exercise effects because of reduced responsiveness. The aim was to investigate the effects of a high-intensity functional exercise program on gait speed in people with dementia living in nursing homes, when tested using habitual walking aid if any and without walking aids. Further aims were to investigate whether effects differed according to support in the test, type of dementia, sex, or level of cognitive impairment.

Methods

This study was part of the Umeå Dementia and Exercise Study (UMDEX), a cluster-randomized controlled trial, conducted in nursing homes in Umeå, Sweden, including general and dementia units, all with private rooms and staff on hand, as well as, units with private apartments with access to on-site nursing and care. The Regional Ethics Review Board of Umeå approved the study (2011-205-31M). The study protocol (ISRCTN31767087) is published on the ISRCTN registry.

Participants

Residents with a Mini-Mental State Examination (MMSE) score ≥ 10, a dementia diagnosis, age ≥ 65 years, dependent on assistance in ≥ 1 personal activity of daily living (ADL), ability to stand up from a chair with armrests with assistance from ≤ 1 person, physician’s approval, and ability to hear and understand spoken Swedish were included. All individuals included in the study gave informed oral consent to participation, which was confirmed by their next of kin. Age (P = .189) and MMSE score (P = .713) did not differ between participants included in the study and those who declined participation (n = 55; Figure 1). A larger proportion of men than women declined participation (34% vs 18%; P = .008).

Randomization

Randomization was performed after completion of the enrollment process and baseline assessment to ensure concealed allocation. Clusters (n = 36) of 3–8 participants each (who lived in the same wing, unit, or floor) were formed. Two researchers not involved in the study performed randomization by drawing lots using sealed opaque envelopes.

Sample Size

Sample size was calculated for the main outcome, the Barthel ADL Index, in the UMDEX study. A sample size of 183 participants were required to verify significant intervention effects at a statistical power of 80% at the 4-month follow-up, a significance level of 0.05, 2-sided, and a presumed dropout rate of 10%.

Intervention

The exercise and attention control activities were conducted at nursing homes in small groups (n = 3–8) supervised by 2 physical therapists (PTs) and 1 occupational therapist (OT) or OT assistant, respectively. The intervention started October 2011 and lasted 4 months (40 sessions in total) and consisted of five 45-minute sessions per 2-week period. When possible, supervised individual sessions were offered when participants were unable to attend a group session. Participation in activities other than provided by the study was not restricted.

Exercise

The exercise intervention was based on the high-intensity functional exercise (HIFE) program available from authors and described further elsewhere (Appendix 1). The HIFE program comprises 39 functional exercises that aim to improve lower limb strength, balance, and mobility, and performed in weight-bearing positions. Exercise intensity aimed to be high and exercises adapted accordingly through progressive adjustment of load and base of support, while also taking into account participants’ symptoms and changes in health and functional status. Participants were supervised individually to promote the highest possible exercise intensity, while ensuring their safety.

Attention Control

The OT and OT assistant who took part in the study developed the attention control activity program. While seated in a group, participants conversed, sang, listened to music or readings, and/or looked at pictures and objects associated with topics such as wildlife and current seasons and holidays.

Measurements

PTs and physicians blinded to activity allocation and previous test results performed all measurements at baseline and follow-ups. Physicians used electronic records of participants’ past medical histories, which included brain imaging in most cases, current pharmaceutical treatment, and assessment results to record dementia type, depressive disorders, and delirium diagnoses. A specialist in geriatric medicine reviewed and confirmed these diagnoses according to DSM-IV-TR criteria.

Outcome Measures

Usual gait speed (GS) was measured over 4 m. GS mode was chosen based on the results of a previous study in nursing homes that showed effects on usual but not fast gait speed. A 4-m distance was marked along the base of a wall, and a visible target (eg, a chair) placed approximately 2 m beyond it. From a standing still start position, participants were asked to walk in their usual pace to the visible target. Using a digital stopwatch, the time was measured from when instructed to start until the participant’s trunk crossed the marking on the wall. The procedure was repeated twice, and the mean GS time (m/s) calculated. When only 1 GS time was registered, it was included in the analyses. The habitual walking aid was used in the GS test.

To reduce the support provided by walking aids, a second gait speed test without walking aids and with minimum amount of support (GS-noWA) was conducted according to the same test procedure as outlined above. Participants who used a walking aid performed the GS-noWA test without the walking aid. Participants who walked unsupported only performed the GS test, and their time was carried over to the GS-noWA test. Participants who were unable to walk without a walking aid were offered a minimum amount of living support. One or 2 testers provided single-sided or double-sided support in a standardized manner. The participant placed their pronated hand(s) over the supinated hand of the tester(s). To reduce the influence on pace, testers were instructed to provide support only in an upright direction and only by this point of contact, with no other contact or support allowed.

When unable to perform a gait speed test, the reason was registered and categorized as physical impairment, motivation, other causes (eg, pain, dizziness, absence from ward), or deceased. In all gait speed tests, at baseline, and 4 and 7 months, the same type of
walking aid or amount of support was used. The same PT measured gait speed at baseline and all follow-ups.

Data Analysis

Possible confounders were selected a priori (Appendix 2, Table A1), from which significant imbalances between exercise and attention control groups and associations \( r > 0.3 \) with changes in outcome measures at 4 and 7 months were analyzed using Student t-test or the Pearson \( \chi^2 \) test, and Pearson correlation coefficients. No variable was found to associate with change in outcome measures above predefined levels. The variable antidepressant use differed between groups \( (P = .04) \) and was adjusted for in analyses.

In agreement with the intention-to-treat principle, available data for each participant were analyzed according to original allocation and regardless of level of attendance. Longitudinal changes in GS and GS-noWA from baseline to 4 and 7 months were analyzed in linear mixed effects models, using interaction terms for activity and time point and adjustment for age, sex, and antidepressant use as fixed effects, and individual and cluster allocation as random effects. Baseline values for outcome measures were included in the dependent variable to avoid loss of data. The least square mean of measurements available when values were missing. In interaction analyses, exercise effects on gait speed significantly differed according to support, with larger effects in participants who walked unsupported and smaller effects in participants who walked with support.

Table 1

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Total n = 186</th>
<th>Exercise n = 93</th>
<th>Control n = 93</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>85.1 ± 7.1</td>
<td>84.4 ± 6.2</td>
<td>85.9 ± 7.8</td>
</tr>
<tr>
<td>Female</td>
<td>141 (75.8)</td>
<td>70 (75.3)</td>
<td>71 (76.3)</td>
</tr>
<tr>
<td>Dementia type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vascular</td>
<td>77 (41.4)</td>
<td>36 (38.7)</td>
<td>41 (44.1)</td>
</tr>
<tr>
<td>Alzheimer</td>
<td>67 (36.0)</td>
<td>34 (36.6)</td>
<td>33 (35.5)</td>
</tr>
<tr>
<td>Other</td>
<td>27 (14.5)</td>
<td>15 (16.1)</td>
<td>12 (12.9)</td>
</tr>
<tr>
<td>Mixed Alzheimer/vascular</td>
<td>15 (8.1)</td>
<td>8 (8.6)</td>
<td>7 (7.5)</td>
</tr>
<tr>
<td>Diagnoses and medical conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depressive disorders</td>
<td>107 (57.5)</td>
<td>53 (57.0)</td>
<td>54 (58.1)</td>
</tr>
<tr>
<td>Delirium previous week</td>
<td>102 (54.8)</td>
<td>48 (51.6)</td>
<td>54 (58.1)</td>
</tr>
<tr>
<td>Previous stroke</td>
<td>57 (30.6)</td>
<td>33 (35.5)</td>
<td>24 (25.8)</td>
</tr>
<tr>
<td>Heart failure</td>
<td>56 (30.1)</td>
<td>24 (25.8)</td>
<td>32 (34.4)</td>
</tr>
<tr>
<td>Prescription medication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analgesics</td>
<td>112 (60.2)</td>
<td>55 (59.1)</td>
<td>57 (61.3)</td>
</tr>
<tr>
<td>Antidepressants</td>
<td>102 (54.8)</td>
<td>58 (62.4)</td>
<td>44 (47.3)</td>
</tr>
<tr>
<td>Number of drugs</td>
<td>8.3 ± 3.8</td>
<td>8.4 ± 4.0</td>
<td>8.2 ± 3.7</td>
</tr>
<tr>
<td>Assessments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usual mobility device</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheelchair</td>
<td>24 (12.9)</td>
<td>11 (11.8)</td>
<td>13 (14.0)</td>
</tr>
<tr>
<td>Rollator</td>
<td>117 (62.9)</td>
<td>64 (68.8)</td>
<td>53 (57.0)</td>
</tr>
<tr>
<td>Stick or crutch</td>
<td>4 (2.2)</td>
<td>1 (1.1)</td>
<td>3 (3.3)</td>
</tr>
<tr>
<td>Unsupported</td>
<td>41 (22)</td>
<td>17 (18.3)</td>
<td>24 (25.8)</td>
</tr>
<tr>
<td>MMSE ((0–30))</td>
<td>14.9 ± 3.5</td>
<td>15.4 ± 3.4</td>
<td>14.4 ± 3.5</td>
</tr>
<tr>
<td>Barthel ADL index ((0–20))*</td>
<td>10.9 ± 4.4</td>
<td>10.7 ± 4.5</td>
<td>11.0 ± 4.4</td>
</tr>
<tr>
<td>Neuropsychiatric inventory</td>
<td>14.8 ± 14.2</td>
<td>15.2 ± 15.8</td>
<td>14.4 ± 12.6</td>
</tr>
</tbody>
</table>

GS, gait speed with habitual walking aid if any; GS-noWA, gait speed without walking aid and with minimum support.

Values are mean ± SD or n (%). Numbers reported after covariates indicate number of measurements available when values were missing.

*Higher scores indicate better status.

Lower scores indicate better status.

Results

There were 186 participants (141 women and 45 men) included in the study (Table 1). One hundred forty-five (78%) used wheelchair or walking aids. At baseline, 42 participants (23%) performed the GS test unsupported and 99 participants (53%) the GS-noWA test unsupported. Reasons for missing values on the GS test at 4 and 7 months were presented in Figure 1. In the GS-noWA test 17, 31, and 44 participants had missing gait speed values at baseline, 4 months, and 7 months, respectively, because of physical impairment, motivation, or other causes. Adherence over the 4-month intervention period was 73% in the exercise group and 70% in attention control group. Strength exercises were performed at moderate or high intensity (for 76% of attended sessions) and balance exercises at high intensity (for 75% of attended sessions).

Outcomes

There were no differences between exercise and activity groups in either gait speed test at 4 or 7 months (Table 2, Figure A and B). In interaction analyses, exercise effects on gait speed significantly differed according to support, with larger effects in participants who walked unsupported in the GS test at 4 and 7 months and in the GS-noWA test at 7 months (Table 3). The between-group analyses showed positive effects on gait speed (m/s, 95% confidence interval) in participants who walked unsupported in the exercise group both at 4 and 7 months \((G S: 0.07, 0.020–0.129 and 0.13, 0.070–0.182 and GS-noWA: 0.05, 0.013–0.095 and 0.07, 0.022–0.109, respectively; Figure 2, C and D). In participants who walked with support, there was no difference between groups at 4 months \((G S: 0.03, −0.064 to 0.006; GS-noWA: −0.01, −0.065 to 0.049), and whereas at 7 months, the exercise group had negative effects on GS \((−0.04, −0.077 to −0.002), no difference was observed in GS-noWA \((−0.05, −0.116 to 0.016; Figure 2, C and D). Interaction analyses according to sex, dementia type, and cognitive level showed no differences in exercise effects at 4 and 7 months in either gait speed test (Appendix 2, Table A2).

Sensitivity Analyses

When primary analyses were repeated using the multiple imputed data sets the results remained essentially the same (Appendix 2, Table A3).
To further explore the absence of exercise effects in participants who performed the gait speed test with walking aids or minimum support, additional analyses on change in the Berg balance scale (BBS) was conducted using the same interaction terms for walking aid use and amount of support and adjustments as described previously. We have previously reported positive exercise effects on the BBS, which measures balance in functional activities (e.g., reaching while standing, rising from a chair, transfer between chairs) at 4 months.16 The additional interaction analyses showed that the positive exercise effects on balance (BBS score, 95% confidence intervals) did not differ according to walking aid use or amount of support in the GS and GS-noWA tests (0.06, 0.047 to 0.035, P = .983 and 0.31, 0.052 to 0.048, P = .901, respectively).

Discussion

In this study, where the majority of participants habitually used walking aids, the effects of the exercise program on GS appeared to differ according to amount of support used in the test. Exercise seemed to have a positive effect on gait speed in participants who tested unsupported compared with when walking aids or living support was used. The effects of exercise did not differ according to sex, cognitive level, or dementia type.

The positive exercise effects on gait in the subgroups that walked unsupported are in line with a large randomized controlled trial that included only ambulant people with dementia living in nursing homes11; although the comparison is limited because walking aid use was not reported. The study found that a 1-year exercise intervention had positive effects on gait speed compared with usual care. Considering the reduced social interaction in nursing homes, the extra attention of the intervention may have resulted in larger effect sizes while also limiting inferences regarding exercise effects per se.

The absence of positive exercise effects in participants who walked with a walking aid are comparable with a large study in people with dementia living in nursing homes, which showed improvement to balance while not to gait.12 Furthermore, although the study similarly to ours had a high proportion of participants who used walking aids, its influence on exercise effects was not analyzed. In accordance with

Table 2
Within- and Between-Group Differences From Baseline in GS and GS-noWA

<table>
<thead>
<tr>
<th>Measures</th>
<th>Within-Group Differences</th>
<th>Between-Group Differences</th>
<th>ICC *</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Exercise, Mean m/s (SE)</td>
<td>N Control, Mean m/s (SE)</td>
<td>Mean m/s (95% CI)</td>
</tr>
<tr>
<td>GS</td>
<td>4 months</td>
<td>75 –0.021 (0.015)</td>
<td>78 –0.015 (0.015)</td>
</tr>
<tr>
<td></td>
<td>7 months</td>
<td>64 –0.031 (0.016)</td>
<td>69 –0.035 (0.015)</td>
</tr>
<tr>
<td>GS-noWA</td>
<td>4 months</td>
<td>67 0.005 (0.017)</td>
<td>68 –0.022 (0.016)</td>
</tr>
<tr>
<td></td>
<td>7 months</td>
<td>53 –0.024 (0.018)</td>
<td>57 –0.046 (0.018)</td>
</tr>
</tbody>
</table>

CI, confidence interval; ICC, intracluster correlation coefficient; N, number of participants with complete data; SE, standard error; GS, gait speed with habitual walking aid if any; GS-noWA, gait speed without walking aid and with minimum support.

Values are from linear mixed-effects models adjusted for age, sex, and antidepressant use.

*Based on proportion of variation explained by cluster.

Fig. 2. Changes in GS and GS-noWA (A and B) and according support in the test (C and D). Values are least square mean change from baseline, with 95% confidence intervals, from linear mixed-effects models adjusted for age, sex, and antidepressant use. GS, gait speed with habitual walking aid if any; GS-noWA, gait speed without walking aid and with minimum support; ES, effect size; Min, minimum.
results of a study set in a geriatric inpatient ward, our study suggests that when gait speed is tested using walking aids, it may reduce the responsiveness of the test.\textsuperscript{15} When gait was tested without walking aids, and a greater number walked unsupported, positive subgroup effects persisted. The reduced responsiveness may explain the absence of positive exercise effects in participants unable to test without walking aids or living support. A concealment of effects is further supported by results from the interaction analyses on balance, where positive exercise effects were observed irrespective of use of walking aid or support while walking.

The result of our study may be of value both in clinical and research settings when interested in best medical practice concerning care of older people with dementia living in nursing homes, as well as, when effectiveness of rehabilitation is measured in populations where walking aid use are common. The exercise effects in participants who walked unsupported at 4 and 7 months, 0.07 m/s and 0.13 m/s in the GS test and, 0.05 m/s and 0.07 m/s in the GS-noWA test, seem clinically meaningful. In comparison, small and substantial meaningful changes in gait speed has been reported to correspond with 0.05 m/s and 0.10 m/s, respectively, in older people with mild to moderate mobility disability.\textsuperscript{26} Walking aids appear to conceal changes over time in gait speed; it may be important to measure gait unsupported to fully understand the progression and severity of the impairment and the association to health-related outcomes such as falls and survival.

This study has many strengths. The randomized design, a nonexercise attention control group, blinded assessors, and a relatively low dropout rate, all contribute to results that may be generalized to older people with dementia living in nursing homes. This study also has limitations. A floor effect of both gait speed tests was evident because inclusion criteria were comparatively generous. To improve generalization, those unable to perform the test without their usual walking aid were, therefore, offered a standardized minimum amount of living support in the GS-noWA test; this type of support has not been tested for reliability. Furthermore, some participants were still unable to perform the gait speed tests, particularly at the last follow-up. Therefore, the primary analyses were repeated using multiple imputed data sets, which showed similar results. Although the sample size was based on power calculations on a different outcome (the Barthel ADL index), it is within recommended estimates for older people with mobility disability\textsuperscript{26}; however, subgroup analyses may still have limited power and should be interpreted with caution.

**Conclusions**

In this study of people with dementia living in nursing homes, where a majority used walking aids, a 4-month high-intensity functional exercise program had positive effects on gait in participants who tested unsupported compared with when walking aids or living support was used. The study suggests that the use of walking aids in gait speed tests may conceal exercise effects.

**Acknowledgments**

We would like to express our sincere gratitude to all who contributed to data collection and implementation of the UMDEX study, as well as, the Social Authorities of the Municipality of Umeå, care staff, and participants.

**References**


