Improved Functional Performance in Individuals With Dementia After a Moderate-Intensity Home-Based Exercise Program: A Randomized Controlled Trial

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ABSTRACT
Background and Purpose: Individuals with dementia (IWDs) experience difficulties across cognitive and functional domains. Nonpharmacological interventions aimed at reducing disability are greatly needed. Exercise is a low-cost and easily implemented approach, but investigation has yielded mixed evidence to date. The purpose of the current study was to evaluate a novel and innovative moderate-intensity functional exercise intervention for IWDs, which was developed using principles from exercise science along with a Strength-Based Approach, consisting of 24 home-based sessions.

Methods: A randomized, controlled intervention trial with a 2-group pretest and posttest design was used with a sample of 23 community-dwelling IWDs (intervention group: n = 13; comparison group: n = 10). Average age of participants was 73.9 years (standard deviation, 9.1) with mild to moderate cognitive impairment (Mini-Mental State Examination, Mean = 20.8; standard deviation, 5.0).

Results and Discussion: A 99.0% attendance rate indicated high adherence to the moderate-intensity exercise program. Efficacy was examined using multiple linear regression. Group assignment significantly predicted performance in key outcome measures, with IWDs from the intervention group improving in lower extremity strength (B = 5.92, t = 3.26, P = .004), balance (B = 4.04, t = 4.13, P = .001), and fast gait speed (B = .32, t = 2.61, P = .02). These findings indicated IWDs are able to participate in and benefit from a moderate-intensity functional exercise program, consisting of strength and balance activities.

Conclusions: The current intervention used a Strength-Based Approach to facilitate implementation of exercise activities that could be completed by the sample. Therefore, integration of these techniques into mainstream clinical practice and research should be feasible with this patient population. Future research directions and implications of these findings also are discussed.

Key Words: dementia, exercise, functional performance

INTRODUCTION
An estimated 35.6 million people (5%-7% of the population) lived with dementia worldwide in 2010, with numbers expected to almost double every 20 years, to 65.7 million in 2030 and 115.4 million in 2050.

Individuals with dementia (IWDs) experience changes in cognitive and functional abilities as well as neuropsychiatric symptoms and changes in psychological well-being. Most dementia result in progressive decline over several years, resulting in dependence on caregivers, with an estimated cost to the health care system of $9.7 billion in 2014 in the United States and $604 billion worldwide in 2010. Approximately 42% of individuals with Alzheimer disease, which is the most common type of dementia, live in residential care settings as opposed to 2% of the general population. To date, there is no cure for dementia and little evidence that the current medication regimens can effectively halt the progression of the illness; therefore, there is a need for efficacious nonpharmacological intervention protocols that facilitate IWD's independence and psychosocial well-being. One potential avenue may be exercise, as it is inexpensive and accessible nonpharmacological approaches for managing the symptoms of dementia.
Moderate-intensity exercise has been found to impact multiple domains including cognition,\textsuperscript{9,10} functional status,\textsuperscript{11-13} as well as various aspects of psychological well-being\textsuperscript{14} in both healthy older adults and those with dementia. Using exercise as an intervention modality may address changes in mobility and falls, which are experienced at a higher rate for IWDs.\textsuperscript{2,15,16} Underlying mechanisms for these deficits have been linked to gait and balance difficulties experienced by IWDs.\textsuperscript{2,3,15,17} Research has found improvements in functional outcomes for IWDs following a moderate-intensity exercise intervention, with gait, balance, and transfers being the most common.\textsuperscript{11-13,18-23}

In addition, research has examined the impact of exercise on the cognitive process of executive functioning (e.g., reasoning, judgment, and problem solving).\textsuperscript{9,10,19,24} The neuroprotective benefits associated with functional exercise are vast,\textsuperscript{25} specifically into old age. Ahlskog et al\textsuperscript{25} note that although no pharmacological intervention has been identified to reduce the risk of dementia or age-related cognitive impairment, exercise has been found to have neuroprotective benefits and resilience to neurodegenerative diseases. Specifically, results have found that aerobic training, resistance training, and especially combined programs improve cognitive performance in both healthy and cognitively impaired older adults on measures of cognitive function, especially executive function measured by the Trail Making Test.\textsuperscript{9,10,19,22}

Identifying strategies to combat declines associated with the neurodegenerative process is crucial in maximizing an individual’s independence and facilitating optimal participation in daily activities, as IWD’s executive functioning are related to functional decline. This decline is initially observed with instrumental activities of daily living (IADLs) and later progresses to personal activities of daily living (PADLs), such as dressing and grooming.\textsuperscript{26} Therefore, identifying programs that could affect executive function also may have significant functional benefits for IWDs by maintaining higher levels of independence and reducing dependence on others. Improvements in domains of strength, balance, and gait, which are typically affected by dementia, may further reduce dependence on caregivers as well as delaying or preventing the need for transfer into a long-term care facility. For example, gait cadence has been found to predict falls in patients with Alzheimer disease,\textsuperscript{27} whereas walking speed has been found to be associated with transfer from an assisted living residence to a skilled nursing facility;\textsuperscript{28} therefore, it is possible that improvements in these areas through exercise could allow an IWD to “age in place” longer.

Several studies have not revealed beneficial effects of exercise on cognition or functional performance in IWDs.\textsuperscript{29-33} These mixed findings may be due to the heterogeneity in methodologies utilized and outcomes assessed.\textsuperscript{33} In addition, no exercise study to date has explicitly used a conceptual model or framework that addresses key implementation issues for working with IWDs. Intervention protocols that could impact both cognitive (i.e., executive functioning) and functional outcomes (i.e., gait, balance, and strength) could be instrumental for this patient population, as exercise provides a safe modality that could be easily modified to suit individuals throughout the illness.

To build on the successes of prior studies and account for limitations, the current study examined the effects of a moderate-intensity home-based functional exercise program for IWDs on executive function and functional performance including strength, balance, gait speed, and perceived activities of daily living (ADL) performance. Researchers hypothesized that IWDs in the intervention group would demonstrate significant improvements in (1) executive function (Trail Making Test—Part B); (2) lower extremity strength (30-second chair stand test); (3) balance (modified Berg Balance Scale); (4) comfortable and fast gait speed (8-ft walk test); and (5) perceived activities of instrumental and personal activities of daily living performance (IADL/ADL scale).

**METHODS**

**Design Overview**

A randomized, controlled intervention trial with a 2-group pretest and posttest design was used. The study was approved by the Institutional Review Board at Cleveland State University.

**Participants**

Participants for the current study were recruited from the Greater East Ohio Area Chapter of the Alzheimer’s Association during the period of August 2014 through February 2015 and were (1) 50 years or older to include participants with early-onset dementia; (2) community-dwelling; (3) experiencing memory impairment affecting daily activities; (4) a Mini-Mental State Examination (MMSE) score of 7 or higher\textsuperscript{34-37}; and (5) have a caregiver who could attend and assist with exercise sessions. Participants were excluded if there was the presence of other neurological or myopathic conditions (Parkinson’s disease, brain tumor, traumatic brain injury, muscular dystrophy, and myositis ossificans).

The recruitment flow sheet (Figure) outlines recruitment methods and activities. Thirty-three individuals were screened for eligibility via telephone. Four individuals did not meet the participation criteria with telephone screening and 2 withdrew after initially expressing interest, resulting in 27 participants being scheduled for a baseline assessment.

**Measures**

Assessment tools used in the study were chosen on the basis of previous literature and psychometric properties in samples of IWDs. Measures were either self-reported by the IWD or performance-based assessed by the researcher.

Demographic and health information was obtained via a self-report questionnaire. Participants were asked to rate their overall health on a 4-point Likert scale (poor
to excellent). In addition, participants provided highest level of education completed and previous level of weekly exercise measured in minutes reported by the IWD. The number of exercise minutes per week was an estimation of the average of minutes the IWD participated in moderate to vigorous physical activity over the past month.

It is important to examine whether the participants were able to complete the program at the prescribed dosage. This not only included the number of prescribed sessions (treatment adherence), but also ensuring that each session was completed at the prescribed intensity. In addition, the session log completed by the exercise practitioner included the number of repetition maximum (RM) completed for each strength exercise and the time completed for each balance activity, which were averaged over the period of the intervention to ensure adequate intensity. The goal, following a 2-week acclimation period, was 8 to 12 RM for strength exercises and 1 minute for each balance activity.

The Trail Making Test—Part B (TMT-B) examined components of executive function that represent cognitive flexibility and complex attention. The TMT-B is a timed task with participants, alternating between 13 consecutively numbered and 12 consecutively lettered circles (1-A-2-B-3-C…), with higher scores (longer time to complete) indicating greater impairment. Reported reliability coefficients vary but most fall within the 0.80 range. Poorer performance on the TMT-B has been linked to decreased executive function and difficulty with IADLs.

The 30-second chair stand test assessed lower extremity strength. Eriksrud and Bohannon reported the correlations of the knee extension muscle force measurements with sit-to-stand success ranged from 0.65 to 0.7 without the use of hands and from 0.55 to 0.6 for those using their hands to stand. The sit-to-stand test has been used to successfully measure effects of exercise programs for IWDs. Higher number of repetitions indicates better strength. One trial of the chair stand test was completed.

Balance was assessed using the modified Berg Balance Scale (m-BBS), which is an abbreviated version of the original 14-item scale. The modified version excludes 3 items found in the original assessment (chair-to-chair transfer, forward reach with outstretched arm, and alternate stepping on-off stool) to allow brevity, consistency, safety, and ability to convey instructions when testing participants with cognitive impairment. The score on this test ranges from 0 to 44, with higher scores indicating better balance.

The 8-ft walk test was used to assess the participants’ walking speed at both a comfortable speed and at a fast pace. Participants used assistive devices if needed. Two trials were completed with the participant being asked to walk at a “comfortable and normal pace” as well as 2 trials “walking as fast as you safely can.” The average of the 2 trials were used as measures of comfortable and fast gait speed.

A 16-item self-report assessment tool assessed perceived difficulty across PADLs (eg, toileting, grooming, and bathing) and IADLs (eg, finances, leisure activities, and meal preparation). Participants reported their level of difficulty with the given activity on a 4-point Likert scale (0 = no difficulty, 1 = a little amount of difficulty, 2 = a fair amount of difficulty, and 3 = very difficult), with higher difficulty scores indicating greater impairment.

![Recruitment flow sheet.](image-url)
scores indicating greater perceived difficulty. The factor structure identified a single factor for the 16-item scale, with most items having greater than 0.4 factor loading. This scale has demonstrated good internal consistency (Cronbach α > 0.8) when used with IWDs in previous research as well as in the current study with 0.7.

Research Team
All baseline, follow-up assessments and pilot exercise sessions were completed by the principal researcher (ND). Remaining exercise sessions were led by an exercise practitioner, either the principal researcher (ND) or a trained exercise specialist (HG). The principal researcher is a board-certified geriatric physical therapist, whereas the other trained exercise specialist is a certified strength and conditioning coach and a certified health fitness specialist through the American College of Sports Medicine.

The training for the exercise specialist included two 2-hour in-person training sessions regarding dementia-specific information as well as reviewing various journal articles relating to the topic of exercise interventions for IWDs. In addition, the intervention manuals and the session logs, which were developed by the principal researcher for this intervention, were reviewed in detail. This review and training included the proper usage with the participant and caregiver as well as its completion during sessions. Following the initial training sessions, the exercise specialist shadowed the principal researcher during 1 week of implementation including the initial session. Following this observation period, the exercise specialist completed 2 weeks of implementation while being observed by the principal researcher. Throughout the intervention implementation, regular contact via e-mail, phone/text, and in-person meetings was completed to maintain a level of communication regarding study protocol and implementation.

Intervention Description
The intervention was a moderate-intensity home-based functional exercise program, consisting of strength and balance exercises. Principles from exercise science and the Strength-Based Approach were used as overarching frameworks for the development and implementation of the protocol. The Physical Stress Theory and principle of specificity were used to ensure adequate dosage and intensity of the exercises, whereas the Strength-Based Approach was used to address the cognitive and functional needs of IWDs making the protocol a novel and innovative approach to exercise with this population. Central tenets of the Strength-Based Approach include (1) identifying strengths and abilities, rather than deficits and limitations (using familiar and functional activities that rely on procedural and long-term memory as exercises instead of new and unfamiliar fitness equipment); (2) including individuals as active rather than passive participants in treatment process (allowing the individual to choose the activity, such as ballroom dancing instead of walking on a treadmill); and (3) emphasizing current possibilities and options rather than past events and performance (encouraging continuation of enjoyed activities even if it will require some modification, such as addition of adaptive equipment for gardening).

The functional strength and balance program was delivered individually in the participant’s home by a trained practitioner (ND or HG), with occasional assistance from the caregiver, 2 times per week lasting 12 weeks for a total number of 24 sessions. Each of these practitioner-led sessions was composed of 4 elements: (1) review, which examined results from previous sessions and identified the barriers to exercise completion reported by the caregiver or IWD; (2) education, which initially outlined the purpose of the intervention and provided subsequent education to improve adherence; (3) planning, which allowed the exercise practitioner to utilize available implementation strategies, based on the Strength-Based Approach, to overcome barriers reported by the IWD or caregiver (see Table 3); and (4) activity, which delivered a tailored functional strength and balance program based on the participant’s functional status.

Initial starting exercises were determined from baseline walking performance, as developed by Littbrand et al (see Table 1). The practitioner and participant chose exercises based on the individual’s needs and preferences (Table 2). To account for needs of this special population, enhancement techniques from the Strength-based Approach were included in the design and implementation of the intervention (Table 3). For example, the intervention included training for the exercise practitioner in techniques such as using 1- or 2-step instructions for completion of activities as well as allowing the participants to have chosen activities. External memory aids (eg, written instructions and spots for foot placement) to compensate for deficits in short-term memory were implemented on an individual basis, allowing a standardized but flexible intervention protocol.

Over the first 2 weeks of the program, a 15 RM was targeted to allow acclimation to exercises and act as a build-up process. This intensity is representative of 50% of an individual’s 1 RM. Target intensity of strength exercises following this initial phase ranged from 8 to 12 repetitions, representing 60% to 80% of a 1 RM; therefore, as more repetitions can be completed, the exercise intensity was increased appropriately. Once a participant was able to complete more than 12 repetitions of a particular strengthening exercise, the intensity was either increased by addition of a weighted vest, weighted belt or medicine ball, or increased by progression of activity (eg, progress to floor to stand tasks). Intensity of balance exercises was altered by variation of base of support or increased compliance of surface to continue to challenge the participant’s postural stability. The intervention protocol was found to be an acceptable and feasible approach with IWDs as measured by treatment adherence and tolerance of the protocol.

Procedure
After obtaining written informed consent from the IWD, the MMSE and baseline assessments were administered
will serve as a first step in the intervention research process, the comparison group. The results from the current study in the intervention group and 11 participants enrolled in randomization, which was completed using a random number generator. In total, 15 participants were enrolled as efficacy was being assessed in the current study. Using the “as-treated approach” is most appropriate in the current research design, with the goal of measuring the effect of the intervention on those who received the appropriate dosage.

Table 1. Recommended Initial Exercise Categories

<table>
<thead>
<tr>
<th>Physical Function Groupa</th>
<th>Recommended Categories in the Collection of Exercises</th>
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</table>
| Walking without any physical support or supervision | A. Static and dynamic balance exercises in combination with lower limb strength exercises  
B. Dynamic balance exercises in walking |
| Walking with supervision or minor physical support from 1 person | A. Static and dynamic balance exercises in combination with lower limb strength exercises  
B. Dynamic balance exercises in walking  
C. Static and dynamic balance exercises in standing |
| Walking with major physical support or not able to walk | C. Static and dynamic balance exercises in standing  
D. Lower limb strength exercises with continuous balance support  
E. Walking with continuous balance support |

*aThe participant’s need for personal support when walking a short distance (5-10 m) without walking aid.52*

Table 2. Collection of Exercises: Categories and Examples

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Examples of Exercises</th>
</tr>
</thead>
</table>
| A | Static and dynamic balance exercises in combination with lower limb strength exercises | Forward/side lunge  
Step-ups  
Jumping |
| B | Dynamic balance exercises in walking | Stepping over obstacles  
Lateral hopping  
Heel/toe walking |
| C | Static and dynamic balance exercises in standing | Foot placement on target  
Stand with narrow base  
Tandem standing |
| D | Lower limb strength exercises with continuous balance support | Sit to stand  
Squats  
Heel raises |
| E | Walking with continuous balance support | Forward walking  
Lateral walking |

Statistical Analysis
Data were input into SPSS Statistical Software (version 22.0, IBM Statistics) for analysis. Descriptive statistics were analyzed and compared with known norms to allow for representation of sample in the current study. To determine the need of covariates in further analyses, baseline statistics between intervention and comparison groups were compared for demographic information and baseline performance.

An “as-treated approach” was used during analysis, as efficacy was being assessed in the current study. Using the “as-treated approach” is most appropriate in the current research design, with the goal of measuring the effect of the intervention on those who received the appropriate dosage.

Linear regression analyses were used to test the efficacy of the protocol for each outcome measure. This approach was selected, as it is a more robust analysis due to the relatively small sample size and unequal group numbers in each of the conditions. Separate analyses were conducted for each dependent measure, with the key independent variable being a dichotomous variable, representing assignment into the intervention or comparison group (0 = comparison group; 1 = intervention group) for a total of 6 regression equations. To control for baseline performance and to examine change across time, the baseline value for each dependent variable was included in the regression equation. Each regression equation contained 2 independent variables (group assignment and baseline performance). To examine the magnitude of change from baseline to completion in the intervention group, the unstandardized regression coefficient was interpreted with a significance level set at 0.05. Using the unstandardized regression coefficient to examine the incremental change in each outcome measure based on group assignment to the intervention protocol allows interpretation of the amount of improvement noted.
Participant Characteristics
Of the 26 participants who met study criteria, 23 completed a follow-up (Time 2) assessment and were included in the analyses. Reasons for not completing included withdrawal due to IWD feeling anxious after completing T1 assessment (n = 1); placement in a skilled nursing facility (n = 1); and had a cerebrovascular accident (n = 1). Participant characteristics along with performance on baseline outcome measures are summarized in Table 4. No statistical differences were found between intervention and comparison groups on participant characteristics or baseline measures; therefore, no covariates were needed in subsequent analyses.

<table>
<thead>
<tr>
<th>Participant Characteristic</th>
<th>Sample (N = 23) Mean (SD)</th>
<th>Intervention (N = 13) Mean (SD)</th>
<th>Comparison (N = 10) Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (range = 53-92 y)</td>
<td>73.9 (9.1)</td>
<td>73.8 (8.5)</td>
<td>74.0 (10.4)</td>
</tr>
<tr>
<td>MMSE (range = 9-28)</td>
<td>20.8 (5.0)</td>
<td>19.9 (6.1)</td>
<td>22.0 (3.1)</td>
</tr>
<tr>
<td>Chronic health conditions (range = 1-7)</td>
<td>4.0 (1.9)</td>
<td>4.2 (2.0)</td>
<td>3.9 (1.8)</td>
</tr>
<tr>
<td>GDS-short form (range = 0-16)</td>
<td>5.6 (5.6)</td>
<td>5.4 (6.1)</td>
<td>5.9 (5.2)</td>
</tr>
<tr>
<td>Exercise, min/wk (range = 0-350 min)</td>
<td>69.8 (93.3)</td>
<td>90.4 (101.0)</td>
<td>43.0 (79.2)</td>
</tr>
<tr>
<td>Trail Making Test (B), time</td>
<td>4.36 (2.29)</td>
<td>4.27 (2.01)</td>
<td>4.44 (2.57)</td>
</tr>
<tr>
<td>Comfortable gait speed, m/s</td>
<td>0.7 (0.2)</td>
<td>0.7 (0.2)</td>
<td>0.7 (0.2)</td>
</tr>
<tr>
<td>Fat gait speed, m/s</td>
<td>1.3 (0.4)</td>
<td>1.2 (0.3)</td>
<td>1.4 (0.6)</td>
</tr>
<tr>
<td>Chair stand test (reps)</td>
<td>14.7 (5.9)</td>
<td>14.0 (5.8)</td>
<td>15.7 (6.1)</td>
</tr>
<tr>
<td>Modified Berg Balance Scale, max 44</td>
<td>39.0 (5.7)</td>
<td>39.5 (3.3)</td>
<td>38.5 (8.0)</td>
</tr>
<tr>
<td>ADL scale, max 48</td>
<td>5.9 (5.5)</td>
<td>7.3 (6.4)</td>
<td>4.2 (3.9)</td>
</tr>
<tr>
<td>Female</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>College graduate</td>
<td>56.5</td>
<td>46.2</td>
<td>70</td>
</tr>
<tr>
<td>Self-rated health (“good” or “excellent”)</td>
<td>47.8</td>
<td>38.5</td>
<td>60</td>
</tr>
</tbody>
</table>

Abbreviations: ADL, activities of daily living; GDS, Geriatric Depression Scale; MMSE, Mini-Mental State Examination; SD, standard deviation.

*For GDS, higher scores indicate more depressive symptoms, with a maximum score of 45. For ADL scale, 0 = “no difficulty,” 1 = “little difficulty,” 2 = “fair amount of difficulty,” 3 = “very difficult” for 16 items, with a maximum score of 48. No significant differences were noted between groups on demographic or baseline performance variables, P = .05.
RESULTS

Intervention Fidelity
Three hundred nine of the scheduled 312 sessions were completed as prescribed for a total treatment adherence of over 99%. Of the 13 participants assigned to the intervention group, 12 were placed in physical function group 1, 1 was placed in physical function group 2, and none were placed in physical function group 3 at the beginning of the intervention period. These physical function groups guided the exercise practitioner in which exercise categories to use during each session. On average, beginning in week 3, participants performed strength exercises at 11.7 RM (standard deviation = 1.5) and balance exercise for a period of 60 seconds (standard deviation = 0.1), indicating good fidelity to the protocol. These results indicated that the exercises were completed at the prescribed level of intensity.

Intervention tolerance was examined by monitoring adverse events, which were defined as “discomfort that manifested itself or became worse because of the exercises” and categorized as either temporary and minor or serious and major. An adverse event was recorded if expressed by the participant (or caregiver) or changes in performance were noted by the practitioner.

Over the course of the current study, 5 minor adverse events (eg, dizziness, back spasms, and headache) and no major adverse events were noted during the 309 completed sessions (1.6%). All symptoms resolved, allowing the participants to continue and complete the session. In addition, 16 adverse events were noted between sessions with all being minor and temporary events (eg, delayed onset muscle soreness and specific joint soreness) resolving before the subsequent session. Including both measures of adverse events, there were a total of 21 adverse events during the study, of which 16 were noted between sessions with all being minor and temporary events (eg, delayed onset muscle soreness and specific joint soreness) resolving before the subsequent session. Including both measures of adverse events, there were a total of 21 adverse events during the study, accounting for 6.7% of the total 312 available sessions.

Efficacy Testing
In addition to the results from the regression analyses (see Table 5), the baseline and follow-up mean values of the outcome measures along with standard deviations have been summarized (Table 6) to allow estimation of variance around the mean. Mean values of the outcome measures demonstrating significant improvement have also been graphed (Figure 2, the Supplemental Digital Content, available at: http://links.lww.com/JGPT/A10) to illustrate the direction of change in clinical findings.

Support was not found for improved executive functioning, with no significant improvement observed by the intervention group on the TMT-B when compared with the comparison group.

IWDs in the intervention group demonstrated significant improvement in lower extremity strength compared with IWDs in the comparison group (t = 3.3, P = .004). Unstandardized regression coefficients show an average of 5.9 more repetitions on the 30-second chair stand test completed by the intervention group.

IWDs in the intervention group demonstrated significant improvement in balance compared with IWDs in the comparison group (t = 4.1, P = .001). Unstandardized regression coefficients show an average of over 4 points improvement on the m-BBS for the intervention group.

No significant improvement was found in the intervention group for comfortable gait speed (t = 0.6, P = .6). However, IWDs in the intervention group demonstrated significantly better fast gait speed than IWDs in the comparison group (t = 2.6, P = .02). Unstandardized regression coefficients showed that an average of 0.3-m/s improvement was found in fast gait speed for intervention group participants.

No significant improvement in self-reported difficulty in completing instrumental and PADL was found.

DISCUSSION

The current study contributes to the literature by demonstrating that IWDs can participate in and maintain fidelity to a moderate-intensity functional exercise program. In addition, improvements were noted on multiple functional performance measures including balance, lower extremity strength, and fast gait speed. The program consisted of functional lower extremity strength and balance activities

| Table 5. Regression Analysis for Predicting Outcome Variables (N = 23) |
|---------------------------------|-----------------|-----------------|-----------------|
| **Independent Variable**       | **TMT-B (Cognition)** | **m-BBS (Balance)** | **Chair Stand (Leg Strength)** |
| Assigned group                  | B    | β    | B    | β    | B    | β    | B    | β    |
| Assigned group                  | 34.4 | 0.1  | 4.0a | 0.3a | 5.9a | 0.5a |
| Baseline performance            | 0.8a | 0.7a | 0.9  | 0.9  | 0.8a | 0.7a |
| Comfortable Gait Speed          | B    | β    | B    | β    | B    | β    |
| Assigned group                  | 0.01 | 0.2  | 0.3c | 0.4c | −1.4 | −0.01 |
| Baseline performance            | 0.7a | 0.8a | 0.8a | 0.8a | 0.9a | 0.9a |
| Fast Gait Speed                 | B    | β    | B    | β    |
| Assigned group                  | 0.01 | 0.2  | 0.3c | 0.4c |
| Baseline performance            | 0.7a | 0.8a |

Abbreviations: ADL, activities of daily living; m-BBS, modified Berg Balance Scale; TMT-B, Trail Making Test—Part B.

aP ≤ .001; bP ≤ .01; cP ≤ .05.
and resulted in noteworthy improvements in these areas. Gait speed can be described as a function of strength and balance; therefore, improvements in fast gait speed are most likely due to the contributions of strength and balance gains. These results are in line with previous literature linking exercise to improvements in functional performance in IWDs.11,12,30,62

Although strength, balance, and fast gait speed demonstrated significant improvements, there were no improvements found for cognition or comfortable gait speed, which does not support prior findings.10,19 A potential explanation for this discrepancy is the lack of an aerobic component in the current study, whereas several of the prior studies included an aerobic component that found a positive impact on cognition. Although it has been identified that strength training can induce hormonal adaptations that are neuroprotective,25 Kramer et al.25 indicate that the best results have been found using strength training and aerobic activity. Therefore, it is possible that addition of a moderate- to high-intensity aerobic activity (eg, running, playing tennis, biking, and gardening) to the current intervention may be required to elicit changes required for improvements in cognition and has been supported by previous research.10,19

Another possible explanation for the difference in findings may be that the sample of participants used by Baker et al.10 displayed mild cognitive impairment, with MMSE scores of approximately 27 out of 30, whereas the sample in the current study had lower cognitive performance, with an average MMSE score below 21 indicating mild to moderate impairment. The participants in the current study took an average of 4 minutes and 36 seconds to complete the TMT-B test. When compared with normative data for community-dwelling older adults of 86.3 seconds, indicating participants in the current study began with a high level of executive dysfunction. Although Baker et al.10 did not report average performance on this measure, making it difficult to compare to the current sample, it is possible that a simpler test of executive function may be more appropriate to use with a sample of more impaired individuals.

Significant changes in perceived ADL/IADL functioning were not found, which does not support prior findings by Santana-Sosa et al.21 A possible consideration for these nonsignificant findings may stem from the study design that captured the short-term effects of the protocol rather than longer term effects that may require more time to unfold. For example, changes in perceived ADL/IADL functioning may necessitate a longer time to develop in that more time is required to change individual’s perceptions about their day-to-day functioning. Another explanation is the need for a diverse multicomponent intervention. For example, Teri et al.12 found that Reducing Disability in Alzheimer’s Disease (RDAD), a dyadic multicomponent intervention with exercise and behavioral management techniques, significantly improved scores on the physical functioning subscale of the 36-Item Short Form Health Survey (SF-36) as reported by the caregiver. In addition, Judge and colleagues63,64 found significant improvements in perceived distress in ADL function following a dyadic intervention (Project ANSWERS) including cognitive rehabilitation and skills training for IWDs and their caregivers. Project ANSWERS did not incorporate any type of physical activity or exercise, but was able to demonstrate improvements in perceived distress in ADL function after only 6 sessions. Incorporating both physical and psychosocial components, possibly through an interdisciplinary approach with clinicians from psychological sciences as well as health sciences, may be the best approach to impact both objective and subjective function. These examples highlight the possibility of requiring psychosocial components to intervene in a more holistic approach to truly affect the illness or disability experience. Assessing symptoms of depression and anxiety as well as quality of life may allow researchers and clinicians to better understand the association between cognitive and physical function, exercise, and overall well-being.

On the basis of these considerations, modifications to the intervention may be warranted in future research, including the addition of an aerobic component to target cognition. This would bring changes to the implementation of the intervention and likely warrant increased participation from the caregiver to monitor completion of daily aerobic exercise. However, with daily session logs and tightly scripted instructions this could be feasible. Furthermore, addition of cognitive rehabilitative skills or behavioral management training may be introduced to determine effects of a more diverse multicomponent intervention that addresses the illness and disability experience.

Examining how exercise with the IWD affects the caregiver is another topic of interest for future research. For example, it is possible that improving balance, strength, and gait speed in the IWD would reduce caregiver strain or burden, as the IWD is more independent and engaged

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group</th>
<th>Time 1 Mean (SD)</th>
<th>Time 2 Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trail Making Test (B)</td>
<td>I</td>
<td>4.27 (2.01)</td>
<td>7.42 (5.35)</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>4.44 (2.57)</td>
<td>5.51 (3.12)</td>
</tr>
<tr>
<td>Modified Berg Balance Scale</td>
<td>I</td>
<td>39.5 (3.3)</td>
<td>41.5 (2.2)</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>38.5 (8.0)</td>
<td>36.8 (6.7)</td>
</tr>
<tr>
<td>30-s chair stand</td>
<td>I</td>
<td>14.0 (5.8)</td>
<td>17.9 (6.8)</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>15.7 (6.1)</td>
<td>13.2 (4.9)</td>
</tr>
<tr>
<td>Gait speed (comfortable, m/s)</td>
<td>I</td>
<td>0.7 (0.2)</td>
<td>0.7 (0.1)</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>0.7 (0.2)</td>
<td>0.6 (0.3)</td>
</tr>
<tr>
<td>Gait speed (fast, m/s)</td>
<td>I</td>
<td>1.2 (0.3)</td>
<td>1.6 (0.3)</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>1.4 (0.6)</td>
<td>1.3 (0.6)</td>
</tr>
<tr>
<td>Activities of daily living scalea</td>
<td>I</td>
<td>7.3 (5.1)</td>
<td>6.8 (5.1)</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>4.2 (3.9)</td>
<td>5.40 (6.7)</td>
</tr>
</tbody>
</table>

Abbreviation: SD, standard deviation.
a0 = “no difficulty,” 1 = “little difficulty,” 2 = “fair amount of difficulty,” and 3 = “very difficult” for 16 items, with a maximum score of 48.
in completing daily activities. In addition, IWDs engaged in more purposeful activities may experience reduced neuropsychiatric behaviors, improved sleep, and/or increased engagement in other aspects of care. All of these factors can affect the IWD, caregiver, or dyad as a unit. Finally, future studies should examine the long-term effects of the exercise intervention on IWDs. Areas of interest may include continued adherence to regular physical activity following completion of the protocol as well as maintenance of gains made during the program. Additional outcomes may include delayed time to nursing home placement, falls, and maintenance of IWD’s independence in performing IADLs/PADLs.

The Strength-Based Approach was successful as an overarching framework for guiding the development and implementation of the protocol, and extends this framework from social work and counseling settings to physical activity and exercise programs. Therefore, it also may be useful in the fields of physical and occupational therapy when working with IWDs. Research has found that rehabilitation participation mediates the relationship between cognitive impairment and rehabilitative outcomes. The high adherence level found in the current study indicates that IWDs can actively participate in an exercise protocol using a Strength-Based Approach. Thus, a Strength-Based Approach may be especially important for rehabilitation professionals to implement when working with IWDs, as this population can pose unique challenges.

Another key point from this study is the importance of the proper dosage or intensity. The Physical Stress Theory states that overload is required to induce beneficial adaptations in muscle and neurological tissue, producing improvements in strength and balance. The current study found that IWDs were able to benefit from a protocol that induced the proper intensity to elicit changes in strength, balance, and fast gait speed. Protocols with less intense dosages may result in nonsignificant findings. The current study found that maintaining a moderate-intensity exercise intervention (60%-80% of maximum) leads to positive effects along with good tolerance.

Limitations
Several study limitations should be considered. The current sample was recruited with assistance from a local chapter of the Alzheimer’s Association, which introduces a recruitment bias. Although a large emphasis of the study was on testing the efficacy of the protocol, it is possible that treatment adherence and fidelity findings may have been different with a more diverse sample of participants. However, the universal design of the intervention was intended to maximize adherence through using purposeful activity, optimizing accessibility, and individualized tailoring.

Another limitation is the TMT-B for measuring executive functioning, which may have resulted in floor effects with this sample. Few assessment tools for assessing executive function in IWDs with mild to moderate dementia are available, with the appropriate level of sensitivity needed to observe significant changes. More research is needed to identify or develop valid and reliable tools for use in this line of research. Also, it is possible that the exploratory nature of the current study resulted in reduced power for some of the outcome measures demonstrating a smaller effect size. Future research should include a larger, more heterogeneous sample of IWDs to provide more power and allow for key comparisons regarding effectiveness including possible stratification by gender or type of dementia.

Neither the researcher nor the participants were blinded to group assignment. However, attempts to minimize this bias were made using random assignment and participants in the intervention group were evenly split between exercise practitioners. In addition, the principal researcher was blinded to the baseline performance of the participant at time of the follow-up. The assessment tools used were objective and straightforward (eg, time via stopwatch and repetitions completed) in attempts to limit the subjectivity of the assessor. In further research, it would be ideal for the researcher completing the baseline and follow-up assessments to be blinded of group assignment to remove all potential measurement biases.

CONCLUSIONS
The current study reveals the ability of IWDs to participate in a moderate-intensity functional strength and balance program using a Strength-Based Approach to facilitate implementation of exercise activities. In addition, results highlight improvements in lower extremity strength, balance, and fast gait speed following participation in the 12-week intervention. On the basis of these key findings, rehabilitation professionals should consider integration of these techniques into mainstream clinical practice and research with this patient population.

REFERENCES