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Exercise and activity level in Alzheimer's disease: A potential treatment focus

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Abstract — This article provides information on the baseline health and physical function of 30 individuals with Alzheimer's disease (AD); describes a community-based program designed to increase balance, flexibility, strength, and endurance in these persons by the training of caregivers to facilitate and supervise exercise activity; and documents the adherence of these subjects and their caregivers to this intervention. Subjects were recruited from an ongoing, community-based Alzheimer's Disease Patient Registry, and met NINCDS-ADRDA criteria for probable or possible AD. Caregivers were family members living with the demented individuals in the community. Physical performance was measured using walking speed, functional reach, and standing balance. Health status was measured with the Medical Outcomes Study Short Form, the Sickness Impact Profile, and caregiver reports of subject's restricted activity days, bed disability days, falls, and exercise participation. Baseline data indicated that persons with AD were impaired on measures of physical performance and function, compared to published data on nondemented older adults. During a 12-wk treatment period, caregivers were taught to guide their demented charges in an individualized program of endurance activities (primarily walking), strength training, and balance and flexibility exercises. Adherence data indicated that 100% of the subjects were compliant with some exercise recommendations, and one-third completed all assigned exercises during the training period. Caregivers were able to learn and direct subjects during scheduled exercise activities. These findings indicate that the integration of exercise training into the care of persons

with AD is both needed and feasible. Further research is currently underway to determine the efficacy of this approach for reducing additional physical disability in these individuals.

Key words: *Alzheimer's disease, caregivers, exercise, physical function.*

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INTRODUCTION

Alzheimer's disease (AD) affects physical function. Although the association between physical health and AD has received little attention, the studies that do exist indicate a consistent adverse relationship between the two. For example, persons with AD show more signs of under-nutrition than age-matched controls (1). Their mobility, ambulation, body care, and home management skills decline more rapidly over the course of a year than controls of comparable age and physical health (2). The risk of injuries, including falls and fractures, is also increased among persons with impaired cognitive functioning (3-5). In one study, 50 percent of persons with AD seen in an outpatient geriatric clinic either fell or became unable to walk during a 3-yr follow-up period (6). Of these, more than half sustained new fractures during the 3 years, a rate three times the age- and gender-adjusted rate for nondemented subjects. Similarly, recent studies have shown that their risk for falls in institutional settings is nearly twice that of nondemented residents of comparable age (7).

Falls are an especially important variable for study because of their link to increased mortality and morbidity: they are the leading cause of death from injury, and a major source of morbidity among persons over age 65, particularly those in the 85+ age group (8). For persons with dementia, prognosis for full functional recovery after a major fall (e. g., one resulting in a hip fracture) is extremely poor (9). Interestingly, fall-related injuries appear to be as much related to adverse drug reactions, musculo-skeletal problems, and physical environmental factors as to dementia severity (3,4,6). Falls have also been linked to symptoms of agitation in persons with geriatric dementia (10).

In contrast to the cognitive impairment of AD, physical health, falls, and frailty may well be amenable to intervention and prevention. However, it is not known whether community-dwelling individuals with dementia could realistically participate in a systematic exercise program, given the cognitive and behavioral symptoms that commonly accompany the disease. This paper, therefore, presents data on the health and physical function of a sample of such community-dwellers with AD. It describes an

activity program designed to increase their balance, flexibility, strength, and endurance, as well as data on their adherence with exercise recommendations over a 12-wk period. Finally, in order to facilitate further study, the paper describes some of the common problems that arise when caregivers are taught to supervise and guide demented persons in regular exercise activities.

METHODS

Study Sample

Subjects were recruited from an ongoing, community-based Alzheimer's Disease Patient Registry (ADPR) established cooperatively in 1987 by the University of Washington Medical School and the Group Health Cooperative (GHC), a major health maintenance organization in Seattle serving approximately 23,000 persons over age 60. One of the aims of the registry was to follow persons with dementia over time to monitor changes in their functional and cognitive status after they first came to medical attention. Subjects received a comprehensive, multidisciplinary diagnostic evaluation, and results were discussed at consensus meetings attended by an internal medicine physician, a neurologist, a psychologist, an epidemiologist, and research staff. Additional details regarding the base population, enrollment, and diagnostic procedures can be found elsewhere (11). In addition, GHC clients with a diagnosis of dementia, but who were not eligible for the ADPR because they lived outside the catchment area, were identified through computerized chart review. For these subjects, relevant diagnostic information (such as neurology reports, CT scans, laboratory studies) was compiled and reviewed as part of an ADPR consensus process to ensure diagnostic comparability with ADPR enrollees.

Eligibility and Exclusion Criteria

Only those subjects who met National Institute of Neurologic and Communicative Diseases and Stroke and the Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA) criteria (12) for probable or possible Alzheimer's disease were eligible to participate. In addition, for this trial, subjects were required to be community-dwelling, ambulatory, and to have an actively involved caregiver living with them who was willing to participate in treatment sessions.

Participants ranged in age from 61 to 90 years, were predominantly male (73 percent), and had been demented for an average of 4.3 years. Caregivers ranged in age from 26 to 85 years; 83 percent were female, and 86 percent were the spouses of the subjects. Additional information about participants is shown in **Table 1.** Two subject-caregiver dyads withdrew prior to completion of the exercise training program (one because the subject suffered a stroke, and the other because the caregiver had a stroke).

Table 1.
Descriptive data for AD subjects.

Variable	N	(%)	Mean	(±SD)	Range
Subject					
Age			78.7	(±6.4)	61-90
Education			13.3	(±3.4)	6-20
Gender: Male	22	(73)			
Female	8	(27)			
Ethnicity					
Caucasian	25	(83)			
African-American	5	(17)			
Pacific	0	(-)			
Duration of dementia			4.3	(±2.2)	1-9
Mini-Mental State Exam			17.8	(±6.0)	0-26
Caregiver					
Age			69.7	(±14.1)	26-85
Education			14.0	(±3.2)	4-22
Gender: Male	5	(17)			
Female	25	(83)			
Ethnicity					
Caucasian	24	(80)			
African-American	4	(13)			
Pacific	2	(7)			
Relationship to patient					
Spouse	26	(86)			
Adult Child	2	(7)			
Other	2	(7)			

N=30; age, education, duration of dementia in years;
Pacific=Asian or Pacific Islander.

Measures

Subjects were evaluated on several standard physical performance measures described below. Caregivers acted as proxy informants, providing information about the exercise patterns, falls, and general health of the subjects. *Physical Performance Measures*

To assess walking speed, an 8-ft distance was marked off on the floor with colored

masking tape, and subjects were told to "walk to the other end of the line at your usual speed" (13). Assistive devices were used as necessary, and two timed trials were completed. Performance was reported as an average of the two trials. To assess functional reach, subjects were told to stand next to a wall holding their arm parallel to a meter stick attached to the wall at shoulder height, and to reach forward as far as possible, without losing balance. Functional reach has excellent inter-rater and test-retest reliability (14), and has been shown to have reasonable sensitivity to change (15). Since a number of subjects became confused during the repeated trials of the functional reach test, their best scores were reported, as a measure of maximal stability and dynamic balance. Tests of standing balance included tandem and one-leg stands, and an 8-step tandem gait. Timing was stopped at 5 s, or when the subject moved his or her feet out of step, or grasped the interviewer for support, whichever came first. Performance on each stand was scored as a categorical variable, according to whether the person was able (or unable) to hold the stand unassisted and without moving for 5 s.

Self-report Measures (Caregiver Proxy)

Three subscales (Body Care and Movement, Mobility, and Home Management) from the physical dimension of the Sickness Impact Profile (SIP) and two (Physical Functioning and Role Functioning--Physical subscales) from the Medical Outcome Study Short Form (SF-36) were used to assess physical and functional status. The SIP is considered one of the most responsive health status questionnaires, and its subscales have been shown to have good test-retest reliability (16). The SF-36 is a brief, well-studied, widely used health status measure (17). Typical SIP items include "(S)he is staying in bed most of the time" (mobility), or "(S)he does not maintain balance" (body care and movement). Typical SF-36 items include asking if the subject is limited a lot, a little, or not at all in various activities, such as his/her ability to walk one block or climb one flight of stairs. For both the SIP and SF-30, higher scores indicate greater impairment. Caregivers also reported on subjects' restricted activity days and bed disability days during the past 2 wks, as well as falls and near falls during the past month. Disability days measures have been widely used (18), are considered valid measures of health status in nonimpaired older adults (19), and are responsive to change in health promotion intervention studies (20). Finally, exercise activity was assessed by asking caregivers the amount of time subjects spent walking or doing other aerobic activity in the past week.

Adherence Measures

Exercise adherence was assessed in two ways. Caregivers completed a daily exercise log as a record, for each day of the week, of whether or not any balance and flexibility exercises were completed; how many minutes were spent walking or participating in some other aerobic activity; and the weight and number of repetitions completed for each strength training exercise. The log was a simplified version of several more complex logs that were found too difficult for many of the elderly participants. In addition, exercise trainers completed a treatment adherence form after each session. The daily exercise log and assigned daily exercises were rated 0-3: 0=not attempted; 1=attempted but not

completed; 2=completed; or 3=not assigned during the previous week. Thus, an overall rating of adherence for each type of exercise was obtained, as well as an indication of adherence for each type of exercise assigned.

Treatment Procedures

Subjects were visited by home health professionals trained in the management of AD. For the first 3 wks, sessions were scheduled twice weekly, followed by weekly sessions for 4 wks, then biweekly sessions for the next 4 wks. Exercise training was offered as part of an integrated treatment program that incorporated physical activity, education about dementing illnesses, behavior management training, and psychosocial treatment. The exercise component consisted of a combination of aerobic/endurance activities, strength training, balance, and flexibility training. The goal was to encourage persons who had not been physically active to establish a regular exercise program, and to encourage persons who were already active to continue or increase their activity to 30 min or more of moderate intensity exercise on most days of the week (21). The treatment program was individualized to meet the needs of each subject and caregiver and was adapted from two previously established treatments: one for behavior problems in AD (22), and one for exercise among older adults (23).

At the first session, each subject and caregiver identified an "exercise buddy" (usually the caregiver) who could assist with the exercise program. Strengthening, balance, endurance, and stretching activities were incrementally introduced in subsequent sessions. Exercises were first demonstrated by the exercise trainer, then practiced by the subject while the buddy/caregiver (hereafter referred to as the caregiver) observed and assisted. A considerable portion of the exercise training and monitoring at each session involved working with the caregiver to ensure that exercises were being practiced safely and correctly by the subject. Caregivers were encouraged to ask questions, and instructed in the use of the weekly exercise log. The various components of the exercise program are described below.

Strength Training

The strength training portion specified exercise on 3 nonconsecutive days per week, alternating with endurance activity days. Training focused on lower-body strengthening. Specific exercises included: dorsiflexion ("toe lifts"), knee extension and flexion ("knee straightening" and "back knee bends"), plantarflexion ("toe raises"), hip flexors ("marches"), abduction ("side lifts"), and extension ("back leg lifts"). Participants were taught exercises initially without weights to a maximum of 1 set of 12 repetitions. Exercise trainers guided the subject through each exercise set, observed the caregiver assisting the subject, and determined whether he or she could safely progress to a higher weight level or number of repetitions. Subjects were provided with incremental lead-shot weights, ranging from 1/2 to 5 lbs that could be attached around the ankles; once 12 repetitions could be safely accomplished at a given weight, the weight quantity was increased. To date, the maximum level reached during treatment is 2 sets of 12 repetitions

of each exercise with 5 lb weights.

Balance and Flexibility

Balance and flexibility exercises were recommended for 10-15 min as part of a warm-up or cool-down to the strengthening or endurance activities. Training included an evaluation of risk factors for increased falls (e.g., sensory deficits, shoeware, environmental hazards, medications). The balance routine alternated between transfer exercises (chair stand), base-of-support exercises (forward lean), and advanced walking skills (backwards walk). Each exercise was graded along several levels of difficulty to ensure safety. For example, the easiest level of backward walking involved holding on to a counter or table edge while walking. At increasing levels of difficulty, the subject walked backward without holding on to a counter (or holding only intermittently), and ultimately walked backward unsupported with eyes closed. Flexibility training focused on the back, shoulders, hips, hamstrings, gastrocnemius/soleus/achilles, neck, and hand. Continued progression involved increased duration of stretch (rather than intensity of exercise). Participants were given stick-figure drawings showing all balance and flexibility exercises to facilitate recall and adherence with the program.

Endurance

The goal of these exercises was to increase endurance by increasing exercise duration. Participants were asked to walk at least 30 min on a minimum of 3 nonconsecutive days each week; these days generally alternated with strengthening exercise days. They were told to begin walking at their natural pace, gradually increasing walking speed to increase their aerobic fitness. The caregiver generally accompanied them on their walks to ensure that they did not become lost or develop any physical distress or difficulty during the walk. Subjects who were already involved in some alternative form of regular aerobic activity (e.g., ballroom dancing or riding a stationary bike), were allowed to replace one or more of the walking days with this alternative activity if it met the criterion of 30 min of continuous, moderate aerobic activity.

Adherence Monitoring

Adherence to the program was monitored by the exercise trainer throughout the active intervention, with weekly review of the daily exercise log, problem-solving around any difficulties with treatment adherence, and periodic in-session observations of the exercises to ensure they were being done properly. In addition, trainers completed progress notes and treatment adherence forms after each session. The notes provided specific information about what exercises were demonstrated, practiced, and assigned as homework at that session. Any modifications to the standard exercise program and an explanation for the change were recorded, as were problems that arose with either subject or caregiver adherence.

Exercise Trainers

Exercise training was conducted in the homes of subjects by master's level home health

professionals (one physical therapist and one social worker trained in the exercise program) who had experience with dementia subjects and their families. Each trainer was supervised weekly by expert clinical geropsychologists (LT, SM) and a physical therapist.

RESULTS

Descriptive statistics (means, standard deviations, frequency distributions) were computed to examine the baseline characteristics of subjects and caregivers who participated in the study, subject physical and health variables, and subject-caregiver adherence with recommended exercises over the 12-wk training period. **Table 1** shows the summary demographics for all subjects. As can be seen, the majority were white males with moderate levels of cognitive impairment. Caregivers were largely their white female spouses. These demographics are consistent with what has been reported in the literature, concerning the preponderance of female caregivers of persons with AD (24).

Physical Performance Measures

Table 2 shows the physical measurement data at baseline. Subjects performed more poorly on physical performance measures than has been reported for nondemented older adults, averaging, for example, 5.7 seconds to complete an 8-foot walk. Guralnik et al. (13), in their community survey of 5,000 persons over age 71, reported mean walk times of 4.0 and 4.7 seconds, respectively, for men and women aged 71 to 79, and 5.1 and 6.3 seconds, respectively, for those aged 80 and older. It was also comparable to baseline gait speed reported for nursing home residents at two sites, and slower than values for community-dwelling older adults at four sites in the nationwide *Frailty and Injuries: Cooperative Studies of Intervention Techniques* (FICSIT) study (25).

Table 2.

Physical measurement data for AD subjects.

Variable	N	(%)	Mean	(±SD)	Range
Exercise			109.7	(±153.9)	0-720
8-foot walk			5.57	(±1.78)	1-1110
Functional reach			9.7	(±6.0)	0-20
Sickness Impact Profile					
Body care subscale			12.3	(±12.9)	0-45
Movement subscale			19.3	(±24.5)	0-100

Home management subscale	32.9	(±26.6)	0-92
Medical Outcome Study--SF-36			
Physical functioning subscale	65.3	(±23.6)	5-100
Role functioning--physical subscale	55.8	(±38.1)	0-100

Standing Balance (% success)		
5-s tandem stand	25	(83)
5-s one-leg stand	23	(77)
8-step tandem gait	15	(50)
Disability days past 2 weeks		
0 reduced activity	27	(90)
1-7 reduced activity	1	(3)
8-14 reduced activity	2	(7)
0 bed disability	28	(93)
1-7 bed disability	2	(7)
Subject w/no falls	26	(87)
Subject w/falls	4	(13)
injurious	1	(3)
medically attended	3	(10)
hospitalized	0	(-)

Exercise=min/past week; walk=s/best of two trials; reach=in/best of five trials.

Similarly, subjects had functional reach scores of 9.7 inches (SD=5.5; range=0-17.3 in) slightly lower and more variable than those reported (26) for nondemented community-dwelling older adults (mean=10.9; SD=3.1 in; range=4.3-16.5 in). Although the majority of the AD subjects were able at baseline to hold a 5-s one-leg or tandem stand (77 and 83 percent, respectively), only half could complete the tandem gait.

Caregiver Proxy Measures

In this sample, mean SIP subscale scores at enrollment (expressed as a percentage of the maximum possible score) ranged from 0 to 45 for Body Care and Movement, 0 to 100 for Mobility, and 0 to 92 for Home Management, with higher scores indicating greater levels of impairment in each domain (**Table 2**). Subjects' SIP scores were comparable to those

reported by Krenz and colleagues (2) for a sample of 88 persons with AD. Scores on the SF-36 indicated as great an impairment as scores that have been reported for persons with other chronic medical conditions, such as advanced coronary artery disease (27), ranging from 0 to 100 for Physical Functioning, and from 5 to 100 for the Role Functioning--Physical subscale (out of a maximum impairment score of 100 for both scales). Very few falls (N=4), reduced activity (N=3), or bed disability days (N=2) were reported for subjects in the 2-4 wks prior to entry into the study.

Adherence Measures

Examination of treatment adherence forms completed by exercise trainers showed that all subjects who were assigned exercises completed some portion of their recommended program, and more than one-third (38 percent) completed all exercises assigned to them each week during the treatment period (see **Table 3**). Adherence with the exercise logs was also good (ranging from 96 percent making some attempt to complete a log to 29 percent completing all assigned logs).

Table 3.
Adherence rates with exercise homework and completion of assigned daily exercise logs.

Completion Rate	Homework Assignment			
	Exercises		Log	
	N	(%)	N	(%)
100% Completed	11	(38)	8	(29)
>50% Completed	6	(21)	10	(36)
<50% Completed	9	(31)	4	(14)
Attempted, Never Completed	3	(10)	5	(18)
Never Attempted	0	(-)	1	(4)

Of the three program components recorded by caregivers on the weekly exercise logs, best adherence was obtained with endurance activities: 42 percent of the subjects exercised 3 or more days per week. Walking was the most common endurance activity, although riding a stationary bike, swimming, and using a treadmill were also reported. The average duration of the chosen activity was 22.9 min (range=7.5-60.9 min). Adherence to recommended strengthening exercises was also good: 31 percent reported practice of the strengthening exercises three or more days per week, and almost half (43 percent) increased their weight resistance during the 3-mo period (to a maximum of 5 lbs). Poorest adherence was with the stretching exercises: only 8 percent of subjects reported

completion 3 or more days per week.

DISCUSSION

This article reported on exercise and activity levels in a sample of 30 persons with AD, residing in the community with an adult family member. Baseline data revealed a consistent pattern of impaired performance on measures of walking speed, functional reach, and standing balance when compared to published data on nondemented older adults. Proxy reports of physical and functional status on the SIP and SF-36 also indicated impairment relative to published scores for persons with other chronic medical conditions.

We have also described an exercise program offered to persons with AD and their caregivers. Conducted by home health professionals trained in the management of AD, the training consisted of a combination of aerobic/endurance activities (primarily walking), strength training, balance, and flexibility training. The goal was to encourage persons who had not been physically active to establish a regular exercise program, and to encourage those who were already active to continue or increase their activity. Adherence to program recommendations was very good; 100 percent of subjects attempted some exercises during the 12-wk intervention, and one-third completed all exercises that were assigned. Participation with endurance activities was particularly good; half of all participants reported that they were performing some aerobic activity 3 or more days per week during the treatment period.

Subjects were, obviously, not homogeneous. At baseline, some were quite frail and sedentary, others more hearty and active. For caregivers of the former, the exercise program was particularly well-received, since it offered a practical, positive step that subjects and caregivers could take. Caregivers frequently commented that their charges enjoyed doing the exercises, and that mood and behavior was better on days when exercises were completed. However, active subjects were also able to improve and expand upon their existing exercise routines. These findings are particularly encouraging, since they relied upon community-dwelling lay caregivers who were trained to monitor and assist the demented person. Although other studies have found that exercise programs can be implemented by exercise professionals in structured nursing home settings (28), training in this study involved participants with much more variability in care, function, environment, and living situation.

Of course, the exercise training faced its own set of unique challenges. These can be classified into three broad categories: 1) problems arising from the declining physical health of the subject and caregiver; 2) those arising from the cognitive deficits and behavioral problems of the demented person; and 3) those arising from caregiver's style of

interacting with the subject. For example, one-third of the subjects experienced symptoms of dizziness, muscle strain, chronic pain, or fall-related injury severe enough to warrant a temporary discontinuation of their exercise activity. For these subjects, care was taken to ensure that the exercise program was not causing or exacerbating physical problems, and to help caregivers recognize and respond appropriately to unsteadiness or complaints of pain during exercise. When health problems of the caregivers limited their ability to assist their subjects, alternative resources (e.g., finding a volunteer who could walk with him or her) were found, or the exercise regimen was simplified so that the caregiver could participate at a lower level. The symptoms of memory loss and confusion, apraxia and agnosia, and psychotic, paranoid, or agitated behaviors of the subjects also interfered with participation at times. Caregivers often needed reminders to use 1-step instructions, to be very specific and concrete, and to use frequent visual demonstrations and hands-on guidance.

A number of limitations to the current study are worth noting. First, although findings from this study show that persons with AD can participate in a systematic exercise program under the guidance of family caregivers, further study examining the impact and participation of such a program with both demented and nondemented older adults is needed. Currently, this program is being investigated as part of a larger randomized clinical trial to evaluate treatment outcome. Second, the small sample size, ethnic homogeneity, and relatively high education level of participants in this study may limit generalizability of results, and we are unable to evaluate the extent to which potentially confounding variables (e.g., severity of cognitive impairment, level of behavioral disturbance, or caregiver relationship to subject) might alter response to treatment. Third, although the overall pattern of impairment in this sample relative to the published reports of nondemented older adults provides support for increased physical disability in persons with dementia, additional study directly comparing these individuals to nondemented, age-matched controls is needed.

SUMMARY

This study provides data showing the increased physical frailty in persons diagnosed with AD. It also provides evidence that community-dwelling AD subjects and their caregivers can participate in a structured exercise program designed to improve balance, flexibility, lower-body strength, and endurance. Caregivers were taught how to assist and monitor daily practice sessions to ensure safety and proper exercise performance. Adherence with the program was excellent: 100 percent completed some exercises, and one-third completed all assigned exercises during the treatment period. The integration of exercise into standard care practices for individuals with AD appears relevant and feasible. Further research is currently underway to determine the efficacy of this approach for reducing physical disability in these persons.

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