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Correlation between Caregiver Reports of Physical Function and Performance-Based Measures in a Cohort of Older Adults with Alzheimer Disease

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Abstract

The objectives of this report are to determine the association between performance-based measures of physical function with caregiver reports of physical function in older adults with Alzheimer's disease (AD) and to examine whether those associations vary by the level of patients' cognitive functioning.

Subjects included 180 patient-caregiver dyads who are enrolled in a clinical trial testing the impact of an occupational therapy intervention plus guideline-level care to delay functional decline among older adults with Alzheimer's disease. The primary caregiver-reported measure is the Alzheimer's Disease Cooperative Study Group Activities of Daily Living Inventory (ADCS-ADL). Performance-based measures include the Short Physical Performance Battery (SPPB) and the Short Portable Sarcopenia Measure (SPSM).

Analysis of covariance (ANCOVA) models were used to determine the associations of each physical performance measure with ADCS-ADL, adjusting for cognition function and other covariates.

We found significant correlations between caregiver-reports and observed performance-based measures across all levels of cognitive function, with patients in the lowest cognitive group showing the highest correlation. These findings support the use of proxy reports to assess physical function among older adults with AD.

Keywords

Alzheimers disease; dementia; physical function; self-reports

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Introduction

The number of worldwide cases of Alzheimer disease (AD) and related dementias is growing as the population ages; an estimated 22% of the world's population will have dementia by the year 2050.[1] There is currently no cure for AD and over a period of 5–10 years, the condition typically results in severe functional and cognitive disability. Previous studies specifically targeting physical decline have provided evidence that physical function can be improved among older adults with dementia.[2,3] In a prior clinical trial, we previously reported that a collaborative care program for older adults with AD could improve behavioral symptoms, but this program did not slow the progression of physical decline.[4]

Previous studies have compared self-report as compared to performance-based measures of physical function in older adults, but not in the context of persons with AD and their caregivers.[5–8] We are currently conducting the Alzheimer's Disease Multiple Intervention Trial (ADMIT) which seeks to delay functional decline in AD patients.[9] This study is unique in that the outcomes include two different performance-based measures of physical function, the Short Performance Physical Battery (SPPB) and Short Portable Sarcopenia Measure (SPSM) as well as a caregiver reported measure of function. The objective of this report is to determine the association of these performance-based measures with caregiver assessments of patients' physical function and to examine whether those associations vary by the level of the patients' cognitive functioning in a cohort of older adults with AD.

Methods

Data for this report were collected from baseline assessments of all subjects in the ADMIT trial.[9] A complete description of the ADMIT protocol has been previously published.[9] Briefly, ADMIT is a randomized single blind controlled clinical trial with a parallel design and a 1:1 allocation ratio comparing the effectiveness of a two-year home-based occupational therapy intervention to enhanced usual care in preventing physical decline among older adults with AD.[9] Subjects were enrolled from the Healthy Aging Brain Center and its related clinical programs at Eskenazi Health in Indianapolis, Indiana.[10–14] Patients were eligible if they met diagnostic criteria for possible or probable Alzheimer's disease as determined by the physicians in this memory care practice. All patients in this practice complete formal neuropsychological testing and clinical assessments adapted from the CERAD battery of tests.[9] Other inclusion criteria included community-dwelling, English-speaking patients who were aged 45 years and older who had an eligible caregiver willing to participate in the study. The caregiver was eligible if he or she was 18 years old, English speaking, and had regular access to a telephone. Following informed consent of both patients and their caregivers, a team of professional research assistants completed an in-home baseline assessment (described below). Following the baseline in-home assessment, dyads were randomized to the control or intervention group. Prior to enrollment, study procedures were approved by the institutional review board of Indiana University/ Purdue University Indianapolis.

Instruments

The primary caregiver-reported measure is the Alzheimer's Disease Cooperative Study Group Activities of Daily Living Inventory (ADCS-ADL).[15] This is a 23-item inventory developed by the ADCS Group that is administered to the patient's caregiver by trained research staff. The caregiver is asked to focus on the patient's performance over the past month. Notably, the caregiver reports on what the patient actually did rather than an assessment of what the patient might be able to do. The inventory assesses the traditional activities of daily living (e.g., bathing) as well as variations on instrumental activities of daily living (e.g., using the telephone). [15] Scores vary from 0 to 78 with higher scores indicating greater levels of function.

Patient's cognitive function was measured by the Mini Mental Status Examination (MMSE), a 30 point scale, with lower scores indicating increased cognitive impairment.[16] We use the MMSE is this study for three reasons. First, scores on the MMSE allow other researchers to compare our study sample with previously reported study samples with dementia on this commonly used measure of cognitive function. Second, we sought to examine whether subjects with poorer cognitive function as measured by the MMSE would be able to understand the examiner instructions to properly complete performance-based measures. Third, we use the MMSE score to determine if the correlations between proxy-reported and performance-based measures deteriorate as cognitive function worsens.

Physical performance measures include the Short Physical Performance Battery (SPPB) and the Short Portable Sarcopenia Measure (SPSM). The SPPB is a standardized measure of lower extremity physical performance that includes walking, balance, and power tasks. It has been used in a broad range of epidemiological studies of aging.[17–20] This scale has proven reliable and valid for predicting disability, nursing home placement, hospital admission, and mortality.[8,20–23] The SPPB score is based on timed measures of standing balance, walking speed, and repeated chair rises, each of which is scored 0 to 4 based on standardized criteria. Total scores vary from 0 to 12, with higher scores indicating better function. The SPSM was conceptualized as a measure of sarcopenia that combines muscle quantity and function.[24] The SPSM can be used to follow change in muscle status over time with each person as his or her own control. The scale is based on timed chair rises, body mass index, and grip strength. Scores vary from 0 to 18, with higher scores indicating less sarcopenia. Patients only received total scores on the SPPB and SPSM if they received a score for each item within the scale. Performance tasks that were refused were not scorable. Patients who were unable or unsafe to stand on a scale did not receive a score for SPSM.

Analyses

Descriptive statistics including mean, standard deviation, and range for continuous variables and frequency and percent in each category for categorical variables were calculated. Analysis of variance (ANOVA) models and chi-square tests were used to compare baseline characteristics across the MMSE quartiles. Pearson correlation coefficients and their p-values were calculated for the associations of the two performance-based measured with the ADCS-ADL. Analysis of covariance (ANCOVA) was used to identify baseline characteristics significantly associated with the ADCS-ADL. These baseline characteristics

are shown in Table 1 but only significant variables are shown in Table 2. The two physical performance measures were each regressed against ADCS-ADL in analyses adjusting for these same covariates. Stepwise and backwards selection methods were used to identify final separate parsimonious models for the ADCS-ADL scores including covariates significant at the alpha=0.05 level. Standardized regression coefficients were shown from the models where one standard deviation increase on the independent variable indicates the change in standard deviations of the dependent variable. Interactions between the covariates with SPSM or SPPB were investigated and included if significant at the alpha=0.05 level. If the final model included significant interactions, partial correlation coefficients were also calculated after stratifying by that covariate.

Results

One-hundred eighty patient-caregiver dyads were enrolled in the study between March 2011 and October 2013; 91 (50.6%) were randomized to receive the occupational therapy intervention. Of the total enrolled patients, 175 had ADCS-ADL scores, 174 patients had SPPB scores, 144 had SPSM scores, and 179 had MMSE scores. The final study sample was composed of the 168 patients with completed ADCS-ADL, SPPB and MMSE scores.

Table 1 shows the baseline characteristics of patients and caregivers both overall and stratified by quartiles based upon MMSE scores. Among all patients, 69% were women and 42% were white. The mean (SD) age was 78 (9) years with a range from 53–102 and a median of 79. Only 24% had attained education beyond high school. Mean ADCS-ADL and MMSE scores are consistent with other clinical trials reported in the literature among older adults with AD.[25,26] There were 164 caregivers for the 168 patients; 160 caregivers cared for one patient and 4 cared for 2 patients each. There were no differences in patient or caregiver demographic characteristics or SPSM scores across the MMSE quartiles ($p>0.05$ for all). However, ADCS-ADL and SPPB scores differed significantly according to MMSE levels. In particular, those in the highest MMSE quartile had significantly better ADCS-ADL scores than those in all other quartiles ($p<0.05$) and higher SPPB scores than those in the lowest two quartiles ($p<0.05$).

Figure 1 shows scatter plots and regression lines between each of the performance-based physical function measures with the ADCS-ADL total. SPPB was highly correlated with the ADCS-ADL ($r=0.52$, $p<0.0001$). SPSM was modestly but significantly correlated with the ADCS-ADL ($r=0.20$, $p=0.0202$).

The standardized Cronbach coefficient alpha was 0.77 for the SPPB and 0.42 for the SPSM. Results on the SPPB were comparable to established internal consistency of 0.76.[8]. There are no published results on the internal consistency of SPSM. However, given that there are only three items in the SPSM, it is possible that Cronbach alpha underestimates its internal consistency. We were encouraged that we did not find floor or ceiling effects with the SPPB in this patient population although there may be a slight floor effect for the SPSM. The range for the SPSM is 0–14.5 with a mean of 3.9 and a standard deviation of 3.6. The range for the SPPB was 0–11 with a mean of 4.2 and a standard deviation of 3.0. There were 28

patients (20.6%) who scored a 0 on the SPSM and 10 (6.0%) who scored 0 on the SPPB. The correlation between the SPSM and SPPB was 0.35 ($p<0.0001$; n=136).

Table 2 shows the results from the ANCOVA models on the association between the reported measure (ADCS-ADL) and performance-based measures (SPPB and SPSM) including significant interactions. We found a significant interaction between SPPB and the MMSE quartiles ($p=0.0241$) in the model on ADCS-ADL, indicating significant differences in the correlations between SPPB and ADCS-ADL across MMSE quartiles. In fact, the partial correlation coefficient was significantly higher for patients in the lowest MMSE quartile group ($\rho=0.65$, $p=0.0043$) when compared to patients in the highest MMSE quartile group ($\rho=0.43$). While spousal caregiver relationship was associated with lower ADCS-ADL scores, this relationship had no impact on the correlation between SPPB and ADCS-ADL.

Looking at the models using SPSM, a significant interaction between age group (dichotomized at the median) and SPSM was found in the model for ADCS-ADL ($p=0.0108$). Patients younger than 80 had a significantly higher partial correlation coefficient ($\rho=0.33$) between the SPSM score and ADCS-ADL than older subjects ($\rho= -0.09$). Similar to SPPB, spousal caregiver relationship had no impact on correlations between SPSM and ADCS-ADL.

Discussion

Obtaining reliable physical function assessments from cognitively impaired study subjects poses challenges in terms of subject's ability to provide self-reports and the subject's understanding and ability to perform physical tasks correctly.[27] While there is no gold standard measure of physical function among older adults with AD, in the study section review of our ongoing clinical trial[9] reviewers recommended that performance-based measures be collected rather than relying on proxy reports of physical function. Previous studies have used SPPB[23,28–30] and SPSM[24] as performance based measures in older adults, but not necessarily focused on older adults with dementia. The ADCS-ADL is a standardized measure and has been widely used in prior AD clinical trials but it relies on self-reports of caregivers rather than performance-based assessments.[9,31–33] This study examines whether proxy reports are correlated with performance-based measures. We found significant correlations between caregiver-reports using the ADCS-ADL when compared to observed performance-based measures across all levels of cognitive function, with patients in the lowest cognitive group showing the highest correlation. These results also indicate that the SPPB and SPSM appear not to be significantly affected by impaired cognition and thus are reasonable performance-based physical function measures to include in trials targeting older adults with dementia. We also found that proxy reports are correlated with performance-based measures and thus could offer a lower cost, more practical measure of physical function in the context of clinical trials for AD.

A pilot study by Fox et al. examined the psychometric properties of certain functional and anthropometry measures including SPPB and grip strength among dementia patients living in residential aged care. While they found grip strength and anthropometric measures to be reliable in this population, other functional measures like the SPPB were found to have low

levels of absolute reliability and high variance at the individual level. Data on MMSE scores or level of dementia was not reported in that study.[27] Bruce-Keller et al. demonstrated the complex interaction between cognitive function and physical performance, finding changes in individual cognitive domains to be more correlated than global cognitive measures, specifically in early changes to gait and SPPB in mildly demented patients.[34] Building on these findings, this study incorporated correlations across the cognitive spectrum, taking into account MMSE of patients as well as caregiver-reported function and professionally-observed patient performance. Notably, the SPPB had stronger correlations with ADCS-ADL than SPSM. This finding may suggest that mobility and standing balance are more closely associated with function than lean mass and strength in patients such as those enrolled in this study.

Performance-based measures might be argued as ideal for assessing function in persons with AD, but these measures have important practical limitations. The SPPB is a well-established measure of lower body physical functioning that was shown to identify persons at greater risk for functional decline.[24] The SPPB, in conjunction with the SPSM which combines muscle quantity and function [24], could be considered a well-balanced performance-based physical assessment. However, these scales were not specifically designed for assessment of persons with AD. Each assessment was completed in the patient's home. This factor creates differences in assessment administration because each home environment is unique. Standardization is a challenge for items like chair rises, which require the patient to have a hard-surfaced, average height chair, and open wall space to use. Gait speed was occasionally administered with limited space, and moving furniture was sometimes necessary. It was sometimes difficult to create a comfortable and safe environment for movement and positioning during balancing. Environmental distractions during the testing such as interruptions by family members, televisions, or other media were additional obstacles for research staff

Administration of the ADCS-ADL posed its own set of practical limitations in data collection in the ADMIT trial. Caregivers varied in their understanding of the ADCS-ADL questions and additional explanation was often needed. The multiple choice answer selections from the ADCS-ADL required clarification, and sometimes none of the options fit the caregivers' explanation. In these circumstances the caregiver would be prompted to choose the "best option." Furthermore, ADCS-ADL questions tended to be catalysts for conversation and stories that caregivers wanted to share. Research assistants at times found it difficult to keep the interview on track while respecting additional information caregivers were willing to share.

The ADMIT data collection was able to incorporate a home-based evaluation-setting for both the patient assessments and caregiver reports. An important consideration when choosing this method over clinic or phone interviews is additional time and travel expenses. In-home assessments were typically completed in 40–70 minutes. Each home visit required an average of 14 miles of driving distance which equated to $8 in mileage reimbursement. An hour was typically allotted for each in-home assessment with 30–60 minutes of travel time in between those visits.

Overall, our findings indicate that (a) caregiver-reports provide a reliable portrayal of how patients will perform on performance-based measures of physical function and cognition and (b) in this trial cohort, our two performance-based measures (SPPB and SPSM) appeared to be valid and not affected by the patient's degree of cognitive impairment. In fact, the strongest correlation was shown in the lowest cognitive group. Going forward, these three outcome metrics (SPPB, SPSM, and ADCS-ADL) show to be acceptable measures for use in AD patients and the ADMIT trial.

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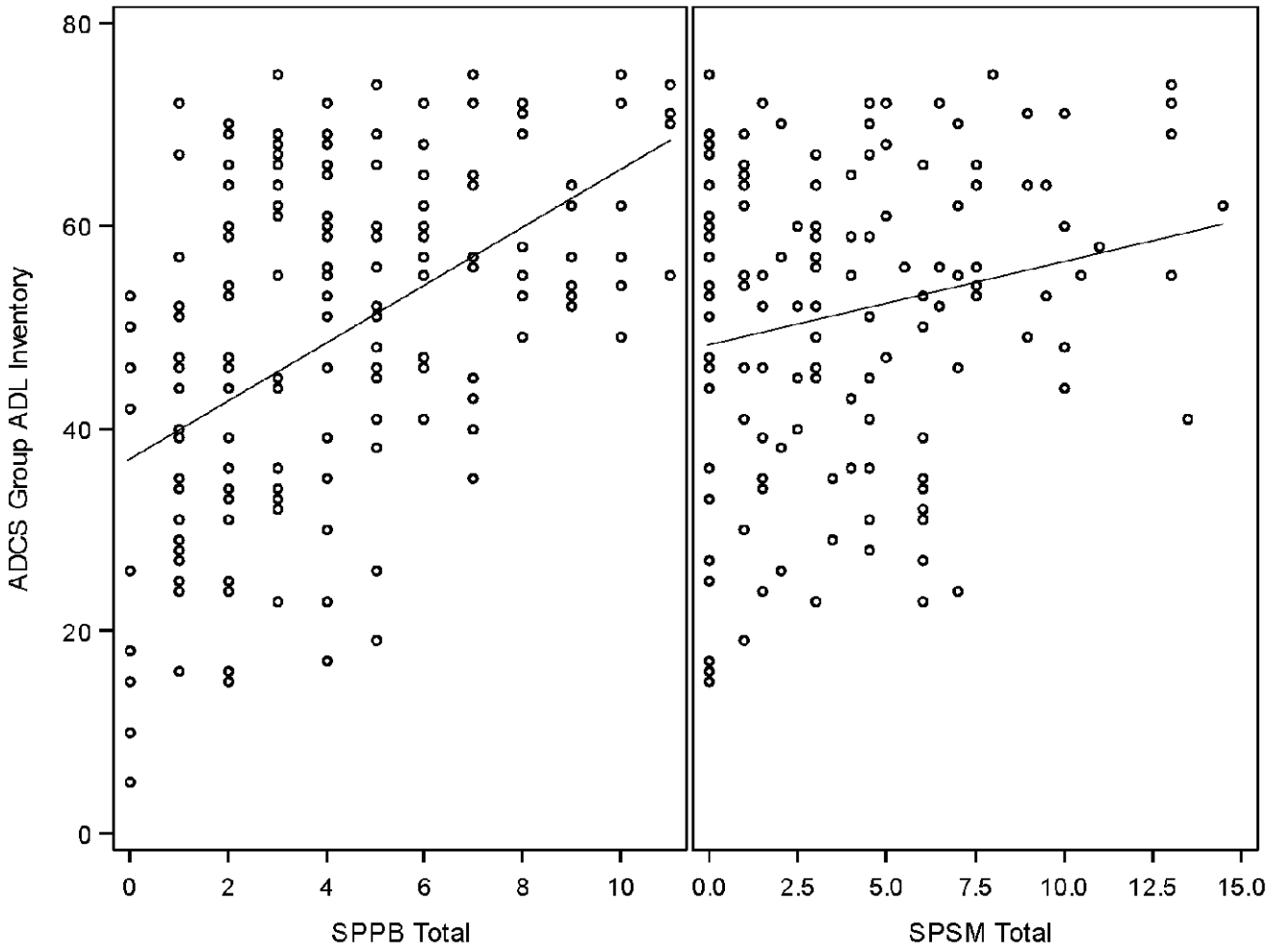

Figure 1.

Scatter plots and univariate linear regression lines of the association of the performance-based physical function measures with the ADCS-ADL score

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Table 1

Baseline Characteristics of Patients and their Caregivers (n=180)

			MMSE Quartiles				
	N	**Overall**	**1st (0–15) (n=41)**	**2nd (16–20) (n=38)**	**3rd (21–24) (n=42)**	**4th (25–29) (n=47)**	**p-value**
Patient							
Female gender, n (%)	168	116 (69.0)	27 (65.9)	24 (63.2)	33 (78.6)	32 (68.1)	0.4548
White race, n (%)	168	70 (41.7)	17 (41.5)	14 (36.8)	18 (42.9)	21 (44.7)	0.9044
Age, mean ± SD	168	78.5 ± 8.7	77.7 ± 9.1	80.3 ± 8.0	78.0 ± 7.5	78.1 ± 9.9	0.5391
What is the highest grade or year of school you completed, n (%)	166						0.2823
Grades 1 through 8 (Elementary)		34 (20.5)	8 (20.0)	6 (16.2)	11 (26.2)	9 (19.1)	
Grades 9 through 11 (Some high school)		43 (25.9)	6 (15.0)	10 (27.0)	12 (28.6)	15 (31.9)	
Grade 12 or GED (High school graduate)		49 (29.5)	15 (37.5)	15 (40.5)	12 (28.6)	7 (14.9)	
College 1 year to 3 years (Some college or technical school)		19 (11.4)	5 (12.5)	4 (10.8)	3 (7.1)	7 (14.9)	
College 4 years or more (College graduate)		21 (12.7)	6 (15.0)	2 (5.4)	4 (9.5)	9 (19.1)	
ADCS-ADL, mean ± SD	168	48.9 ± 16.7	33.8 ± 15.3	49.2 ± 14.6	51.7 ± 13.1	59.3 ± 12.7	<0.0001
MMSE, mean ± SD	168	19.3 ± 7.2	8.7 ± 5.2	18.7 ± 1.4	22.5 ± 1.1	26.3 ± 1.2	<0.0001
SPPB, mean ± SD	168	4.2 ± 3.0	2.9 ± 2.2	4.0 ± 2.8	4.6 ± 3.0	5.2 ± 3.3	0.0018
SPSM, mean ± SD	136	3.9 ± 3.6	3.3 ± 3.2	3.0 ± 2.9	4.6 ± 3.4	4.6 ± 4.4	0.1437
Caregiver (n=164) *							
Caregiver is Spouse of Subject, n (%)	164	46 (28.0)	12 (30.8)	8 (21.1)	12 (30.0)	14 (29.8)	0.7505
Age, mean ± SD	160	57.4 ± 12.2	55.9 ± 13.1	57.5 ± 12.5	57.6 ± 12.0	58.3 ± 11.6	0.8365
Female gender, n (%)	164	118 (72.0)	28 (71.8)	26 (68.4)	29 (72.5)	35 (74.5)	0.9426
White race, n (%)	164	68 (41.5)	15 (38.5)	15 (39.5)	17 (42.5)	21 (44.7)	0.935

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* 4 caregivers cared for 2 subjects each

Table 2

Results of analysis of covariance (ANCOVA) models on ADCS-ADL scores by SPPB or SPSM after adjusting for MMSE Quartiles, Caregiver Relationship to Patient, and Significant Interactions

	ADCS-ADL	
	Standardized Coefficient	**P-value**
SPPB	0.28	0.0043
MMSE quartiles		<0.0001
1st	−0.78	<0.0001
2nd	−0.30	0.0128
3rd	−0.17	0.1626
4th	Ref	Ref
Caregiver is Spouse	−0.15	0.0089
Interaction between SPPB and MMSE quartiles		0.0241
1st	0.29	0.0043
2nd	0.11	0.3374
3rd	0.0005	0.9969
4th	Ref	Ref
SPSM	0.29	0.389
MMSE quartiles		<0.0001
1st	−0.55	<0.0001
2nd	−0.26	0.0027
3rd	−0.15	0.0716
4^{th}	Ref	Ref
Caregiver is Spouse	−0.15	0.0468
Age≥80	0.19	0.0811
Interaction between SPSM and Age≥80	−0.28	0.0108