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Associations of Gait Speed and Other Measures of Physical Function With Cognition in a Healthy Cohort of Elderly Persons

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Background. Recent evidence suggests that physical decline and slower gait may be associated with early signs of dementia, but more information on healthy older adults is needed.

Methods. We determined associations between cognitive function, gait speed, and self-reported measures of physical function in 3035 healthy mobile participants of the Ginkgo Evaluation of Memory Study evaluated in 2000–2001. Gait speed was measured over a 15-foot course with participants walking at both their usual and rapid pace. Self-reported difficulties with Activities of Daily Living (ADLs) and other physical function tasks were also collected. Results of the Modified Mini-Mental State Examination (3MSE) determined cognitive function.

Results. The average age of the cohort was 78.6 years (standard deviation [*SD*] 3.3), and 53.9% of participants were men. Mean gait speed was 0.95 (*SD* 0.23) m/s at a usual pace and 1.35 (*SD* 0.58) m/s at a rapid pace. More than three-fourths of participants had 3MSE scores > 90. In multiple logistic models adjusted for demographics and comorbidities, risk of low cognition (defined as 3MSE score of 80–85) was almost twice as great for participants in the slowest quartile of the rapid-paced walking task than for the fastest walkers (odds ratio: 1.96, 95% confidence interval, 1.25–3.08). Associations between cognition and usual-paced walking were borderline, and no relationships were found with self-reported measures of physical function, including ADLs.

Conclusions. In very healthy older adults, performance-based measures better predict early cognitive decline than do subjective measures, and tasks requiring greater functional reserve, such as fast-paced walking, appear to be the most sensitive in assessing these relationships.

COGNITIVE dysfunction and physical impairment are two of the most prevalent age-related conditions and the primary cause of institutionalization in older adults (1–3). Although it is becoming increasingly apparent that the two conditions are inter-related in the path toward disability, much about the temporal relationships between cognitive and physical decline as individuals age remains unknown. Cross-sectional studies have demonstrated an association between cognitive deficits and functional impairment or disability in individuals with established dementia (4,5). The relationship between cognitive and physical function may exist, however, prior to onset of dementia, and it has been hypothesized that physical dysfunction may be a manifestation of subclinical cognitive defects in persons not classified as having met diagnostic criteria for dementia (6–9). Thus, studies assessing healthy samples of older adults, especially in populations older than 75 years, are extremely important to further understand this relationship. Furthermore, it is becoming clear that some measures of physical function may be better markers than others of early cognitive decline. Several studies have indicated that motor dysfunction as measured by a slower gait speed may be an indicator of early cognitive deficits prior to dementia onset (10–12).

Many studies examining the relationship between cognitive function and disability examine function by means of self-reported Activities of Daily Living (ADLs) (13) and Instrumental Activities of Daily Living (IADLs) (14). Although IADLs and ADLs have been found to be useful markers of functional decrements and decline in individuals with mild to moderate dementia (15,16), research on more subtle decrements of physical function in individuals with subclinical cognitive impairment before the development of deficiencies in ADLs or IADLs is limited. In addition, using these measures may be problematic in studies of cognitive decline due to the subjectivity of self-reported information and low specificity (17). Use of performance-based measures may be more appropriate in these settings to provide more objectivity in measurement and to allow for variability in effort needed for different tasks (18).

We used data from the Ginkgo Evaluation of Memory (GEM) Study to evaluate the relationship between baseline

cognitive function and both self-reported and performance-based measures of physical function, the 15-foot walk, in a group of adults 75 years old or older without dementia. Because the GEM Study incorporated this standardized, objective measure of physical function as well as self-reported ADLs and IADLs, these results may be useful in providing comparisons between the measures as well as insight into the relationships between physical disability and cognitive impairment in aging. Early detection of impairments may, in turn, potentially lead to interventions aimed at preventing further decline.

Methods

Study Population and Entry Criteria

The GEM Study is a double-blind, randomized controlled clinical trial of 3070 nondemented individuals $\geq$75 years old to assess *Ginkgo biloba* 240 mg/d versus placebo for the prevention of dementia. Details of the study have been previously described (19,20). Briefly, 3070 participants 75 years old or older were recruited from four communities in the United States: Hagerstown, Maryland; Pittsburgh, Pennsylvania; Winston-Salem/Greensboro, North Carolina; and Sacramento, California. As a prevention trial, it was important that study participants be cognitively intact and sufficiently healthy to participate in the study for four or more years. Previously described in detail (19), exclusion criteria focused on neurological or neurodegenerative diseases that would significantly affect cognitive function (e.g., Parkinson's disease or mental disorders indicated by use of antipsychotic agents, tricyclic antidepressants, electroconvulsive treatment within 10 years, or hospitalized depression in the last year), use of cognitive enhancers or treatments for Alzheimer's disease (donepezil or similar medications), contraindications for use of *G. biloba* (history of bleeding disorders or use of anticoagulants such as warfarin), and conditions that might lead to serious short-term morbidity or mortality (including prevalence of heart failure with disability, cancer treated within the past 5 years, or abnormal serum laboratory values for creatinine, liver or thyroid function, hematocrit, platelets, or white blood count).

In addition, a comprehensive evaluation for cognitive function was administered prior to enrollment into the trial. Potential participants underwent initial screening via the Telephone Interview for Cognitive Status (TICS) questionnaire (21). Persons without evidence of cognitive impairment based on a score of 28 or higher on this phone screen were then evaluated in a clinical setting to ensure the absence of dementia and to determine further eligibility and baseline health status. A two-stage design was then implemented in the clinic to assess cognition utilizing the Modified Mini-Mental State Examination (3MSE) (22). The 3MSE was used for this purpose as it has been found in the past to be an efficient screen to determine persons at high risk of dementia (23–25). Although cut-points used in the past to identify persons at greatest risk have not been consistent (recommendations range from 78 to 88), a score of 80 was selected by study neurologists for screening here based on methods used in the Cardiovascular Health Study (CHS) Cognition Study (26). Persons achieving a score of $\geq$ 80 on the 3MSE were allowed to progress to a more rigorous battery of 14 neuropsychiatric tests (19). These tests were chosen to provide detailed assessments of several major cognitive domains (executive, language, visuospatial) as well as psychomotor speed and global assessments. Criteria for individual tests to allow entry into the study were derived from the CHS Cognition Study utilizing cutoff scores that had predicted dementia in the CHS cohort (26). If participants achieved passing scores in all or all but one cognitive domain, they were eligible for entry into the GEM Study assuming that they met all the other criteria.

The demographic and baseline health characteristics of the study population were assessed using questionnaires modified from the CHS (27). Demographic characteristics ascertained at study enrollment included age, race, gender, and years of education. Anthropometric measures included using standardized protocols for height and weight, which were used to calculate body mass index (BMI) as weight (kg)/[height (m)]^2. Comorbidities including depressive symptoms were ascertained and measured by the Center for Epidemiologic Studies Depression Scale (CES-D) (28), and medical history was based on self-report of a history of 16 diseases including myocardial infarction, angina, stroke, transient ischemic attack, osteoporosis, hypertension, diabetes mellitus, and emphysema.

Measures of Cognitive and Physical Function

As noted above, all participants were screened for entry into the study by using the 3MSE (22), an expanded version of the Mini-Mental State Examination. Scores on the 3MSE range from 0 to 100, with a higher score reflecting better global cognitive functioning. The 3MSE has demonstrated moderate internal consistency and temporal reliability with good sensitivity and specificity for detecting cognitive impairment (29,30). Following a full neuropsychological evaluation, persons with evidence of dementia were excluded from the GEM Study.

Collection of self-reported physical function involved participants' responses to questions in a standardized interview asking if they had any difficulties conducting specific tasks related to ADLs (13) and IADLs (14). ADLs include self-care functions such as bathing, dressing, using the toilet, and eating, as well as several mobility tasks including getting out of a bed or chair, walking around the home, and walking 5 blocks. IADLs involve more complex tasks such as preparing meals, managing finances, using the telephone, shopping, and doing light housework. Several other physical function measures were calculated. Mobility was measured as the ability to walk 5 blocks, get out of bed or a chair, walk around the home, and walk up 10 stairs. Upper extremity strength was defined as no difficulties associated with reaching out, gripping with hands, or lifting objects. Difficulties with individual tasks were recorded and categorized into performance of ADLs, IADLs, and subsets of tasks.

The performance-based assessment of physical function was obtained using a 15-foot timed walk procedure, a validated measure of physical performance that is part of

the Short Physical Performance Battery (31). Time to walk a 15-foot course marked with tape at either end was recorded with participants' walking at both their usual and rapid pace. Timed walk at a usual pace has been previously validated as an important predictor of adverse health outcomes in community-dwelling older adults (32,33). Whereas walking at a fast pace has not been investigated to this extent, it is included in many studies evaluating physical function as it requires additional physiologic effort and may be considered a more ''conscious'' task than walking at a self-selected pace. Time was measured using a stopwatch (timed to 0.1 seconds), and participants were asked to walk at their usual pace and at a rapid pace, in that order, walking past the other end of the course before stopping. Following the usual-paced walk, respondents were asked to ''. . . walk at a rapid pace as fast as you can and go all the way past the end of the course.'' Timing began with the participant standing with both feet touching the starting line; it was stopped when his or her first foot crossed the 15-foot line. A 3-foot walk, which may be considered a short practice for the longer procedures, was done prior to each of the 15-foot trials. The technician walked alongside the participant for the length of both walks.

Statistical Analysis

Participants were included in these analyses if they scored $\geq$80 on the 3MSE and were found to be free of dementia based on a comprehensive neuropsychiatric battery of tests at baseline to ensure that only the highest functioning participants were evaluated. In addition, we required completion of both 15-foot walks (usual pace and rapid pace). Thirty-five GEM Study participants who had 3MSE scores < 80 ($n = 16$ allowed into the study by Principal Investigator discretion) or who had not completed both of the 15-foot walks ($n = 19$) were excluded from these analyses; these exclusions resulted in a sample of 3035 persons. Excluded individuals were older, less educated, and had more heart disease and a lower level of self-reported health than did the individuals who were included in these analyses.

For categorical analyses of cognition, baseline scores on the 3MSE were classified into categories: 80–85, 86–90, 91–95, and 96–100. In addition to quantification of difficulties with ADLs and IADLs, analyses were performed on other physical function tasks including mobility (difficulties with walking 5 blocks, getting out of a bed or chair, walking around the home, or walking up 10 stairs), upper extremity strength (difficulties with reaching out, gripping with hands, or lifting objects), and difficulty walking a half mile.

Time to walk 15 feet at both a usual and rapid pace were converted into measurements of gait speed as meters per second. Means and respective standard deviations were calculated for both values of gait speed, selected demographic characteristics, and comorbidities. Analysis of variance was used to detect differences in mean speed by category of selected characteristics. In addition, descriptive statistics including number and percentage of persons within each 3MSE category were calculated by demographics and physical function including gait speed and self-reported difficulties. Chi-square tests were used to determine group differences. Cross-sectional associations between baseline physical and cognitive function were determined using unconditional logistic regression analysis to evaluate whether there was an increased risk of lower cognition based on a 3MSE score of $\leq$85. Odds ratios (OR) and 95% confidence intervals (CI) were calculated for unadjusted and hierarchically adjusted models. Models were adjusted first for demographics including age, race, gender, and years of education. The second adjusted model included (in addition to demographics) adjustment for BMI, depressive symptoms (CES-D), self-reported smoking status, and history of coronary heart disease, cerebrovascular disease (stroke or transient ischemic attack), pulmonary disease, or osteoporosis. All statistics were computed using SPSS (version 12.0; SPSS, Inc., Chicago, IL).

Results

Average age of the cohort was 78.6 years (*SD* 3.3), 53.9% were men, and 95.5% were Caucasian. Mean gait speed for participants overall was 0.95 (*SD* 0.34) m/s at a usual pace and 1.35 (*SD* 0.58) m/s at a rapid pace. Bivariate differences in gait speed by selected characteristics are shown in Table 1. Differences in gait speed were detected by age, gender, education, BMI, depressive symptoms, and history of stroke and osteoporosis for measures of both usual and rapid pace. Smoking status and race were found to affect usual gait but not rapid pace. All self-reported physical function items were found to be bivariately associated with both measures of gait speed.

Baseline characteristics by 3MSE category are shown in Table 2. More than three-fourths of individuals fell within the two higher scoring groups (scores > 90). Participants in the higher scoring groups tended to be younger, male, and had higher mean years of education. Gait speed at both usual and rapid pace, as well as age, gender, race, and education, were associated with 3MSE score ($p < .001$). Gait speed at the usual pace in the lowest cognition category (3MSE of 80–85) ranged from a minimum of 0.36 to a maximum of 1.47 m/s with a mean of 0.89 (*SD* 0.21). Fast gait speed ranged from 0.56 to 2.29 with a mean of 1.23 (*SD* 0.30) in the lowest cognition category. Although trends in greater difficulties with ADLs, IADLs, and other physical function categories with lower cognition were observed, these were not statistically significant except for self-reported ability to walk a half mile ($p = .02$).

Results of logistic regression to determine multivariate associations with lower cognition are shown in Table 3. Associations between cognition and gait speed were found. Persons in the slowest quartile of walking speed at both a usual and rapid pace were more than twice as likely to have a 3MSE score of 80–85 compared to persons in the fastest quartile (usual pace OR: 2.20, 95% CI, 1.46–3.33 and fast pace OR: 2.50, 95% CI, 1.66–3.76). Although the association between usual pace walking speed and cognition was somewhat attenuated when adjusted for demographics and comorbidities (OR: 1.58, 95% CI, 1.01–2.49), the adjusted risk remained close to doubled for fast pace (OR: 1.96, 95% CI, 1.25–3.08). Unadjusted associations were found between presence of difficulties in several self-reported

Table 1. Gait Speed at Usual and Fast Pace by Selected Demographics, Comorbidities, and Other Measures of Physical Function in 3035 Participants of the GEM Study (Age 75 or Older)

		Gait Speed (m/s)			
		Usual Gait		Fast Gait	
Selected Measure	*N*	Mean (*SD*)	*p*	Mean (*SD*)	*p*
Age, y					
75–79	2014	0.97 (0.22)	< .001	1.39 (0.65)	< .001
80–84	838	0.92 (0.26)		1.30 (0.41)	
85+	183	0.83 (0.22)		1.16 (0.32)	
Gender					
Female	1399	0.92 (0.23)	< .001	1.28 (0.52)	< .001
Male	1636	0.97 (0.23)		1.41 (0.62)	
Race					
Caucasian	2899	0.95 (0.23)	.04	1.35 (0.59)	.09
Minority	136	0.91 (0.22)		1.27 (0.35)	
Education					
Less than high school	331	0.89 (0.20)	<.001	1.27 (0.48)	< .001
High school graduate	753	0.92 (0.22)		1.30 (0.32)	
Some college or graduate	1243	0.95 (0.23)		1.35 (0.69)	
Postgraduate	708	0.99 (0.26)		1.43 (0.63)	
Body mass index					
≤20	79	1.00 (0.26)	< .001	1.46 (0.78)	< .001
20.1–25	900	0.98 (0.24)		1.38 (0.35)	
25.1–30	1393	0.96 (0.23)		1.36 (0.49)	
> 30	654	0.87 (0.20)		1.26 (0.90)	
Smoking					
Never	1209	0.94 (0.25)	.01	1.33 (0.35)	.11
Former	1635	0.95 (0.22)		1.37 (0.72)	
Current	133	0.89 (0.20)		1.28 (0.31)	
Depression (CES-D score)					
0–1	1000	0.98 (0.26)	< .001	1.40 (0.56)	< .001
2–3	788	0.94 (0.22)		1.36 (0.86)	
4–6	721	0.94 (0.20)		1.33 (0.32)	
≥7	524	0.90 (0.23)		1.25 (0.31)	
History of CHD*					
Absent	2430	0.95 (0.24)	.06	1.35 (0.62)	.28
Present	605	0.93 (0.22)		1.33 (0.38)	
History of stoke†					
Absent	2784	0.95 (0.24)	.005	1.35 (0.60)	.05
Present	251	0.91 (0.19)		1.28 (0.35)	
History of pulmonary disease‡					
Absent	2758	0.95 (0.24)	.09	1.35 (0.60)	.16
Present	277	0.92 (0.19)		1.30 (0.28)	
History of osteoporosis§					
Absent	2577	0.95 (0.23)	.001	1.36 (0.54)	.02
Present	458	0.91 (0.25)		1.29 (0.79)	
Difficulty with ADLs					
None	2504	0.96 (0.23)	< .001	1.38 (0.62)	< .001
One or more	530	0.86 (0.23)		1.19 (0.32)	
Difficulty with IADLs					
None	2137	0.97 (0.22)	< .001	1.39 (0.66)	< .001
One or more	897	0.89 (0.26)		1.24 (0.33)	
Mobility difficulties					
None	2083	0.99 (0.23)	< .001	1.42 (0.66)	< .001
One or more	951	0.86 (0.22)		1.19 (0.31)	
Strength difficulties					
None	2386	0.96 (0.23)	< .001	1.37 (0.43)	.001
One or more	648	0.89 (0.23)		1.28 (0.94)	
Ability to walk a half mile					
Yes	2352	0.98 (0.23)	< .001	1.40 (0.63)	< .001
No	679	0.83 (0.21)		1.16 (0.32)	

Notes: *Self-reported history of myocardial infarction, angina pectoris, coronary bypass, or angioplasty.

†Self-reported history of stroke or transient ischemic attack.

‡Self-reported history of asthma or emphysema.

§Self-reported history of osteoporosis.

GEM = Ginkgo Evaluation of Memory; *SD* = standard deviation; CES-D = Center for Epidemiologic Studies Depression Scale; CHD = coronary heart disease; ADLs = Activities of Daily Living; IADLs = Instrumental Activities of Daily Living.

categories of physical function and cognition, i.e., IADLs ($p = .06$), mobility ($p = .04$), and ability to walk 5 blocks ($p = .01$). All were attenuated ($p > .25$) when adjusted for demographics and comorbidities.

Discussion

In this cross-sectional study of elderly individuals not meeting criteria for dementia, we found there to be a significant association between risk of a lower 3MSE score (80–85) and time to walk 15 feet at a rapid pace even after adjusting for potential confounders such as age and comorbidities. Although unadjusted associations were found for the timed walk at a usual pace, it was attenuated in adjusted models. There was a low prevalence of self-reported ADL difficulty but a relatively high prevalence of self-reported difficulty in mobility tasks, a finding typical of community-dwelling older adults in this age group (34). After adjustment, no associations with self-reported difficulties with ADLs, IADLs, or other measures of physical function were found. Results of this study demonstrate the greater utility of objective performance-based measures in investigating relationships between physical and cognitive function. Similarly, we found fast gait speed to be a more sensitive measure than self-paced walking speed in differentiating levels of cognition in older healthy adults without dementia.

One likely explanation for these findings is that, in a cognitively and physically high functioning cohort such as this, differences in physical function may only be detected in those activities that provide greater levels of variability to better separate individuals at the extremes of functionality. For example, whereas all participants in our sample may have had less difficulty with walking at usual pace, walking at a faster pace allowed participants at higher and lower levels of fitness to be identified. Walking at a self-selected usual pace may not have sufficiently stressed persons with lower physiologic reserve, and the additional effort needed

Table 2. Bivariate Associations Between Demographics and Baseline Measures of Physical Function and Cognition Based on the Modified Mini-Mental State Examination (3MSE) Scores in 3035 Participants of the GEM Study (Age 75 or Older)

	Baseline 3MSE Score				
	80–85	86–90	91–95	96–100	
Selected Measure	204	540	1118	1173	
N	*N* (%)* or Mean (*SD*)	*N* (%)* or Mean (*SD*)	*N* (%)* or Mean (*SD*)	*N* (%)* or Mean (*SD*)	$p^{\dagger}$
Mean age, y (*SD*)	79.9 (3.7)	79.2 (3.7)	78.6 (3.2)	78.1 (2.9)	< .001
Gender					
Female	83 (5.9)	228 (16.3)	480 (34.3)	608 (43.5)	< .001
Male	121 (7.4)	312 (19.1)	638 (39.0)	565 (34.5)	
Race					
Caucasian	186 (6.4)	500 (17.2)	1069 (36.9)	1144 (39.5)	< .001
Minority	18 (13.2)	40 (29.4)	49 (36.0)	29 (21.3)	
Education					
Less than high school	56 (16.9)	102 (30.8)	128 (38.7)	45 (13.6)	< .001
High school graduate	58 (7.7)	147 (19.5)	304 (40.4)	244 (32.4)	
Some college or graduate	70 (5.6)	210 (16.9)	457 (36.8)	506 (40.7)	
Postgraduate	20 (2.8)	81 (11.4)	229 (32.3)	378 (53.4)	
Gait speed (m/s)					
Usual pace	0.89 (0.21)	0.92 (0.29)	0.94 (0.21)	0.97 (0.22)	< .001
Gait speed (m/s)					
Fast pace	1.23 (0.30)	1.28 (0.35)	1.35 (0.56)	1.40 (0.71)	< .001
Difficulty with ADLs					
None	168 (6.7)	451 (18.0)	922 (36.8)	963 (38.5)	.92
One or more	36 (6.8)	89 (16.8)	196 (37.0)	209 (39.4)	
Difficulty with IADLs					
None	132 (6.2)	374 (17.5)	788 (36.9)	843 (39.4)	.18
One or more	72 (8.0)	166 (18.5)	330 (36.8)	329 (36.7)	
Mobility difficulties					
None	127 (6.1)	361 (17.3)	767 (36.8)	828 (39.8)	.08
One or more	77 (8.1)	179 (18.8)	351 (36.9)	344 (36.2)	
Upper strength difficulties					
None	164 (6.9)	418 (17.5)	901 (37.8)	903 (37.8)	.16
One or more	40 (6.2)	122 (18.8)	217 (33.5)	269 (41.5)	
Ability to walk a half mile					
Yes	144 (6.1)	405 (17.2)	871 (37.0)	932 (39.6)	.02
No	60 (8.8)	134 (19.7)	245 (36.1)	240 (35.3)	

Notes: *Row percent.
$^{\dagger}p$ value for chi-square test or analysis of variance.
SD = standard deviation; GEM = Ginkgo Evaluation of Memory; ADLs = Activities of Daily Living; IADLs = Instrumental Activities of Daily Living.

for rapid paced walking may have allowed differences in fitness and functionality to emerge. Similarly, the reporting of ADLS and IADLs may not be a sensitive indicator of the range of difficulties actually present in individuals. However, we suggest that differences in less strenuous activities or those measured less precisely might become more apparent in longitudinal studies of these individuals as cognition declines.

A number of recent studies have examined the relationship between cognition and physical function using physical performance measures. A recent prospective study reported that objectively measured physical function predicted persons subsequently classified with dementia and Alzheimer's disease (6). Other studies have also shown relationships between physical and cognitive performance in community-dwelling older populations (6,7,9,35,36), but these studies have not carefully excluded participants that could be classified as having mild dementia at either baseline or follow-up. Nevertheless, these studies have demonstrated the importance of this relationship in progression to disability. Further understanding of the interrelationship between cognitive and physical function is needed in higher functioning populations of older adults because these individuals are at a stage of functional independence where preventive interventions may be effective.

Investigation of specific cognitive domains have shown associations to exist between executive function and performance of physical tests involving dual tasks in both demented (37) and in healthy older adults (38,39). It appears that lower executive function negatively affects walking

Table 3. Associations Between Gait Speed and Other Measures of Physical Function and Cognition in 3054 Participants of the GEM Study (Age 75 or Older)

	Unadjusted		Adjusted for Demographics*		Adjusted for Demographics and Comorbidities†	
Main Effect	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Usual gait (m/s)		< .001		.10		.09
≥1.06	1.0 (Reference)		1.0 (Reference)		1.0 (Reference)	
0.93–1.05	1.34 (0.85–2.11)	.21	1.13 (0.71–1.80)	.62	1.13 (0.70–1.82)	.61
0.80–0.92	1.19 (0.76–1.86)	.44	1.02 (0.64–1.61)	.94	1.01 (0.63–1.61)	.98
< 0.80	2.20 (1.46–3.33)	< .001	1.55 (1.00–2.38)	.05	1.58 (1.01–2.49)	.05
Fast gait (m/s)		< .001		.02		.02
≥1.53	1.0 (Reference)		1.0 (Reference)		1.0 (Reference)	
1.31–1.52	1.40 (0.89–2.19)	.15	1.26 (0.79–1.99)	.33	1.30 (0.81–2.08)	.27
1.14–1.30	1.58 (0.98–2.56)	.06	1.45 (0.88–2.37)	.14	1.38 (0.83–2.30)	.22
< 1.14	2.50 (1.66–3.76)	< .001	1.93 (1.25–2.98)	.003	1.96 (1.25–3.08)	.004
Difficulty with ADLs		.94		.57		.28
None	1.0 (Reference)		1.0 (Reference)		1.0 (Reference)	
One or more	1.01 (0.70–1.47)		0.90 (0.61–1.32)		0.80 (0.53–1.20)	
Difficulty with IADLs		.06		.18		.51
None	1.0 (Reference)		1.0 (Reference)		1.0 (Reference)	
One or more	1.33 (0.98–1.79)		1.24 (0.91–1.69)		1.12 (0.81–1.55)	
Mobility difficulties		.04		.25		.65
None	1.0 (Reference)		1.0 (Reference)		1.0 (Reference)	
One or more	1.36 (1.01–1.82)		1.20 (0.88–1.63)		1.08 (0.77–1.51)	
Upper strength difficulties		.53		.43		.26
None	1.0 (Reference)		1.0 (Reference)		1.0 (Reference)	
One or more	0.89 (0.62–1.87)		0.86 (0.59–1.25)		0.80 (0.54–1.18)	
Ability to walk a half mile		.01		.20		.55
Yes	1.0 (Reference)		1.0 (Reference)		1.0 (Reference)	
No	1.49 (1.09–2.04)		1.24 (0.89–1.72)		1.12 (0.78–1.60)	

Notes: Unadjusted and adjusted odds ratios (ORs), 95% confidence intervals (CIs), and *p* values are shown.

*Adjusted for age, gender, race, and years of education.

†Adjusted for demographics plus body mass index, depressive symptoms, smoking status, and history of coronary heart disease, cerebrovascular disease, pulmonary disease, and osteoporosis.

GEM = Ginkgo Evaluation of Memory.

ability and is task-dependent with a greater influence on more challenging tasks (38). These findings may also help to explain the differences in results found here between usual and fast gait speed and to support the concept that additional concentration needed for the faster paced task may be calling upon more cognitive reserve than self-paced walking. The fact that dual tasking destabilizes gait has important implications in the prevention of falls in older adults. Consideration of preclinical cognitive decline and differential domain effects should be included in the development of interventions for fall-related adverse outcomes in the elderly population. Inclusion of tests to measure functions of specific domains will be useful in future studies evaluating gait and cognition.

It is important to note that there is some evidence that physical activity may positively affect cognitive function. Recent evidence supports the likelihood that exercise can have a beneficial effect on the brain and on cognitive functioning. Large observational studies involving community-dwelling persons have shown a reduced risk of cognitive decline (40) and dementia (41) in adults participating in exercise programs. A 7-year longitudinal study based on 3MSE measures in nondemented elderly women found that individuals with higher levels of self-reported physical activity had a lower risk for cognitive decline, defined as a ≥3-point decline on repeat 3MSE performed at a mean follow-up of 7.5 years (42). Baseline walking speed, however, was not associated with the risk of cognitive decline.

Results of this study should be considered with respect to the characteristics of persons enrolled in the GEM Study. As noted previously, participants in the GEM Study represent a very healthy subset of older adults based on high levels of education, low rates of smoking, and low prevalence of many diseases including asthma, cancer, diabetes, hypertension, and cardiovascular disease (43). Although evaluating these associations in the very healthiest elderly population is a strength of this study, greater variability present in a more population-based sample may have produced a greater number of significant associations between physical and cognitive function.

Limitations of this study include the use of self-report measures of ADL and IADL, which may not be a reliable indication of actual function and, as discussed above, are less sensitive to change over time. It should also be noted that both 15-foot walks in the GEM Study started at

a standstill and did not allow for acceleration prior to timing the procedure. Thus, walking speed here may be slower than in similar studies that allowed participants to begin walking prior to crossing the threshold of the measured course. An additional limitation of the timed walk protocol was the failure to alternate the order of the two paces to eliminate a learning effect in completion of the second (rapid pace) walk. Because ours was a cross-sectional study, we were also unable to examine whether there is a causal nature to the relationship between cognitive and physical function or to measure associations in decline over time.

Our finding of an association between cognitive function and walking speed at a fast pace confirms results of smaller studies in this large cohort of very healthy adults and provides further evidence of the value performance-based measures have in predicting early cognitive decline. One can speculate that the slower walking speed observed in those individuals in the lower 3MSE scoring groups, although without signs of clinical cognitive problems, may reflect very early physical changes that precede neurological/psychological symptoms of dementia. However, it may also be the case that those individuals with the faster walking speed are more likely to preserve cognitive function. Additionally, it is possible that rather than a causal relationship, physical and cognitive function may be interrelated or linked by common pathophysiologic mechanisms (44). These issues may be addressed further by longitudinal studies of this population and by further exploration of the etiology by investigating biological mechanisms and genetic markers. Such work has the potential to shed light on new approaches that would identify earlier persons at high risk of decline (cognitive, physical, or both) and to reduce the rate of institutionalization and adverse outcomes in this expanding age group.

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