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Self-Reported Walking Ability Predicts Functional Mobility Performance in Frail Older Adults

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OBJECTIVE: To determine how self-reported physical function relates to performance in each of three mobility domains: walking, stance maintenance, and rising from chairs.

DESIGN: Cross-sectional analysis of older adults.

SETTING: University-based laboratory and community-based congregate housing facilities.

PARTICIPANTS: Two hundred twenty-one older adults (mean age, 79.9 years; range, 60–102 years) without clinical evidence of dementia (mean Folstein Mini-Mental State score, 28; range, 24–30).

INTERVENTION AND MAIN OUTCOME MEASURES: We compared the responses of these older adults on a questionnaire battery used by the Established Populations for the Epidemiologic Study of the Elderly (EPESE) project, to performance on mobility tasks of graded difficulty. Responses to the EPESE battery included: (1) whether assistance was required to perform seven Katz activities of daily living (ADL) items, specifically with walking and transferring; (2) three Rosow-Breslau items, including the ability to walk up stairs and walk a half mile; and (3) five Nagi items, including difficulty stooping, reaching, and lifting objects. The performance measures included the ability to perform, and time taken to perform, tasks in three summary score domains: (1) walking ("Walking," seven tasks, including walking with an assistive device, turning, stair climbing, tandem walking); (2) stance maintenance ("Stance," six tasks, including unipedal, bipedal, tandem, and maximum lean); and (3) chair rise ("Chair Rise," six tasks, including rising from a variety of seat heights with and without the use of hands for assistance). A total score combines scores in each Walking, Stance, and Chair Rise domain. We also analyzed how cognitive/behavioral factors such as depression and self-efficacy related to the residuals from the self-report and performance-based ANOVA models.

RESULTS: Rosow-Breslau items have the strongest relationship with the three performance domains, Walking, Stance, and Chair Rise (eta-squared ranging from 0.21 to 0.44). These three performance domains are as strongly related to one Katz ADL item, walking (eta-squared ranging from 0.15 to 0.33) as all of the Katz ADL items combined (eta-squared ranging from 0.21 to 0.35). Tests of problem solving and psychomotor speed, the Trails A and Trails B tests, are significantly correlated with the residuals from the self-report and performance-based ANOVA models.

CONCLUSIONS: Compared with the rest of the EPESE self-report items, self-report items related to walking (such as Katz walking and Rosow-Breslau items) are better predictors of functional mobility performance on tasks involving walking, stance maintenance, and rising from chairs. Compared with other self-report items, self-reported walking ability may be the best predictor of overall functional mobility. **J Am Geriatr Soc 48:1408–1413, 2000.**

Key words: ADLs; mobility; ambulation; disability

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Evaluating physical functioning in older adults is an important component of geriatric assessment and has a number of public health, clinical, and research applications. Methods to evaluate physical function include both self-report and performance-based measures. A number of researchers who contrasted self-report and performance-based measures[1–5] found both to be useful, depending upon a number of factors, such as the goal of assessment (e.g., research- or clinically based). It has been proposed that measurement of physical function is sufficiently complex to warrant use of multiple methods, both self-report and performance-based.[5] Finally, a number of investigators have commented that the relationship between self-report and performance-based measures may be related to cognitive/behavioral factors, such as cognitive impairment, depression, and self-efficacy.[6]

Given the large populations often used in performance-based assessment studies, the number of performance tests

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has been limited to a few representative tasks. Furthermore, some studies use global scores of self-reported functional or performance decrement. Our goal was to relate both global and individual self-report items included in a standard functional mobility scale to quantitative performance of a broad range of tasks in each of three mobility domains: walking, stance maintenance, and rising from chairs. We also sought to determine these relationships among more frail, disabled older adults who still lived in the community, such as might be found residing in congregate housing facilities. Of all of the individual and global self-report items, we hypothesized that self-reported walking ability would be the strongest predictor of performance-based mobility measures. Finally, we investigated how the relationship between self-report and performance-based measures might be affected by cognitive/behavioral factors such as depression and problem-solving ability.

METHODS

These data are part of a study[7] examining the relationships among age, functional status, physical capabilities (such as joint ranges of motion and strength), cognitive/behavioral capabilities (such as attention and psychomotor speed), and performance on mobility tasks in three domains, walking, stance maintenance, and rising from chairs.

Subjects

We recruited subjects aged 60 and over who lived independently in the community from among registrants of the University of Michigan Claude Pepper Older Adults Independence Center (OAIC) Human Subjects Core (n = 36). To enhance participation of older and more frail older adults, we also recruited volunteers from five area congregate housing facilities and tested these volunteers on-site at these facilities (n = 185). For the combined OAIC and congregate housing facility sample (n = 221), mean age was 79.9 years (range, 60–102 years).

To be eligible to participate, participants had to be able to stand independently from a sitting position, with or without an assistive device, but without human assistance; stand unassisted for at least 5 minutes; walk independently, with or without an assistive device, but without human assistance; and follow simple commands and cooperate with the protocol (i.e., able to hear commands, able to see the apparatus, not agitated or uncooperative). Subjects also had to have stable cardiorespiratory status (no acute chest pain or dyspnea) and no acute infection or inflammation such as acute joint pain flare. Because self-reported functional disability was a major outcome measure, all subjects were screened to be free of substantial dementia (mean Folstein Mini-Mental State score, 28.3; range, 24–30). A relatively high percentage of subjects had abnormal findings on screening medical history and physical examination (such as previous hip fracture, degenerative joint disease, and extremity weakness).[7]

Self-reported Physical Function Measures

Subjects answered questions from the Established Populations for the Epidemiologic Study of the Elderly (EPESE) questionnaire,[8] a global self-report measure of mobility derived originally from Katz activities of daily living (ADL), Rosow-Breslau, and Nagi items (see Table 1). For the present study, a score of one was given for: (1) each ADL task item where the subject required help or that the subject was unable to perform; (2) each Rosow-Breslau item that the subject was unable to perform; and (3) each Nagi item that the subject had at least a little difficulty with. The total possible self-reported disability score was thus 15 (7 total for ADL, plus 3 total for Rosow-Breslau, and 5 total for Nagi items). Thus, a higher self-report score reflects increased disability. In addition, two relevant individual Katz items, walking ("Walk") and getting from a bed to a chair ("Transfer") were analyzed using a different scoring method (score of 1 for no help, 2 for needing help).

Table 1. Self-reported Physical Function Measures from EPESE Questionnaire[8]

Katz (ADL)

In past 12 months, needing help from some person or equipment or device in:
- Walking
- Bathing
- Grooming
- Dressing
- Eating
- Getting from a bed to a chair
- Using a toilet

Responses: no help, Help, Unable to do

Total score equals number of items (seven) with response "help" or "unable."

Separate scores (1 = No help, 2 = Help, 3 = Unable) given for walking and getting from a bed to a chair.

Rosow-Breslau

Able to do heavy work around the house like shoveling snow and washing windows, walls, or floors without help.

Able to walk up and down stairs to the second floor without help.

Able to walk a half a mile without help.

Responses: yes or no

Total score equals number of items (three) with response "no."

Nagi

Difficulty with:
- Pulling or pushing large objects like a living room chair
- Stooping, crouching, or kneeling
- Lifting or carrying weights over 10 pounds, like a heavy bag of groceries
- Reaching or extending arms above shoulder level
- Writing or handling or fingering small objects.

Responses: no difficulty at all, a little difficulty, some difficulty, a lot of difficulty, just unable to do it

Total score equals number of items (five) with a response other than "no difficulty at all."

Performance-Based Measures

Subjects performed a series of 19 graded difficulty tasks (see Table 2) in three different domains: walking (7 tasks), stance maintenance (6 tasks), and rising from chairs (6 tasks).[7] In the Walking domain, tests included walking with and without an assistive device, tandem walk, walking up steps, and turning. In maintaining stance, both bipedal and unipedal stance were tested with eyes open and closed, as well as forward and backward leaning, and tandem stance. For rising from chairs, a laboratory chair allowed the seat height

Table 2. Performance-based Measures: Walking, Maintaining Stance, Rising from Chairs

Walking (task #)
1–3. Walk 10 feet, turn 180 degrees, and return 10 feet:
  1. Using assistive device, if preferred
  2. Using right hand rail but no assistive device
  3. Without hand rail or assistive device
4. Tandem walk along line for 8 steps.
5–6. Walk up two steps, turn on landing and walk down:
  5. Using right hand rail
  6. Without hand rail
7. 360 degree turn while maintaining feet on forceplate*

Maintaining stance*
1–2. Bipedal stance, one subject foot width apart, for 30 seconds
  1. Eyes open
  2. Eyes closed
3. Lean as far forward as possible without taking step, hold for 2 seconds, then repeat lean backwards.
4. Tandem stand for 30 seconds
5–6. One leg stance, preferred leg, for 30 seconds
  5. Eyes open
  6. Eyes closed

Rising from chairs

Seat height†	*Armrest or handle use*
1. 140	Side armrests
2. 100	Front handles
3. 100	Side armrests
4. 100	None (arms across chest)
5. 60	Side armrests
6. 60	None (arms across chest)

*Tasks performed while standing on 2 ft × 2 ft forceplate.
†In % of floor to knee height.

to be adjusted from 140% to 60% of floor to knee height and the use of the arms and starting position of the armrests were altered as well.

Two scores were derived for each domain. The first score reflected the total number of tasks successfully performed in each domain (TNTP). The second score in each domain was derived from interval scale measures (ISM) associated with task performance. The measures used included walking speeds (Walking), numbers of steps (Walking), performance times (Chair Rise and Stance), and center of reaction excursion on a force plate (Stance). Because these measures could not be obtained if the subject could not perform the task, the data was recoded to take into account task failures. The distribution of each continuous variable was divided into quartiles; subjects who did not attempt or failed to complete a task were coded as 1, whereas for subjects who could complete the task, a score of 2 represented the lowest quartile and 5 the highest quartile. The ISM measure for each of the three domains was obtained by averaging the several recoded variables in each domain. The resulting measures take on the values 1–5. Thus, in contrast to the self-report scores above, *lower* total and ISM performance scores reflect increased disability.

Cognitive/Behavioral Measures

Three areas of cognitive/behavioral function were thought to possibly influence the relationship between self-report and performance measures: affect/personality, problem solving/mental flexibility, and memory. In the affect/personality domain, depressed mood was assessed by the Geriatric Depression Scale,[9] and perception of efficacy in avoiding falls while performing everyday activities was assessed by the Falls Efficacy Scale.[10] The Trails A and Trails B[11] and the Wisconsin Card Sorting Test,[12] the former motor-related and the latter nonmotor-related, were used as measures of problem solving and mental flexibility. Finally, the Logical Memory subtest of the Wechsler Memory Scale-Revised[13] served as a measure of learning and memory.

Data Analysis

The TNTP and ISM measures for each of the three domains were analyzed using one-way analysis of variance (ANOVA) models in which groups were defined by discrete self-report score levels. These levels represented the total number of disability items noted on ADL (maximum seven levels) and for Katz walking (maximum two levels) and Katz transfer (maximum two levels). An additional level was added for Rosow-Breslau and Nagi analyses when subjects denied any disability (resulting in four levels for Rosow-Breslau and six levels for Nagi). The strength of the relationship between each pair of a dependent and an independent variable was characterized using the eta-squared statistic. The eta-squared statistic can be thought of as the percent of variance in the dependent variable that can be explained by differences among several groups. The significance with each eta-squared value is the significance level associated with rejecting the null hypothesis of no intergroup differences.

A similar analysis was used to estimate the influence of cognitive/behavioral predictors on the relationship between self-report and performance. TNTP scores for Walking, Stance, and Chair Rise domains were added to give an overall TNTP score for all three domains. This overall TNTP score was then analyzed via one-way ANOVA models using the ADL, Rosow-Breslau, and Nagi levels noted above. Residuals of these ANOVA models were then correlated with individual cognitive/behavioral test scores. An increasing residual indicates that subject performance tends to be better than expected based on self-report, i.e., the subject underestimates their ability or overperforms. A declining residual indicates that subjects may perform poorer than expected by report, i.e., the subject overestimates performance ability or underperforms.

RESULTS

Self-Report and Performance-Based Performance Scores

Table 3a illustrates the self-report data according to scale, total ADL score, score for the individual walk and transfer items (on a different scale), and the total score for the Rosow-Breslau and Nagi items. These data indicate that many in the study population were at least somewhat disabled. The highest mean reported disability among the total scores tended to appear with the Nagi items (mean, 2.6), as compared with the total ADL (mean, 0.7) and total Rosow-Breslau (mean, 1.2) items. Stated in another way, subjects admitted to difficulty with more than two Nagi items, compared with nearly one item and slightly more than one item in the Katz and Rosow-Breslau items, respectively. Table 3b shows the mean task performance according to domain and according to TNTP or ISM scores. No subject failed the

Table 3a. Mean (±SD) and Range of Self-reported Function Score According to Scale*

Scale	Mean (±SD)	Range (Minimum–Maximum)
Total ADL	0.7 (1.2)	0–6
Walk only	1.2 (0.4)	1–2
Transfer only	1.1 (0.3)	1–2
Total Rosow-Breslau	1.2 (1.2)	0–3
Total Nagi	2.6 (1.6)	0–5

*Higher self-report score reflects increased self-reported disability.

easiest tasks (bipedal stance or walking with an assistive device), whereas over half failed the most difficult tasks (tandem walk, one-legged stance with eyes closed, rising from a low chair without use of hands).

Relationship Between Self-report and Performance Scores

The relationship between self-report and performance scores (reported as eta-squared) appears in Table 4 for both TNTP and ISM scales. All eta-squared are significant, with P frequently below .0001. Total Rosow-Breslau score had the strongest relationship with all three Walking, Stance, and Chair Rise performance domains in both TNTP and ISM scales (0.21–0.44), particularly for walking (0.43 and 0.44). With respect to the ADL items, the Walk item alone (0.15–0.33) was nearly as strongly related to the three performance domains as total ADL score (0.21–0.35). The Transfer item was related to the Chair Rise domains at more modest levels (0.08 and 0.14). The total Nagi score was related to the three domains again, generally at more modest levels (0.11–0.24).

Influence of Cognitive/Behavioral Function

Residuals of the ANOVA models of overall TNTP performance score on ADL, Rosow-Breslau, and Nagi scores correlated only modestly with cognitive/behavioral variables (0.2 or less), with a few notable exceptions. All correlations between residuals and Trails A and Trails B scores were statistically significant (at $P < .01$), ranging from −0.21 (ADL residual and Trails B) to −0.37 (Nagi residual and Trails A). The negative coefficient indicates that as Trails performance rose, indicating more time required to perform the task, and thus more cognitive impairment, the residual declined. A declining residual, suggesting either an overestimate of ability or task underperformance, can thus be predicted by declining Trails performance. The only other exception was in Falls Efficacy Scale score, which was significantly correlated only with the Nagi residual (0.31, $P < .01$).

Table 3b. Mean (±SD) and Range of Total Number of Tasks Performed (TNTP) and Interval Scale Scores Associated with Task Performance (ISM)*

Domain	Mean (±SD)	Range (Minimum–Maximum)
TNTP		
Walking	5.9 (1.2)	1–7
Stance	4.7 (1.0)	0–6
Chair Rise	4.9 (1.0)	1–6
ISM		
Walking	3.3 (1.1)	1–5
Stance	3.4 (0.9)	1–5
Chair Rise	3.1 (0.9)	1–5

*Lower performance score reflects increased performance disability.

DISCUSSION

We purposely selected performance-based assessments of walking, stance maintenance, and rising from chairs commonly used in epidemiological and clinical studies of mobility in older adults.[4,14–16] Our assessments were broader (e.g., including chairs of different heights) and included more "high-tech" data (e.g., center of reaction excursion measurements) than what has been used in these epidemiological and clinical studies. Study participants also completed a relatively well-known battery used in the EPESE and MacArthur studies[15–17] to report upon their ADL function and mobility status. Finally, we enriched our sample with congregate housing populations, thought to be advanced in age and at risk for functional disability. Our goal was to determine how our quantitative performance assessments related to self-reported functional status, particularly in older adults with advanced age and the presence of at least some disability.

The total Rosow-Breslau self-report score was most strongly related to the three performance domains, particularly with Walking. Because two of the three questions focused on walking, the relationship between self-reported walking and walking performance is not surprising. However, the significant relationship between total Rosow-Breslau score and Stance and Chair Rise was somewhat surprising. One possible explanation is that the tasks referred to by the Rosow-Breslau items require the balance, coordination, and strength exhibited by subjects performing the Stance and Chair Rise tasks. Another possible explanation is that the Walking, Stance, and Chair Rise tasks involve walking and/or attributes (such as balance) required to walk independently. Reported difficulty with walking might then mean that subjects have difficulty with performing other common tasks, i.e., self-reported walking difficulty becomes a marker for difficulty performing other mobility-related tasks. Others have also found that self-reported ADL and walking function relate to walking, stance, and chair rise performance measures,[15,18] even on a prospective basis.[14,17] A final explanation relates to self-report terminology. Some self-report items refer to the *ability* to perform a task (Rosow-Breslau items) with or without assistance (Katz items), whereas others refer to *difficulty* in performance (Nagi items). Some suggest that reports of *ability* are preferable to *difficulty*, at least in terms of measure reliability over time[19]; others suggest that these items both provide essential information and complement each other.[20]

As an individual ADL item, self-reported walking was the most strongly related to the three performance domains. This suggests again that the capabilities (i.e., balance) required to walk are similar to those needed to maintain stance and rise from a chair and that the self-reported walking difficulty is a marker for ADL disability. Surprisingly, difficulty with transfers was not strongly related to Chair Rise performance. One possible reason may be that transferring from a bed to a chair involves different movement strategies than those required to rise from a sit-to-stand position under different seat and hand use configurations.

Table 4. Relationship Between Self-Report and (a) TNTP and (b) ISM Performance Data

a. TNTP (Total Number of Tasks Successfully Performed by Domain)

TNTP Score	Self-report Items: ADL	Walk	Transfer	Rosow	Nagi
Walking	0.35	0.27	0.12	0.42	0.17
Stance	0.21	0.15	0.06	0.21	0.11
Chair Rise	0.28	0.20	0.14	0.33	0.14

b. ISM (Interval Scale Performance Scores)

ISM Score	Self-report Items: ADL	Walk	Transfer	Rosow	Nagi
Walking	0.34	0.33	0.11	0.44	0.24
Stance	0.23	0.17	0.07	0.42	0.14
Chair Rise	0.24	0.21	0.08	0.29	0.19

*Numbers above represent eta-squared ($P < .0002$ for values greater than 0.06).

Others have found similarly modest relationships between self-report and timed performance-based assessments, including tasks such as walking and rising from chairs.[4–6,15,21] These modest relationships may reflect discrepancies between self-report and actual performance, such as when subjects underestimate their true performance capacity.[15] A number of factors, such as depression, a sense of mastery, and perceived physical competence can contribute to these self-report–performance capacity discrepancies.[4,6] The present study did not find a significant relationship between the self-report–performance discrepancies and depression and found a limited relationship between these discrepancies and falls efficacy. However, cognitive impairment may contribute to these discrepancies.[4] Even among our nondemented subjects, declining Trails A and Trails B test performance, tests of problem solving and visuomotor speed, suggested either an overestimate of ability or task underperformance. Accurate self-report of mobility status may require the mental flexibility and problem-solving ability that is assessed by the Trails tests, particularly Trails B. Furthermore, both Trails A and B involve visuomotor speed, and slowed fine motor (upper extremity) performance on these Trails tests may predict slowed large motor performance (Walking, Stance, Chair Rise). Note also that there is a stronger relationship between cognitive/behavioral status (among a number of domains including affect) and self-reported function alone,[22] than between cognitive/behavioral status and the residuals of self-report–performance models reported in the present study.

The key finding from this study is that self-reported walking ability may be the best indicator of ADL and mobility performance in community-dwelling older adults, many of whom have ADL and mobility difficulty. Thus, self-reported walking ability has the potential to serve as a broad measure of functional status and other health-related outcomes. Others have found that self-reported ADL function[23] and walking-related items[15] also predict mortality and nursing home admission. Other measures of walking ability, such as comfortable walking speed, can provide an index of functional status.[24] Self-selected walking speed, in fact, may predict self-reported function better than other performance measures such as balance and strength.[4] Perhaps self-reports of walking ability may eventually prove to be as useful as measured walking speed as an indicator of mobility function, thereby decreasing the need for performance-based evaluations in certain situations, such as large-scale public health assessments.

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REFERENCES

1. Guralnik JM, Branch LG, Cummings SR et al. Physical performance measures in aging research. J Gerontol A Biol Sci Med Sci 1989;44:M141–M146.
2. Elam JT, Graney MJ, Beaver T et al. Comparison of subjective ratings of function with observed functional ability of frail older persons. Am J Public Health 1991;81:1127–1130.
3. Sager MA, Dunham NC, Schwantes A et al. Measurement of activities of daily living in hospitalized elderly: A comparison of self-report and performance-based methods. J Am Geriatr Soc 1992;40:457–462.
4. Cress ME, Schechtman KB, Mulrow CD et al. Relationship between physical performance and self-perceived physical function. J Am Geriatr Soc 1995;43:93–101.
5. Reuben DB, Valle LA, Hays RD et al. Measuring physical function in community-dwelling older persons: A comparison of self-administered, interviewer administered, and performance based measures. J Am Geriatr Soc 1995;43:17–23.
6. Kempen GIJM, Steverink N, Ormel J et al. The assessment of ADL among frail elderly in an interview study: Self-report versus performance-based tests and determinants of discrepancies. J Gerontol B Psychol Sci Soc Sci 1996;51;P254–P260.
7. Schultz AB, Thelen DG, Ashton-Miller JA et al. Physical capacities and mobility performance of old adults. J Am Geriatr Soc 1995;43:SA18.
8. Smith LA, Branch LG, Scherr PA et al. Short-term variability of measures of physical function in older people. J Am Geriatr Soc 1990;38:993–998.
9. Yesavage JA, Brink TL, Rose TL et al. Development and validation of a Geriatric Depression Rating Scale: A preliminary report. J Psychiatr Res 1983;17:37–49.
10. Tinetti MF, Richman D Powell L. Falls efficacy as a measure of fear of falling. J Gerontol B Psychol Sci Soc Sci 1990;45:P239–P243.
11. Boll TJ. Diagnosing brain impairment. In: Wolman BB, ed. Clinical Diagno-

sis of Mental Disorders. New York: Plenum Publishing, 1978.
12. Berg EAA. A simple objective test for measuring flexibility in thinking. J Gen Psych 1948;39:15–22.
13. Wechsler D. WMS-R, Wechsler Memory Scale-Revised. New York: Psychological Corporation, 1987.
14. Gill TM, Williams CS, Tinetti ME. Assessing the risk for the onset of physical dependence among older adults: The role of physical performance. J Am Geriatr Soc 1995;34:603–609.
15. Guralnik JM, Simonsick EM, Ferrucci L et al. A short physical performance battery assessing lower extremity function: Association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol A Biol Sci Med Sci 1994;49:M85–M94.
16. Seeman TE, Charpentier PA, Berkman L et al. Predicting changes in physical performance in a high functioning elderly cohort: MacArthur Studies of Successful Aging. J Gerontol A Biol Sci Med Sci 1994;49:M97–M108.
17. Guralnik JM, Ferrucci L, Simonsick EM et al. Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. N Engl J Med 1995;332:556–561.
18. Berkman LF, Seeman TE, Albert M et al. High, usual, and impaired functioning in older men and women: Findings from the MacArthur Foundation Research Network on Successful Aging. J Clin Epidemiol 1993;46:1129–1140.
19. Crawford SL, Jette AM, Tennstedt SL. Test-retest reliability of self-reported disability measures in older adults. J Am Geriatr Soc 1997;45:338–341.
20. Gill TM, Robison JT, Tinetti ME. Difficulty and dependence: Two components of the disability continuum among community-living older persons. Ann Intern Med 1998;128:96–101.
21. Siu AL, Reuben DB, Hays RD. Hierarchical measures of physical function in ambulatory geriatrics. J Am Geriatr Soc 1990;38:1113–1119.
22. Giordani B, Miller AC, Alexander NB et al. Neuropsychological factors relate to self-report and performance-based measures of functional mobility. Gerontologist 1995;35:363.
23. Reuben DB, Siu AL, Kimpau S. The predictive validity of self-report and performance-based measures of function and health. J Gerontol A Biol Sci Med Sci 1992;47:M106–M110.
24. Alexander NB. Gait disorders in older adults. J Am Geriatr Soc 1996;44: 434–451.