Physical-Performance Tests to Evaluate Mobility Disability in Community-Dwelling Elders

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The purposes of this study were to evaluate community-dwelling elderly adults with different levels of perceived mobility with 5 physical-performance tests, determine the cutoff values of the 5 tests, and identify the best tests for classifying mobility status. The community-mobility statuses of 203 community-dwelling elders were classified as able, decreased, or disabled based on their self-reported ability to walk several blocks and climb stairs. They also performed the functional reach, timed 50-ft walk, timed 5-step, timed floor transfer, and 5-min-walk endurance tests. We found in all tests that the "able" outperformed the "decreased" and that the "decreased" outperformed the "disabled," except on the floor-transfer task. The optimum cutoff values of the 5 performance tests were also reported. The 5-min walk and timed 5-step test could best separate the "able" from the "decreased," whereas the 50-ft-walk-test could best differentiate the "decreased" from the "disabled." The results suggest that community-mobility function of older adults can be captured by performance tests and that the cutoff values of the 5-min-walk, 5-step, and 50-ft-walk tests can be used in guiding intervention or prevention programs.

Key Words: aging, prevention of disability, older adults

Community-dwelling elderly adults who report being unable to walk a half-mile or climb stairs independently are considered to have a mobility-related disability (Guralnik, Ferrucci, Simonsick, Salive, & Wallace, 1995; Guralnik et al., 1993; Ostir, Markides, Black, & Goodwin, 1998) and are at twice the risk of developing disability in activities of daily living (Harris, Kovar, Suzman, Kleinman, & Feldman, 1989). Thus, mobility-related disability is an important marker of an older person's health.

The geriatrics literature has produced a plethora of performance tests that are recommended to predict outcomes such as falls (Duncan, Weiner, Chandler, & Studenski, 1990; Nevitt, Cummings, Kidd, & Black, 1989; Tinetti, Speechley, & Ginter, 1988), institutionalization or death (Reuben, Siu, & Kimpau, 1992; Williams, Gaylord, & Gerrity, 1994), and future disablement (Guralnik et al., 1995).

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It is impractical to subject older adults to extensive testing, particularly during community screening. It would therefore be useful to identify a subgroup of assessment procedures that could address several different functional outcomes. In addition, only a limited number of lower extremity performance measures, including standing up from a chair, tandem standing, and an 8-ft walk, predict mortality and institutionalization (Reuben, Valle, Hayes, & Siu, 1995; Guralnik et al., 1994) and identify community-dwelling elderly residents at risk for future mobility-related disablement (Guralnik et al., 1995). Expanding the tasks and difficulty required in tests of lower extremity function might yield better guidelines for interventions.

Walking capacity has been evaluated according to usual and fast gait speed and walking endurance. Gait speed was the strongest predictor of self-perceived physical function in older adults both in the community and in nursing homes (Cress et al., 1995) and has been associated with falling in elderly individuals (Guimaraes & Issacs, 1980). Gait speed and time to turn 360° have also been linked to dependence in activities of daily living (Gill, Robison, & Tinetti, 1997). A timed 50-ft walk that consists of a timed 25-ft walk, a 180° turn, and a 25-ft walk back to the starting point has been used to measure older adults' walking speed in a similar population (Murphy, Olson, Protas, & Overby, 2003).

Endurance depends on the supply of energy by oxidative mechanisms, which depend on the cardiopulmonary system (Pendergast, Fisher, & Calkins, 1993). The 5-min-walk test is used to assess cardiovascular endurance by recording the distance walked as quickly as a participant can in 5 min (Protas, 1997). This test was moderately correlated with peak oxygen consumption in elderly women (R^2 = .38, p = .05) and provided moderately better estimates of maximal exercise performance than a 3-min walk (Stanley & Protas, 1991). The 5-min-walk test has excellent test–retest reliability (r = .92; Peloquin, Gauthier, Bravo, Lacombe, & Billiard, 1998) and responsiveness (Price, Hewett, Kay, & Minor, 1988).

The ability to climb at least one step is required to maneuver over a curb or threshold and to access public transportation or other public environments (Reuben & Siu, 1990). In addition, approximately 10% of falls in the elderly occur on stairs (Tinetti & Speechley, 1989). Therefore, the ability to get up and down stairs is an essential indicator of mobility independence in elders. Stairs are not always available in testing environments, however. Thus, an aerobic step has been used to simulate stairs in the timed five-step test, which measures the length of time it takes to step forward/up and backward/down from the 4-in. step five times as quickly as possible (Murphy et al., 2003).

Tinetti, Liu, and Claus (1993) noted that older adults who were unable to get up from the floor were also more likely to suffer functional decline or expire in the following year than were those who were able to rise independently from the floor. Thus, inability to perform a floor transfer might indicate decreased mobility and increased frailty. A timed floor-transfer test has been used to measure older adults' ability to get up from the floor (Murphy et al., 2003).

Balance function is also an important component of mobility and a predictor of falls in the elderly (Nevitt et al., 1989; Robbins et al., 1989; Tinetti, Williams,

& Mayewski, 1986). The functional-reach test, designed by Duncan et al. (1990) to measure the forward limit of dynamic postural control in standing, has been strongly related to physical frailty and falls (Weiner, Duncan, Chandler, & Studenski, 1992). The functional reach has shown test–retest reliability, ICC(1, 3) = 0.92; intertester reliability, ICC(1, 3) = 0.98; criterion validity (r = .71; Duncan et al., 1990); and concurrent validity (r = .48–.71; Weiner, Bongiorni, Studenski, Duncan, & Kochersberger, 1993). The predictive validity of functional reach in identifying elderly at risk for falling was found to be as follows: If individuals were unable to reach, the adjusted odds ratio (OR) of having two falls was 8.07 (2.8–23.71); if their reach was less than or equal to 6 in., the OR was 4.02 (1.84–8.77); and if reach was greater than 6 in. but less than 10 in., the OR was 2.00 (1.35–2.98; Duncan, Studenski, Chandler, & Prescott, 1992).

Functional reach, a 5-min-walk endurance test, a timed five-step test, a timed 50-ft walk, and a timed floor transfer can therefore be identified as physical functions that relate to independent community mobility, and they have been used previously to screen for fall risk in a community-dwelling elderly population (Murphy et al., 2003). The purpose of this study was to evaluate these five performance tests in individuals with different perceived mobility statuses and to develop an effective model to assess mobility status in community-dwelling older adults. The specific aims of this study were (a) to determine whether individuals with different self-reported mobility statuses also performed differently on these tests, (b) to determine the relationships between the five performance tests and self-reported mobility status, (c) to identify the optimum cutoff values of the performance tests to classify people with different mobility statuses, and (d) to determine the test(s) that could best distinguish among the "able," "decreased," and "disabled" groups.

Methods

PARTICIPANTS

Two hundred three community-dwelling older adults from a large metropolitan area volunteered to participate in this study. Participant inclusion criteria were age of 60 years or older, living in the community, and ability to follow verbal commands. Forty-seven men and 156 women with a mean age of 74 years (range 60–91) participated in this study. The sample comprised 32% Whites, 38% African Americans, and 30% Hispanics. Most of the participants were women (76.8%). Almost 29% needed an assistive device: 23.3% used a cane and 5.5% used a walker. Before participating in the study, 44% of the participants had experienced falls at least once, 40.3% had experienced dizziness, and 6.9% had experienced brief losses of consciousness. A few participants reported being unable to perform the following activities independently without assistance: walk across a room (5.5%), take a bath (24.4%), perform a bed-to-chair transfer (3.7%), and use the toilet (7.5%). Over one quarter of the participants reported having heart disease (27.3%) or diabetes (26.9%). The demographic characteristics of the participants are reported in Table 1.

Table 1   Demographic Characteristics of Participants by Mobility Group, $M \pm SD$

	Group		
	Able (*n* = 123)	Decreased (*n* = 43)	Disabled (*n* = 37)
Age[a] (years)	72.6 ± 6.8	75.5 ± 7.0	78.8 ± 6.6
Body weight (kg)	76.9 ± 17.9	75.5 ± 13.8	75.5 ± 19.8
Height (cm)	162.0 ± 9.7	161.0 ± 8.0	164.0 ± 12.4

[a]The disabled group is significantly older than the able group ($p < .05$).

All participants read and signed an institutionally approved informed-consent form before participating in this study.

PROCEDURES

   Measures of Mobility Status.   The perceived mobility status of the participants was determined by asking if they were able, needed help, or were unable to walk several blocks and to walk up and down stairs (Guralnik et al., 1995; Guralnik et al., 1993; Ostir et al., 1998). Participants who were able to perform both tasks independently were assigned to the able group (*n* = 123); those who stated that they needed help to perform at least one of the two tasks were assigned to the decreased group (*n* = 43); and those who reported inability to perform either one or both tasks were assigned to the disabled group (*n* = 37). Participants in the three groups had similar body weight and height, but the disabled group (79 ± 7 years) was older, $F(2, 199) = 9.77$, $p < .0005$, than the able group (73 ± 7 years). The frequency of men and women in the three groups was not significantly different ($\chi^2 = 1.757$, $p = .415$).

   Physical-Performance Tests.   All participants performed five performance tests, including a functional reach, a 5-min walk, a timed five-step test, a timed 50-ft walk, and a timed floor transfer. The tests were performed in a predetermined random order using a table of random numbers. Five testers from various health professions (nursing, occupational therapy, and physical therapy) were taught by an experienced physical therapist to administer the tests and practiced on several participants before data collection.

   The functional reach was performed with the standard procedure suggested by Duncan and colleagues (1990). A participant was asked to stand with shoes on next to a yardstick placed horizontally at shoulder height on a wall. The right upper extremity was raised to 90° with the elbow extended, and the hand was held in a fist. The participant was asked to lean and reach as far forward as possible without taking a step or losing his or her balance. The investigator recorded the difference

between the initial and final positions of the third metacarpal aligned along the yardstick. The participant was given one practice trial followed by two testing trials. The mean of the two testing trials for the distance reached in centimeters was used for analysis (Duncan et al., 1990; Weiner et al., 1992). The functional reach has been reported to be reliable and valid (Duncan et al., 1990; Weiner et al., 1992).

For the 5-min-walk test the participants were asked to walk in a rectangular hallway at the fastest speed they were able to maintain for 5 min (Protas, 1997). Participants were allowed to slow down or take a rest if needed, but they resumed walking as soon as they were able during the 5-min period. A tester used a surveyor's wheel to measure the distance while walking with the participants for their safety, giving encouragement ("You are doing well, keep up the good work.") and noting elapsed time after every minute. The distance walked in 5 min was recorded in meters and used in data analysis. The 5-min-walk test has been moderately correlated with peak oxygen consumption in elderly women ($R^2 = .38$, $p = .05$) and has provided moderately better estimates of maximal exercise performance than a 3-min walk (Stanley & Protas, 1991). The 5-min-walk test has excellent test–retest reliability ($r = .92$; Peloquin et al., 1998).

To perform the timed five-step test, participants stood and faced a 4-in.-high step and were asked to step up and forward and step down and backward five times as quickly and safely as possible. They could lead with either leg. Timing was begun as soon as the first step was initiated and stopped after both feet were on the floor again after the fifth step. An investigator stood by the participants for safety and counted as the steps were completed. The required time for this performance was measured in seconds, and the speed of stepping (steps/s) was calculated and used in data analysis. This test has excellent test–retest reliability ($r = .97$, $p < .001$; Murphy et al., 2003).

The timed 50-ft walk is one component of the Physical Performance Test (PPT) developed by Reuben and Siu (1990) to assess upper fine and coarse motor function, balance, mobility, coordination, and endurance. Tape was placed on the floor at a 25-ft distance from the starting line to mark where participants should turn. Participants were timed while they walked forward as quickly as they could for 25 ft, turned 180°, and walked back to the starting point. Timing was started when a participant was ready and the tester said "go" and was stopped when the participant's first foot crossed the starting line. Fast walking speed (m/s) was calculated and used for data analysis. Test–retest reliability of this measure is high, ICC(2, 1) = 0.98, $p < .0001$ (Murphy et al., 2003).

The timed floor-transfer test began with the participants standing upright on a floor mat. When the tester said "go" the participants quickly sat down on the floor and immediately rose again to a standing position as the time was recorded. If they required assistance to get down or up, a chair was placed nearby to be used for support. The time needed was recorded in seconds and then standardized by using each participant's body height to determine the speed of this task (m/s), which was used in data analysis. For each of the tests, higher values indicate better scores.

The interrater reliability for all three timed tests (50-ft walk, five-step, and floor transfer) between various pairs of two testers was determined to be excellent ($r = .99$) for a subset of participants in the current study. The testers all used the surveyor's wheel, which has been shown to produce an accurate representation of distance traveled in pilot testing, to measure the distance for the 5-min walk. The intertester reliability for the average of two trials of the functional reach in pilot work in a similar population of community-dwelling older adults was found to be high ($r > .90$).

STATISTICAL ANALYSIS

Descriptive statistics of the five physical-performance tests were developed for the three groups (able, decreased, and disabled). Group differences for each of the performance tests were assessed with univariate analyses of variance at a significance level of .01. Tukey's post hoc testing was used to identify pairwise differences. Because the assumption of homogeneity was violated for the timed floor transfer, the Dunnett T3 test was used to determine the group differences.

The relationships between each of the five performance tests and the self-reported mobility measures were determined using Kendall's tau coefficient. The relationships among the five performance tests were determined by Pearson correlation coefficients. Receiver-operating-characteristic curves were developed using SPSS® 10.0. The cutoff points with the greatest sum of sensitivity and specificity were determined for each test. The optimum cutoff values for the performance tests were determined to differentiate the able from the decreased group, as well as the decreased from the disabled group. The point on a receiver-operating-characteristic curve that is closest to the upper left-hand corner is the "best" cutoff in terms of making the fewest mistakes; that is, it minimizes the sum of false positives plus false negatives (Sackett, Hayenes, Guyatt, & Tugwell, 1991).

Stepwise discriminant-function analysis (DFA) was performed on the total number of available cases to identify those that could distinguish best among groups. Multivariate outliers and assumptions were examined through residual analysis. The accurate group-membership classification rate was determined using a jackknifed classification (Tabachnick & Fidell, 1996). In a jackknifed procedure, one case at a time is left out from the analysis when the coefficients used to assign it to a group are computed; therefore, each case has a set of coefficients that are developed from all other cases (Tabachnick & Fidell). It gives a more realistic estimate of the ability of predictors to separate groups. To discriminate the able from the decreased group, all five tests were entered stepwise into the equation. To discriminate between the decreased and disabled groups, all tests except floor transfer were entered stepwise into the equation.

Results

The groupwise descriptive statistics for the five performance tests are reported in Table 2. All participants could perform the functional-reach, 5-min-walk, and 50-

Table 2 Descriptive Statistics of the Five Physical-Performance Tests for the Able, Decreased, and Disabled Groups

Group	Test	Value, $M \pm SD$	Number of participants unable to perform	Minimum	Maximum
Able (n = 123)	Functional reach[a] (cm)	27.55 ± 6.58	0	12.70	46.36
	5-min walk[a] (m)	347.56 ± 82.56	0	107	549
	50-ft walk[a] (m/s)	1.09 ± 0.24	0	0.7	1.9
	Five-step[a] (steps/s)	0.37 ± 0.10	0	0.18	0.64
	Floor[a] (m/s)	0.16 ± 0.08	4	0.01	0.45
Decreased (n = 43)	Functional reach[a,b] (cm)	23.35 ± 7.39	0	8.05	41.91
	5-min walk[a,b] (m)	240.90 ± 78.45	0	84	373
	50-ft walk[a,b] (m/s)	0.82 ± 0.24	2	0.30	1.30
	Five-step[a,b] (steps/s)	0.24 ± 0.11	5	0.00	0.50
	Floor[a] (m/s)	0.08 ± 0.05	0	0.02	0.24
Disabled (n = 37)	Functional reach[b] (cm)	16.91 ± 7.45	0	0.00	27.31
	5-min walk[b] (m)	172.04 ± 99.41	0	24	417
	50-ft walk[b] (m/s)	0.55 ± 0.23	0	0.1	1.1
	5-step[b] (steps/s)	0.17 ± 0.1	3	0.00	0.39
	Floor (m/s)	0.06 ± 0.06	13	0.01	0.25

[a] A significant group difference was found in ANOVA test ($p < .01$). All tests demonstrated significant difference between the able and the decreased groups. [b] Nonetheless, only four tests showed significant differences between the decreased and the disabled groups except for in the floor transfer.

ft-walk tests without problems. There were 22 participants, however, who were unable to perform the floor transfer (4 in the able group, 5 in the decreased group, and 13 in the disabled group). Five participants were unable to perform the timed five-step test (2 in the decreased group and 3 in the disabled group).

There were significant group differences for all five performance tests ($p < .01$), and their calculated effect sizes were as follows: 5-min walk = .64, 50-ft walk = .66, five-step test = .63, functional reach = .51, and floor transfer = .48. The power for each was above .9. Post hoc analysis revealed that the able group outperformed the decreased group, which in turn outperformed the disabled group, on four of the five tests ($p < .01$). There was no difference between the decreased and the disabled groups ($p > .05$) on the floor-transfer test (Table 2).

Table 3 presents correlations of the performance tests with mobility status (1 = able, 2 = decreased, 3 = disabled) and correlations among the performance tests. The 50-ft walk had the highest correlation with mobility status ($\tau = .536$, $p < .01$), followed by the five-step test ($\tau = .515$, $p < .01$) and the 5-min walk ($\tau = .505$, $p < .01$). As for the intertest correlations, the highest significant correlation was found between the 50-ft walk and 5-min walk ($r = .813$, $p < .01$). The five-step test was moderately correlated with the 50-ft walk ($r = .785$, $p < .01$) and the 5-min walk ($r = .724$, $p < .01$). The walk tests and step test demonstrated only fair correlations with the functional-reach ($r = .507–.615$, $p < .01$) and floor-transfer tests ($r = .507–.662$, $p < .01$).

The optimum cutoff values to distinguish groups, along with sensitivity and specificity values, are reported in Table 4. The timed five-step and 5-min-walk tests showed better specificity (>85% and >73%, respectively), whereas the functional reach and the timed floor transfer showed better sensitivity (85.7% and 87.5%

Table 3   Correlation Matrix for the Five Performance Tests and the Disability Status

	Functional reach (cm)	50-ft walk (m/s)	5-min walk (m)	5-step (steps/s)	Floor transfer (m/s)
Functional reach (cm)[a]					
50-ft walk (m/s)[a]	.59*				
5-min walk (m)[a]	.62*	.81*			
5-step (steps/s)[a]	.60*	.79*	.72*		
Floor transfer (m/s)[a]	.45*	.62*	.63*	.58*	
Disability status[b]	.38*	.54*	.51*	.52*	.44*

[a]The association among the five performance tests was determined by the Pearson correlation coefficient. [b]The association between the disability status and each of the five performance tests was determined by Kendall's tau.
*$p < .01$

Table 4 Cutoff Values of the Five Performance Tests to Distinguish the Able, Decreased, and Disabled Groups

Performance test	Disability group	Cutoff value[a]	Sensitivity	Specificity
Functional reach (cm)	Able – decreased	30	85.7%	37.7%
	Decreased – disabled	24	80.6%	52.4%
5-min walk (m)	Able – decreased	286	71.4%	79.2%
	Decreased – disabled	196	71.4%	73.8%
50-ft walk (m/s)	Able – decreased	0.96	74.4%	67.2%
	Decreased – disabled	0.71	74.3%	79.1%
5-step (steps/s)	Able – decreased	0.26	60.5%	85.4%
	Decreased – disabled	0.15	47.1%	90.7%
Timed floor transfer (m/s)	Able – decreased	0.11	87.5%	70.7%
	Decreased – disabled	0.04	64.7%	78.1%

[a]Performance better than cutoff value indicates negative classification. Performance equal to or worse than cutoff indicates positive classification.

for the able- and the decreased-group separations, respectively). The 50-ft-walk cutoff scores demonstrated closer sensitivity and specificity values (67.2–79.1%). Specificity describes the proportion of those without the condition that are correctly identified by a test, whereas sensitivity describes the proportion of those with the condition that are correctly identified by the test (Sackett et al., 1991).

The stepwise DFA revealed that both the 5-min walk and the five-step test were significant predictors of membership for the able and decreased groups, with an eigenvalue of .399 and a canonical correlation of .534 ($\chi^2_2 = 44.683, p < .0005$), which explained about 28.5% of variability in mobility-group membership. Group membership was correctly classified 75.9% of the time, including 72.5% for the able group and 85.7% for the decreased group. A second stepwise DFA revealed that the 50-ft-walk speed was a significant predictor of membership in the decreased versus the disabled group, with an eigenvalue of .281 and a canonical correlation of .468 ($\chi^2_2 = 9.807, p < .005$), which explained about 21.9% of the variability in mobility-group membership. Group membership was correctly classified 71.8% of the time, including 79.1% for the decreased group and 62.9% for the disabled group.

Discussion

The results of this study support Guralnik and colleagues' findings that mobility-related disability among community-dwelling older adults can be captured by physical-performance tests (Gill, Williams, & Tinetti, 1995; Guralnik et al., 1995; Guralnik et al., 1994). Our five performance tests demonstrated a hierarchy of ability among the three groups. In general, the able group outperformed the decreased

group, whereas the decreased group outperformed the disabled group. The floor transfer appeared to be the most challenging test in that 22 participants were unable to complete the task, and there were no significant differences in performance of that test between the decreased and the disabled groups. It also demonstrated 87.5% specificity in discriminating the able and the decreased groups. Thus, the floor-transfer test seems useful in identifying very early decline in mobility for relatively high-functioning individuals. The next-most-challenging task was the timed five-step test. It is possible that there is a hierarchical sequence of physical-performance decline.

A self-report measure is an efficient way to identify mobility disability during community screening. Our results suggest that the self-report measure we used could partially reflect the current mobility status of older adults, because the performance-test results showed a significant difference among the three mobility groups. Perceived mobility status depends, in part, on physical-performance abilities, but psychosocial and environmental factors also play a significant role in self-reports of mobility (Myers, Holliday, Harvey, & Hutchinson, 1993). The moderate relationships between the self-report and performance-based measures of mobility, which are consistent with previous studies (Sager et al., 1992; Sherman & Reuben, 1998), indicate that they provide complementary information. The use of self-report measures alone is likely not sufficient; studies have shown that self-report measures might not be as sensitive to changes in early stages of decline or to changes with interventions as the performance-based measures are (Brach, VanSwearingen, Newman, & Kriska, 2002). Once mobility status is identified by self-report, clinicians might need to further define the causes of reduced mobility in order to develop effective interventions. Using physical-performance tests with established cutoff values would help clinicians determine whether physical function is a limiting factor for mobility in specific individuals.

An optimum cutoff value indicates the value that has the greatest diagnostic accuracy (greatest sum of sensitivity and specificity), that is, the least false positive and false negative results. For example, the optimum cutoff values of the 5-min walk for the able and decreased groups and for the decreased and disabled groups were 286 m and 196 m, respectively. Thus, an individual who walks more than 286 m in 5 min is considered to have a true negative test result (able), and one who walks 196 m or less in 5 min has a true positive test result (disabled). Those who walk between 197 and 285 m would belong in the decreased group (Table 3). These grouping techniques would facilitate planning for individual clients, in that the most disabled might receive active interventions, those with decreased ability might benefit from disability-prevention strategies, and those who are currently able to perform these tasks would just be monitored over time.

Specific cutoff values identified in this study were similar to those that distinguish older adults with and without a history of falls (Murphy et al., 2003). For example, in the present study, a cutoff score of 286 m on the 5-min walk differentiated the able and the decreased groups. This value is close to the 305-m cutoff score reported by Murphy et al. for older adults with a history of falls. The cutoff

scores are also similar in these two studies for the five-step test (0.26 steps/s for able–decreased differentiation vs. 0.24 steps/s for faller–nonfaller differentiation). In contrast, the functional-reach cutoff score to differentiate able and decreased is substantially higher, at 30 cm, than the 17.6 cm for faller versus nonfaller groups. Nonetheless, our functional-reach cutoff value of 24 cm to differentiate the decreased and disabled groups is close to that suggested by Duncan and colleagues (1992) in that anything below 10 in. (25.4 cm) presented a significant fall risk. The similarities of these cutoff values suggest that these three tests might be used to assess both mobility disability and fall risk in elderly populations.

The results from the DFA indicate that the 5-min walk and the five-step speed discriminated between the able and decreased group members, and the 50-ft-walk speed was the only measure that differentiated the decreased group from the disabled group. Therefore, to determine mobility disability, we would recommend using these three tests.

There were some limitations of this study. We did not ask the participants to define their usual environment for stair climbing or the number of stairs climbed. The communities in which this testing was performed, however, had few buildings with outside stairways, and internal flights of stairs usually include at least 10–12 steps. We did not include assessments for psychosocial factors such as depression, motivation, socioeconomic support, environmental accessibility, and self-efficacy that could have an influence on perceived mobility status (Myers et al., 1993). For optimum disability prevention, these factors should also be addressed.

In addition, according to the standard procedures for the tests in this study, participants performed at their fastest speed rather than their preferred speed. The 5-min-walk test is similar to the 6-min walk in that it is meant to assess cardiovascular endurance by recording the distance walked as quickly as an individual possibly can in 5 min (Protas, 1997). This test was moderately correlated with peak oxygen consumption in elderly women and provided moderately better estimates of maximal exercise performance than a 3-min walk (Stanley & Protas, 1991). The standard procedures for the 5-min walk and the 50-ft walk followed the original developers' instructions. Previous studies have found fast walking speed to be a sensitive predictor of the onset of functional dependence in older adults age 65–74 years, whereas usual walking speed was most sensitive for those over 75 years of age (Shinkai et al., 2000). Thus, fast walking speed is more sensitive in detecting functional dependence in younger individuals than is usual walking speed. This "fast-speed" context, however, could increase the sensitivity to minor changes in performance and could also cause fatigue or anxiety. To minimize fatigue effects, we provided ample rest time and randomized the test sequence. For the floor transfer and timed five-step test, we found in our pilot studies that the request to perform the tasks as quickly as possible appeared to focus participants' attention on the task and to improve the reliability of the tests. Performance-based tests can also be conducted at a preferred pace if the goal is to determine whether older adults can independently move around in their environment, a marker of being able to "age in place."

In this study, we focused on specific tests that have been used in previous work (Murphy et al., 2003). There are other performance tests that have been validated for use in discriminating levels of mobility. This study is unique, however, in that we have not only suggested the tests themselves but also provided cutoff points that can be used to guide further assessment and intervention. We would encourage other researchers to provide similar cutoff scores for tests they recommend as mobility screening tools in order to improve their usefulness.

Conclusions

The results of this study support Guralnik and colleagues' (1995) findings that lower extremity performance tests are associated with mobility-related disability. Although all five tests were able to confirm mobility levels as differentiated according to self-report, the 5-min-walk distance, the 50-ft-walk speed, and the five-step-test speed have the greatest potential to discriminate among the groups. These three performance tests are easy to administer, do not require expensive instruments or extensive training, and can be completed in 10 min, depending on the amount of rest time required. We recommend using these three tests and the cutoff scores established for them when screening elderly populations for mobility disability.

References

Brach, J., VanSwearingen, J., Newman, A., & Kriska, A. (2002). Identifying early decline of physical function in community-dwelling older women: Performance-based and self-report measures. *Physical Therapy,* **82**, 320-328.

Cress, M.E., Schechman, K.B., Mulrow, C.D., Fiatarone, M.A., Gerety, M.B., & Buchner, D.M. (1995). Relationship between physical performance and self-perceived physical function. *Journal of the American Geriatrics Society,* **43**, 93-101.

Duncan, P.W., Studenski, S., Chandler, J., & Prescott, B. (1992). Functional reach: Predictive validity in a sample of elderly male veterans. *Journal of Gerontology*, **47**, M93-M98.

Duncan, P., Weiner, D., Chandler, J., & Studenski, S. (1990). Functional reach: A new clinical measure of balance. *Journal of the American Geriatrics Society,* **40**, 203-207.

Gill, T.M., Robison, J.T., & Tinetti, M.E. (1997). Predictors of recovery in activities of daily living among disabled older persons living in the community. *Journal of Internal Medicine,* **12**, 757-762.

Gill, T.M., Williams, C.S., & Tinetti, M.E. (1995). Assessing risk for the onset of functional dependence among older adults: The role of physical performance. *Journal of the American Geriatrics Society,* **43**, 603-609.

Guimaraes, R.M., & Issacs, B. (1980). Characteristics of the gait in old people who fall. *International Rehabilitation Medicine,* **2**, 177-180.

Guralnik, J.M., Ferrucci, L., Simonsick, E.M., Salive, M.E., & Wallace, R.B. (1995). Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. *New England Journal of Medicine,* **332**, 556-561.

Guralnik, J.M., LaCroix, A.Z., Abbott, R.D., Berkman, L.F., Satterfield, S., Evans, D.A., & Wallace, R.B. (1993). Maintaining mobility in late life. I. Demographic characteristics and chronic conditions. *American Journal of Epidemiology,* **137**, 845-857.

Guralnik, J.M., Simonsick, E.M., Ferrucci, L., Glynn, R.J., Berkman, L.F., Blazer, D.G., et al. (1994). A short physical performance battery assessing lower extremity function: Association with self-reported disability and prediction of mortality and nursing home admission. *Journal of Gerontology,* **49**, M85-M94.

Harris, T., Kovar, M.G., Suzman, R., Kleinman, J.C., & Feldman, J.J. (1989). Longitudinal study of physical ability in the oldest-old. *American Journal of Public Health,* **79**, 698-702.

Murphy, M.A., Olson, S.L., Protas, E.J., & Overby, A.R. (2003). Screening for falls in community-dwelling elderly. *Journal of Aging and Physical Activity,* **11**, 66-80.

Myers, A.M., Holliday, P.J., Harvey, K.A., & Hutchinson, K.S. (1993). Functional performance measures: Are they superior to self-assessments? *Journal of Gerontology,* **48**, M196-M206.

Nevitt, M.C., Cummings, S.R., Kidd, S., & Black, D. (1989). Risk factors for recurrent non-syncopal falls: A prospective study. *Journal of the American Medical Association,* **261**, 2663-2668.

Ostir, G.V., Markides, K.S., Black, S.A., & Goodwin, J.S. (1998). Lower body functioning as a predictor of subsequent disability among older Mexican Americans. *Journal of Gerontology,* **53**, M491-M495.

Peloquin, L., Gauthier, P., Bravo, G., Lacombe, G., & Billiard, J-S. (1998). Reliability and validity of the five-minute walking field test for estimating VO_2 peak in elderly subjects with knee osteoarthritis. *Journal of Aging and Physical Activity,* **6**, 36-44.

Pendergast, D.R., Fisher, N.M., & Calkins, E. (1993). Cardiovascular, neuromuscular, and metabolic alterations with age leading to frailty. *Journal of Gerontology,* **48**, 61-67.

Price, L.G., Hewett, H.J., Kay, D.R., & Minor, M.M. (1988). Five-minute walking test of aerobic fitness for people with arthritis. *Arthritis Care and Research,* **1**, 33-37.

Protas, E.J. (1997). Cardiovascular and pulmonary function. In Van Deusen, J., & Brunt, D. (Eds.), *Assessment in occupational therapy and physical therapy*. Philadelphia: W.B. Saunders.

Reuben, D.B., & Siu, A.L. (1990). An objective measure of physical function of elderly outpatients: The physical performance test. *Journal of the American Geriatrics Society,* **38**, 1105-1112.

Reuben, D.B., Siu, A.L., & Kimpau, S. (1992). The predictive validity of self-report and performance-based measures of function and health. *Journal of Gerontology,* **47**, M106-M110.

Reuben, D.B., Valle, L.A., Hayes, R.D., & Siu, A.L. (1995). Measuring physical function in community-dwelling older persons: A comparison of self-administrated, interviewer-administrated and performance-based measures. *Journal of the American Geriatrics Society,* **43**, 17-23.

Robbins, A.S., Rubenstein, L.Z., Josephson, K.R., Schulman, B.L., Osterweil, D., & Fine, G. (1989). Predictors of falls among elderly people: Results of two population-based studies. *Archives of Internal Medicine,* **149**, 1628-1633.

Sackett, D.L., Hayenes, R.B., Guyatt, G.H., & Tugwell, P. (1991). *Clinical epidemiology: A basic science for clinical medicine*. Boston: Little, Brown & Co.

Sager, M.A., Dunham, N.C., Schwantes, A., Mecum, L., Halverson, K., & Harlowe, D. (1992). Measurement of activities of daily living scales in hospitalized elderly: A comparison of self-report and performance-based methods. *Journal of the American Geriatrics Society,* **40**, 457-462.

Sherman, S.E., & Reuben, D. (1998). Measures of functional status in community-dwelling elders. *Journal of General Internal Medicine, 13*, 817-823.

Shinkai, S., Watanabe, S., Kumagai, S., Fujiwara, Y., Amano, H., Yoshida, H., et al. (2000). Walking speed as a good predictor for the onset of functional dependence in a Japanese rural community population. *Age and Ageing, 29*, 441-446.

Stanley, R.K., & Protas, E.J. (1991). Validity of a walk test in elderly woman. *Physical Therapy, 71*, S72-S73.

Tabachnick, B.G., & Fidell, L.S. (1996). *Using multivariate statistics*. New York: Harper-Collins College.

Tinetti, M.E., Liu, W.L., & Claus, E.B. (1993). Predictors and prognosis of instability to get up after falls among elderly persons. *Journal of the American Medical Association, 269*, 65-70.

Tinetti, M.E., & Speechley, M. (1989). Prevention of falls among the elderly. *New England Journal of Medicine, 320*, 1055-1059.

Tinetti, M.E., Speechley, M., & Ginter, S.F. (1988). Risk factors for falls among elderly persons living in the community. *New England Journal of Medicine, 319*, 1701-1707.

Tinetti, M.E., Williams, T.F., & Mayewski, R. (1986). Fall risk index for elderly patients based on number of chronic disabilities. *American Journal of Medicine, 80*, 429-434.

Weiner, D., Bongiorni, D., Studenski, S., Duncan, P., & Kochersberger, G. (1993). Does functional reach improve with rehabilitation? *Archives of Physical Medicine and Rehabilitation, 74*, 796-800.

Weiner, K., Duncan, P.W., Chandler, J., & Studenski, S.A. (1992). Functional reach: A marker of physical frailty. *Journal of the American Geriatrics Society, 40*, 203-207.

Williams, M.E., Gaylord, S.A., & Gerrity, M.S. (1994). The timed manual performance test as a predictor of hospitalization and death in a community-based elderly population. *Journal of the American Geriatrics Society, 42*, 21-27.