

Refining the Categorization of Physical Functional Status: The Added Value of Combining Self-Reported and Performance-Based Measures

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Background. When considered individually, self-reported functional status and performance-based functional status predict functional status decline and mortality. However, what additional prognostic information is gained by combining these approaches remains unknown.

Methods. The authors used three waves of three sites (5138 participants) of the Established Populations for Epidemiologic Studies of the Elderly to determine the prognostic value of individual and combined approaches. Baseline self-reported (mobility and activities of daily living [ADL] items) and performance-based (Physical Performance Score) functional status information was classified into three and four hierarchical categories, respectively.

Results. Based on self-reported information alone, at 1 year, 73% participants had not changed, 15% declined, 6% improved, and 6% died. At 4 years, 53% had not changed, 24% declined, 2% improved, and 22% died. Based on performance-based assessment alone, at 4 years, 33% of the sample remained stable, 37% declined, 6% improved, and 24% died. In the top two self-reported categories, functioning on the performance-based assessment varied widely. Among those who were independent in all self-reported functioning, approximately 40% scored in each of the top two performance-based categories. Among persons in the top two self-reported categories, poorer performance was associated with progressively higher 1-year and 4-year mortality rates. Among persons with impaired mobility and at least 1 ADL dependency, the mortality rate was high and was not influenced by performance-based score.

Conclusions. Combining self-reported and performance-based measurements can refine prognostic information, particularly among older persons with high self-reported functioning. However, if ADL dependency is present, performance-based measures do not add prognostic value regarding mortality.

AN older person's ability to function can be viewed as a summary measure of the overall effect of medical conditions, lifestyle, and age-related physiologic changes in the context of his or her environment and social support system. Although functional status can be conceptualized at the molecular, cellular, and organ levels (1), from a clinical perspective, the foci are primarily at the levels of the organism and its interaction with society. In this clinical context, physical functional status is an important dimension that ranges from basic components (e.g., strength, balance, and endurance) to role function (e.g., paid or volunteer work) (1). Using a variety of instruments that capture different aspects of this range, physical functioning has become a common outcome measure for epidemiologic and clinical research on older persons.

Two general methods, subjective and objective, can be used to measure physical functioning (1). Subjective measures rely on a person's (or their proxy's) perception and may be obtained by questionnaires that the person completes or by interview. In contrast, objective (also called performance-based) measures rely on the assessment of

a trained observer. Both self-reported functional status and performance-based functional status predict outcomes such as functional status decline, nursing home placement, and mortality in diverse populations (2–9). Self-reported (or proxy-reported) functional status can be obtained by questionnaire or telephone interview, thus facilitating convenience and reducing administrative costs. Furthermore, subjective assessment generally focuses on items that have direct clinical and caregiving relevance, such as shopping or bathing. However, subjective measures may be inaccurate because a person may overestimate or underestimate his or her capabilities. Furthermore, dependency in the traditionally assessed self-reported items, such as basic and instrumental activities of daily living (ADL) (10,11), is uncommon (12), which results in ceiling effects (i.e., a large proportion will score at the top of the scale or are unimpaired) that limit the range that can be captured. As a result, interest in using performance-based measures to assess physical functioning has been increasing.

Performance instruments can be standardized and objectively scored, may be useful in monitoring disease

progression and response to therapy, and often provide data suitable for robust statistical analysis. Although objective measurements have theoretical advantages (13), they are neither superior to nor interchangeable with subjective measures (14,15). Rather, they may measure different, although related, constructs (16) and may provide complementary information. In fact, a recent study indicated that among high-functioning older persons, self-reported and performance measures were independent predictors of walking endurance (17). Furthermore, previous studies of preclinical disability have shown the prognostic value of physical performance testing among persons without ADL disability (5,18).

Based on the strengths and limitations of subjective and objective measurements of function, combining these approaches might provide additional information regarding function. For example, within a self-reported functional status category, the addition of performance-based information may further classify the population into meaningful subgroups.

In this study, we used the Established Populations for Epidemiologic Studies of the Elderly (EPESE) database, including 4-year follow-up data, to answer the following questions about self-reported and performance-based functional status: What are the relations between performance-based function scores and the self-reported ability to perform basic ADLs? Can performance-based and self-reported functional status be combined to refine the categorization of physical functioning for the elderly population? What are the self-reported and performance-based transitions in functional status during a 4-year period? What is the prognostic value of combining self-reported and performance-based physical functioning measures to predict subsequent mortality?

METHODS

The EPESE was initiated in 1981 and follow-up continued through 1992 (19). At baseline (in the years 1981 to 1982) and in subsequent waves, EPESE collected a broad array of self-reported information. In the sixth follow-up wave (1988), an in-home interview was conducted in which self-reported and basic physical examination (including performance-based measures) data were collected. Because the sixth follow-up wave was the only wave to have physical examination information, uniformly collected as part of the core measures collected by each site, we used this wave as the inception point for analysis of subsequent functional decline and mortality.

We focused the analysis on variables that were collected at the sixth, seventh, and tenth follow-up waves. All three sites (Iowa, New Haven, and East Boston) had complete Physical Performance Scores (PPSs) and self-reported functional status available for the sixth follow-up wave. After the sixth follow-up, the EPESE sites were less consistent in the data collected. The Iowa and New Haven sites collected only self-reported ADL and mobility items at the seventh follow-up, and the Iowa site collected both self-reported and PPS data at the tenth follow-up (9). The East Boston site did not collect data on functional status after the sixth follow-up wave.

Participants

Our analysis used data from the original sites of the EPESE study, which were East Boston, Massachusetts; Iowa and Washington Counties in East Central Iowa; and New Haven, Connecticut. The sampling frame for each site differed. East Boston employed a total-community census, whereas Iowa used a population list from the local Area Agency on Aging and a special census conducted by the investigators; both of these sites tried to recruit all enumerated persons aged 65 years or older. New Haven conducted a stratified cluster sampling of three different types of residents: those dwelling in public housing, private housing for the elderly, and elsewhere in the community.

Participation rates in the baseline EPESE survey in 1981 and 1982 ranged from 80% to 85% across sites. At the initial baseline interview, there were 10,294 participants who were at least 65 years old. By the time of the sixth follow-up (the baseline for the current study), 3200 were known to have died, 113 were lost to follow-up, and 414 refused to be interviewed. Of the remaining 6567 persons, 543 were determined to be in a nursing home at that time, 452 had their interview through a proxy, 383 were interviewed by telephone, and 51 could not be linked to Health Care Financing Administration data to obtain Part A Medicare costs, which was the primary focus of a companion study. After these persons were excluded, 5138 cases were available at baseline for the current analyses.

Because of previously noted inconsistencies in EPESE data collection across sites, the sample sizes for changes in functional status are smaller. Information on self-reported disability status at 1 year (the seventh follow-up wave) was obtained for 1924 persons in Iowa and for 1183 persons in New Haven; 123 and 66 participants had died at these sites, respectively, at 1 year. Information on disability status at 4 years (the tenth follow-up) was obtained for 1601 persons in Iowa; a total of 435 persons had died during this 4-year follow-up. Information on vital status came from obituaries, contact with proxies, and the National Death Index.

Measures

Self-reported functional status was measured using selected ADLs (9) and mobility-related functional tasks (20). The ADLs included self-reports of bathing, transferring from bed to chair, dressing, eating, and using the toilet. We dichotomized these variables as being “unable to do or requiring human help” (dependent) versus “able without help” (independent). Mobility-related disability was defined as in a previous EPESE report (21) as two items from the Rosow-Breslau scale: inability to walk one-half mile, to walk up and down stairs to the second floor without help, or both. Reporting inability to perform either of these tasks resulted in a classification of disabled. As with previous EPESE analyses (20), we established a three-level hierarchical scale for self-reported functional status that included (a) independence in mobility and all ADLs (66%); (b) dependence in mobility and independence in all ADLs (27%); and (c) dependence in mobility and 1 or more ADL (7%). Only 96 of the 5138 (1.9%) participants could not be classified at baseline using this system (e.g., 32 were missing ADL responses and 64 were independent in

Table 1. One- and 4-Year Transitions in Self-Reported Functional Status Based on the Hierarchical Classification System
($N = 3299$ for 1 Year, $N = 2054$ [Iowa Only] for 4 Years)*

Percentage of Sample at Baseline		Percentage** of Sample at Each Level at 1 and 4 Years									
Level	%	1-year					4-year				
		A	B	C	Dead	Total N	A	B	C	Dead	Total N
A	66	79	15	2	4	2210	59	16	8	17	1375
B	27	19	59	14	8	854	6	38	27	30	491
C	7	4	16	63	17	210	2	5	37	56	98
Total N	5042	1847	855	298	184	3184	842	415	279	428	1964

Notes: *115 (3.5%) of nondecedents were lost to follow-up at 1 year and 90 (4.4%) were lost at 4 years. Those lost to follow-up did not differ on age, gender, ethnicity, or educational level except that those who were lost to follow-up at 4 years were younger (mean age 77.1 vs 78.7 years, $p = .007$).

**1-year and 4-year percentages indicate the percentage of those who were at each baseline level of function (i.e., rows sum to 100% for each year).

Hierarchical classification: A = independent in mobility and all ADLs; B = dependent in mobility and independent in all ADLs; C = dependent in mobility and 1 or more ADLs.

ADL = activities of daily living.

mobility but impaired in ADL functioning). Similarly, 2.1% of the 1-year and 2% of the 4-year participants could not be classified. These participants were excluded from analyses of self-reported functioning.

Performance-based functional status was measured using the PPS. This measure consists of three tasks: standing with the feet together in the side-by-side, semitandem, and tandem positions; time to walk 8 feet; and time to rise from a chair and return to the seated position 5 times. Each task was scored from 0 (unable to complete) to 4 (fastest based on quartiles of time needed to complete the task or best using a hierarchical scoring of difficulty), and the scores were summed to create an overall score from 0 to 12. The battery has been validated in the EPESE cohort after being administered to more than 5000 participants in their homes and can distinguish risk for mortality and nursing home placement among older persons who are at the high end of the functioning spectrum (22). The instrument has also been predictive of subsequent 1-year and 4-year disability in the EPESE population (5,9). We categorized PPS as it has been used in previous studies in four categories [10–12, 7–9, 4–6, and 0–3], with 0 indicating worst and 12 indicating best performance (5). Among the 5138 participants, 448 (8.7%) were missing baseline PPS data, so these participants were not included in analyses of performance-based functioning. Among the Iowa sample, 318 (15.7%) of the 4-year participants were missing PPS data.

Analyses

We first calculated descriptive statistics of the relations between performance-based and concurrent self-reported functional status dependencies at baseline. For participants with dependency in each self-reported functional task, we described PPS performance and other dependencies in self-reported functional status. We analyzed transitions in functional status based on self-reported and performance methods independently. For self-reported functional status, we evaluated 1-year and 4-year transitions using the hierarchical scale. For performance-based functional status, we evaluated 4-year transitions in PPS score. We combined baseline self-reported functional status with baseline PPS functional status for the 4611 participants who had complete data on both sets of measures to create a more precise method of categorization.

With this approach, we cross-classified the 3 states of self-reported functional status and the 4 states of PPS function to create 12 unique categories. Only 11 of these had enough cases ($n \geq 10$) for analysis; the last category included those with low self-reported functional status and high performance-based functional status, which would be clinically improbable. For each of the categories with at least 10 cases, we calculated 1-year and 4-year mortality rates. To determine whether PPS score provided independent predictive value, we stratified on self-reported functional status and then used logistic regression (adjusted for age and sex) to determine the effect of PPS score on 1-year and 4-year mortality rates. The logistic regression with the independent variable of PPS is a test for linear trend of the PPS variable, and an alternative (using continuous rather than categorical or ordinal level data) to the Mantel-Hanzel test. We also analyzed the major findings across sites and found that results were similar. Accordingly, only combined results are presented.

RESULTS

Sociodemographic characteristics of the entire sample were mean age, 78.4 years; female, 65.1%; African American, 5.1%; fewer than 9 years of education, 42.4%; and more than high school education, 14.4%.

Mobility dependency was common in this population (34%), and most persons (approximately 80%) with mobility dependency did not have other dependencies. Among those with mobility dependence, 96% were dependent in walking one-half mile and 41% were dependent in climbing stairs. Dependency in bathing was the most common ADL dependency (7%), and approximately one half (56%) of those with bathing dependency had no other ADL dependency. In contrast, more than 90% of those with eating, transferring, or toileting dependency had other ADL dependencies as well. Nevertheless, dependencies in eating, toileting, and transferring were extremely rare (approximately 1% or less) in this population.

We analyzed transitions in 1-year and 4-year self-reported functional status using the hierarchical classification system. Participants could have remained the same, declined, improved, or died. At 1 year (using the Iowa and New Haven samples only), 73% had not changed in functional

Table 2. Four-Year Transitions in Performance-Based Function (N = 2022 [Iowa Only])*

Baseline Score	%	Percentage* of Sample at Each Level at 4 Years Physical Performance Score					Total N
		10-12	7-9	4-6	0-3	Dead	
10-12	32	35	37	10	3	15	552
7-9	38	9	35	27	9	19	647
4-6	18	1	10	24	31	35	310
0-3	11	0	2	7	42	49	195
Total N	4690	255	467	320	257	405	1704

Notes: *318 (15.6%) of nondecedents were lost to follow-up. Those lost to follow-up were more likely to be women (77% versus 66%, $p = .005$).

**4-year percentages indicate the percentage of those who were at each baseline level of performance (i.e., rows sum to 100%).

status level, 15% declined, 6% improved, and 6% died. Table 1 provides percentages of participants at each level at baseline and at 1 and 4 years by baseline level. For example, at baseline, 66% of participants were at level A and of those, 79% remained at level A at 1 year, 15% declined to level B, 2% declined to level C, and 4% died. One-year death rates ranged from 4% among those at level A to 17% of those at level C. At 4 years (using only the Iowa sample), 53% had not changed in functional status level, 24% declined, 2% improved, and 22% died. Four-year death rates ranged from 17% of those who were at level A to 56% of those who were at level C.

We examined 4-year transitions in PPS. Overall, one third of the sample remained stable in PPS, 37% declined, 6% improved, and 24% died. Of those who declined, 78% declined by only one level. Table 2 shows the baseline distribution of PPS and also 4-year PPSs by baseline level. For example, 32% scored 10-12 at baseline. Of these, 35% scored 10-12, 37% scored 7-9, 10% scored 4-6, 3% scored 0-3, and 15% died by 4 years.

Next, we combined self-reported and performance-based methods by analyzing the baseline distribution of PPS among those who were at various levels in the self-reported hierarchy (Table 3). For example, 28% of all participants were at level A and had PPSs of 10-12, representing the best-performing group. Although nearly all (93%) of those in the top level of PPS were at level A of the self-reported hierarchy, the converse was not true. Only 41% of those who were at level A at baseline scored at the top of the PPS. Among those who were level C in the hierarchy, only 8% (less than 0.5% of the total population) scored in the top 2 levels of PPS.

Table 4 shows 1-year and 4-year mortality rates by the combination of baseline self-reported and PPS measures. Among those who were in the top two self-reported (A and B) categories, poorer PPS scores were associated with progressively higher 4-year mortality rates (reading across rows). Among persons with impaired mobility and at least 1 ADL (level C), the PPS score did not influence the 4-year survival rate. In the logistic regression models stratified according to self-reported level, for participants with baseline self-reported levels of A or B, a higher PPS was significantly associated (all $p \leq .005$) with a lower risk for 1- and 4-year mortality (adjusted relative risks, .86 to .91 per

Table 3. Combined Self-Reported and Performance-Based Function at Baseline (N = 4611)

Self-Reported Level	Percentage of Sample* Physical Performance Score					Total N
	10-12	7-9	4-6	0-3	Dead	
A	28	28	10	2		3177
B	2	7	9	7		1173
C	0	<.5%	1	4		261
Total N	1416	1662	917	616		4611

Notes: *Total = 98.5% due to rounding.

Hierarchical classification: A = independent in mobility and all ADLs; B = dependent in mobility and independent in all ADLs; C = dependent in mobility and 1 or more ADLs.

ADL = activities of daily living.

PPS unit). For participants at baseline self-reported level C, the PPS was not significantly associated with 1- or 4-year mortality.

DISCUSSION

In this large, community-based population of older persons, we found self-reported functional disability of basic ADLs to be rare. Furthermore, those who were ADL disabled frequently had several ADL disabilities. These findings are consistent with those of other reports (23,24) and indicate that relying solely on self-reported ADL function would fail to detect functional limitation in a substantial proportion of the population. In contrast, self-reported mobility-related disability and poor performance-based function were common and frequently isolated functional limitations. This scenario of a predominantly ADL-independent population with substantial mobility and performance-based limitations suggests the need for a more comprehensive classification system that can more precisely categorize those who are functionally intact in their ADLs.

Using a combination of self-reported and performance-based measures, the entire EPESE population could be classified into 11 categories, with no more than 28% of the population fitting into any single category. Of particular importance, by combining performance-based data with self-reported information on mobility, we created eight different categories for the 93% of community-dwelling older persons who were independent in ADL function. These eight categories reflected substantial diversity in performance-based function. Among the 66% of the population who were unimpaired in any self-reported disability (including mobility) at baseline, only 41% scored in the top category (PPS score of 10-12) using performance-based testing. Of the 27% who were independent in ADL but had mobility-related disability, performance-based scores were poorer than for the best self-reported category but were well distributed across the range of the PPS.

These findings are consistent with the theory that measurable observations (e.g., slowing of gait velocity) can detect "preclinical" limitations, perhaps even before a person is aware of any decline (25). Furthermore, this categorization system had prognostic value. Among those who were independent in all self-reported functions (including mobility), progressively poorer baseline scores on

Table 4. One- and 4-Year Mortality Rates Using Combination of Self-Report and Performance-Based Baseline Function ($N = 4611$)*

Baseline Self-Report	Mortality Rate (Expressed as a Percentage)**									
	Baseline Physical Performance Score									
	1-year					4-Year				
	10-12	7-9	4-6	0-3	Total <i>N</i>	10-12	7-9	4-6	0-3	Total <i>N</i>
A	2 (1311)	3 (1313)	3 (465)	7 (88)	3 (3177)	9 (1311)	13 (1313)	18 (465)	30 (88)	13 (3177)
B	2 (104)	4 (330)	5 (408)	9 (331)	6 (1173)	14 (104)	22 (330)	27 (408)	30 (331)	25 (1173)
C	* (1)	11 (19)	9 (44)	12 (197)	11 (261)	* (1)	53 (19)	46 (44)	46 (197)	46 (261)
Total <i>N</i>	(1416)	(1662)	(917)	(616)	(4611)	(1416)	(1662)	(917)	(616)	(4611)

Notes: *Numbers of persons in each cell are listed in parentheses; cells with sample size <10 are excluded.

Hierarchical classification: A = independent in mobility and all ADLs; B = dependent in mobility and independent in all ADLs; C = dependent in mobility and 1 or more ADLs.

ADL = activities of daily living.

the performance-based measure were associated with progressively higher 4-year mortality rates. In contrast, those who self-reported ADL disability almost uniformly scored in the bottom category of PPS, and performance-based testing did not add any prognostic value. These findings suggest that performance-based testing is most valuable for those who are functioning at higher levels.

This research builds on that of others who have tried to further refine the classification of functional status. For example, by asking about difficulty in performing functional tasks, Gill and colleagues (8) found that approximately 20% of the functionally independent older population were at higher risk for functional decline, hospitalizations, nursing home placement, and mortality. Nevertheless, "difficulty" is a subjective perception and may be interpreted differently by different persons. Using performance-based measures to differentiate among those within a self-reported functional status category may provide more uniform classification. Nor are these two approaches mutually exclusive. Performance-based measures may be the earliest harbingers of decline in some functional tasks in some older persons. Conversely, for other functional tasks, the patient may be able to sense an impending problem earlier. We could not determine whether combining self-reported perceived difficulty and performance-based measures provides additional prognostic value. However, combining these two measures may help determine whether patients are performing up to the levels of their capability.

The findings of this study must be interpreted in the context of its strengths and limitations. The sample was large and geographically diverse. Nevertheless, the sample was primarily white and the applicability of these findings to minority populations is uncertain. Furthermore, all sites did not uniformly collect self-reported disability information or administer performance-based testing at the same time periods. As a result, the sample size for changes in self-reported and PPS function varies. We were also limited to measures that were collected in EPESE, and thus some important functional status variables, such as instrumental ADLs and difficulty with ADL tasks, were unavailable.

As a practical approach, we suggest the following strategy to classify the physical functioning of community-dwelling older persons. The evaluation begins by asking about self-reported functional status, which would be used to categorize persons into three groups: unimpaired,

impaired only in mobility, or impaired in mobility and ADL function. Because this classification generally follows a hierarchical pattern, the first questions would ask about mobility-related function. Information about ADL function would only be asked if mobility-related function was impaired. For those who are independent in all self-reported functions or are dependent only in mobility-related functions, performance-based testing would be administered. This strategy can rapidly categorize a person with respect to physical functional status and provide prognostic information.

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