Functional Limitations and Disability among Elders in the Framingham Study

ABSTRACT

Background. The measurement of physical disability as an indication of the impact of disease is commonly seen in research. However, these measures often do not clearly differentiate between functional limitations and daily performance of an activity.

Methods. We measured the differences between self-reported disability and observed functional limitations in six activities of daily living tasks among community-dwelling elders. The value of functional limitations vs disability measures in determining risk factors for disablement was ascertained.

Results. Systematic differences were found among the 1453 participants. At least 89% of the time when a difference was identified, the subjects ranked disability greater than the functional limitations observed. For those who were cognitively impaired, discrepancies occurred up to 11% of the time. In determining risk factors for disablement, we found that neurological impairments were associated with both functional limitations and disability, while sociocultural factors were associated with disability only.

Conclusions. Our findings suggest that physical functional limitations and disability in the elderly are two distinct concepts and that the measure of choice should be determined by research objectives and the type of population being studied. (*Am J Public Health.* 1992;82:841–845)

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Introduction

Changes in life expectancy have resulted in an elderly population of increasing size and proportion where significant numbers are affected by disability.[1,2] Although physical limitations clearly increase with advancing age, reports of prevalence and severity of disability from existing studies may vary up to 3.1%. Although these differences are small in absolute terms, they can be large in percentage differences across surveys.[3] Methodological differences in obtaining the data and the type of population studied are two sources for these discrepancies.

Efforts to determine the magnitude of disability among elders have been hampered by lack of conceptual clarity.[4,5] Most of the current information on physical disability has been generated from self-report measures of activities of daily living (ADL). Often, these measures do not clearly differentiate between the presence of a functional impairment that makes an activity difficult or impossible to carry out and the actual performance of the activity.[6] Understanding of the methodology used to measure disability and determination of the specific functional limitations will not only improve precision for defining levels of disability among elders but also will increase our understanding of risk factors for disablement.

Important distinctions among concepts measurement in disability research have been addressed in a model developed by Saad Nagi[7,8] in which he proposes that there are three major consequences of disease or pathology. The first is impairment, representing the anatomical or physiological abnormality resulting from a pathologic process; the second, functional limitation, is the loss of ability to perform tasks and obligations of usual roles and normal daily life; and the third, disability, is an individual's behavior pattern that evolves with long-term impairment. In this report, we use Nagi's concept of functional limitation to describe a person's inability or restriction in performing an activity and disability to describe a person's pattern of behavior in daily life.

Documentation of the differences between a person's functional limitations and disability is sparse.[9] To distinguish these differences, we compared self-reported disability in six ADLs with observed functional limitations in the same activities in a controlled setting. Knowledge of the relationship between these two concepts and what factors may cause discrepancies will further understanding of disability measurement.

Methods

The study population was the Framingham cohort, a general population sample of residents of the town of Fram-

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TABLE 1—Differences in Observed Functional Limitations and Self-Reported Disability in Activities in Daily Living (ADL)

ADL	Overall Differences		Self-reported Disability Greater than Observed Functional Limitations	
	%	n	%	No. of Differences
Dressing	3.9	1448	96.4*	56
Grooming	4.5	1453	96.8*	64
Feeding	3.1	1409	90.6*	43
Chair transfer	3.4	1446	97.9*	48
Walking	6.5	1448	96.8*	94
Stair climbing	6.5	1448	89.3*	94

*$P < .005$, extension of McNemar's test.

ingham, Mass. This cohort of 5209 men and women, aged 28 to 62 at entry in 1948, has routinely been assessed every 2 years for factors related to disease occurrence. The sampling procedures, clinical protocols, and disease determinants have been reported previously.[10,11] During a 2-year period (1983 to 1985), 1453 of the 1826 subjects participating in the 18th biennial cycle completed a disability questionnaire prior to their physical examination. At the time of this exam, 2758 of the original cohort of 5209 had died, 151 were institutionalized, and 474 had refused the biennial examination or were lost to follow-up.

Sixty percent of the participants (870 of the 1453) were women, the mean age was 72 years (range = 63 to 94), and all resided in the community. Because cohort members in nursing homes had on-site examinations and the controlled environment for testing functional limitations was not available, they were excluded from this analysis. The 373 cohort members taking Exam 18 who did not complete the disability questionnaire prior to the examination were also excluded. Those excluded were older (mean age = 76.7) and more likely to be female (64%).

Measures

Reported disability questionnaire. A questionnaire was mailed to Framingham participants 1 week prior to the examination. Each was asked to identify his or her normal day-to-day performance of six basic ADLs as defined by variables from the Katz and Mahoney and Barthel indexes.[12,13] These activities included dressing, grooming, feeding, transferring, walking, and stair climbing. Disability scores were assigned to each response (0 = "uses no help to perform the activity," 1 = "uses a device to perform the activity," 2 = "uses assistance of another person to perform the activity," and 3 = "does not perform the activity").

Functional limitation measure. At the beginning of the exam, a trained nurse measured each participant's ability to accomplish the specific tasks reported on the questionnaire according to a standard protocol. The functional limitation score ranged from 0 to 3 (0 = "did the activity without assistance," 1 = "did the activity using a device," 2 = "required human assistance to do the activity," and 3 = "was unable to do the activity").

Other variables. Several factors thought to influence disability measurement were included in the analyses. Age was dichotomized at below 75 years and 75 years and older. The Folstein Mini Mental State Exam (MMSE), a test of cognition, was administered.[14] MMSE scores range from 0 to 30, with scores of 23 or below reflecting probable cognitive deficits. Perceived health, whether a person lived alone or with others, and documentation of stroke or coronary heart disease, which included myocardial infarction, coronary insufficiency, and angina, were included.

Data Analysis

Cross tabulations between each functional limitation and disability item were performed to determine the frequency and direction of differences across each of the six activities. An extension of McNemar's test was used to determine the significance of differences in the discrepancies between functional limitations and disability,[15] and χ^2 tests were used to determine whether bivariate subgroup differences by age and cognition were statistically significant.

Multiple logistic regressions of discrepancies for each ADL were performed to determine the association with selected variables. The coding for the dependent variable for each ADL task was as follows: 0 = "agreement between functional limitations and self-reported disability in the ADL tasks" and 1 = "self-reported disability greater than functional limitations." The few cases in which the reported disability was less severe than the limitations observed were not included in the analyses. Odds ratios and 95% confidence intervals were calculated for each of the predictor variables. The independent variables were age, living situation, perceived health, cognitive function, stroke, and coronary heart disease.

To demonstrate the potential empirical impact of using functional limitations vs self-reported disability measures, we used two multivariate models to predict the presence of disability using both a sum of the observed functional limitation scores and a sum of the self-reported disability scores. For the first model, the sum of the functional limitations score was dichotomized as follows: 0 = "functionally independent in all ADL tasks by observation" and 1 = "functionally dependent in one or more ADLs by observation." The summary self-reported disability score was similarly dichotomized. The same predictor values were used as in the previous analyses.

Results

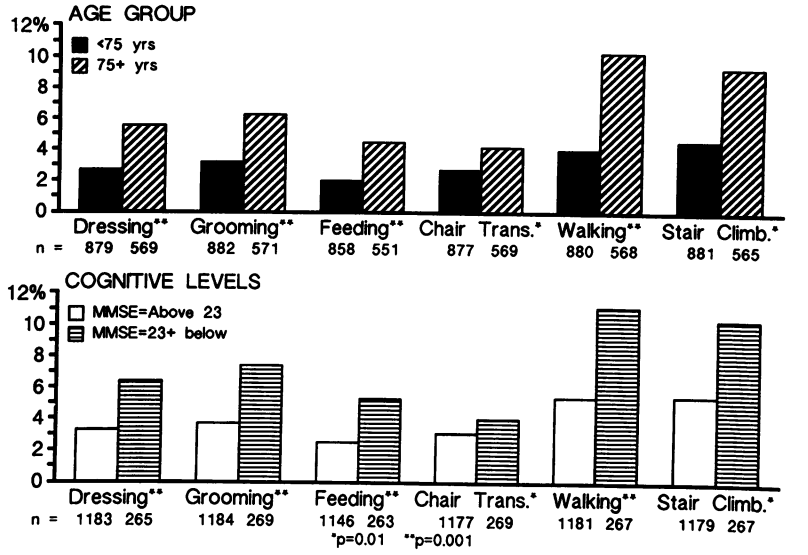
In this study of community-dwelling elders, over 92% of the cohort neither reported disability nor were observed to have functional limitations in the six ADL tasks. Differences did occur between functional limitations and disability in 3.1% to 6.6% of the cohort, most frequently in walking and stair climbing (6.5%) and least frequently in feeding (3.1%). The direction of the differences was highly systematic; at least 89% of the time when a difference was identified, the reported disability was greater than the functional limitations observed (Table 1).

Moreover, when the study sample was examined by age groups and cognitive levels, greater differences were identified. In all six ADL tasks, those who were older and those with cognitive impairment demonstrated significantly larger differences between reported disability and functional limitations (Figure 1). Disparities by age ranged from 3.2% to 4.7% in the below-75 age group and from 4.3% to 10.4% in those 75 years and older. Reported and observed limitations for mobility tasks showed the largest differences by age, with the older group having dif-

ferences of 10.4% in walking and 9.9% in stair climbing. When the sample was divided into those with low cognition scores (MMSE scores of 23 and below) and those within the normal range, the greatest differences between reported disability and observed limitations were seen, with the disparity between functional limitations and disability reaching 11.3% for the cognitively impaired. Again, the largest differences were observed in mobility activities.

The multiple logistic regressions (Table 2) revealed that age, cognitive impairment, and prior stroke were most strongly associated with disparities between functional limitations and reported disability. Stroke was significantly associated with differences in dressing, feeding, and stair climbing. Those in the older age group reported greater disability than the limitations observed in three of the six ADL tasks. Women, the cognitively impaired, those in the older age group, and those who perceived their health as fair or poor reported significantly more disability in walking, the ADL task with the most frequent differences.

To demonstrate the potential value of using a measure of functional limitations vs reported disability in determining risk factors for disablement, we calculated two multivariate models to predict physical disablement. Results of these summary analyses showed that only two of the seven predictors were significantly correlated with both functional limitations and disability scores (Table 3). The two strongest predictors of both functional limitations and disability were stroke and cognitive impairments. The three variables associated with reported disability, but not functional limitations, were age, sex, and perceived health.



Note. MMSE = Mini Mental State Exam.

FIGURE 1—Percentages by age groups and cognitive levels with disagreement between functional limitations and observed disability

Discussion

The results of this study demonstrate that in a cohort of community-dwelling elders, the vast majority neither reported disability nor were observed to have functional limitations. However, those with some restrictions/limitations rarely rated their disability below their functional limitations. These persons reported that their day-to-day disability in specific ADL tasks was greater than the observed functional limitations 89% of the time or more when a difference was identified. These results should dispel the persistent fear that self-report measures of functional disability will yield underestimates of the prevalence of disablement because of the older person's reluctance to admit to his or her limitations.[16] In fact, self-report of disability may yield higher estimates as compared with observed functional limitations if the self-report focuses on the individual's actual behavior in daily life.

Investigators are increasingly using performance testing in large-scale surveys of physical disability in older populations.[9] This trend may reflect legitimate concern that self-reported questions of physical capacities may elicit a subjective response that indicates what older persons think they are capable of, even though they may not normally attempt the activity. Such judgments are subject to potential error and may not accurately estimate the functional ability of the older person. A different challenge is faced when using self-reported disability measures. Here the question is whether or not a particular activity is not performed because of health problems or as a result of other unrelated reasons. Some investigators have used the concept of perceived difficulty in performing ADLs to distinguish the health-related significance of the reported behavior, while others have asked the respondents only to report limitations related to their health.[17–19]

This study examined the hypothesis that performance of ADLs has an integral cognitive component that influences day-to-day function. Those with cognitive impairment showed significantly greater differences between functional limitations and disability. This supports the need for further investigation into the specific manifestations and etiology involved in cognitive impairment and outcome measurements used in this population.[6] The fact that the older age group displayed significantly greater disparity for the ADLs studied, especially for mobility, may be the result of a more cautious life-style.

In general, mobility tasks more than self-care activities were associated with differences between functional limitations and disability. Disparities in walking were significantly associated with age, gender, cognitive impairment, and overall perceived health status of the cohort members.

The last goal of this study was to ascertain whether functional limitations and disability were associated with different risk factors. In other words, does the choice of one or the other influence the findings using the same predictive model? We found that cognitive impairment and history of stroke are the only two risk factors for functional limitations among the six variables in the logistic model. In contrast, disability was associated with four of the six factors, including age, gender, perceived health, and cognitive impairment and stroke. This supports Nagi's formulation that disability, unlike functional limitations, has a major social component.[7] Since disability reflects performance within a sociocultural context, one could expect that daily performance of an activity would be strongly influenced by sociocultural factors. One could speculate that

TABLE 2—Multiple Logistic Models Showing Association between Demographic Characteristics, Health Status, and Reported Disability Greater than Observed Functional Limitations

	Odds Ratios (95% Confidence Intervals)					
	Dressing	Grooming	Feeding	Chair Transfers	Walking	Stairs
Age[a]	1.77 (1.06–2.97)	1.76 (1.05–2.91)	1.55 (0.99–2.43)	1.23 (0.71–2.12)	1.75 (1.13–2.70)	1.23 (0.78–1.94)
Sex[b]	1.04 (0.62–1.74)	1.38 (0.82–2.33)	1.05 (0.67–1.64)	1.11 (0.65–1.91)	2.31 (1.41–3.77)	1.43 (0.92–2.28)
Living situation[c]	1.08 (0.72–1.64)	1.04 (0.69–1.55)	1.06 (0.73–1.53)	1.07 (0.68–1.67)	1.06 (0.75–1.49)	1.33 (0.95–1.87)
Perceived health[d]	1.05 (0.56–1.98)	1.30 (0.72–2.30)	1.04 (0.59–1.83)	1.97 (1.10–3.54)	2.79 (1.78–4.38)	2.30 (1.42–3.72)
Cognition (MMSE)[e]	1.99 (1.16–3.42)	1.63 (0.94–2.84)	1.00 (0.45–1.32)	1.00 (0.52–1.93)	1.62 (1.01–2.60)	1.87 (1.15–3.03)
Stroke[f]	2.70 (1.15–6.34)	1.44 (0.50–4.17)	2.31 (1.04–5.10)	1.16 (0.35–3.87)	1.71 (0.73–1.51)	2.29 (1.02–5.13)
Coronary heart disease[g]	1.11 (0.58–2.09)	1.22 (0.62–2.42)	1.23 (0.71–2.13)	1.22 (0.60–2.51)	1.60 (0.63–1.87)	1.23 (0.68–2.21)

Note. The dependent variable was coded as follows: 0 = "agreement between self-report and observed limitations" and 1 = "disagreement between self-report and observed limitations."
[a]1 = ≥75; 0 = <75.
[b]1 = female; 0 = male.
[c]1 = living with others; 0 = living alone.
[d]1 = fair or poor; 0 = good or excellent.
[e]MMSE = Mini Mental State Exam. 1 = MMSE ≤ 23 (impaired); 0 = MMSE > 23 (normal).
[f]1 = yes; 0 = no.
[g]1 = yes; 0 = no.

TABLE 3—Logistic Regression Models of Predictors of Observed Functional Limitations and Disability for All ADL Tasks

	Dependent Variable			
	Functional[a] Limitations		Disability[b]	
	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval
Age (<75/75+)	0.72	0.45–1.17	2.1	1.41–3.10
Sex (male/female)	0.84	0.53–1.33	1.52	1.01–2.28
Living situation (alone/with others)	0.91	0.63–1.33	0.82	0.61–1.12
Perceived health (excellent or good/fair or poor)	1.32	0.97–1.80	2.03	1.57–2.62
Cognition (≤23/>23 on MMSE)	2.55	1.27–5.12	2.58	1.41–4.71
Stroke (absent/present)	3.13	1.47–6.65	2.56	1.27–5.19
Coronary heart disease (absent/present)	0.64	0.31–1.35	1.0	0.49–2.03

Note. MMSE = Mini Mental State Exam.
[a]0 = no functional limitations in all six ADL tasks, 1 = functional limitations in one or more ADL tasks.
[b]0 = no disability in all six ADL tasks, 1 = disability in one or more ADL tasks.

these factors are proxies for other variables that influence disability but not actual functional limitations.

Limitations in the design of this investigation prevent us from determining conclusively the extent to which differences were due entirely to the difference between the functional limitations and reported disability dimensions being assessed. The disability measures differed with respect to the methods used to assess the older person's function: the functional limitations measure relied upon the professional's report of observed behavior, while the reported disability measure relied upon the self-report of the elder. Our analyses are unable to differentiate the degree to which observed differences are due to these different methods. Factors that may influence reported disability include mood, pain, and general feeling of health at the time the questionnaire is completed. Also, the estimates of disability are limited to those who were able to be evaluated at the clinic site, where observation by a professional could influence performance. Therefore, they do not represent those who are more likely to be more disabled at home or in an institution.

Our analyses do not suggest a clear preference for using either functional limitations or disability as the most appropriate outcome variable. Rather, we recommend that the choice between the two measurements be based on the objective of the specific research hypotheses and the population under study. For descriptive questions, this analysis suggests that estimates of prevalence will be similar regardless of whether the focus is on functional limitations or disability. Greater concern, however, should be exercised when the research focus is on high-risk subgroups such as the cognitively impaired, where prevalence estimates can differ to a greater extent. Although differences in prevalence estimates may be small, the choice of measuring functional limitations or disability may seriously affect empirical results. Risk factors for disability and functional limitations may be quite different, as posited by Nagi over 25 years ago. □

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