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This research was aimed at identifying critical steps in the decline in physical function that often parallels aging. Six basic and nine instrumental activities of daily living (ADLs) were classified into four domains of disability characterized by specific underlying physical impairment. The hierarchical order of this classification was verified in two random samples representative of the older home-dwelling population. The concordance level of disability and results of performance-based measures of physical function were also tested. Finally, the cross-cultural reliability of the model was verified in seven population-based samples of older persons living in five European countries. In older persons the disabling process follows a general pattern of progression based on a typical sequence of impairments.
Key Words: Disability, Disablement process, Aging

Constant Hierarchic Patterns of Physical Functioning Across Seven Populations in Five Countries[1]

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Chronic diseases and physical impairments are major causes of disability in old age (Ettinger, Fried, Harris, Shemanski, Schulz, & Robbins, 1994; Fried, Herdman, Kuhn, Rubin, & Turano, 1991). Over the life span persons may become disabled through a variety of mechanisms. In young and middle age, disability is usually the consequence of an isolated event such as a single disease or trauma. The resulting profile of disability is strongly disease-specific. When disability affects an older person, however, it is often the consequence of multiple causes (Guralnik & Simonsick, 1993; Fried et al., 1991), such as co-occurring pathologic conditions, physiological changes directly attributable to the aging process, and disuse and deconditioning. Several lines of research indicate that this age-related, multifactorial decline in function follows a general pattern; disability in some specific activities typically appears in the early, less severe stages of the process, while disability in other activities develops in the more advanced, more severe stages. This stereotyped pattern is, at least in part, independent of the underlying pathological causes (Katz & Akpom, 1976; Katz, Ford, & Moskowitz, 1963; Kempen, Myers, & Powell, 1995; Kempen & Suurmeijer, 1990; Lammi, Kivela, Nissinen, Punsar, Puska, & Karvonen, 1989; Rosow & Breslau, 1966; Spector, Katz, Murphy, & Fulton, 1987; Tesi, Antonini, Ferrucci, Maggino, & Baroni, 1990; Verbrugge, Lepkowski, & Imanaka, 1989; Verbrugge & Jette, 1994). Katz and Apkom (1976) described this phenomenon for basic activities of daily living (ADLs). More recently, Spector et al. (1987) and Kempen and Suurmeijer (1990) showed such a hierarchic structure for a more complex scale including both basic and instrumental ADLs, and Wolinsky and Johnson (1991) suggested a three-dimensional hierarchic structure for ADL disability. Considered together, these studies point out that the inability to perform specific ADLs tends to follow a typical sequence with progressing disability. Furthermore, such a process tends to involve groups of activities rather than single activities, suggesting that, at a population level, physical functioning declines following a

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typical pattern that implies progressive deterioration of the specific motor abilities required for each cluster of activities (Fried, Ettinger, Hermanson, Newman, & Gardin, 1994; Guralnik et al., 1994; Nagi, 1964). For example, it has been demonstrated that poor performances in balance and mobility are not only cross-sectionally associated with ADL disability but also provide information on the risk of future disability in persons who are not disabled (Briggs, Gossman, Drews, & Shaddeau, 1993; Guralnik et al., 1994; Guralnik, Ferrucci, Simonsick, Salive, & Wallace, 1995; Kelly-Hayes, Jette, Wolf, D'Agostino, & Odell, 1992).

Building on previous research, we assumed that some critical steps could be identified in the continuum of the disabling process. We further hypothesized that these critical steps are based on the type and severity of the underlying physical impairments and identify levels of disability that have a hierarchical distribution.

We tested these assumptions in the following steps: (1) Four domains of disability were identified, each including disability in specific ADLs and instrumental ADLs that were expected to result from similar type and severity of impairments. (2) The hierarchic order of the four domains was verified in two population-based samples of older persons by testing their scalability. (3) The agreement between type and severity of impairments and disability in each of the four domains was directly verified using objective measures of physical performance available for one of these two samples. (4) Finally, the assessment of scalability was repeated in five population-based samples of older persons from five European countries.

Methods

Theoretical Development of Hierarchic Domains of Disability

We searched for a method of measuring functional disability that could divide subjects into groups characterized by a similar type and severity of impairments. Self-report and performance-based measures of disability are usually unreliable in subjects with severe cognitive impairments. Therefore, we restricted our theoretical framework to physical impairments and, as a starting point, we selected the list of items used to assess disability by self-report in the European Longitudinal Study on Aging (ELSA) (Ferrucci, Heikkinen, Waters, & Baroni, 1995; see Table 1). In fact, this battery, compared to other widely used lists of activities such as Lawton and Brody's (1969) instrumental ADLs, does not include activities that load mainly on cognitive function, such as managing money (Lammi et al., 1989). Moreover, data on disability in these activities were available from a number of epidemiologic surveys performed in Europe (Ferrucci et al., 1995).

A panel of 10 health professionals (5 geriatricians and 5 physical therapists) experienced in the field of geriatrics was randomly selected among those working at the Instituto Nazionale di Ricovero e Cura degli Anziani (INRCA) Geriatric Department (Florence, Italy). The panel was asked to identify within the ELSA instrument at least three groups of activities for which disability is usually caused by similar type and severity of underlying impairments (for example, poor manual dexterity is expected to cause disability both in *eating* and in *washing arms and face*). Each member created his or her own classification scheme. Nine out of the 10 schemes provided were based on four domains of disability, but the assignment of certain activities—namely cutting toenails, shopping, and bathing—to specific domains differed somewhat between the members of the panel. These schemes were compared during a one-day meeting. After extensive discussion, a consensus was reached on four domains of disability which were defined as:

Table 1. The 15 Items Used to Assess Disability in the European Longitudinal Study on Aging

1.	Cutting own toenails
2.	Doing heavy housework
3.	Moving around outdoors
4.	Walking at least 400 meters
5.	Shopping daily for basic necessities
6.	Doing own cooking
7.	Doing light housework
8.	Bathing or showering
9.	Using stairs
10.	Walking between rooms
11.	Using the lavatory
12.	Dressing and undressing
13.	Getting in and out of bed
14.	Feeding oneself
15.	Washing arms and face[a]

[a]This item was not included in the original ELSA instrument.

1. Ability to perform complex manual dexterity activities while being in unstable postures (cutting own toenails; doing heavy housework);
2. Good balance on slippery or steep surfaces and capacity to walk long distances and overcome obstacles or steps (moving around outdoors; walking at least 400 meters; shopping daily for basic necessities; doing own cooking; doing light housework; washing and bathing self; using stairs);
3. Capacity to maintain static balance, mobility in the home environment, and good upper extremity control (walking between rooms; using the lavatory; dressing and undressing; getting in and out of bed);
4. Ability in activities that can be performed using the upper extremities even in a seated position (feeding self; washing arms and face).

Based on clinical experience and face validity, a hierarchic order across domains was postulated. Activities included in the first domain are considered the hardest to perform and those included in the fourth the easiest. Between these two domains are activities that are traditionally considered among instrumental (domain 2) and basic (domain 3) ADLs. The members of the panel suggested that, within each domain, disability in specific activities and not in others could be attributed to small individual differences and, therefore, scalability of activities could be questionable within a domain. Pursuing an approach less sensitive to the effect of such individual differences, the members of the panel proposed that disability in one domain would be established only when need for help in at least half the activities in a given domain was reported. This was particularly important for the domains that include a larger number of activities.

Based on a theoretical model of disability progression (Table 2), a hierarchic relationship among areas was hypothesized, such that they could be ranked in a Guttman scale (Torgerson, 1958) to obtain five levels of functional status, from no disability to disability in all four domains. In a perfect Guttman scale, presence of disability at one level suggests presence of disability at all more difficult levels. Analogously, absence of disability at a given level indicates absence of disability for all less difficult levels.

The fact that the four functional areas differed substantially in the number of items was recognized as a major problem. However, all the members of the panel felt that it is was important to test the "hierarchic domains" approach on available data before creating a new instrument.

Study Population

This study uses data from three separate epidemiologic surveys on elderly populations: the Lugo study, the Dicomano Study, and the ELSA study. Detailed descriptions of these studies have been reported elsewhere (Benvenuti, Ferrucci, Guralnik, Gangemi, & Baroni, 1995; Ferrucci et al., 1993; Ferrucci et al., 1995); a brief description of each follows:

The Lugo study is an epidemiologic survey performed in 1991 in Lugo di Romagna, Italy. The study population included 1,531 subjects randomly selected from the local registry of those age 70 years and older.

The Dicomano study was performed in 1989 and includes interviews with all 658 consenting persons age 65 years or older living in Dicomano, a small town in the surroundings of Florence, Italy.

The European Longitudinal Study on Aging (ELSA) is an epidemiologic survey involving 11 different countries. The project was started in 1979 under the supervision of the World Health Organization Regional Office for Europe. Each country selected an age- (5-year age groups, from 60–64 to 85+) and gender-stratified random sample from the electoral lists or the central registry. The analyses presented here used baseline data collected over the period 1979–80 from five sites: Florence, Italy (n = 1,026); Tampere, Finland (n =1,061); Berlin, Germany (n = 1,515); Kiev, Ukraine (n = 1,364); and Belgrade, Republic of Serbia, Federation of Yugoslavia (n = 1,914).

Table 2. Theoretical Model of Functional Deterioration That Evolves Across 5 Progressively More Severe Levels of Disability, Based on Patterns of Impairments

	Level of Disability[a]				
	1	2	3	4	5
Balance	Normal	Problems with unstable postures	Problems when walking	Problems in maintaining a standing position	
Lower extremity strength	Normal		Moderate impairment	Severe impairment	
Gait	Normal		Problems for long distances or with steep, slippery or irregular floors	Severe impairment	Impossible
Manual dexterity	Normal		Mild impairment	Moderate/severe impairment	
Upper extremity strength	Normal		Mild impairment	Moderate impairment	Severe impairment

[a]Based on self-report. Levels of disability are defined as:
1. Ability in all activities.
2. High risk of disability in cutting own toenails and doing heavy housework.
3. High risk of disability also in moving around outdoors, walking at least 400 meters, shopping daily for basic necessities, doing own cooking, doing light housework, bathing or showering, and using stairs.
4. High risk of disability also in walking between rooms, using the lavatory, dressing and undressing, and getting in and out of bed.
5. High risk of disability in all 15 activities.

Data Collection

The interview protocol was similar in all three surveys. Participants were interviewed at their homes by trained interviewers. Information was collected using structured questionnaires.

In all three studies, the level of functional ability was assessed using a structured questionnaire including questions on both basic and instrumental ADLs (Ferrucci et al., 1991). The original form of the ELSA questionnaire included only 14 items. The 15-item version used for the Lugo and the Dicomano studies was obtained by splitting the item "wash and bathe self" into two components, namely "washing arms and face" and "bathing and showering." This modification recognizes that the levels of physical capacity needed to perform these two tasks are quite different. Note that for the ELSA study population only the item "feeding oneself" was considered to be in the first domain.

Subjects were asked to estimate their capacity to perform each activity independent of whether they had actually had the opportunity to perform it recently. When respondents could not do some activities due to habits, family customs, or cultural traditions (e.g., "doing housework" for men) the response was coded as missing. Level of disability was scored using two categories for each item: (1) Nondisabled = able to perform the activity with or without difficulty but without help; and (2) Disabled = unable to perform the activity without help. This definition of disability is used consistently throughout the entire article.

Simple objective measures of physical performance were obtained for 457 participants in the Dicomano study. Balance was assessed as ability to stand on a single foot up to ten seconds. Times of stable balance maintained on each leg were recorded, and their average was used in the analysis. Gait was evaluated by having the participant walk at his or her usual pace over a 3-meter course (Guralnik et al., 1994). The time to complete the task was used in the analysis. Tests of lower extremity strength included the participant's ability to rise from a bed and from a chair without using his or her arms, climbing a step 40 cm high, and extending the knees to 180° from a seated position. A summary score ranging from 0 to 4 was calculated as the number of tasks that the participant was able to perform. Upper extremity strength was assessed by asking the participant to lift an object weighing 3 kg from a table and then above his or her head. Scores for this test ranged from 0 to 2 (0 = unable to perform, 1 = lifted the object but not above the head, 2 = test completed). Manual dexterity was evaluated as the participant's ability to hold a glass, cross his or her fingers, fasten and unfasten a clip and a button, and buckle a belt. A summary score ranging from 0 to 5 was calculated, representing the number of tasks that the participant was able to perform. Internal consistency of the summary scores for lower extremity strength and manual dexterity was evaluated by Chronbach's alpha and yielded values of 0.66 and 0.72, respectively.

It should be pointed out that the aforementioned performance-based measures of function were not originally created for this study and, therefore, are somewhat nonspecific and approximate. Based on this, we expected a large variability of performance within each functional level and some overlap across different functional levels.

Statistical Analysis

All of the analyses were performed using the SAS statistical package (SAS Institute Inc., 1993).

For the Guttman scalogram analysis, several criteria have been developed that evaluate deviation from the ideal pattern (Menzel, 1953; Guttman, 1944, 1950). A great deal of deviation indicates that the a priori classification does not fit the Guttman model. The number of errors found in subjects who did not fit the ideal pattern was calculated using the method termed "deviation from perfect reproducibility," which is defined as the number of permutations that are needed to obtain an ideal pattern in all subjects. The coefficient of reproducibility (CR) was calculated as (1 – (Number of errors/Total responses)) where "Total responses" are (Number of items) × (Number of respondents). Moreover, to obtain an indication of the percentage of the improvement in prediction provided by the scale compared to chance alone, reproducibility was expressed as the percent of improvement in reproducibility in the range between the minimal marginal reproducibility (MMR), which defines the minimum level of reproducibility the scale could have by chance alone (based on its marginal distribution), and perfect reproducibility: ((CR–MMR)/(1–MMR) × 100) (McIver & Carmines, 1981).

Differences in performance scores across the five levels of disability defined by self-report were tested by analysis of variance (ANOVA). The Student-Newman-Keuls post hoc test was used to identify groups homogeneous for the severity of each underlying impairment. Finally, to estimate how well measures of impairment accounted for severity of functional deterioration, performance scores were introduced in a linear regression model predicting level of disability.

Results

Scalability Study

The scalability of the hierarchic domains of disability identified in the Delphi study was first verified in the population sample of the Lugo Study. The prevalence of combinations of disabilities in each functional area are shown in Table 3. In this table, for each column, a "+" indicates disability and "–" indicates autonomy in half or more of the activities included in that functional area. According to the Guttman model, the first five combinations, which include 98.4% of the sample, fit the ideal pattern (there are no "–" to the left of one "+"), whereas the others, which include 1.6% of the subjects, do not (there are one or more "–" to the left of a "+"). The reproducibility coefficient (RC) was 0.996 and the minimal marginal

Table 3. Prevalence of All Combinations of Disabilities in Four Functional Areas in the Lugo Study Population

Functional Level	Functional Domains[a] 1	2	3	4	Percent	(*n*)
1	–	–	–	–	70.7	1082
2	+	–	–	–	9.3	143
3	+	+	–	–	5.4	83
4	+	+	+	–	5.7	88
5	+	+	+	+	7.2	110
	+	+	–	+	0.6	9
	+	–	+	–	0.3	4
	–	+	+	+		
	+	–	–	+	0.1	2
	–	–	+	+		
	–	+	+	–		
	–	+	–	–	0.5	8
	–	–	+	–	0.1	2
	–	–	–	+		
	+	–	+	+		
	–	+	–	+		

Note: Those combinations used in the hierarchic scale are denoted as functional levels 1 through 5. All the other combinations violate the assumption of scalability.
[a]Definition for domains of disability:
1. Includes cutting own toenails and doing heavy housework.
2. Includes moving around outdoors, walking at least 400 meters, shopping daily for basic necessities, doing own cooking, doing light housework, bathing or showering, and using stairs.
3. Includes walking between rooms, using the lavatory, dressing and undressing, and getting in and out of bed.
4. Includes self-feeding and washing arms and face.

reproducibility (MMR) was 0.923, yielding a 93.9% improvement in scalability compared to the scalability expected by chance alone for a list of items with the same marginal distribution. These results indicate that the a priori classification fits the Guttman model extremely well.

Concurrent Validity with Performance Measures

Using data on performance collected in the Dicomano study, we tested the hypothesis that transition between two adjacent levels of disability implies the development of specific physical impairments. Preliminary to this analysis, the reliability of the hierarchic domains was also verified in this population, with findings similar to those obtained in the Lugo study (1.5% of the participants did not fit the hierarchic pattern; CR = 0.996; MMR = 0.961; improvement in scalability compared to chance alone = 92.1 %).

Mean scores in performance-based tests of physical function were compared across the five different functional levels that can be obtained using the domains (Level 1 includes participants with no disability, Level 2 includes participants with disability in the first domain only, Level 3 includes participants with disability in the first and in the second domain, and so on). Values for balance, lower extremity strength, gait, manual dexterity, and upper extremity strength (shown in Table 4), were statistically different across functional levels; the boxes in Table 4 identify levels of disability that, in post hoc analyses, were found to be homogeneous for specific performances.

Level 1 differs from Level 2 mainly for performance in balance; a difference in lower extremity strength, gait, and manual dexterity exists between Level 2 and Level 3. Significant differences in all the indicators of physical impairment are shown between Level 3 and Level 4, which implies disability in basic ADLs. Finally, gait, upper extremity strength and manual dexterity discriminate Level 4 from Level 5. It is interesting to note that these patterns of impairments and their relationships with the domains are quite similar to those hypothesized and presented in Table 2. Thus, the findings of this analysis directly confirm our theoretical assumptions.

In a linear regression model, each of the five mea-

Table 4. Comparison of Average Performance Scores Across Disability Levels for the 5 Dimensions Considered in the Study

	Level of Disability[a] 1 (n = 319)	2 (n = 99)	3 (n = 20)	4 (n = 6)	5 (n = 6)
Balance (in seconds)	7.42 ± .16	4.95 ± .34	2.93 ± .58	0.50 ± .33	0.33 ± .33
Lower extremity strength (score)	3.92 ± .02	3.82 ± .05	3.35 ± .21	2.17 ± .60	1.83 ± .48
Gait (in seconds)	5.75 ± .14	7.30 ± .36	11.11 ± 1.29	14.5 ± 2.25	20.00 ± 5.0
Manual dexterity (score)	4.98 ± .00	4.94 ± .05	4.40 ± .18	3.67 ± .49	2.83 ± .60
Upper extremity strength (score)	1.98 ± .01	1.90 ± .04	1.80 ± .14	1.00 ± .45	0.33 ± .33

Notes: ANOVA models comparing mean levels of each performance across levels of disability were all significant at $p < .0001$ (within each line). The boxes in the table identify levels of disability that were found to be homogenous for specific performance in post hoc analyses. Values are means ± SE.
[a]Based on self-report. See Table 2 for definitions of the levels of disability.

sures of impairment was a significant independent predictor of overall level of disability. Together, these variables explained 60% of the variance in functional status ($R^2 = 0.6$) as measured by the five-level hierarchic classification.

Cross-Cultural Reliability

The scalability analysis of the hierarchic domains of disability was replicated in five population-based samples from different European countries: Italy, Finland, Germany, Ukraine, and Republic of Serbia, Federation of Yugoslavia. Table 5 shows the prevalences of disability in each of the activities reported in the ELSA instrument for the seven populations analyzed in this study. With only one exception found in the Kiev population, prevalences of disability in activities included in one domain were all higher than any prevalence of disability in activities belonging to the domain immediately lower in the hierarchic order. Furthermore, the rank of prevalences within specific domains showed substantial variability across populations. In accordance with our primary hypothesis, this pattern suggests that the scalability based on domains is more stable than the scalability performed on single items.

The percentages of persons classified in each functional level and of those who could not be classified according to the hierarchic model are reported in Figure 1. Overall, across the five ELSA populations and the two Italian populations analyzed in this study, only a small percentage of persons (ranging from 0.4% to 1.7%) did not fit the proposed hierarchy. The distribution of persons classified in each functional level was remarkably similar in the five ELSA populations, while it was quite different in the other two Italian samples. This was expected, because the study populations of the ELSA were obtained using an age- and gender-stratified sampling technique that tends to oversample the older section of the population (Figure 1), whereas the samples used in the other two studies were directly representative of the general population.

Discussion

The purpose of this research was to define critical steps in the progression of disability in old age. Based on clinical experience and on existing literature, we postulated the existence of four conceptually well-differentiated states of disability. These four states may be viewed both as degrees of severity of disability and as subsequent stages of the disablement process. Each state is defined by severity and specific types of underlying physical impairments.

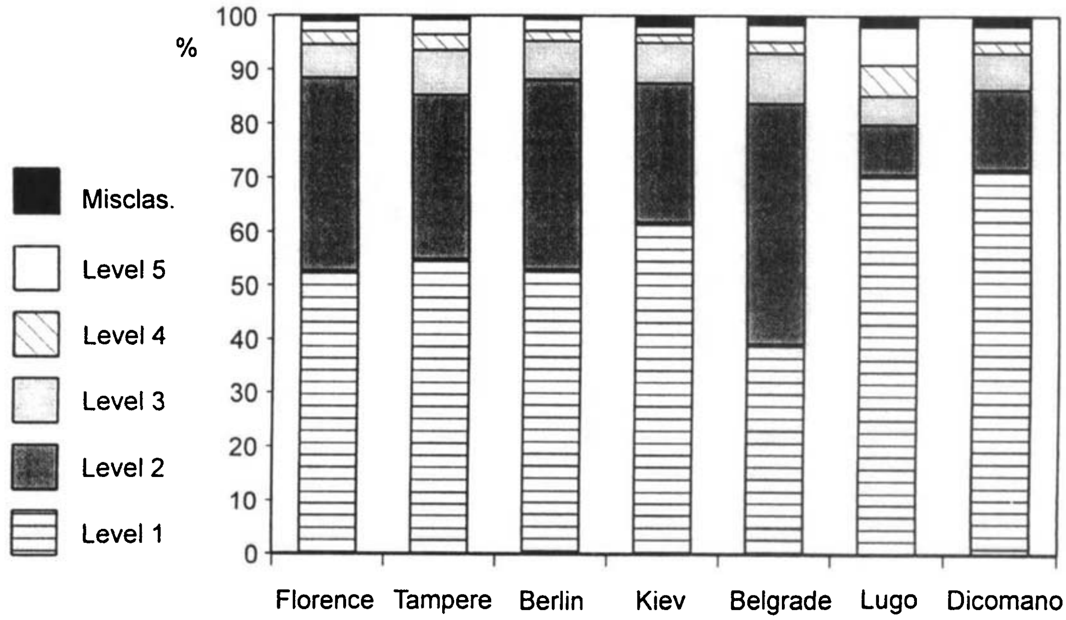
The validity of this model was verified by proving that, in seven populations across five different European countries, these states of disability have an almost perfect hierarchic structure and by comparing levels of disability with objective measures of impairments.

Although the relationship between specific impairments and the capacity to perform ADLs has not been thoroughly established, many studies have shown a strong association between decline in physical capacities and disability (Benvenuti et al., 1995; Ensrud et al., 1994; Ferrucci et al., 1996; Fried et al., 1994; Gill, Williams, & Tinetti, 1995; Guralnik, 1994; Guralnik et al., 1994; Hochberg, Kasper, Williamson, Skinner, & Fried, 1995). Jette and Branch (1984) used performance-based tests to assess the distribution of musculoskeletal impairment in a noninstitutionalized elderly population. The frequency of impairments showed a clear and consistent increase with increas-

Table 5. Prevalence of Disability (Defined as Need for Help) in Specific Activities of Daily Living in 7 Populations Across 5 European Countries

Activity	Berlin (*n* = 1,512)	Tampere (*n* = 1,061)	Florence (*n* = 1,026)	Belgrade (*n* = 1,914)	Kiev (*n* = 1,364)	Lugo (*n* = 1,536)	Dicomano (*n* = 656)
Domain 1							
Feeding oneself	2.6	3.2	2.4	4.4	3.2	6.6	2.9
Washing arms and face[a]	–	–	–	–	–	7.9	4.1
Domain 2							
Walking between rooms	4.2	5.7	2.9	5.1	2.9	10.7	4.4
Getting in and out of bed	4.2	4.9	4.4	5.4	2.7	11.8	4.6
Using the lavatory	3.9	5.7	4.5	5.3	3.2	10.7	5.8
Dressing and undressing	5.0	7.8	5.3	6.4	3.5	15.4	8.5
Domain 3							
Using stairs	12.6	12.7	11.7	13.9	11.4	16.4	8.8
Walking at least 400 m	13.3	13.4	11.1	15.7	15.2	15.8	9.1
Moving around outdoors	12.4	12.7	12.2	12.5	11.0	14.4	9.3
Bathing or showering	6.8	12.5	12.5	12.6	7.6	24.0	19.8
Doing own cooking	15.6	15.2	12.9	21.8	11.4	15.4	12.5
Doing light housework	11.3	18.3	20.7	25.0	15.0	16.7	20.1
Shopping daily for necessities	25.8	23.5	22.7	24.3	25.1	19.4	25.5
Domain 4							
Cutting own toenails	25.8	32.3	28.2	29.3	18.7	30.1	28.2
Doing heavy housework	49.2	46.7	55.4	70.7	49.9	28.6	39.5

[a]This item was not included in the original ELSA instrument.



	Florence	Tampere	Berlin	Kiev	Belgrade	Lugo	Dicomano
Tot (n)	1026	1061	1515	1364	1914	1531	658
60-64 years (%)	13.6	18.4	16.3	17.0	16.5	-	-
65-69 years (%)	16.3	18.0	16.4	17.6	17.1	-	35.1
70-74 years (%)	16.5	17.8	16.6	17.1	17.0	32.2	22.2
75-79 years (%)	16.9	18.2	17.1	16.2	16.7	31.8	20.2
80-84 years (%)	18.1	17.1	16.9	16.2	17.1	22.5	15.4
85+ years (%)	18.6	10.6	16.6	15.9	15.7	13.6	7.0

Figure 1. Distribution of the five hierarchic levels of disability in seven populations across five European Countries. Persons were considered as misclassified if the characteristic of their disability violated the hierarchic assumption. The table presented in the lower part of the figure shows the age distribution for the seven populations.

ing age both in men and in women; "balance problems" were the most prevalent condition. Moreover, factorial analysis revealed four meaningful impairment dimensions: wrist, hand, upper extremity and lower extremity. Greene, Williams, Macera, & Carter (1993) studied the dimensionality and construct validity of physical function within the context of performance-based measures. Using a factor analytic approach, they identified six meaningful dimensions (muscular strength, unimanual dexterity, mobility/agility, static balance, general upper extremity control, movement planning speed) that are implicated in the deterioration of physical functioning in elderly people. Jette, Branch, and Berlin (1990), using a longitudinal approach, found that changes in musculoskeletal function relative to hand, upper extremity, and lower extremity functions were predictors of change in self-reported disability.

The interpretative model presented in this article assumes that a certain degree of performance in meaningful physical dimensions is needed, on average, to maintain ability in specific groups of activities. We also postulated that searching for scalability within groups of activities that are similar in terms of underlying physical capacities is inappropriate. Indeed, in our study, the rank of prevalences within specific domains showed substantial variability across populations. This may explain some of the inconsistencies and inconclusive reports of studies that have tested the hypothesis of scalability using single ADLs (Lammi et al., 1989; Lazaridis, Rudberg, Furner, & Cassel, 1994; Wolinsky & Johnson, 1991). In fact, it has recently been suggested that, considering single activities, several hierarchic patterns satisfy the criteria for acceptable scalability (Lazaridis et al., 1994). To overcome this problem, we hypothesized that the hierarchic structure of disability should not be based on single activities but rather on groups of activities clustered according to underlying impairments. Indeed, our findings provide strong evidence that fluctuations of functional ability in elderly adults may be thought as moving up and down a staircase of five discrete steps that are conceptually well-defined. At a population level, decrements in functional ability progress from activities that require dynamic balance, agility, and muscular strength down to activities that are performed using only the upper extremities. However, because this research uses cross-sectional data, the practical applicability to the study of disability of the hierarchic model presented in this article, which is by nature a dynamic process, remains hypothetical and needs to be verified within a longitudinal framework.

It should also be pointed out that, despite the scalability of the domains found at the population level, in persons affected by certain medical conditions, progression of disability may take a different course. For example, subjects with hand arthritis may have severe manual dexterity problems while all of their other physical capacities (e.g., balance, gait) may be intact. We believe that our approach fits particularly well the disablement process in older persons in which disability is caused by multiple, interacting conditions.

Two important methodologic issues need further discussion: the choice of ignoring cognitive function in our theoretical hypothesis and the fact that each of our domains included a different number of activities. As mentioned earlier, we purposely chose to exclude activities that require integrity of cognitive function, such as using the telephone or handling finances, from our working list of ADLs. As no attempt was made to exclude from the study population participants with dementia and the selected indicators of physical impairment explained as much as 60% of the variance in functional status, our findings suggest that very often the loss of ability in ADLs involves a physical cause. However, cognitive impairment may have been responsible for a large part of the remaining variance and, indeed, inclusion of cognitive related activities in our analysis might have changed our findings partially.

As noted, we classified a different number of activities into each of the four domains of disability. We made this choice because we were planning to use data from multiple sources to validate our approach. However, this problem makes the interpretation of our results somewhat complex. The rationale of using the domains is that the activities classified into a specific domain represent units of information sampled from all the possible activities that belong to that domain. The precision of the estimate of the true "global" disability in that domain depends on the number of items assessed (information on five activities is better than information on two activities), so the ideal scale would be one with the same number of activities in each domain. Future studies using our approach should take this problem into account.

Our picture of the disabling process should not be regarded as a new method for measuring disability, but rather as a first step in understanding the pathophysiology of the progressive deterioration of physical function that often parallels the aging process. The strength of this scaling approach might open a new perspective in the field of research on the causal pathways leading to disability, allowing us to examine how specific diseases and functional limitations map to different domains and to generate new hypotheses concerning the most effective way of delaying the deterioration of functional status in older persons who are already disabled.

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