Disability in Older Adults: Evidence Regarding Significance, Etiology, and Risk

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SPECIAL ARTICLES

Disability in Older Adults: Evidence Regarding Significance, Etiology, and Risk

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OBJECTIVES: This article synthesizes and assesses current evidence about the importance of physical disability to older adults. It then considers the applications of research findings to clinical geriatrics practice.

RESULTS: Physical disability is a major adverse health outcome associated with aging. Certain subgroups of older adults, including individuals with mobility difficulty, with preclinical functional changes, and persons who are hospitalized, are at particularly high risk of becoming disabled or experiencing disability progression. The major underlying causes of physical disability are chronic diseases, including both acute events, such as hip fracture and stroke and slowly progressive diseases such as arthritis and heart disease. These diseases appear to have task-specific effects; understanding this may assist in setting treatment and prevention goals. Comorbidity, particularly certain combinations of chronic diseases, is a strong risk factor for disability in itself. Recent trials indicate that clinical interventions may be able to prevent onset or progression of disability.

CONCLUSIONS: Available evidence now suggests clinical approaches to both treatment and prevention of disability and directions for defining optimal clinical care for the future. J AM Geriatr Soc 45:92-100, 1997.

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The functional consequences of the common diseases and conditions of aging are of paramount concern in geriatric medicine. Decreased functioning in physical, cognitive, or sensory domains can have a major effect on an older person's life, and the progression of functional decrements beyond a certain threshold can curtail an individual's ability to live independently in the community. As the old and very old segments of the population grow rapidly in the future, disability and long-term care requirements are likely to have an increasing impact on healthcare needs in the US and throughout the world.

A large proportion of the older population that is disabled resides in the community, and many receive home care from informal or formal sources. The National Center for Health Statistics estimates that 84% of persons 65 years and older who are dependent in activities of daily living (ADLs) or instrumental activities of daily living (IADLs) live in the community. [1] [2] Even 64% of those aged 85 years and older who have such disabilities reside outside of nursing homes. Thus, the great majority of functionally compromised older adults live in the community and will require care in outpatient or home settings.

The consistent findings across many studies that disability prevalence is higher in women aged 65 years and older than in men, coupled with the increased longevity of older women, results in older women spending more years living in the disabled state. In the Alameda County Study, the results of a 19-year follow-up show women were more likely to survive and have disability and men were more likely to die. [3] Calculations of active life expectancy also show that while women have longer total life expectancy and longer active (non-disabled) life expectancy than men, they can also expect, on average, to spend more years disabled. [4] It has been demonstrated that

even among those with a severe degree of disability, women survive longer than men. [5]

Physical disability has many consequences. It is a major risk factor for dependency and institutionalization. [6] [7] [8] In addition, the presence of disabilities is associated with high healthcare needs and utilization compared with those with no disability. This includes recurrent hospitalization and greater use of outpatient care and increased risk of falls, injuries, and acute illnesses. [9] [10] [11] As an example of what that means in people's lives, 25% of the 1002 moderately to severely disabled, community dwelling older women in the Women's Health and Aging study reported being hospitalized in the previous year [12] compared with 13 to 15% of men and women without disability who were assessed in the Longitudinal Study on Aging (1986-1989). [11] In addition, 89% of

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these disabled women had seen a physician in the last year, 15% had had physical therapy, and 13% had used a visiting nurse and/or home health aide. Eighty-five percent of this moderately to severely disabled population reported receiving help from one or more people, especially for heavy housework (71%), shopping (56%), money management (38%), and meal preparation (23%). [12]

This article will focus on the scientific rationale for clinical evaluation of physical function in geriatric patients, based on recent research findings. Specifically, it will discuss the significance of various decrements in physical function, current evidence as to the medical etiologies of disability, the implications of these findings for clinical assessment, the target patient groups for evaluation, and the potential for prevention and treatment.

ASSESSING DISABILITY IN CLINICAL PRACTICE

Disabled individuals are high users of medical care services. As a result, disability is even more prevalent in a clinical population than in the population at large. Those who are disabled are a high risk group clinically as described above. For these reasons, there is a need for clinicians to identify and treat disability in older adults. At the same time, clinicians cannot rely solely on patients to initiate a report of functional problems. There is evidence that patients may underreport disability, [13] or they may not report concerns about their function until it drops below a certain threshold and is no longer tolerable. [14]

Clinical assessment must, therefore, evaluate function to identify problems. Calkins reported that 66% of clinicians underestimated their patients' disabilities if they relied on routine clinical assessments and didn't ask explicitly about functioning. [15] Additionally, the usual clinical neuromuscular examination is likely to miss important mobility dysfunctions in older patients. [16] Finally, even performance-based measures of functioning, while they may identify mobility problems, may not reveal the difficulties in performing tasks that a patient is experiencing at home. [17] Therefore, it is essential that the clinician pro-actively screens for functional decrements and for those at risk for such losses. On this basis, the American College of Physicians, [18] the Society for General Internal Medicine, [19] and others [10] [20] [21] [22] have published recommendations for methods for standardized clinical assessment of functioning in older adults. It is beyond the scope of this article to review these recommendations.

NATURAL HISTORY Of DISABILITY

The onset of physical disability is often a dynamic, progressive process which is largely the consequence of underlying chronic disease and physiological changes associated with aging. Disability also results from acute events such as hip fracture or stroke. The impact of disease on disability is modified by the individual's psychological and cognitive status, age, gender, education, activity levels, social supports, and other factors in the environment. Recent reports have provided insight into the incidence and natural history of disability, as well as its prevalence at any one point in time. For example, in the Established Populations for Epidemiologic Studies of the Elderly (EPESE), 36% of people aged 65 and older with intact mobility (able to walk ½ mile and climb stairs without help) lost their mobility over the subsequent 4 years. [23] The likelihood of losing mobility increased two-fold with each 10-year increase in age after 65. [23] Among very high functioning men and women aged 70 to 74 years assessed in the Health Interview Survey Longitudinal Study on Aging, 29% developed new difficulty in carrying 25 pounds, walking one-quarter mile, climbing 10 steps, or doing heavy housework after 2 years. [24] Among nondisabled men and women older than 70 years, only half of those 70 to 79 and one-quarter of those more than 80 years were alive and not disabled after 6 years. [11] Figure 1 shows the experience of women 75 to 84 years of age participating in the National Long Term Care Survey. Among those who had no disability in IADLs or ADLs, approximately 15% developed disability in these tasks 2 years later; among those with IADL disabilities, almost 40% developed disability in ADLs or were institutionalized 2 years later. [24] Thus, functional status declines rapidly in later years. The incidence of disability is high and increases with age.

However, functional decrements can change for the better as well. Several studies show that some disabled older adults have improvements in function. In the EPESE study, 18% of those who lost mobility regained it. [23] In the National Long Term Care Survey, 18% of older adults with one or two ADL disabilities were no longer disabled in ADLs after 2 years. [24] The likelihood of improvement decreased, however, with increasing disability: among those with three or more ADL disabilities fewer than 6% percent had no ADL disability 2 years later. The rates of improvement and their decline with worsening levels of baseline function are seen for women 75 to 84

years of age in Figure 1 . Overall, improvement was more likely for those who were younger (65 to 74) or who had less severe or shorter duration of disability. [11] [24] [25] [26]

There is increasing evidence that certain levels of function are predictive of future status, and this information is central to clinical use for screening. First, some types of disability predict others. For example, mobility difficulty is predictive of more severe disablement. Individuals 80 years and older with difficulty in mobility tasks such as walking one-quarter mile and climbing 10 steps were at twice the risk of developing difficulty in IADLs or ADLs or of being admitted to a nursing home as people without such mobility difficulty. [27] Among men and women 65 years and older with mobility disability, those who scored most poorly on objective performance tests of walking, rising from a chair, and balance were more likely to have disability in ADLs 4 years later than those who had higher scores. [28] These and other

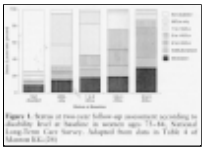

Figure 1. Status at two-year follow-up assessment according to disability level at baseline in women ages 75-84, National Long-Term Care Survey. Adapted from data in Table 4 of Manton KG.(24)

studies [29] [30] [31] indicate that mobility problems, whether measured by self-report or timed performance, often precede the development of difficulty in complex tasks. Mobility difficulty predicts other adverse outcomes, including falls [32] [33] and hip fracture. [34] Thus, mobility disability is a marker of a high risk group for whom interventions may well be beneficial in preventing further decline in function.

There also appear to be hierarchical relationships between difficulty in at least some IADLs and ADLs, suggesting an ordered development of task disability. [27] [35] This raises the question as to whether there are sentinel tasks in which difficulty is predictive of future difficulty in other tasks. For example, it is likely that difficulty with more demanding mobility tasks, such as walking one-half mile, is predictive of future difficulty in less demanding mobility tasks that are critical in daily life, such as transfers and walking in the home. [36] [37] This is exemplified in the history of functioning provided by one patient, a 75-year-old woman. This woman reported progression of mobility difficulty over a 5-year period, starting with difficulty walking longer distances and progressing to difficulty with heavy housework, then stairs, transfers, and using cars and buses. [36] Such evidence suggests that clinical evaluation should seek to identify those with early and mild mobility problems as well as more readily reported difficulty or dependency in household maintenance or self-care tasks.

There may also be a preclinical or subclinical state of functional compromise before the individual perceives difficulty in mobility or tasks that could predict those at highest risk of becoming disabled. [36] There is evidence that individuals may be somewhat compromised functionally as a result of underlying health status changes but may be able to compensate for this compromise and function at a satisfactory level. [36] These compensations can include use of assistive devices

TABLE 1 -- Chronic Diseases Reported * by Women 65 years and Older × Whether They Were Disabled. (Women's Health and Aging Study ‖)

Chronic Disease	Not Disabled or Mildly Disabled † (n = 2226) %	Moderate to Severe Disability ‡ (n = 1409) %
Myocardial infarction	8.1	20.9
Angina	8.5	20.8
Congestive heart failure	2.0	8.3
Hypertension	48.7	59.8
Arthritis	47.8	76.5
Lung disease §	6.7	16.9
Stroke	3.7	14.9
Cancer	12.1	16.1
Hip fracture	2.7	7.3
Diabetes	10.1	21.0
Visual Impairment	69.4	79.6

* Self-report of physician diagnosis.

‖ N = 3841 women screened; those not accounted for had Minimental State Examination Scores <18.

† Persons with self-reported difficulty in ≤ 1 of the following areas: mobility, upper extremity function, household management tasks, or basic self-care tasks (ADL's).

‡ Persons with self-reported difficulty in ≥ 2 of the areas in footnote †, above.

§ Emphysema, asthma or chronic bronchitis.

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or human assistance or altering the method, environment, or frequency of performing tasks. [36] [38] In terms of the latter, people may cut back on the frequency of doing tasks to the minimum that is essential or increase the frequency of a task while doing less at any one time. People also change the method of performing a task to compensate for, and minimize the effects of, an underlying impairment. For example, they may pull themselves up out of a chair by holding on to adjacent furniture or lean on the shopping cart for support when shopping; at the same time, they report no difficulty doing these tasks. [36] [39] Such compensatory strategies can be sought in the medical history. People who report no difficulty but are employing such modifications could be functioning at a compromised level, i.e., disabled although not reporting it, or their compensation could be successful in maintaining their function in a normal range. [40] In either case, recent cross-sectional data indicates that self-report of task modification but no difficulties identifies a group with intermediate function that may be at risk of functional decline. [40] Compensation is also reported by people who note difficulty with an activity [39] who are generally considered disabled.

Subsets at high risk of becoming disabled can also be identified using performance-based measures of functioning. [28] [41] Nondisabled people 71 years and older with the poorest scores on tests of walking, balance, and rising from a chair were at more than 4-fold higher risk of disability 1 and 4 years later in both mobility and ADLs than those with high scores. [28] These timed measures of lower extremity function, therefore, identified a subset of individuals with preclinical disability who were at high risk of progressing to disability over a 4-year period. In another cohort 75 years and older, a large group of performance tests were predictive of onset of ADL disability 1 year later. [41] For several timed tests with decreasing performance, there was a threshold beyond which disability incidence increased substantially.

Thus, there appear to be identifiable markers of the older persons who are at high risk of becoming disabled. Future prospective studies will provide information on the clinically-relevant approaches to screen for those with such preclinical changes in functioning and will identify the interventions most likely to prevent progression to disability.

There are also moments, as well as states, of risk. For example, hospitalization predicts decline in functioning in older adults for periods up to 3 years after discharge. [42] Similarly, periods of immobilization are viewed clinically as leading to decline in ambulation ability. [43] These episodes are moments of high risk for which preventive rehabilitation, which might be termed "prehab," could potentially be useful

before planned hospitalizations.

The data above give insight into the dynamics and natural history of disability, but also provide information as to the high risk groups for whom preventive interventions may be most effective. They indicate that limitation or difficulty in certain areas of functioning can be predictive of future difficulty in other areas. In addition there are high risk groups, including persons with preclinical disability, individuals with mobility difficulty who are not yet disabled in ADL and IADL tasks, those who are hospitalized, those older than age 80, and older women in general,.that warrant particular attention, There may also be sentinel tasks in which difficulty predicts future losses in that type of function. Improving function in these individuals could be important for long-term prognosis as well as for current abilities.

ASSOCIATION OF DISABILITY WITH DISEASE

The functional status of older adults is linked, primarily, to underlying disease status. There are several conceptual models that characterize the etiological relationship between disease and disability. [38] [44] [45] [46] In these models, pathophysiological changes and organ-level impairments are the primary cause for decrements in functioning. This relationship is seen most clearly clinically in the dramatic changes in physical function that often result from acute events such as a stroke or hip fracture [47] [48] [49] [50] or in the impact of arthritis of the hip on ambulation or arthritis of the hands on grasping or other hand functions. For example, only 60% of people who have hip fractures regain their pre-fracture ability to walk after 2 to 6 months. [49] However, in most instances the onset of disability is slow, subtle, and progressive, much like the development of the chronic diseases that cause it.

Numerous studies have assessed this relationship between disease and disability. A number of chronic diseases are observed more frequently in disabled older adults than in those who are not disabled. For example, Table 1 shows the frequency of selected chronic diseases among the women age 65 and older screened for participation in the Women's Health and Aging Study. In this representative sample of 3841 community-dwelling older women, those who were disabled reported a 2 to 4-fold higher frequency of heart disease and stroke and a 50% higher frequency of arthritis and diabetes compared with those who were not disabled or only mildly disabled. [12]

Thirteen chronic diseases have been associated consistently with the development of physical disability in older adults in a large number of studies. These include both conditions that are highly prevalent with aging, such as arthritis and heart disease, and conditions that are less frequent (although not rare), such as stroke. Most consistently, across studies, disability is associated with knee osteoarthritis, hip fracture, diabetes, stroke, heart disease (specifically, myocardial infarction, angina, and congestive heart failure), claudication, chronic obstructive pulmonary disease, visual impairment, depression, and cognitive impairment. Other diseases, such as cancer, are also known to cause disability, [51] but the association is less strong than for the diseases just cited; this may be a result of the high mortality of many cancers, or for other reasons discussed below. In addition to the disease-specific associations, physical disability is also associated with constitutional status and age-associated changes that may be indicators of frailty. This includes evidence that weakness, balance and gait abnormalities, and history of falling are risk factors for disability. [8] [52] [53]

Notably, the new onset of diseases during follow-up may have different import in predicting disability than their baseline presence. For example, one study of persons initially free of mobility disability found that many of the diseases above predicted incident disability when present at study onset. Two conditions, hip fracture and cancer, when reported by these nondisabled subjects at baseline, did not predict incident mobility disability. However, when the latter conditions occurred during the 4-year follow-up period, they were associated strongly with incident disability. Conversely, for diabetes it was the duration of the diabetes - and not its new onset - that was associated with disability. [23]

Thus, the import of prevalent and incident disease may vary between diseases. It may be that some diseases are relatively stable and/or of low severity after recovery, as with cancers of long duration or hip fracture, in the example above; those with pre-existing disease may be survivors with low likelihood of worsening. In these cases, it appears to be the incidence of disease that is most associated with loss of function over time. Conversely, other diseases may be progressive and not curable, and then duration may be a marker for severity; here, prevalence may have more import than incidence in predicting disability.

Several studies have quantified the contributions of specific diseases to disability. Ford [54] estimated that arthritis accounted for 34% of physical disability, with another 50% accounted for by stroke, visual impairment, heart disease, and dementia together, and a final 15% accounted for by peripheral vascular disease, lung disease, depression, diabetes, hearing impairment, and hypertension. Guccione et al. found that the largest proportions of dependency in mobility and household management tasks (such as heavy home chores, grocery shopping, and cooking) were attributable to knee osteoarthritis, stroke, heart disease, and depressive symptoms, with smaller proportions attributable to other conditions. [52] Finally, Kosorok et al. calculated the number of days of restricted activity attributable to different diseases and conditions from an average of 31 restricted activity days per person per year in the Health Interview Survey. In this population of community-dwelling older adults, six restricted activity days were associated with falls (18% of total restricted activity days), four each with heart disease (14%) and arthritis (12%), and two with each of the following: atherosclerosis, diabetes, major

malignancies, and osteoporosis. [55]

TASK-SPECIFIC IMPACT OF DISEASES

Recent work has focused on understanding better how diseases cause disability, as well as defining the specificity and strength of the association. Clinically, it appears that different diseases may have their own, characteristic "fingerprints" on a person's functioning. This has been pointed out in studies of single diseases and their impact. For example, both Guccione [56] and Ettinger [57] have shown that the effects of osteoarthritis of the knee on function are highly task-specific, affecting limitations of ambulation and transfers. Task-specific relationships with a disease are also perceived by individuals. This was demonstrated in the Cardiovascular Health Study, where for example, heart and lung disease and their symptoms were primarily cited as the causes of difficulty doing activities requiring aerobic work capacity, while stroke was primarily associated with difficulty with upper extremity tasks and ADLs. [53]

When considering a single disease, it can be a relatively straightforward task to hypothesize how the disease causes disability and what aspects of disability it affects. For example, Figure 2 shows the clinically observed pathway in individuals with angina, exacerbated by underlying declines in VO_2 max (exercise tolerance) associated with aging. In this scenario, the symptoms of dyspnea and angina may cause individuals to limit their activity to minimize symptoms; such limitation may be evidence of preclinical disability. [36] This decline in activity may, in turn, exacerbate the decline in exercise tolerance, leading to difficulty doing tasks requiring exercise tolerance (e.g., walking and stair climbing). Through such basic clinical examples, it is apparent that diseases can have task-specific impacts, and defining those relationships

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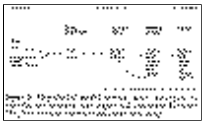

Figure 2. Hypothetical modal pathway from impairment to disability in individuals with angina and underlying decreased VO_2 max (exercise tolerance) associated with aging.

can assist with diagnosis and targeting appropriate treatment. The "fingerprints" of specific diseases on disability remain to be defined for most chronic diseases.

COMORBIDITY AND DISABILITY

A study that clinically evaluated disabled persons living in the community found that more than half had impairments in more than one physiological system, including cognitive, sensory, neurological, musculoskeletal, and cardiorespiratory impairments. [58] Similarly, research findings indicate that the presence of more than one chronic disease in an individual - or comorbidity - is related to the presence of disability and to that person's future risk of disability. In fact, cross-sectional studies show that the number of chronic diseases that are present is associated with dependency in ADLs, [59] with IADLs, [60] and with mobility difficulty [61] in a stepwise or linear fashion. The number of chronic diseases present is also predictive of future disability. For example, the number of chronic diseases in a disability-free group at baseline is directly associated with risk of losing mobility over 4 years. [23] Also after 4 years, the risk of becoming limited in ability to perform ADL and IADL tasks is 4-fold higher for a person with four chronic diseases (13%) than for a person with no chronic diseases (3%). [62]

Clinically, it is reasonable to predict that the types of diseases that are jointly present are important in addition to the numbers of diseases present. In clinical observations, there can be synergistic morbid effects when specific diseases occur together in an individual. In this scenario, the combined effect of these diseases causes functional problems greater than those resulting from any one disease alone. [14] In fact, very specific interactions between diseases are associated with different types of disability. This has been well described in relation to arthritis. In one study, the joint presence of arthritis with other comorbid conditions caused substantially greater risk of mobility difficulty than was found for arthritis alone. [63] Another study found synergistic effects on disability for certain disease combinations with arthritis, but not for others. For example, compared with those with no knee osteoarthritis (OA) or heart disease, the relative risk of developing difficulty in ambulation was 4.4 for those with symptomatic knee OA,and 2.3 for people with heart disease alone, but 13.6 for those with both knee OA and heart disease. [57]

In some instances, a disease may not be sufficient to cause substantial disability in itself, but it may increase risk of subsequent functional decline when a new condition develops. For example, Verbrugge reported that individuals with arthritis were more likely to develop disability in the presence of other chronic diseases. [64] Other data suggest that while heart disease or stroke independently contribute to disability, they also place individuals at increased risk for disability when new disease events occur. [23] Thus, there may be an interaction between prevalent disease and incident, or new onset, disease in causing disability.

These data suggest that medical intervention in patients with disability should decrease the synergy between diseases as well as the

disease-specific effects. This could be accomplished, theoretically, through decreasing the severity of comorbid diseases or treating one completely so as to minimize the interactions that contribute to disability. This approach has clinical face validity, as in a patient with both heart disease and osteoarthritis, where the gait pattern of the latter disease can exacerbate the shortness of breath or angina from the former, thus decreasing functional abilities. [14] Recent clinical trials of multiple risk factor reductions to prevent or reduce disability have, in fact, shown decreased incidence of disability (see below).

A substantive decrease in disability might be achieved by focusing preventive efforts on those diseases that have been shown to have a particularly strong synergistic impact on disability when present with other diseases. Furthermore, reducing a risk factor that may cause multiple diseases, such as cigarette smoking, may also affect disability risk.

THE TASK-SPECIFIC EFFECTS OF CONSTELLATIONS OF DISEASES

The data described above indicate that comorbidity is an important factor in disability and that specific combinations of diseases are particularly high risk. It may also be that different constellations of diseases may affect different areas of function. [8] This question was addressed in a recent study that evaluated the associations of 14 different chronic diseases and several age-associated symptoms (dizziness, balance problems, weakness) with different types of physical functioning in the 5201 men and women 65 years of age and older participating in the Cardiovascular Health Study. [8] Specifically, these diseases and conditions were assessed for their associations (cross-sectionally) with difficulty with four different groups, or domains, of tasks: (1) difficulty in mobility/exercise tolerance tasks; (2) upper extremity tasks; (3) complex household tasks (a subset of IADLs), and (4) basic self-care tasks (a subset of ADLs). The patterns of associations differed for the four domains. Most diseases were not associated with all types of disability. Some diseases were associated with only one domain or with two or three domains of functioning. For example (Table 2) , congestive heart failure, cancer, balance problems, and being overweight were associated with difficulty in mobility/exercise tolerance, whereas hearing impairment was associated with difficulty in the complex household management tasks; each of these conditions was not associated with difficulty in the other group of tasks. In addition, cognitive impairment was associated with difficulty in mobility/exercise tolerance-demanding, complex household (IADL), and basic self-care (ADL) tasks, but not with upper extremity function. Angina was associated with mobility/exercise tolerance and upper extremity and complex household task difficulty, whereas myocardial infarction was associated with self-care task difficulty. [8]

Although the cross-sectional design of this study limits the inferences that can be drawn, it has the advantage of

TABLE 2 -- Chronic Conditions Associated with Disability in Older Adults

Characteristics Entered into Each Model	Association with Disability in: A Mobility/Exercise Tolerance Demanding Tasks	B Upper Extremity Tasks	C Complex Household Management Tasks	D Self-Care Tasks
Age	•		•	
Gender (male)		•		
Angina (nitroglycerine use)	•	•	•	
Myocardial infarction				•
Congestive heart failure	•			
Stroke	•	•	•	•
Claudication	•		•	
Arthritis	•	•	•	•
Lung disease	•		•	
Depressive symptomology	•	•	•	•
Hearing Impairment			•	•
Cognitive impairment: Digit symbol substitution	•		•	•
Cancer	•			
Weakness	•	•	•	•
Balance problems, last year	•	•		
Dizziness, last two weeks				•
BMI *		•		•
Weight *	•			

• Indicates significant association ($P < .01$), adjusting for: clinical sites, Minimental State Exam Score, hypertension, Visual Impairment, Diabetes, left ventricular systolic dysfunction by echocardiography, carotid stenosis, and grip strength as well as variables in the table.

Characteristics Entered into Each Model	Association with Disability in: A Mobility/Exercise Tolerance Demanding Tasks	B Upper Extremity Tasks	C Complex Household Management Tasks	D Self-Care Tasks

* Increase of 10 lbs.

offering comparison of associations between diseases and different types of physical disability. Other studies that have looked at subsets of these diseases or of the task groups, both longitudinally and cross-sectionally, have reported findings consistent with the summary observations above. [23] [27] [52] [56] [57] [64] [65] [66] [67] [68] [69] [70] Whereas some diseases were associated with all four task groups (i.e., stroke, arthritis, and depression), better definition of the type of stroke or the joints affected by arthritis may show that these different manifestations do affect different types of tasks. This, in fact, has been shown in a study of arthritis. [56] Thus, there appear to be patterns of association for specific diseases and groups of diseases with different types of physical disability. These observations support our understanding of how different diseases may together have an impact on some aspects of functioning, but not others. These may be modified by disease severity, the presence of other diseases, or the effects of health behaviors, social situations, environment, or psychologic status.

HEALTH BEHAVIORS AND DISABILITY

Lack of exercise is strongly associated with disability onset, while, conversely, regular exercise appears protective in maintaining function. [71] [72] [73] [74] Even among persons age 80 years and older, better function was found among those who had consistently maintained moderate to high physical activity over the previous 19 years. [75] Smoking is also a potent risk factor for functional decline, even after adjusting for diseases associated with smoking that also cause disability. [3] [71] Finally, being overweight is associated with development of disability, particularly mobility difficulty. [71] [76] Thus, behavioral risk factors are important factors in the development of disability. They exert their effect on disability through the diseases they cause, but may also have an independent effect. [77] To better understand how behavioral risk factor interventions might work, the impact of these risk factors independent of disease needs further clarification.

DEMOGRAPHIC CHARACTERISTICS

There is a steep increase in the prevalence and incidence of disability with increasing age, as well as substantially greater prevalence of disability in older women, as previously discussed. It may be that gender modifies the relationship of disease with disability. For example, in a study of survivors after hospitalization for angina or other acute coronary disease, women were at significantly higher risk for subsequent decrease in function, compared with surviving men. [78]

Socioeconomic status has been shown to be a potent predictor of disability in virtually every study in which it has been examined. [3] [4] [25] [27] [29] [47] [62] [79] Data from the nationally representative Longitudinal Study on Aging demonstrated that persons who had incomes of less than $10,000 per year or less than 8 years of education were about 50% more likely to become disabled in ADLs or IADLs than those with higher levels of income and education. [62] In this same population, among persons functioning at a high level, functional decline was significantly less likely in those with higher levels of income and education. [25] In a study of Swedish persons 77 to 98 years of age, previous occupation was found to be strongly

related to ADLs, mobility, and performance measures of functioning. [79]

EVIDENCE FOR ABILITY TO PREVENT DISABILITY

Interventions to prevent or reduce disability could focus on numerous aspects of either etiological factors, extrinsic task demand, or intrinsic capability. Interventions could target the etiological relationship between chronic diseases, comorbidity, and disability. There are also other, non-disease, risk factors that may be alterable. As characterized by Verbrugge and Jette, [37] some are intraindividual factors, including lack of regular exercise, falls, weakness, and being overweight. Other risk factors are extra-individual factors, including medical care, rehabilitation, and hazards or obstacles in the environment (for example, stairs that are difficult to climb or in disrepair). Some factors may impact directly on the level of functioning; for example, disability resulting from the steepness of a staircase or the severity of a disease. Other risk factors may affect multiple points in the pathway to disablement. For example, lack of exercise can decrease exercise tolerance, thus making more difficult the performance of tasks requiring exertion. Lack of exercise is also a risk factor for a number of

diseases and conditions that, in turn, can cause disability: for example, heart and peripheral vascular disease or falls. There are also many potential buffers or compensations that may reduce functional restrictions, [36] [37] [39] [40] including modification of the environment or of the biomechanics or energy demands of task performance, use of assistive devices, or changes in lifestyle and behavior.

There are subsets of older adults who are at higher risk than others for development or progression of disability and who appear most likely to benefit from interventions. These include those with mobility difficulty, those with preclinical disability, hospitalized older adults, and older women generally. Even among hospitalized older adults with ADL impairments, there is a more targeted subset who are at highest risk of loss of function during hospitalization: those who have incontinence, delirium, and pressure sores. [80]

There are still many unanswered questions about the natural history of disability and how to best screen for those at risk. However, there is evidence that this natural history can be modified. Several randomized controlled trials indicate that different points in the pathway to disability can be altered through interventions. Several have targeted underlying abilities that affect function directly. Lower extremity resistance training has been shown to improve strength and gait velocity significantly in both frail nursing home residents [81] and community-dwelling, ambulatory, older persons. [82] [83] In addition, exercise improved postural stability and decreased risk of falling, using either specific exercise regimens or including exercise in multifactorial interventions. [84] [85] [86] We do not yet know whether improvements in intermediate endpoints, such as strength, will result in reduced risk of disability or improved daily functioning, or exactly which exercise regimens and what level of improvement will lead to this outcome.

Three clinical trials of multiple risk factor interventions to prevent disability in community-dwelling older adults have also shown positive effects. One study tested home-based screening of HMO enrollees aged 65 years and older. A home assessment was conducted by a nurse and followed by referral for targeted interventions on risk factors and by follow-ups 1 and 2 years later. At 1 year, there was a significantly lower incidence of decline in functional status in cases than in controls, although no difference was seen at 2 years with this relatively modest intervention. [85] The interventions targeted inadequate exercise, excessive alcohol use, increased fall risk, high-risk medication use, and vision and hearing impairments.

Two other trials tested the effects of comprehensive in-home geriatric assessments on disability. One trial utilized nurse practitioners (with review by geriatricians) to evaluate health behaviors, medical conditions, and use of preventive care and community services in people 75 years and older. [87] Recommendations for interventions were made and follow-up contacts occurred every 3 months. Over a 3-year period, compared with controls, the intervention group was less likely to be dependent in ADLs (OR = .4, P = .02) or to be admitted to a nursing home; there was no difference in IADL dependency. In another trial, in-home geriatric assessments of community-dwelling veterans 70 years and older by a nurse or physician assistant led to improved maintenance of function, with less decline in IADL scores, for the intervention group compared with controls over 1 year, but there was no change in ADL function. [88] This study involved baseline assessment of hearing, vision, weight, orthostatic blood pressure, health behaviors, cognition, depression, gait, balance, and physical function, with recommendations for intervention and follow-ups 4, 8, and 12 months later.

In addition, two randomized controlled trials in hospitalized older adults indicate that loss of functioning can be prevented during hospitalization. [80] [89] In one trial, general medical patients 70 years of age or older were assigned randomly to an intervention consisting of a specially prepared, nonrestrictive environment and patient-centered care emphasizing prevention of disability and rehabilitation or to a control group, which received usual care. [89] The intervention group showed significantly greater improvements in ADLs (34% improved) compared with the controls (24%) as well as reductions in nursing home admissions. The second trial trained nurses in geriatric care and then targeted frail patients 70 years of age and older for enhanced nursing management, including ambulation, mobilization, and decreased restraint use. [80] Sixty percent of the intervention group and 33% of the controls received physical therapy. This trial showed a reduction in functional decline generally and significantly less worsening in ADL function in the subset of intervention patients with ADL impairments, incontinence, delirium, or pressure sores, compared with matched controls.

In summary, there are numerous risk factors that could potentially be modified to prevent or minimize disability. Interventions that target risk factors, such as falls, [84] [85] are likely to decrease risk of disability. It is possible, theoretically, to identify those with early functional problems attributable to chronic disease and to target both treatment of that disease and rehabilitation and other strategies to improve the individual's function and prevent progression of disability. In contrast, acute disorders such as stroke or hip fracture require primary prevention of the disease itself or post-event treatment to modify the outcomes. Randomized controlled trials are currently underway to test the effects of interventions in specific diseases, such as osteoarthritis and congestive heart failure, on minimizing disability. Future clinical trials testing new therapies for disease should also include outcome measures that define their impact on function. Finally, exercise

is likely to be beneficial in preventing disability or improving function, and trials are needed to define the types of exercise that yield such benefits.

Substantial gains have been made in this field in the past 5 years, and we now have a basis for screening and identifying those at highest

risk of disability, potentially the greatest beneficiaries of interventions. Those with preclinical changes in function or those with mobility difficulty or dependency who do not yet have IADL or ADL difficulty, and individuals who are hospitalized, appear to be particularly high risk groups. Another key to success in these endeavors will be the correct targeting of interventions to the specific modifiable risk factors and to the type or stage of function to be improved. Many of the diseases associated with disability have been identified, and the role of comorbidity is better understood. It is reasonable to apply these early findings in the clinical setting, targeting prevention and treatment of high risk diseases as well as minimizing comorbidity. In particular, clinical attention to underlying causes is indicated for those with difficulty in mobility, who are at high risk of progression to difficulty in IADLs and ADLs. In such patients, minimizing the severity and functional impact of current disease, preventing comorbidity, and employing appropriate exercise regimens and rehabilitation therapy as indicated all appear to be valuable targets for clinical care in the prevention of disability. In the future, studies will define the roles played by disease severity and interaction between specific diseases in causing different types of disability and any new factors associated with improvement in function that have clinical applications. Ultimately, the result of effective interventions will be to increase the active life expectancy of older adults or the years of life spent without disability and dependency.

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