Research Article

Factors Associated With Insidious and Noninsidious Disability

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Abstract

Background: Although disability is often precipitated by an illness/injury, it may arise insidiously. Our objectives were to identify the factors associated with the development of insidious and noninsidious disability and to determine whether these risk factors differ between the two types of disability.

Methods: We prospectively evaluated 754 community-living persons, 70+ years, from 1998 to 2016. The unit of analysis was an 18-month person-interval, with risk factors assessed at the start of each interval. Disability in four activities of daily living and exposure to intervening events, defined as illnesses/injuries leading to hospitalization, emergency department visits, or restricted activity, were assessed each month. Insidious and noninsidious disability were defined based on the absence and presence of an intervening event.

Results: The rate of noninsidious disability (21.7%) was twice that of insidious disability (10.8%). In multivariable recurrent-event Cox analyses, six factors were associated with both disability outcomes: non-Hispanic white race, lower extremity muscle weakness, poor manual dexterity, and (most strongly) frailty, cognitive impairment, and low functional self-efficacy. Three factors were associated with only noninsidious disability (older age, number of chronic conditions, and depressive symptoms), whereas four were associated with only insidious disability (female sex, lives with others, low SPPB score, and upper extremity weakness). The modest differences in risk factors identified for the two outcomes in multivariable analyses were less apparent in the bivariate analyses.

Conclusions: Although arising from different mechanisms, insidious and noninsidious disability share a similar set of risk factors. Interventions to prevent disability should prioritize this shared set of risk factors.

Keywords: Longitudinal study, Older persons, Disability, Activities of daily living

Many geriatric conditions, such as delirium and disability, arise from a combination of intrinsic vulnerability and extrinsic insults or intervening events (1,2). Factors contributing to intrinsic vulnerability include frailty, impairments in cognition, vision and hearing, depressive symptoms, deficits in physical capacity, and advanced age. In addition, increasing evidence indicates that disability is often precipitated by serious illnesses or injuries leading to hospitalization (3,4) or by less serious events leading to an emergency department (ED) visit or restricted activity, but not hospitalization (3–5). Although the most common precipitants include cardiac conditions and infections, fall-related injuries confer the highest likelihood for developing new or worsening disability (3,4).

For some older persons, disability may also arise in the absence of a discrete illness or injury. This phenomenon has been referred to as insidious disability (6). We have previously shown that nearly 30% of first disability episodes among nondisabled, community-living older persons are insidious, when operationalized as the absence of a preceding hospitalization or restricted activity (6).

Relatively little is known about the factors that make one vulnerable to insidious disability versus noninsidious disability. To address this gap in knowledge, we used high-quality data from a unique longitudinal study of community-living older persons that includes monthly assessments of functional status and intervening events and a large array of potential risk factors that were assessed every 18 months for nearly 19 years. Our objectives were to

identify the factors associated with the development of insidious and noninsidious disability, respectively, and to determine whether these factors differ between the two types of disability. The results of this study may inform the development of evidence-based interventions to prevent the onset of insidious and noninsidious disability.

Methods

Study Population

Participants were members of an ongoing longitudinal study of 754 community-living persons, aged 70+ years, who were initially nondisabled in four essential activities of daily living—bathing, dressing, walking, and transferring (7). Potential participants were members of a large health plan and were excluded for significant cognitive impairment with no available proxy (8), life expectancy less than 12 months, plans to move out of the area, or inability to speak English. Only 4.6% of persons refused screening, and 75.2% of those eligible agreed to participate and were enrolled from March 1998 to October 1999. The study was approved by the Yale Human Investigation Committee, and all participants provided informed consent.

Data Collection

Data on the candidate risk factors were collected during comprehensive home-based assessments, while data on disability and intervening events were obtained from monthly telephone interviews and Medicare claims. The comprehensive assessments were completed by trained nurse researchers at baseline and every 18 months, while the telephone interviews were completed by a separate team of researchers through December 2016. For participants who had significant cognitive impairment or were otherwise unavailable, we interviewed a proxy informant, using a rigorous protocol with demonstrated reliability and validity (8). Deaths were ascertained by review of local obituaries and/or from an informant. Six hundred sixty-nine (88.7%) participants died after a median of 106 months, while 43 (5.7%) dropped out of the study after a median of 27 months. Data were otherwise available for 94.8% of the 4,944 comprehensive assessments and 98.7% of the 69,096 monthly interviews.

Candidate risk factors

In addition to demographic factors, we considered candidate risk factors from four domains that have been linked to disability in prior studies (9). The health-related factors included nine self-reported, physician-diagnosed chronic conditions (2); corrected near vision, assessed with a Jaeger card (10); hearing, assessed with a handheld audioscope (11); and frailty based on the Fried phenotype (2). The cognitive–psychosocial factors included cognitive impairment, assessed by the Folstein Mini-Mental State Examination (12); depressive symptoms, assessed by the Center for Epidemiologic Studies Depression Scale (13); functional self-efficacy, based on level of confidence in performing 10 activities (14); and social support, assessed by a modified version of the MOS Social Support Survey (14). The behavioral factors included smoking status and body mass index, based on self-reported height and weight (14). The physical capacity factors included a modified version of the Short Physical Performance Battery (SPPB) that included the standard balance maneuvers but substituted three timed chair stands (instead of five) and timed rapid gait (instead of timed usual gait) (14); nondominant, upper and lower extremity muscle strength, assessed

with a handheld Chatillon MSE 100 dynamometer (14); manual dexterity, assessed by a pegboard test (14); gross motor coordination, assessed by having the participant alternatively tap his/her index finger between two circles on a paper and his/her nose 10 times (14); and peak expiratory flow (14). Additional operational details are provided in [Supplementary Table 1](#).

Intervening events

Intervening events included acute hospitalizations, ED visits, and other illnesses or injuries leading to restricted activity. The primary source of information on hospitalizations and ED visits was linked Medicare claims data, which were available for nearly all hospitalizations and for ED visits among fee-for-service participants (2). For periods when participants had managed Medicare, hospitalizations were ascertained using Medicare Provider and Analysis Review files, while information on ED visits and some hospitalizations (ie, those without a Medicare claim) was obtained from the monthly interviews. Participants were asked whether they had visited an ED or stayed at least overnight in a hospital since the last interview. The accuracy of this self-reported information was high (5,6).

To ascertain less potent intervening events, participants were asked two questions related to restricted activity using a standard protocol with high reliability (7): (a) “Since we last talked on (date of the last interview), have you cut down on your usual activities due to an illness or injury?” and (b) “Since we last talked on (date of the last interview), have you stayed in bed for at least half a day due to an illness or injury?” Participants were considered to have restricted activity if they answered “Yes” to one or both of the questions (7). We have previously demonstrated a strong and independent association between the occurrence of restricted activity and development of disability (3). The three most common reasons for restricted activity include fatigue, pain or stiffness in joints, and pain or stiffness in the back (7).

Disability assessments

Complete details regarding the assessment of disability are provided elsewhere (8,15). Each month, participants were asked, “At the present time, do you need help from another person to (complete the task)?” for each of the four essential activities. Participants who needed help with any of the tasks were considered to be disabled. For participants with major cognitive impairment, the monthly interviews were completed with a designated proxy. The reliability of our disability assessment was high (2). To address the small amount of missing data on disability, multiple imputation was used with 100 random draws per missing observation (16). Disability was classified as insidious if it developed in the absence of an intervening event and noninsidious otherwise.

Statistical Analysis

The unit of analysis was an 18-month person interval, the time between the comprehensive assessments. Participants could contribute more than one 18-month interval to the analysis, but they had to be nondisabled and living in the community at the start of an interval. Of the 4,702 person-intervals through December 2016, 3,550 (75.5%) were eligible. For each interval, we evaluated time to first disability episode.

The characteristics of the candidate risk factors were summarized according to disability status per interval: insidious, noninsidious, or neither. We used Cox models for recurrent events to evaluate the bivariate and multivariable relationships between the candidate

risk factors and time to onset of insidious and nonsidious disability, respectively (17). For each outcome, the comparison group included person-intervals with no disability. For each type of disability, participants were censored if and when they developed the other type of disability, because it was not possible to develop both types within a specific interval. Participants who did not develop disability were censored at the time of death or end of an interval. For the multivariable analyses, we used a backward, step-down selection procedure, retaining candidate risk factors with p -value $< .20$. The models accounted for the correlation among observations within individuals through the use of robust sandwich variance estimators for standard errors of the coefficients and for calendar time by including the 18-month interval as a count variable (17).

The amount of missing data for the candidate risk factors ranged from 0.3% for smoking to 8.1% for peak flow, with the exception of upper and lower extremity muscle strength, for which 10.2% and 9.7% of the observations were missing. To account for these missing data, we used sequential Markov Chain Monte Carlo imputation for multivariate normal data. Missing data were not imputed for the intervening events (0.5%, 0.5%, and 0.2% of observations for hospitalizations, ED visits, and restricted activity, respectively).

All analyses were conducted using the SAS version 9.4.

Results

Disability developed in 1,155 (32.5%) of the 3,550 person-intervals. The rate of nonsidious disability (21.7%) was twice that of insidious disability (10.8%). The time (mean [SD] in months) to develop insidious disability (8.0 [5.5]) was a bit shorter than that of nonsidious disability (8.4 [5.3]), but the number of activities disabled was greater for nonsidious (2.1 [1.3]) than insidious (1.2 [0.6]) disability. The median [IQR] number of months disabled was

also a bit greater for nonsidious (1 [1–2]) than insidious (1 [1–3]) disability.

Supplementary Table 1 provides the characteristics of the three disability groups, along with the bivariate associations between the candidate risk factors and two disability outcomes. With few exceptions, the most favorable characteristics were observed for the no disability group, while the least favorable were observed for the insidious disability group. For each outcome, the strongest associations, as denoted by unadjusted hazard ratios ≥ 2 , were observed for ages 80–84, 85–89, and 90+, frailty, low functional self-efficacy, SPPB score < 7 , upper and lower extremity muscle weakness, and poor manual dexterity. For insidious disability, strong associations were also observed for cognitive impairment and poor gross motor coordination, with unadjusted hazard ratios of 2.73 and 2.37, respectively.

Figure 1 provides the multivariable results for the factors associated with the two disability outcomes. Six factors were associated with both outcomes (non-Hispanic white race, frailty, cognitive impairment, low functional self-efficacy, lower extremity muscle weakness, and poor manual dexterity). The magnitude of these associations, as denoted by the adjusted hazard ratios, was modestly higher for insidious than nonsidious disability. The strongest and most consistent associations were observed for frailty, cognitive impairment, and low functional self-efficacy, with adjusted hazard ratios ranging from 1.45 to 2.08. Three factors were associated with only nonsidious disability (older age, number of chronic conditions, and depressive symptoms), while four were associated with only insidious disability (female sex, lives with others, low SPPB score, and upper extremity muscle weakness). Among the seven factors that were independently associated with one outcome but not the other, the strongest association was observed for age ≥ 90 (for nonsidious disability), with an adjusted hazard ratio of 2.21.

Figure 1. Risk factors in multivariable analysis with time to onset of nonsidious and insidious disability. Values are not provided for some entries because only risk factors with p -values $< .20$ were retained in the models, which included the 18-month interval as a count variable to account for calendar time. The reference group included persons 70–74 years of age and persons with normal or underweight for BMI (body mass index). Values are per one unit increase in the number of chronic conditions. CI = confidence interval; SPPB = Short Physical Performance Test. Full color version is available within the online issue.

Discussion

In this prospective longitudinal study of community-living older persons, we found that the factors associated with the development of insidious disability were generally comparable with those associated with the development of noninsidious disability. For each outcome, the strongest risk factors included frailty, cognitive impairment, and low functional self-efficacy. The modest differences in risk factors identified for the two outcomes in the multivariable analyses were less apparent in the bivariate analyses. Our results suggest that interventions to prevent disability should prioritize this shared set of risk factors.

About two-thirds of the disability episodes were noninsidious. Unlike its insidious counterpart, noninsidious disability arises in the setting of an intervening illness or injury. Although participants developing insidious disability were more vulnerable, based on the characteristics assessed, the severity of disability onset was greater for noninsidious than insidious disability, likely reflecting the deleterious effects of the intervening events. Because vulnerable older persons may also develop disability in the setting of an intervening event, the noninsidious group includes a mix of participants with lower and higher levels of vulnerability, thereby explaining its relatively high prevalence of frailty, cognitive impairment, and other vulnerability indicators.

For each of the disability outcomes, a similar set of independent risk factors were identified from the health-related and physical capacity domains, but not from the demographic domain. Given its lower outcome rate, the power to detect differences was diminished for insidious disability, which could explain the nonsignificant association for older age in the multivariable analysis. Despite diminished power, however, four tests of physical capacity were identified as independent risk factors for insidious disability versus two for noninsidious disability. In addition, the magnitude of association was modestly higher for insidious than noninsidious disability for the six shared independent risk factors. Although other demographic factors were independently associated with insidious disability alone (female sex and lives with others) or both outcomes (non-Hispanic white race), none of these associations were statistically significant in the bivariate analyses. In contrast, depressive symptoms was associated with both disability outcomes in the bivariate analysis, with comparable effect sizes, but with only noninsidious disability size in the multivariable analysis, with considerable diminution in effect size. When results from bivariate and multivariable analyses are not consistent, some caution in interpretation may be warranted. Nonetheless, because disability was defined as the need for personal assistance, the availability of a caregiver may have increased the likelihood that vulnerable older persons would accept assistance in the absence of an intervening event, possibly explaining the multivariable association between lives with others and insidious disability.

Our results can be used to inform interventions to promote functional independence among older persons. Several of the shared risk factors for insidious and noninsidious disability are amenable to intervention, including frailty (18), functional self-efficacy (19), cognitive impairment (20), and diminished physical capacity (21). Among vulnerable older persons, especially those who are physically frail, prehabilitation and environmental modifications may be particularly effective in preventing insidious disability and facilitating independent function (22,23). Although distinguishing between insidious and noninsidious disability may not be necessary when the goal is prevention, this distinction is highly relevant when the goal is to promote independent function. For noninsidious disability, several of the most common intervening events, including falls, heart

failure, myocardial infarction, stroke, and arthritis, are preventable (24,25) or amenable to aggressive in-hospital management (26), restorative interventions posthospitalization (27), or self-management and structured physical activity (28,29).

A unique feature of our study is the availability of data from monthly interviews, which allowed us to more precisely determine the onset of disability, to more completely ascertain exposure to intervening events and, in turn, to distinguish between insidious and noninsidious disability. Additional strengths of the study include the high participation rate, low attrition, and availability of data on a large array of potential risk factors, which were reevaluated at 18-month intervals.

Our results should be interpreted, however, in the context of potential limitations. First, because study participants were members of a single health plan in a small urban area, the results may not be generalizable to older persons in other settings. The demographic characteristics of the cohort reflect those of older persons in New Haven County, Connecticut, which are similar to the characteristics of the U.S. population as a whole, with the exception of race and ethnic group (30). Second, we did not ascertain events that did not lead to restricted activity. A prior study found no relationship between a series of new or worsening conditions, when ascertained without such a threshold, and a decline in physical or cognitive performance (31). Third, although comprehensive, our set of candidate risk factors was not exhaustive. Factors suggested in other conceptual models of disability (32), such as household income, net worth, and home environment, were not evaluated. Finally, the current study was not designed to evaluate the “causes” of insidious disability. In an earlier report, we suggested potential mechanisms underlying the development of insidious disability (6).

In summary, although arising from different mechanisms, insidious and noninsidious disability share a similar set of risk factors. Interventions to prevent disability should prioritize this common set of shared risk factors, whereas interventions to promote independent function should also focus on the intervening events that commonly precipitate disability.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Conflict of Interest

T.M.G. serves on the Editorial Board of the *Journal of Gerontology: Medical Sciences*.

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