Patterns of Functional Impairment over Time Amongst Older Men—the Manitoba Follow-up Study

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ABSTRACT

Background

To determine the incidence and prevalence patterns of activity of daily living (ADL) impairments in ageing men.

Methods

3,983 men were enrolled in the Manitoba Follow-up Study (MFUS) cohort study in 1948. From 1996 onwards, functional status was measured. We classified basic (BADL) and instrumental (IADL) into mutually exclusive categories as a time dependant factor after the second survey wave as: First survey response; no limitation; incident (first episode of disability); persistent (limitation which was seen on all questionnaires after the incident episode); resilient (noted in previous surveys but not present); and recurrent (noted in present survey, and limitations noted as present and absent in previous surveys).

Results

There were 1,745 participants in 1996 at a mean age of 76 years. Incident BADL limitations increased substantially with age: from 1% at age 75 to 15% at age 95. Similarly, persistent limitations increased with age: from 0.4% at age 75 to 18% at age 95. However, BADL function was fluid, with many individuals grouped within the resilient and recurrent patterns. Similar age effects and variability were noted in IADLs.

Conclusion

New and persistent disabilities are highly associated with age. However, there is considerable change in functional status over time.

Key words: ageing, men, disability, functional status, cohort study, Manitoba Follow-up Study

INTRODUCTION

Impaired functional status has been shown to predict death,[1,2] depression,[3] falls,[4] long-term care utilization,[5] and hospitalization[6,7] in community-living older adults. In hospitalized older adults, impaired functional status at admission predicts a long length of stay[8,9] and death,[10,11] and has been considered as an important outcome in randomized clinical trials of models of care for hospitalized older adults.[12] Moreover, older adults value highly being able to maintain a high level of functioning.[13] Understanding the epidemiology of disability in population of older adults is, therefore, important for planning health-care and social care services.

To date, a considerable body of population-based and clinic-based studies shows that functional impairment is closely related to increasing age,[14] female sex,[14] cognitive impairment,[15] depression,[16] and to an increased burden of chronic illness.[17] Most of this research has considered the point prevalence of disability. This is likely because there are relatively few prospective cohort studies with frequent measures of functional status over time. However, functional status may not be constant over time, but may fluctuate and vary over time. In analyses of the Precipitating Events Project (PEP) study, Han *et al*.[18] have found that functional status is fairly dynamic with considerable variability over time. Furthermore, there are highly heterogeneous trajectories of disability.[18] Thus, presenting a point prevalence of disability at any one time may be an incomplete measure, since functional status may be variable, and the course that led up to the current state of functional impairment may be variable. Some of the individuals with impairment may have been functionally intact shortly prior to the survey, and some may have been disabled for prolonged periods. Conversely, some of the functionally intact individuals may have been intact, or have been impaired on previous occasions.

Understanding patterns of impairment is important for several reasons. First, the epidemiological study of functional loss may need to consider the trajectory that a population has followed prior to a measurement at a particular point in time—and not simply the point prevalence at a particular time. Disability may be a dynamic consideration, unlike the occurrence of a chronic illness, which is usually considered present from diagnosis until death. Similarly, considering only the point estimate of disability also complicates the study of the incidence of disability, since episodes of disability may be recurrent. Second, clinicians may want to understand the course of disability in their patients in planning care and in treatment considerations. Third, health and social care planning requires an understanding not only of the prevalence of disability, but of the path to disability taken by an individual or a population. If disability is stable, then services such as home care will be relatively predictable, and the needs can be anticipated in advance and services altered slowly. However, if disability is dynamic, then home care services must be flexible and able to respond quickly to changes in functional status. Finally, understanding patterns of functional status is important for older adults and their families. Since maintaining functional status is highly valued by older persons, understanding how older adults recover from a period of disability is likely important.

To address some of these issues, we will conduct an analysis of burden of disability in a cohort of men as they age. The Manitoba Follow-up Study (MFUS)[19] is a cohort study of men who were found fit for aircrew training during the Second World War and who have been followed regularly since then. Beginning in 1996, functional status has also been assessed regularly. The specific objectives of these analyses are: 1) To determine the point prevalence of limitations in basic activities of daily living (BADL) and instrumental ADL (IADL) between the ages of 75 to 100; and 2) To describe the pattern of BADL and IADL impairment between the ages of 75 and 100.

METHODS

The Manitoba Follow-up Study (MFUS) cohort consists of 3,983 men who qualified for air crew training in the Royal Canadian Air Force during the Second World War. When the cohort was sealed on 1 July 1948, their mean age was 31 years, with 90% between ages 20 and 39 years. All study members were free of clinical evidence of ischemic heart disease. The protocol of MFUS was to obtain routine medical examinations from these men at regular intervals over time. The initial research goal of the study was to examine the role that any non-specific abnormalities detected on routine electrocardiograms from apparently healthy men might play in the prediction of subsequent diagnoses of cardiovascular disease. The research focus was expanded in 1996 to explore the roles of physical, mental, and social functioning. By the spring of 2017, 124 of the participants were still alive and responding to the survey, and the mean age was 94 years old.

At the time of these analyses, there were 22 participants who have been lost to follow-up (defined as having no contact during the last three years). Details of the study have been reported elsewhere.[19]

The focus of MFUS was expanded in 1996 when a Successful Aging Questionnaire (SAQ) was added.[20,21] The SAQ was conducted in 1996, 2002, 2004, and annually since then. The SAQ is sent only to those participants living in the community, and is not sent to those living in long-term care or to those who ask not to receive the SAQ. Core components of the SAQ in all years have been: living arrangements, marital status, items of social engagement, self-rated health (SRH), items of life satisfaction, a definition and self-assessment of successful aging, and the Short Form-36 (SF-36).[22] The SAQ also includes measures of ADLs and IADLs. These measures were based on the items used in the Aging in Manitoba Study (AIM),[23] which included items from the Older American Resource Survey (OARS),[24] as well as unique items added into the study survey.

Specifically, participants were asked:

> "Now I have some questions about your ability to carry on different activities. I am interested in your capability, not whether or not you actually do them. Are you capable of … without any help from anyone else?"

The response categories were yes/no. We considered BADLs as: getting up out of chair and walking 3 meters, using the toilet, eating, dressing and putting shoes on, buttoning a sweater, washing or bathing or grooming, getting in and out of bed, going out doors in good weather, getting around the house, and going up and down the stairs. We considered IADLs to be such activities as doing light house work, making a cup of tea or coffee, preparing a hot meal, shopping, managing financial affairs (banking, paying bills), taking medications or treatments, and using the telephone. We considered one or more BADL impairment as "BADL impairment" and two or more IADL impairments as "IADL impairment."

To determine the pattern of ADL impairment, we used an approach similar to the approach we used to categorize other time varying characteristics in the MFUS, specifically atrial fibrillation.[25] We consider a participant's state at a particular survey year based upon their state at that time and also their state in previous survey waves. The seven categories we created are:

First Survey Response – no limitation. These are participants who had no ADL or IADL limitation on the first survey that they return.

First Survey Response – limitation. These are participants who had either ADL or IADL limitation on the first survey that they return.

Never Any Limitation. These are participants who have never reported either ADL or IADL limitations in any survey wave.

New Disability. These are participants with a first episode of disability noted on a returned survey. This is similar to an "incident case" of disability.

Persistent. These are participants with a limitation which was seen on all surveys after a new report of disability.

Resilient. These are participants with a limitation noted in previous surveys, but not in the present survey.

Recurrent. These are participants with a limitation noted in the present survey, and limitations noted as present and absent in previous surveys.

We then tabulated these categories by the year of the survey. Since the prevalence of disability at a particular age is more relevant than at a calendar year, we currently present the graphs of functional status by age at the time of the survey response. Since the age of the cohort is relatively homogeneous, the results by calendar year are similar to the results by age. In the graphs for the pattern of disability, we have excluded the participants' first survey response, since the pattern of disability is only apparent after the baseline status is known. Graphs by year with the initial survey response are available upon request.

RESULTS

The characteristics of men responding to each survey are shown in Table 1. In 1996, 2,043 questionnaires were mailed out, and 1,745 were returned with complete responses on functional status. As the cohort aged, participants died, and as of the spring of 2017, there were 124 surveys sent out. The annual completion rate has consistently been higher than 80%. We believe that these missing responses are not completely at random, but reflect non-response due to illness in most cases. The survey is sent only to those who are still living in the community. The number of deaths increased as a percentage of the remaining sample, as one would expect. Note that these are participants who were known to have died in the interval between the SAQ survey waves, at the time the SAQ was mailed to the participant. It does not include those who were identified as having died a later date; many of the deaths are noted when the SAQ is returned by family.

Over the course of the study, the proportion of individuals with impairments in ADLs and IADLs increased steadily. As expected, IADL impairments were more common than basic ADL impairments. Note that the number of participants who have never had an episode of disability declines steadily over the years of the study, so that by the end of the period of observation, the majority of the sample had experienced a period of IADL impairment, and many had also experienced a period of ADL impairment.

At age 75, the point prevalence of disability was low: 77% had no disability; 14% had only IADL disability; 3% had only BADL impairment; and 6% had both IADL and BADL impairment. By age 95, however, 26% had no impairment; 38% had only IADL impairment; 4% had only BADL impairment, and 32% had both BADL and IADL impairment. The association between age and functional status is shown in Figure 1. There is a clear and strong association between the point prevalence of disability and age. In younger men (i.e., those 75 to 80), impairments are very rare; but by the age of 90, most participants had some IADL or BADL impairment.

TABLE 1.
Characteristics of the Manitoba Follow-up Study cohort from 1996 through 2017

Year	Participants Known To Be Dead	Number Of Surveys Not Sent	Number Of Surveys Sent	Number Of Surveys Completed	Age (Years)	Never Any IADL Impairment (%)	Never Any BADL Impairment (%)
1996	1861	79	2043	1745	76.6	-	-
2000	2226	96	1661	1319	80.0	64%	82%
2002	2469	40	1474	1153	82.0	55%	78%
2004	2709	60	1214	870	83.8	50%	75%
2005	2798	73	1112	860	84.6	45%	70%
2006	2896	86	1001	807	85.6	39%	66%
2007	2999	104	880	680	86.3	37%	64%
2008	3107	119	757	589	87.2	34%	63%
2009	3215	101	667	522	88.0	31%	60%
2010	3286	116	581	450	88.8	25%	57%
2011	3383	133	467	360	89.7	25%	60%
2012	3464	133	386	298	90.7	24%	58%
2013	3538	115	330	239	91.4	20%	54%
2014	3604	110	269	193	92.2	16%	47%
2015	3667	85	231	146	93.0	17%	42%
2016	3731	76	176	123	93.9	16%	40%
2017	3803	56	124	87	94.6	18%	41%

Also as expected, IADL impairments were more commonly seen than BADL impairments. There were very few men with impairments only in IADLs.

When we consider the pattern of ADLs, a more nuanced picture emerges. At age 75, very few participants had persistent deficits, and the incidence of BADL was very low. However, incidence and prevalence increased steadily with advancing age. As well, the proportion of participants with recurrent and resilient patterns increased with age (Figure 2). A similar pattern was seen with IADLs (Figure 3). BADL impairment which persists through all study waves is less common than IADL impairments, and considerable numbers of participants exhibit resilient and recurrent patterns (Figures 2 and 3). Indeed, the combination of these two states is more common than persistent disability. Also of note, even in very old men, the prevalence of persistent BADL is fairly low.

DISCUSSION

We have examined the point prevalence and prevalence pattern of functional impairment in a prospective cohort of ageing men. We have found a very strong and linear association between age and limitations in both BADLs and IADLs, and that IADL limitation is more common than BADL limitation. However, the point prevalence of functional impairment may be an incomplete reflection of functional impairment among individuals and populations, since there are different patterns of limitation. At any time, those with resilient and recurrent patterns of functional impairment are common.

There are some strengths and limitations to our approach. First, this is a large, established cohort with few missing responses. However, the missing responses to the survey are unlikely to be at random, but due to illness during that survey wave. Thus, we may be underestimating the point prevalence of disability. The effect of missing variables in the estimation of the pattern of disability is less clear. Second, there are frequent sampling intervals. Most large epidemiological surveys have sampling intervals of three to five years. Fluctuations in function during this time period may not be apparent, so it may be difficult to assign a pattern of disability to an individual participant. With frequent sampling intervals, it is easier to detect rapid fluctuations in function. Third, MFUS considers measures of both IADLs and BADLs with measures similar to other studies. We do not, however, use the OARS scale itself, but items drawn from it. We also did not consider the use of assistive devices in the measurement of BADL, as the original OARS did. Thus, the results may differ somewhat from other studies which use the OARS.

There are also limitations. First, the MFUS cohort consists of only men, and we cannot ascertain the prevalence or patterns of disability amongst ageing women. Second, this cohort was healthy enough to qualify for air crew,[26,27] and have shared life experiences which may have shaped late-life health and not be generalizable to other older populations—notably
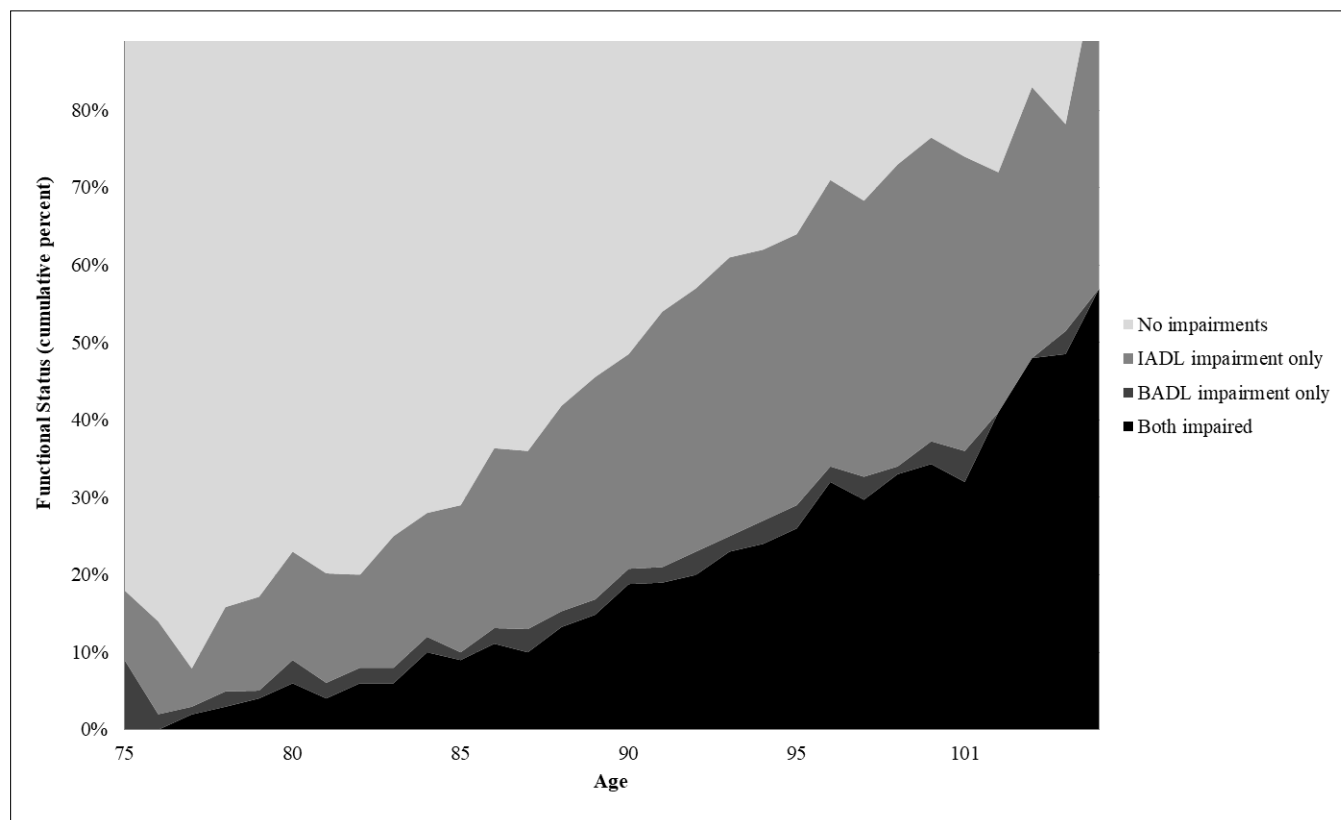

FIGURE 1. Point prevalence of functional impairment by age

those outside Canada and women. Finally, accounting for the effect of death on patterns of disability is complicated. Since functional status predicts death very strongly, it is likely that those who die experience a period of disability prior to death. They are also removed from the pool of observed individuals, making interpretation of the pattern of disability prior
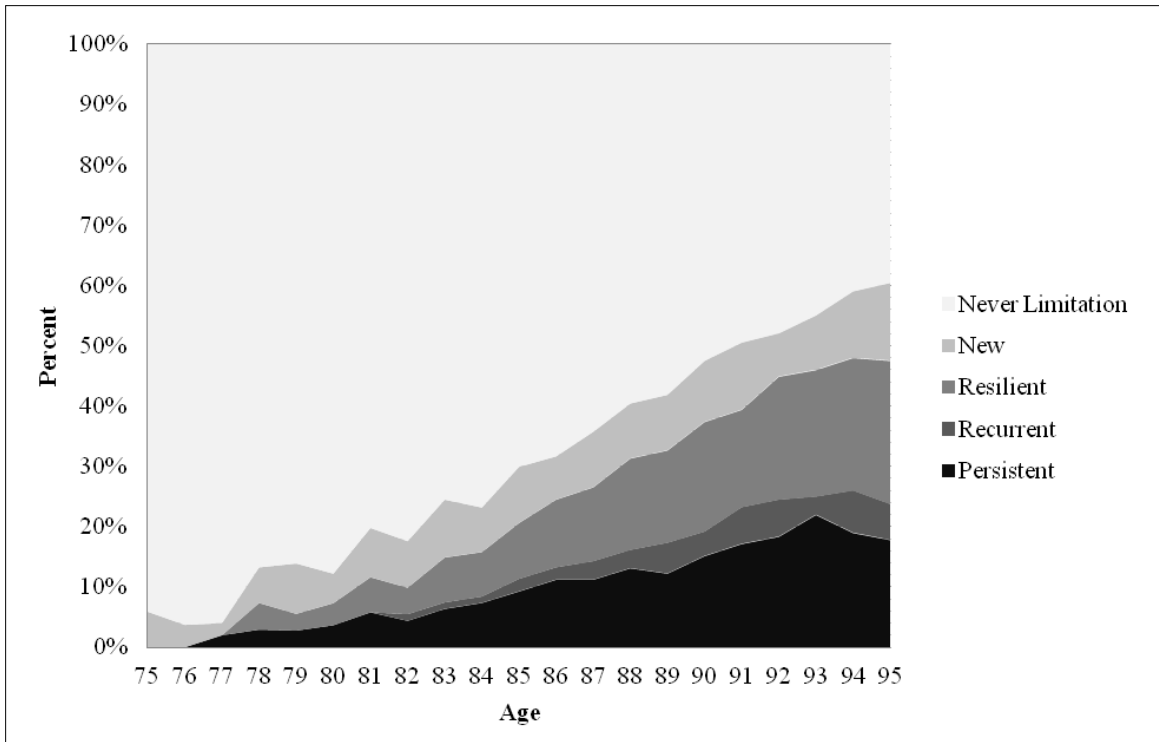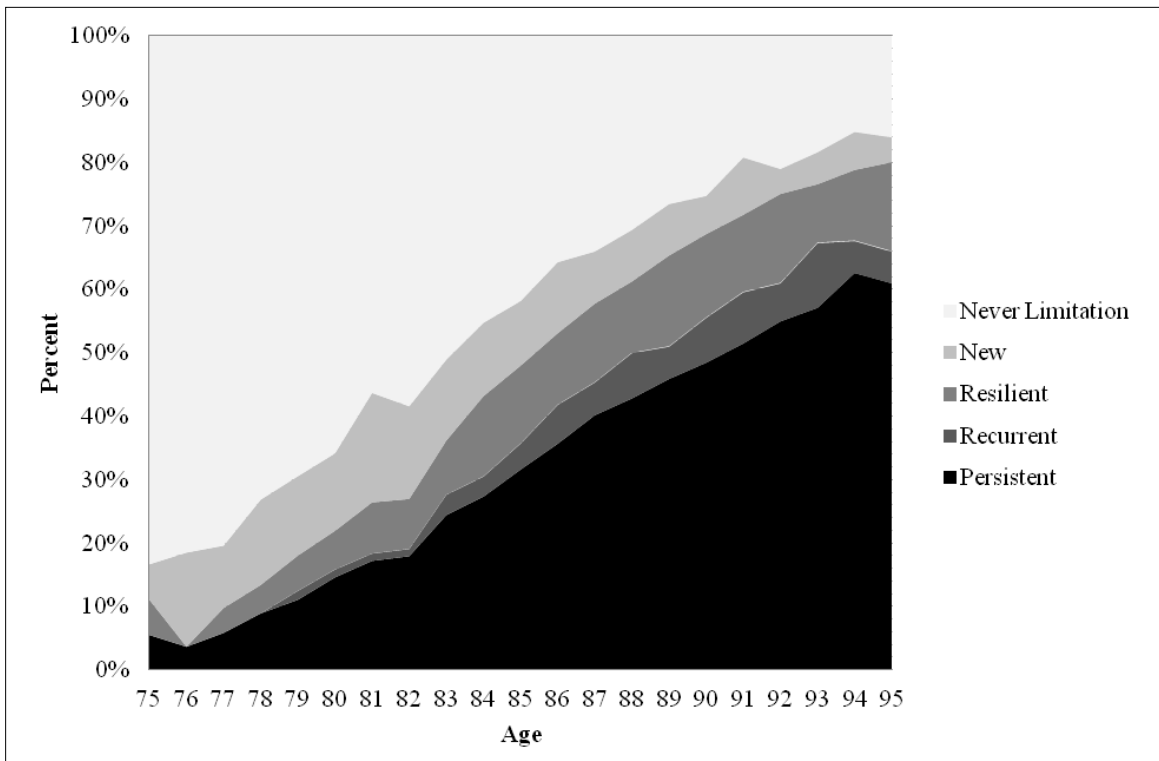
FIGURE 2. BADL impairment categories by age

FIGURE 3. IADL impairment categories by age

to death complicated. This may also partly explain the low numbers of participants with persistent disability. If incident disability is associated with a high death rate, coupled with a short survival time in a state of disability, then there may be an incidence-prevalence (Berkson's) bias[28] in the prevalence estimates of disability, particularly persistent disability. This is also true for the men who were not sent an SAQ, most of whom were in long-term care.

Our results are similar to other studies of functional impairment amongst older populations. The effect of age on functional status has been widely accepted, and is not surprising. Nevertheless, it remains important. By very late life, most individuals have functional impairment. The focus of health interventions to date has focused on preventing disability in late life, and disability rates seem to have declined modestly in recent decades.[29] This is clearly very important. However, even with dramatic reductions in late-life disability, there will still be a high proportion of older adults with disability who require health and social care. Any future reduction in disability may be offset by the growing proportion of very old adults in the population. Ensuring adequate attention to those with functional impairment is, therefore, important.

Our second finding of fluctuating functional status, with substantial numbers of individuals recovering from disability and/or experiencing recurring episodes of disability, is perhaps more important. It is important to note that, at most periods in the study, there were more participants with recurrent or resilient patterns than with persistent disability. To date, service planning has largely considered the point prevalence of disability and assumed that the pattern was fairly stable over time. As this may not be true, reconsidering service delivery may be required. Notably, services such as home care may need to adapt to rapid changes in functional status, and geared up or down depending on the course of functional status. Moreover, these fluctuations may be heterogeneous to an individual, so services may need to be tailored to an individual rather than to a population. Providing rehabilitation and geriatric assessment in hospital[12] and the community[30] may also be important, and may also need to be responsive and adaptive. Home care programs may need to deliver rehabilitation, as well as care provision, in order to maximize recovery from acute disability.[31,32]

Finally, the effect of the pattern of functional status on older adults, their families, and their caregivers may be important. Functional impairment is associated with depressive symptoms and other measures of well-being. The effect of functional recovery on well-being merits further attention. As well, the pattern of recurring disability on well-being also merits further study. Some hope of functional recovery may be encouraging. On the other hand, unpredictable episodes of functional decline may be quite distressing for older adults, and the uncertainty around the precipitants of these declines may be further distressing. Further study into the factors that predict and precipitate these declines, as well as the effect of these declines on well-being, is needed in order to more broadly understand late-life health and well-being.

Our findings also suggest other future research strategies for this and other longitudinal studies. First, the relatively frequent sampling time intervals allow for the study of the natural history of new onset functional impairment—both the risk factors and the outcomes. This may be particularly important in the study of disease states with a high mortality, or in the study of populations with a high baseline mortality. Second, determining the trajectories and/or transitions of functional status is possible. Analytic strategies such as latent class models, joint trajectory models, multilevel models, and multistate modelling can be used to investigate the predictors and consequences of the trajectories and transitions. This information could prove useful in planning services and understanding risk factors for those with changing functional status.

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CONFLICT OF INTEREST DISCLOSURES

The authors declare that no conflicts of interest exist.

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