DEMOGRAPHIC AND HEALTH PREDICTORS OF DISABILITY CHANGE AND NON-CHANGE IN LATE LIFE

Michelle Cheuk

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Approved by

_____
Advisor: Peter Uhlenberg

_____
Reader: Catherine Zimmer

_____
Reader: Linda George

ABSTRACT

Michelle Cheuk
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(Under the direction of Peter Uhlenberg)

For older, nondisabled people, what variables predict change or constancy in disability status over a two-year time period? Do these same variables predict change or constancy for people with an IADL or ADL disability?

Three waves of data from the LSOA II are used to analyze the effects of age, sex, education, marital status, prior disability status, and self-rated health on disability transitions. Age, prior disability status, and self-rated health generally are stronger predictors of disability transitions than sex, education, and marital status. Predictors of transitions differ for independent and disabled people. Among disabled people, variables have similar effects whether the disability is IADL or ADL. Predictors of stable states differ for all three disability statuses: health variables are the strongest predictors for independent people, most variables are significant but of limited magnitude for IADL disabled people, and only prior ADL disability is a significant predictor for ADL disabled people.

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Introduction

The well-known increase in disability and mortality rates with age suggests an image of continual physical decline with age. Although this is a correct picture for the population, it is not necessarily true for individuals (Crimmins, Hayward, and Saito 1994). Some individuals become disabled and die, some become disabled and recover, and others become more or less disabled than they were before. In other words, there is substantial heterogeneity in functional change among disabled people (Manton 1988), with disability never being a permanent state. Every disabled person will eventually experience the transition to death, and a significant number of them will experience the transition of recovery (Manton 1988; Manton 1990; Hayward, Crimmins, and Saito 1998; Manton and Land 2000; Wolinsky, Armbrecht, and Wyrwich 2000). Several longitudinal studies have shown that 25 to 30 percent of disabled older people at one wave go on to recover from disability at the next wave. The same rate of recovery has been found whether the next wave is one, two, six, or ten years later (Branch et al. 1984; Crimmins et al. 1994; Gill, Robison, and Tinetti 1997).

In order to discuss disability and disability transitions, disability needs to be defined: criteria must be established for identifying when a person has entered and exited a disabled state. The most prevalent definition of disability in the social science and public health literature is the inability to perform an expected social role. Independence is measured by the ability to perform activities of daily living (ADL) and instrumental activities of daily living (IADL), with ADL being the more severe form of disability (Wiener, Hanley, and Clark 1990; Verbrugge and Jette 1994; Himes 2001; Molla, Madans, Wagener et al. 2003). Some

studies aggregate disability as being IADL or ADL disability, whereas other ones define disability as being ADL disabled only. Disability statuses are almost always constructed to be mutually exclusive. For example, although a person may have both an IADL and ADL disability, it is common practice to categorize this person as being in the more severe disability status, ADL disability. People with neither an IADL nor ADL disability are categorized as independent.

Previous literature primarily focuses on two functional transitions — from independence to disability and independence to death. However, if one begins with three possible disability statuses (independent, IADL disabled, ADL disabled) and ends with four possible disability statuses (independent, IADL disabled, ADL disabled, and dead), then there are nine possible transitions and three stable states, as shown in Figure 1.

This paper analyzes predictors of all possible transitions and stable states, recognizing that a predictor may not be equally associated with each one (Manton 1988; Crimmins and Saito 1993). For example, more education may be associated with better transition outcomes for people who are independent but not for people who are IADL or ADL disabled. This would be useful information, showing that the lower disability prevalence rates observed in more highly educated people is due to prevention of disability onset rather than increased recovery rates once disabled.

In addition, understanding the factors that lead to decline or recovery is important because decline is associated with higher medical costs and improvement is associated with lower medical costs, with those who recovered having similar medical costs as those who were nondisabled at baseline (Mor, Wilcox, Rakowski et al. 1994). While knowing who recovers is useful, it is equally useful to know who remains persistently disabled. These two different

longitudinal outcomes have very different implications for medical costs, and prior research is particularly lacking on predictors of the stable state of remaining disabled.

Significant predictors of disability status in a cross-sectional analysis include demographic characteristics, prior disability status, and self-rated health (Branch and Ku 1989; Strawbridge, Kaplan, Camacho et al. 1992; Mor et al. 1994; Crimmins, Hayward, and Saito 1996). This paper will analyze how these variables predict changes and constancy in disability status across time. The following questions will be addressed:
(1) What are the most common disability transitions and stable states over a two year time period? (2) What are the predictors of disability transitions and stable states for independent people? (3) Are these predictors the same for people who have an IADL or ADL disability?

Literature review

Evaluating previous research on predictors of disability transitions helps identify areas of knowledge where results are consistent, conflicting, or lacking. In reviewing the literature, particular attention was paid to studies with predictors of age, sex, education, marital status, prior disability status, and self-rated health. Following is a summary of this literature.

Age

Previous research has consistently found an adverse effect of age on disability transitions. Older age increases the probability of transitioning to death and decreases the probability of transitioning to independence from any disability status (independent, IADL disability, or ADL disability) (Branch and Ku 1989; Manton, Corder, and Stallard 1993; Land, Guralnik, and Blazer 1994; Mor et al. 1994; Crimmins et al. 1996). Older age is also associated with a

higher probability of both IADL and ADL disability onset for those who are independent (Manton 1988; Strawbridge et al. 1992). For the stable states of remaining independent, IADL, or ADL disabled, older people are less likely to experience stability in their disability statuses than younger people (Manton et al. 1993). In a study which aggregated the direction of transitions, negative transitions increased and positive transitions decreased with age (Crimmins et al. 1996).

However, one study found that while the risk of ADL disability increased with age, the risk of IADL disability did not (Crimmins, Saito, and Reynolds 1997). This paper will test the consistency of these findings as well as analyze the effect of age on two transitions not covered by the literature: declining from IADL disability to ADL disability and improving from ADL disability to IADL disability. Does age have an adverse effect on all disability transitions?

Sex

Previous studies on transition probabilities by sex produce an incoherent story. Some studies show no gender difference in disability status at follow-up waves (Manton 1988; Manton 1990; Strawbridge et al. 1992; Land et al. 1994; Crimmins et al. 1996), while others show that men are much more likely than women to transition to death (Manton 1988; Branch and Ku 1989; Manton 1990; Strawbridge et al. 1992; Guralnik, Land, Blazer et al. 1993; Land et al. 1994; Mor et al. 1994; Crimmins et al. 1996). This discrepancy of independent men and women being equally as likely to be independent, IADL disabled, or ADL disabled at the next wave but men being much more likely to die occurs because previous studies did not examine all possible transitions simultaneously. Examining all

possible transitions at the same time would take into account the competing risks of each transition. If men are indeed more likely to transition to death, then women must be more likely to experience one or more of the other transitions.

For people who are IADL disabled, previous studies have found that women are more likely to be IADL disabled and ADL disabled at the next wave, while men are more likely to be dead (Manton 1988; Manton 1990; Crimmins et al. 1996). As for recovery to independence, one study found that men are more likely to recover (Manton 1988; Manton 1990) whereas another study found no difference by sex (Crimmins et al. 1996). In summary, IADL disabled women tend to remain disabled with either an IADL or ADL disability while IADL disabled men tend to die and may be more likely to recover.

For people who are ADL disabled, women have been found to be more likely to recover to independence (Land et al. 1994), but men and women are equally as likely to recover to IADL disability (Crimmins et al. 1996). While findings are not available for sex differences for remaining ADL disabled, men are more likely to die (Manton 1988; Manton 1990).

This paper adds to the current literature on sex as a predictor of disability transitions by performing a multivariate analysis. Sex-correlated variables such as marital status and self-rated health are controlled for. Also, the analysis differs from previous studies by taking into account the competing risks of all possible transitions. The goal is to assess how transition patterns differ for men and women — where do men tend to go, and where do women tend to go? In addition, previous research on sex and disability transitions uses data from surveys in the late 1980s. This paper uses more recent data from 1994-2000. A comparison of the results will show whether the effect of sex on disability transitions has been consistent over time.

Education

Previous literature on the effect of education on disability transitions provides mixed results. When education has a significant effect on the probability of making a specified disability transition, the effect is favorable.

For people who are independent, education decreases the likelihood of IADL onset (Crimmins et al. 1996). The same study showed that education has no effect on transitioning to ADL disability and death, while another study showed that education decreases the likelihood of transitioning to ADL disability and death (Land et al. 1994). A study which measured disability in terms of mobility instead of ADL disability also found that education decreased the likelihood of an independent person transitioning to disability and death (Melzer, Izmirlian, Leveille et al. 2001).

For people who are IADL disabled, education appears to have no effect on any of their transitions, whether they were transitions of recovery or decline to ADL disability or death (Crimmins et al. 1996). Similarly, for people who are ADL disabled, education also appears to have no effect on any of their transitions (Land et al. 1994), except for one study which found that education increases the probability of recovery to independence (Crimmins et al. 1996). The study which defined disability in terms of mobility instead of ADL disability found no effect of education on recovery or transitioning to death (Melzer et al. 2001). The effect of education on stable states were not analyzed (Branch and Ku 1989; Land et al. 1994; Crimmins et al. 1996; Melzer et al. 2001).

This paper will add to the literature on the relationship between education and disability transitions by seeing which prior findings will be replicated. Does education have a favorable

effect on all transitions for independent people? Does education have any effect on transitions for disabled people?

Marital status

Only one study on disability transitions (as measured in this paper) includes marital status as a predictor. For people who were independent at baseline, marital status was a significant predictor of ADL disability and death six and ten years later, although not one year later. Independent people who were previously married were more likely to become ADL disabled and more likely to die than those who were married and those who were never married at baseline (Branch and Ku 1989).

Another study that measured disability transitions as a change in a physical functioning score found that marital status was a significant predictor. Compared to people who were not separated or widowed, those who were separated or widowed were significantly more likely to experience a decline in their physical functioning score after six years (Kaplan, Strawbridge, Camacho et al. 1993). Given that marital status is a significant predictor of disability status (Goldman, Korenman, and Weistein 1995; Freedman, Martin, and Schoeni 2004) and that there is evidence that marital status is a significant predictor of some disability transitions, particularly for mortality, (Branch and Ku 1989; Kaplan et al. 1993), including marital status as a predictor is important for this analysis of disability transitions.

Prior disability status

Previous research has shown that baseline disability status is a significant predictor of subsequent disability status, whether the baseline disability status was two, five, six, or ten

years before the subsequent disability status, with worse baseline disability status predicting worse subsequent disability status (Manton 1988; Branch and Ku 1989; Strawbridge et al. 1992; Guralnik et al. 1993; Manton et al. 1993; Crimmins et al. 1994; Mor et al. 1994; Crimmins et al. 1996).

However, limited research exists that takes advantage of the longitudinal data available with more than two points in time. This kind of longitudinal data can be used to shed light on diverse trajectories of aging (George 1995). A number of studies have addressed disability status at two points in time, but only one study has examined disability status at three points in time (Anderson, James, Miller et al. 1998). Controlling for current disability status, what is the role of prior disability status for predicting subsequent disability status? For example, for people who are ADL disabled, does being independent two years prior increase their probability of recovering to independence two years later versus if they had been ADL disabled two years prior? Stated differently, does only current disability status matter in predicting transition probabilities, or does prior disability status matter as well?[1]

One study examined prior disability status for predicting transitions to institutionalization and death, although it did not examine any other transitions or stable states. The study showed that worse prior disability status, controlling for current disability status, increased the probabilities of transitioning to institutionalization and death (Wolinsky, Callahan, Fitzgerald et al. 1993).

[1] Assuming that only current disability status and not prior disability status is a significant predictor of subsequent disability status is an example of the first-order Markov assumption, which is that the probability of the subsequent status depends only on the previous status and not the status before the previous status. A second-order Markov assumption is the probability of the subsequent status depends only on the previous states and the status before the previous status, but not the status before these two statuses. The first-order Markov assumption is used in previous studies (Melzer et al. 2001; Crimmins et al. 1996; Crimmins et al. 1994) to justify the pooling of first, second, and third transitions. If the Markov assumption for disability transitions is true, then it is safe to make the Markov assumption and pooling is acceptable. If it is not true, then the first, second, and third transitions are not independent of each other and therefore pooling transitions is not appropriate.

Another study examined all disability transitions, although none of the stable states. It found that independent people who had been independent two years before were highly likely to be independent two years later. Three-fourths of them continued to be independent two years later compared to 47 percent of those who had an IADL disability two years earlier, 42 percent of those who had moderate ADL disability two years earlier, and 25 percent of those who had severe ADL disability two years earlier (Anderson et al. 1998). Prior disability status appears to have a gradient effect on subsequent disability transitions for independent people.

For people who are IADL disabled, prior independence predicts a higher likelihood of recovering to independence, with a probability of 30 percent. Prior disability, whether IADL or ADL, halves the likelihood. For people who are ADL disabled, the probability of recovery is also dramatically lowered with prior disability compared to prior independence (Anderson et al. 1998).

Self-rated health

Self-rated health has been shown to predict future disability and mortality, with worse self-rated health predicting a higher likelihood of being disabled and dying, whether the time was one, six, nine, or ten years later (Kaplan and Camacho 1983; Branch and Ku 1989; Mor et al. 1994). People with excellent or very good self-rated health are about 60 to 70 percent less likely than people with fair, poor, or missing self-rated health to be IADL disabled, ADL disabled, or dead two years later (Anderson et al. 1998). While these studies show the relationship between self-rated health and subsequent disability status, what they do not show is (1) whether self-rated health has a differential predictive effect for independent people,

IADL disabled people, and ADL disabled people and (2) whether self-rated health is predictive of all transitions.

Data

The data used in this analysis come from the 1994-2000 Second Longitudinal Study on Aging (LSOA II), of which three waves of data have been collected. The time in between waves was approximately two years, with data collected in 1994-1995, 1997-1998, and 1999-2000. The sample was obtained through a stratified multistage sample design and is representative of the civilian noninstitutionalized population, age 70 and older, in the United States in 1995. There are a total of 9,447 respondents. See Appendix for additional details.

The follow-up waves were conducted regardless of the respondent's residence type. Therefore, respondents who had become institutionalized were included.[2] Interviews for incapable respondents, due to health reasons or unavailability for the entire field period, were conducted with proxy respondents, such as a family member or close relative.[3]

One weakness of using the LSOA II for this analysis is the amount of time, two years, between data collection points. This design misses disability transitions that occur between waves. For example, a person who is disabled at the first wave, recovers, and becomes

[2] Institutionalized respondents are those living in a nursing, convalescent, or rest home and did not return home during the one-year data collection period. Retirement homes, supervised apartments, and assisted living facilities are not considered institutions. Respondents who are institutionalized temporarily and expect to return home during the one-year data collection period are considered community-dwelling.

[3] The response rate for Wave 1 was 87.4 percent, Wave 2 was 94.6 percent, and Wave 3 as 81.5 percent. Of respondents who were alive, interviewed, and with known respondent type, 11.5 percent of Wave 1 interviews were with proxy respondents, 19.8 percent of Wave 2 interviews were with proxy respondents, and 21.6 percent of Wave 3 interviews were with proxy respondents. These proxy response rates are similar to the National Long-Term Care Survey (NLTCS) proxy response rates of 23 percent in 1984 and 18 percent in 1999, although the NLTCS includes institutionalized respondents at both times (Spillman 2004). Also, these proxy rates for the LSOA II are substantially lower than the 1984-1990 Longitudinal Study on Aging (LSOA), which had proxy response rates ranging from 31 to 36 percent in the subsequent reinterview waves (Anderson, James, Miller et al. 1998).

disabled again by the second wave, is recorded as being disabled at both waves and the recovery event is not captured. Therefore, more frequent data collection points, perhaps monthly, is ideal (Manton 1988; Uhlenberg 1995; Laditka and Wolf 1998; Gill, Hardy, and Williams 2002; Hardy and Gill 2004) but currently not available on a nationally-representative level. However, if any relationships are strong enough to emerge using incomplete event history data, then these relationships can probably be further strengthened with complete information. The strengths of the LSOA II are its nationally-representative sample, large sample size, high quality data collection methods, wide range of questions asked, and following people into institutions if they become institutionalized.

The sample being analyzed is respondents with complete information on the dependent and independent variables. The dependent variable, disability status at the third wave, requires that the respondents be alive at the second wave in order to remain in the same disability status or make a transition to another disability status at the third wave. Analyzing only the respondents who are known to be alive at the second wave reduces the sample from 9,447 to 7,989 respondents. Also, disability status at all three waves must be available for each respondent in order to (1) specify their disability transition from the second to the third wave and (2) include their prior disability status at the first wave as an independent variable. These additional criteria further reduce the sample to 6,063 respondents. Having complete information on the remaining independent variables produces the final sample of analysis of 5,578 respondents.

Further analysis (not reported in this paper) shows that respondents with unknown alive/dead status at the second wave, unknown disability status at any of the three waves, or unknown values for any of the independent variables tend to do slightly worse on several

different measures of health outcomes.[4] In other words, the people in the sample analyzed for this paper tend to be a little healthier than what we would expect if we were able to take a random sample of the older population at the second wave. A random sample of the older population at the second wave is not possible because a substantial proportion of respondents experience a decline in health from the first to the second wave. These respondents with a decline in health have a higher rate of attrition than those who do not have a decline in health.

Measurement

Dependent variable: Disability status

Disability status is defined as a categorical variable with three states: independent, disabled, and dead. Although one way to define disability is "experienced difficulty doing activities due to health," (p. 4) which can include any activity from bathing to working to engaging in hobbies, the most prevalent way to define disability is the inability to perform an expected social role, which for older people is independence (Molla et al. Nagi 1965; Verbrugge and Jette 1994; 2003).

Independence is measured at two levels: personal care and household management (Verbrugge and Jette 1994). Personal care is measured by the ability to perform activities of daily living (ADL) (Katz et al. 1963), and household management is measured by the ability

[4] For example, Table 2 shows that second transition rates are slightly better than first transition rates, despite second transitions occurring at ages two years older than the first transition. The sample with data available for second transitions differs from the sample with data available for first transitions in that the former sample is healthier. Better health in the sample with data available for second transitions is indicated by being alive at the second wave and proportionately more of them being able able to give disability status information at the second and third waves. The second transition sample's better health status produces better transition rates.

to perform instrumental activities of daily living (IADL) (Lawton and Brody 1969), with ADL being the more severe form of disability (Wiener et al. 1990; Himes 2001).

The ADLs which were asked in all three waves are bathing or showering; dressing; eating; getting in and out of bed or chairs; walking; and using the toilet, including getting to the toilet. The IADLs which were asked in all three waves are preparing your own meals; shopping for groceries and personal items, such as toilet items or medicines; managing your money, such as keeping track of expenses or paying bills; using the telephone; doing heavy housework, like scrubbing floors or washing windows; doing light housework, like doing dishes, straightening up, or light cleaning; and managing medication.

One ADL, getting outside, and one IADL, getting to places outside of walking distance, were asked in the first wave but not asked in either the second or third waves. Therefore they are not included in the analysis. These items are typically not included in other studies (Branch et al. 1984; Branch and Ku 1989; Strawbridge et al. 1992; Guralnik et al. 1993; Crimmins et al. 1994; Land et al. 1994; Mor et al. 1994; Crimmins et al. 1996; Crimmins et al. 1997; Molla et al. 2003).

The number of ADL items included makes a difference in results on disability transitions, with more items (six) being more sensitive to transitions and fewer items (four) being more stable (Branch et al. 1984). Previous studies typically use a six-item ADL measure (Guralnik et al. 1993; Manton et al. 1993; Land et al. 1994; Mor et al. 1994), and a few studies use a five-item ADL measure (Branch and Ku 1989; Crimmins et al. 1994; Crimmins et al. 1996; Crimmins et al. 1997). Two studies use a seven-item ADL measure, but the additional ADL item is atypical from other studies (grooming and getting outside) (Strawbridge et al. 1992; Crimmins and Saito 1993). The six-item ADL measure used in this paper is consistent with

much of the literature on the number and which items are included. Also, the five-item measures used in previous studies (Branch and Ku 1989; Crimmins et al. 1994; Crimmins et al. 1996; Crimmins et al. 1997) either do not include toileting or walking, which substantively seem to be important to include in an ADL measure.

Respondents are asked, "Because of a health or physical problem, do you have any difficulty bathing or showering?" If the answer is yes, for ADLs, they are asked, "By yourself and without special equipment, how much difficulty do you have bathing or showering?" and for IADLs, they are asked, "By yourself, how much difficulty do you have preparing your own meals?" The response categories are some, a lot, or unable. If the respondent is unable to perform the activity, then he/she is defined as having that ADL or IADL (Manton et al. 1993; Crimmins et al. 1994; Crimmins et al. 1996; Crimmins et al. 1997; Mendes de Leon, Glass, Beckett et al. 1999). Unable is chosen over some or a lot of difficulty because the outcome of interest is dependency. The majority of people who say they have some or a lot of difficulty say the activity is very tiring, takes a long time, and/or is very painful,[5] but they are still able to perform the activity.

If the respondent does not perform the activity for some other reason, then he is recoded to no difficulty because this is not a task that is demanded of the respondent, therefore he is not experiencing difficulty with this task. For example, meal preparation may be a task that some male respondents do not do because their wives prepare meals for them (Lawton and Brody

[5] For example, at Wave 1, of people who said they had some or a lot of difficulty walking, 78 percent said that, without special equipment or help, the activity is very tiring, takes a long time, and/or is very painful. Similarly for dressing, of people who said they had some or a lot of difficulty dressing, the proportion who said that, without special equipment or help, the activity is very tiring, takes a long time, and/or is very painful, is 76 percent. The percentages for the other ADLs, in descending order, are: 71 percent getting in or out of bed or chairs, 62 percent eating, 56 percent bathing, and 53 percent using the toilet.

1969). Since the task is not demanded of them, they are not experiencing difficulty in preparing meals for themselves (Verbrugge and Jette 1994).

For IADLs, respondents who say they do not perform this task for some other reason are asked whether someone regularly does this activity for them. The vast majority of them say yes.[6] For ADLs, respondents who say they do not perform this task for some other reason were not asked whether someone regularly does this activity for them. For purposes of recoding, they will be assumed to not have difficulty with this activity for the same reason given above.[7] At Waves 2 and 3, if a respondent is institutionalized, the survey did not ask him/her the questions on IADL tasks. At Wave 2, if the respondent requested a self-administered questionnaire instead of a phone interview, he/she was not asked about the telephone IADL. Omission of survey questions forces the data analyst to make assumptions with regards to the values of these missing data. For the purposes of this analysis, the former group of respondents are recoded as having an IADL disability, and the latter group are recoded as having a telephone IADL. However, not all institutionalized respondents have an IADL disability, and not all respondents who requested a self-administered questionnaire had a telephone IADL. These necessary assumptions thereby introduce noise to the analytical results and may partly explain the relatively less clear results in this paper for transitions to and from IADL disability as compared to the other disability statuses.

[6] For respondents who say they do not prepare meals for some other reason, more than 90 percent said someone regularly does this activity for them. For respondents who say they do not shop for some other reason, also more than 90 percent said someone regularly does this activity for them. The same pattern is demonstrated for managing money, heavy housework, and light housework. For using telephone and managing medication, the proportion was more than 70 percent.

[7] At Wave 1, these respondents constitute a very small proportion of the total sample, ranging from 0.1 to 0.3 percent (for each ADL) of the total sample. At Wave 2, the proportion ranges from 0.6 to 0.8 of the respondents who were interviewed, and at Wave 3, the proportion ranges from 0.1 to 0.8 percent.

An independent person is defined as someone who does not have any ADLs or IADLs. A disabled person is someone who has either at least one ADL or IADL. An ADL disabled person is someone who has at least one ADL, and an IADL disabled person is someone who has at least one IADL but no ADLs. The threshold is set at one ADL or IADL because only one is needed to become dependent on others. These disability statuses are mutually exclusive (Manton 1988; Strawbridge et al. 1992; Guralnik et al. 1993; Crimmins et al. 1996).

Some respondents answered some ADL and IADL questions but not others. Of these respondents, those who answered yes to at least one ADL were recoded as being ADL disabled. Respondents who answered all ADL questions and had no ADLs but had at least one IADL were recoded as having an IADL disability. For the remaining respondents who gave partial answers, instead of coding them as missing, analysis was conducted to calculate the probabilities of being ADL or IADL disabled given the answers to the disability questions which were available, and respondents were recoded according to their highest probability.[8] Respondents who were known to be alive but data was not available for any of their ADL and IADL questions are coded as alive with disability status unknown. Respondents for whom an interview was not obtained and it was unknown whether they are alive or dead are coded as unknown alive or dead with unknown disability status.

[8] At T1, for whom complete disability status information is available, people who had no ADLs had an 86 percent probability of having no IADLs. Therefore people who had no ADLs and an unknown number of IADLs due to partial responses on these questions, were recoded as having no IADLs. People who had no IADLs had a 98 percent probability of having no ADLs. Therefore people who had no IADLs and an unknown number of ADLs were recoded as having no ADLs. People who had an IADL had a 68 percent probability of having no ADLs. Therefore people who had an IADL and an unknown number of ADLs were recoded as having no ADLs. The probabilities at T2 are 73 percent, 99 percent, and 66 percent respectively; the probabilities at T3 are 81 percent, 97 percent, and 60 percent respectively; and the partial responses are recoded in the same way.

A person is identified as being alive, dead, or unknown by the reinterview outcome status variable. A person's status is unknown if he/she could not be located or, at the previous wave, requested to not be contacted again.[9] Respondents with unknown disability status are not included in the multinomial logistic regression analyses of this paper because their disability transitions cannot be assessed, but they are included in the descriptive analysis of the distribution of disability statuses at each wave, which is shown in Table 1. The frequencies and proportions of disability transitions for first and second transitions are shown in Table 2. The transition that is being analyzed is the second transition, from the second wave to the third wave, so that prior disability status at the first wave can be added as an independent variable.

Independent variables

The independent variables in the analysis are composed of the following demographic and health variables: age, sex, education, marital status, prior disability status, and self-rated health. Race was originally included as an independent variable but resulted in zero or near-zero cells for several disability transitions. Therefore, race is not included because estimation of race effects is impossible.

Ideally, a measure of financial resources would be included as well. While family income data are available, using income as a measure of financial resources is problematic for the older population. Most older people do not earn employment income, asset income tends to be substantially underreported, and people receive differential noncash health care benefits from Medicare, Medicaid, and private health insurance (Hurd 1990; Himes 2001). Wealth

[9] Respondents who were recorded as unknown whether they were alive or dead at wave 2 but then were recorded as being alive at wave 3, were recoded as being alive at wave 2.

would be a more accurate measure of financial resources, but unfortunately these variables are not available in the data set.

Age at the first wave is a continuous variable from 70 to 99 and over. The last category is coded as 99. Sex is coded as a dummy variable, with one being female. Education is measured as number of years of education attained, ranging from zero to 18 years. Education is recoded as a categorical variable: less than high school (zero to 11 years), high school graduate (12 to 15 years), and college graduate (16 years or more). High school graduate is the reference category. Marital status is measured at the second wave because the transition being analyzed is the second transition. Marital status is coded as a dummy variable, with one being married.

Prior disability status is measured as disability status at the first wave. Originally coded as an ordinal variable, prior disability status is recoded as three dummy variables for the multinomial logistic regression analysis — independent, IADL disabled, and ADL disabled — with independent as the reference category. Self-rated health is measured at the second wave as an ordinal variable. Response categories are excellent, very good, good, fair, and poor. Self-rated health is recoded as three dummy variables for the multinomial logistic regression analysis: excellent/very good, good, fair/poor/missing. Excellent/very good is the reference category. Respondents with missing data for self-rated health status are placed in the worst self-rated health response category because previous research has shown they have mortality risks similar to people who have fair self-rated health (Rakowski and Mor 1992; Mor et al. 1994; Anderson et al. 1998).

Table 3 shows the weighted distribution of the independent variables in the sample of analysis.

Terminology

Wave 1 will be referred to as Time 1, or T1. Similarly, Wave 2 will be referred to as T2 and Wave 3 as T3. The disability transition from T1 to T2 will be referred to as the first transition, and the disability transition from T2 to T3 will be referred to as the second transition.

Analysis

To examine the effect of age, sex, education, marital status, prior disability status, and self-rated health on disability transitions, separate multinomial logistic regression models are fitted for transitions from each disability status. Prior analysis of nested models with demographic characteristics, prior disability status, and self-rated health showed that all models produced nearly the exact same results, indicating that the effects of demographic characteristics, prior disability status, and self-rated health on subsequent disability transitions were independent from each other. Therefore, the models in this analysis include all variables and are not nested.

In addition, interaction effects of gender with each independent variable were tested since it is reasonable to believe that gender may have an interaction effect with age, education, marital status, prior disability, and self-rated health. None of the interaction effects turned out to be significant. Therefore, gender interaction terms are not included in the models.

The equations for the multinomial logistic regression models are as follows:

For independent people:

P_{01} = probability of being independent at T3
P_{11} = probability of being IADL disabled at T3

P_{21} = probability of being ADL disabled at T3
P_{31} = probability of being dead at T3

The reference category is remaining independent at T3.

$$\log\frac{P_{11}}{P_{01}} = \beta_{01} + \beta_{11}(\text{age}) + \beta_{21}(\text{sex}) + \beta_{31}(\text{less than high school}) + \beta_{41}(\text{college})$$
$$+ \beta_{51}(\text{married}) + \beta_{61}(\text{IADL at T1}) + \beta_{71}(\text{ADL at T1})$$
$$+ \beta_{81}(\text{good SRH at T2}) + \beta_{91}(\text{fair/poor/missing SRH at T2})$$

$$\log\frac{P_{21}}{P_{01}} = \beta_{02} + \beta_{12}(\text{age}) + \beta_{22}(\text{sex}) + \beta_{32}(\text{less than high school}) + \beta_{42}(\text{college})$$
$$+ \beta_{52}(\text{married}) + \beta_{62}(\text{IADL at T1}) + \beta_{72}(\text{ADL at T1})$$
$$+ \beta_{82}(\text{good SRH at T2}) + \beta_{92}(\text{fair/poor/missing SRH at T2})$$

$$\log\frac{P_{31}}{P_{01}} = \beta_{03} + \beta_{13}(\text{age}) + \beta_{23}(\text{sex}) + \beta_{33}(\text{less than high school}) + \beta_{43}(\text{college})$$
$$+ \beta_{53}(\text{married}) + \beta_{63}(\text{IADL at T1}) + \beta_{73}(\text{ADL at T1})$$
$$+ \beta_{83}(\text{good SRH at T2}) + \beta_{93}(\text{fair/poor/missing SRH at T2})$$

For IADL disabled people:

P_{02} = probability of being independent at T3
P_{12} = probability of being IADL disabled at T3
P_{22} = probability of being ADL disabled at T3
P_{32} = probability of being dead at T3

The reference category is remaining IADL disabled at T3.

$$\log\frac{P_{02}}{P_{12}} = \beta_{04} + \beta_{14}(\text{age}) + \beta_{24}(\text{sex}) + \beta_{34}(\text{less than high school}) + \beta_{44}(\text{college})$$
$$+ \beta_{54}(\text{married}) + \beta_{64}(\text{IADL at T1}) + \beta_{74}(\text{ADL at T1})$$
$$+ \beta_{84}(\text{good SRH at T2}) + \beta_{94}(\text{fair/poor/missing SRH at T2})$$

$$\log\frac{P_{22}}{P_{12}} = \beta_{05} + \beta_{15}(\text{age}) + \beta_{25}(\text{sex}) + \beta_{35}(\text{less than high school}) + \beta_{45}(\text{college})$$
$$+ \beta_{55}(\text{married}) + \beta_{65}(\text{IADL at T1}) + \beta_{75}(\text{ADL at T1})$$
$$+ \beta_{85}(\text{good SRH at T2}) + \beta_{95}(\text{fair/poor/missing SRH at T2})$$

$$\log\frac{P_{32}}{P_{12}} = \beta_{06} + \beta_{16}(\text{age}) + \beta_{26}(\text{sex}) + \beta_{36}(\text{less than high school}) + \beta_{46}(\text{college})$$
$$+ \beta_{56}(\text{married}) + \beta_{66}(\text{IADL at T1}) + \beta_{76}(\text{ADL at T1})$$
$$+ \beta_{86}(\text{good SRH at T2}) + \beta_{96}(\text{fair/poor/missing SRH at T2})$$

For ADL disabled people:

P_{03} = probability of being independent or IADL disabled at T3[10]
P_{13} = probability of being ADL disabled at T3
P_{23} = probability of being dead at T3

The reference category is remaining ADL disabled at T3:

$$\log\frac{P_{03}}{P_{13}} = \beta_{07} + \beta_{17}(\text{age}) + \beta_{27}(\text{sex}) + \beta_{37}(\text{less than high school}) + \beta_{47}(\text{college})$$
$$+ \beta_{57}(\text{married}) + \beta_{67}(\text{IADL at T1}) + \beta_{77}(\text{ADL at T1})$$
$$+ \beta_{87}(\text{good SRH at T2}) + \beta_{97}(\text{fair/poor/missing SRH at T2})$$

$$\log\frac{P_{23}}{P_{13}} = \beta_{08} + \beta_{18}(\text{age}) + \beta_{28}(\text{sex}) + \beta_{38}(\text{less than high school}) + \beta_{48}(\text{college})$$
$$+ \beta_{58}(\text{married}) + \beta_{68}(\text{IADL at T1}) + \beta_{78}(\text{ADL at T1})$$
$$+ \beta_{88}(\text{good SRH at T2}) + \beta_{98}(\text{fair/poor/missing SRH at T2})$$

The results from these separate multinomial logistic regression models may demonstrate some overall patterns as well as some transition-specific details that would be missed if we fitted only the direction of transitions — positive, neutral, and negative. Also, modeling only the direction of transitions assumes that the predictors have the same effect on different types of recovery, stability, and decline.

The relative impact of each independent variable on disability transitions will be compared using predicted probabilities with other independent variables held at their means. While predicted probabilities provide information on the likelihood of experiencing a stable state

[10] The recovery transition of ADL disability to independence will be collapsed with the recovery transition of ADL disability to IADL disability because too few respondents experienced the transition of ADL disability to independence (n = 49) to produce meaningful results.

relative to a transition, predicted probabilities and the multinomial logistic regression models do not provide information on whether the likelihood of a stable state is significantly different than the likelihood of a transition. Therefore logistic regression models are fitted for each stable state on the independent variables. The equations for these logistic regression models are as follows:

For independent people:

P_4 = probability of remaining independent at T3

$$\log\frac{P_4}{1-P_4} = \beta_{09} + \beta_{19}(\text{age}) + \beta_{29}(\text{sex}) + \beta_{39}(\text{less than high school}) + \beta_{49}(\text{college}) + \beta_{59}(\text{married}) + \beta_{69}(\text{IADL at T1}) + \beta_{79}(\text{ADL at T1}) + \beta_{89}(\text{good SRH at T2}) + \beta_{99}(\text{fair/poor/missing SRH at T2})$$

For IADL disabled people:

P_5 = probability of remaining IADL disabled at T3

$$\log\frac{P_5}{1-P_5} = \beta_{0\_10} + \beta_{1\_10}(\text{age}) + \beta_{2\_10}(\text{sex}) + \beta_{3\_10}(\text{less than high school}) + \beta_{4\_10}(\text{college}) + \beta_{5\_10}(\text{married}) + \beta_{6\_10}(\text{IADL at T1}) + \beta_{7\_10}(\text{ADL at T1}) + \beta_{8\_10}(\text{good SRH at T2}) + \beta_{9\_10}(\text{fair/poor/missing SRH at T2})$$

For ADL disabled people:

P_6 = probability of remaining ADL disabled at T3

$$\log\frac{P_6}{1-P_6} = \beta_{0\_11} + \beta_{1\_11}(\text{age}) + \beta_{2\_11}(\text{sex}) + \beta_{3\_11}(\text{less than high school}) + \beta_{4\_11}(\text{college}) + \beta_{5\_11}(\text{married}) + \beta_{6\_11}(\text{IADL at T1}) + \beta_{7\_11}(\text{ADL at T1}) + \beta_{8\_11}(\text{good SRH at T2}) + \beta_{9\_11}(\text{fair/poor/missing SRH at T2})$$

Sampling weights are used to adjust for the stratified multistage sample design, non-response, survey design differences to allow comparison of the LSOA II with the 1984-1990 Longitudinal Study on Aging (LSOA), as well as age, sex, and race.[11]

Findings

This section begins with people who are initially independent and describes their state two years later. Then, the predictors of arriving in various possible states are discussed. In a similar way, people who are initially IADL disabled and then people who are ADL disabled will be considered.

For disability transitions, Table 2 shows the frequencies and proportions of disability transitions. Table 4 displays the results of the multinomial logistic regression analyses for all disability statuses. Table 5 shows the predicted probabilities of disability transitions given specified values of independent variables.

For stable states, Table 6 displays the results of the logistic regression analyses for all disability statuses. Table 7 shows the predicted probabilities of stable states given specified values of independent variables.

Independent

Subsequent disability statuses

Table 2 shows that the vast majority, 75 percent, of people who were independent remained stable and continued to be independent two years later. Eleven percent of people who were independent became IADL disabled, nine percent died, and five percent became

[11] The variable in location 187 is used as the primary sampling unit; the variable in location 189 is used as the stratum; and the variable in location 201 is used as the sampling weight.

ADL disabled. ADL onset for independent people is a relatively rare occurrence, and people were about as likely to die as to become IADL disabled.

Predictors of transitions and stable states

The strongest and most striking predictors of disability transitions for independent people are age, prior disability, and self-rated health. For example, Figure 2 visually displays the impact of age on predicted probabilities of various disability transitions. All three of these variables are significant at the .001 level for predicting disability transitions of independent people. The significance levels for each transition compared to remaining stable are shown in Table 4, and the differences in predicted probabilities are shown in Table 5.

At older ages, Table 6 shows that people are less likely to remain independent and Table 4 shows that they are more likely to experience the negative transitions of IADL onset, ADL onset, and death. A 70 year-old person has nearly a 90 percent probability of remaining independent, compared to about 70 percent for an 80 year-old person and only about 45 percent for a 90 year-old person, as reported in Table 5. As for transitions of decline, an additional 10 years of age roughly doubles the probability of experiencing each negative disability transition.

Prior disability, whether IADL or ADL disability, has the same effect as older age on decreasing the likelihood of remaining independent and increasing the likelihood of experiencing a negative transition. About eighty percent of independent people who had been independent at T1 could expect to remain independent at T3, whereas only about 50 percent of independent people who had been disabled at T1 could expect to remain independent at T3. In other words, prior disability cuts the likelihood of continued independence by a third. Prior disability also roughly doubles the probability of two negative transitions, IADL onset

and death (from nine percent to 19 percent for IADL onset and from eight percent to 14 percent for death), and quintuples the probability of ADL onset (from three percent to about 15 percent). Interestingly, any disability, whether IADL or ADL, affects transitions for independent people to the same degree despite their differences in severity.

Self-rated health is also a strong predictor of disability transitions for independent people, demonstrating a hierarchical effect. Worse self-rated health produces worse outcome probabilities. About eighty-five percent of independent people with excellent or very good self-rated health could expect to remain independent at T3, compared to about 75 percent of people with good self-rated health and about 62 percent of people with fair, poor, or missing self-rated health. Similarly, people with excellent or very good self-rated health were less likely to experience disability onset and death compared to people with worse self-rated health.

Although perhaps not substantial in magnitude but interesting in its effects, sex is a significant predictor of disability transitions of independent people ($p = .000$). Specifically, sex significantly predicts transitioning to IADL disability and death but not to ADL disability, as shown in Table 4. Table 5 shows that, compared to men, women are more likely to become IADL disabled (11 percent versus seven percent) and half as likely to die (six percent versus 12 percent). Men and women are equally as likely to remain independent and become ADL disabled. In other words, women who transition from independence are more likely to become IADL disabled whereas men who transition from independence are more likely to die.

Another variable which also does not have a large effect but is a significant predictor of transitions for independent people ($p = .000$) is education. Table 4 shows that people with

less than a high school education are significantly less likely to remain independent and more likely to transition to IADL and ADL disability than high school graduates, but they are not significantly more likely to transition to death. Although the difference is significant, Table 5 shows that the magnitude of the difference is not very large: 12 percent and four percent of those with less than a high school education become IADL disabled and ADL disabled, respectively, compared to nine percent and three percent of those with a high school education. There is no significant difference in transition probabilities between high school and college graduates, indicating that additional years of education at lower levels have a greater impact on decreasing disability onset than additional years of education at higher levels.

Marital status has no significant effect on any disability transitions or stable state for independent people.

IADL disabled

Subsequent disability statuses

For people who are IADL disabled, Table 2 shows that about a fourth remain IADL disabled and over a third recover to independence two years later. The relatively less frequent transitions are to death and IADL disability, with 20 and 14 percent of IADL disabled people making these transitions, respectively. The distribution of subsequent disability transitions for IADL disabled people is more evenly distributed than that of independent people, where three-fourths remain in the same disability status two years later.

Predictors of transitions and stable states

As with transitions for independent people, the strongest predictors of transitions for IADL disabled people are age, prior disability, and self-rated health. All three of these variables are significant at the .001 level for predicting disability transitions of IADL disabled people. Older age predicts higher probabilities of recovery and higher probabilities of decline to ADL disability and death, as shown in Table 4. Table 5 demonstrates that while a 70 year-old person has nearly a 50 percent probability of recovering, this probability drops to 31 percent for somebody who is 80 years old and only 17 percent for somebody who is 90 years old. Interestingly, Table 6 shows that there is no significant difference in likelihood of remaining IADL disabled by age. In other words, the likelihood of stability is roughly the same for people of all ages, and transitions out of IADL disability tend to be worse for older people.

Unlike for independent people, prior disability status is a significant predictor of only one transition for IADL disabled people, as shown in Table 4. Prior disability status significantly predicts recovery but not declines to ADL disability or death. Prior disability, whether IADL or ADL, reduces the likelihood of recovering to independence by almost two-thirds, from 44 percent to about 17 percent, as shown in Table 5. Prior ADL disability, however, is a significant predictor of subsequent ADL disability. Over a quarter of IADL disabled people with prior ADL disability can expect to return to ADL disability two years later.

For remaining IADL disabled, Table 6 shows that prior disability status is a significant predictor. Figure 3 visually displays the impact of prior disability status on predicted probabilities of various disability transitions. Specifically, prior IADL disability significantly increases the probability of continued IADL disability at T3. Table 5 shows that prior ADL disability produces the same probability of remaining IADL disabled as prior independence,

about 26 percent. Prior IADL disability increases the probability of remaining IADL disabled to about 40 percent. Perhaps for the person who is IADL disabled at T2, prior IADL disability at T1 is an indication of a long-term or permanent IADL disability, thus explaining the increased probability of continued IADL disability at T3.

The most common transition for IADL disabled people who were previously independent is recovery to this previous state of independence (44 percent), as shown in Table 5. Similarly, IADL disabled people who were previously IADL disabled are also most likely to be in the same state at T3 as they were in T1 (41 percent). However, those with prior ADL disability can expect to encounter that they are least likely to make a transition to recovery (16 percent) and about equally as likely to remain IADL disabled, decline to ADL disability, or die (26, 27, and 32 percent, respectively).

Self-rated health emerges as a significant predictor of recovery, stability, and decline to ADL disability for IADL disabled people, although this is true for only the worst level of self-rated health (Tables 4 and 6). For transitions of recovery, those with fair, poor, or missing self-rated health are about half as likely as those with better self-rated health to recover to independence, as shown in Table 5. People in the lowest category of self-rated health are also about twice as likely to decline to ADL disability than people with better self-rated health. Interestingly, self-rated health does not reach significance in predicting transitions to death.

Sex and marital status are significant predictors of subsequent transitions of IADL disabled people ($p = .000$ and $p = .007$, respectively), although their effects are moderate. While education is not a significant predictor of transitions for IADL disabled people, it is significant for one transition. Sex, marital status, and education are each a significant

predictor of only one transition for IADL disabled people and the stable state of remaining IADL disabled, as shown in Tables 4 and 6.

Sex is a significant predictor for the transition to death, with men being more likely than women to transition to death after IADL disability. Table 5 shows that thirty percent of men die within two years compared to 17 percent of women. In turn, women are more likely to remain IADL disabled than men. Marital status is a significant predictor of recovery and stability, with married people being more likely to recover from IADL disability and less likely to remain IADL disabled than unmarried people. Forty-three percent of married people can expect to recover compared to 30 percent of unmarried people.

Lastly, education is a significant predictor of recovery to independence and stability. Specifically, people with less than a high school education are significantly less likely than those with a high school degree to recover, 32 percent compared to 37 percent, and more likely to remain IADL disabled, 31 percent compared to 24 percent. Compared to high school graduates, those with a college education do not experience significantly different transition probabilities. Although significant, the magnitude of the effect of having less than a high school education compared to a high school education is small.

ADL disabled

Subsequent disability statuses

Two years later, the most common subsequent disability status for people who are ADL disabled is continued ADL disability or death, as shown in Table 2. Forty-three percent of ADL disabled people remained ADL disabled and another 39 percent were dead two years later. In comparison, only 20 percent of IADL disabled people and nine percent of

independent people transition to death. However, a substantial 18 percent of ADL disabled people recover to independence or IADL disability. The probability of recovering from ADL disability for ADL disabled people is more than three times the probability of experiencing ADL onset for independent people (18 percent versus five percent).

Compared to independent and IADL disabled people, transitions for ADL disabled people are heavily concentrated in a stable state or decline to death. Independent people mostly remain independent, and IADL disabled people are relatively more evenly distributed in their subsequent transitions.

Predictors of transitions and stable states

The common feature of disability transitions for all three disability statuses is the prominence of age, prior disability status, and self-rated health in predicting subsequent disability transitions. For ADL disabled people, these variables and sex are the only significant predictors of subsequent disability transitions, as shown in Table 4.

For ADL disabled people, older age is significantly associated with a steep decline in likelihood of recovery. Table 5 shows that whereas nearly a third of 70 year-old ADL disabled people can expect to recover to independence or IADL disability in two years, only 18 percent of 80 year-olds and nine percent of 90 year-olds can expect to make the same recovery transition.

Prior disability status is a significant predictor of disability transitions and a stable state, as shown in Tables 4 and 6. When comparing prior IADL and ADL disability, though, only prior ADL disability is significant. Table 5 shows that, compared to prior independence or IADL disability, prior ADL disability halves the probability of recovering from about 20 percent to 10 percent. Interestingly, prior ADL disability also reduces the probability of

dying from about 42 percent to 32 percent. The relative reduction in probability of dying is due to ADL disabled people with prior ADL disability being significantly more likely to remain ADL disabled two years later than those with prior independence or IADL disability (58 percent versus about 38 percent).

Self-rated health is a significant predictor of transitions to death. Specifically, fair, poor, or missing self-rated health predicts an increased probability of transitioning to death: 45 percent compared to about 30 percent for those with better self-rated health. Self-rated health is not a significant predictor of recovery, and good self-rated health is not significantly different from excellent/very good self-rated health as a predictor of disability transitions.

The effect of sex for ADL disabled people is the same as for independent and IADL disabled people, with men being more likely than women to transition to death. Half of all ADL disabled men can expect to die in the next two years compared to 36 percent of women. There are no significant educational and marital status differences in transition probabilities for ADL disabled people.

Discussion

Disability and mortality rates for a population show a consistent increase with age, but individual trajectories show a great deal of variability. In fact, over a two-year time interval, the likelihood of recovery for someone who is disabled is actually much greater than the likelihood of experiencing disability for someone who is independent. Whether the disability is IADL or ADL disability, a person is four times as likely to recover from a disability if she is disabled than to become disabled if she is independent. Also, a separate analysis not discussed in this paper showed that while nearly a third of people experienced only a decline

in functioning and no improvement throughout all three waves, more than two-thirds experienced continuous independence, independence to death with no disability, or recovery. In other words, there are a considerable number of other kinds of trajectories of physical functioning besides a persistent downward trend.

The central findings of this study of disability transitions are: (1) age, prior disability status, and self-rated health tend to be stronger predictors of disability transitions than sex, education, and marital status, (2) predictors of transitions differ for independent and disabled people, and (3) predictors of stable states differ for all three disability statuses.

The common finding throughout the analysis of disability transitions for all disability statuses is the significance and magnitude of impact of age, prior disability status, and self-rated health. These predictors have a much greater impact than sex, education, and marital status. While sex, education, and marital status are significant for some transitions, the magnitude of the impact is relatively small. In other words, health-related variables predict disability transitions better than demographic characteristics. In this case, age appears to be a proxy for capacity to maintain or recover health.

I had hypothesized that age, sex, education, and marital status predicted prior disability status and self-rated health, which in turn, predicted disability transitions. Additional analysis not included in this paper demonstrated that all variables operated independently of each other.

Prior research on predictors of disability transitions has focused on significance rather than magnitude. The results in this paper show that while some predictors may be significant, our attention should lie with the predictors which alter a person's probability of making a

transition in a meaningful way. Therefore, future research would be enhanced if magnitude was assessed in addition to significance.

While the current literature on disability transitions identifies significant predictors for particular transitions, an overall pattern has not been evaluated with regards to how predictors differ for independent and disabled people. The findings here show that the kind of effect that a predictor has on a transition differs for independent and disabled people, and the pattern of the effect for disabled people is the same whether the person is IADL or ADL disabled.

For example, Table 6 shows that for independent people, the type of prior disability — IADL or ADL — does not increase the probability of returning to that same type of prior disability. An independent person with prior ADL disability is not more likely to return to ADL disability at T3 than IADL disability. The same is observed for independent people with prior ADL disability. In comparison, for disabled people, the type of prior disability at T1 is associated with a higher likelihood of returning to that type of disability at T3 as opposed to the other type of disability. For example, a disabled person at T2 with prior ADL disability at T1, is much more likely to be ADL disabled at T3 than to be IADL disabled.

In other words, for disabled people, a "stickiness" of prior type of disability is observed. A disabled person has a higher probability of returning to the type of disability, IADL or ADL, she had two years before than people with a different prior disability status. This "stickiness" of prior type of disability is not observed for independent people. This may indicate that independent people's prior disability may have been an acute incident whereas disabled people with prior disability may be experiencing stable or fluctuating levels of persistent disability type.

Self-rated health and age also affect independent and disabled people differently, with the same pattern of effect for IADL and ADL disabled people. For independent people, self-rated health has a hierarchical effect, with lower levels of self-rated predicting more unfavorable transition probabilities. For disabled people, whether IADL or ADL disabled, only the lowest category of self-rated health is significant for predicting transition probabilities. Gradations of self-rated health are not as effective for predicting transitions for disabled people as they are for independent people.

As for age, older age predicts unfavorable transition probabilities for independent people. While the effect for disabled people is the same in terms of predicting unfavorable transition probabilities as well, age does not affect stable states for disabled people. Old-old and young-old are equally as likely to remain IADL or ADL disabled, although the old-old are more likely to experience a transition of decline than recovery.

The predictors of all three stable states differ in prominent ways which indicate that each stable state is a distinct condition. For continued independence, strong predictors are age, any prior disability, and self-rated health. Education has a relatively small effect. Health-related variables are most important for predicting continued independence.

For persistent IADL disability, however, the significant predictors are sex, education, marital status, prior IADL disability, and fair/poor/missing self-rated health. However, none of the predictors have a very large effect on predicting persistent IADL disability. Most of these predictors change the predicted probability of remaining IADL disabled by a maximum of only eight percent. Given the variety of predictors as well as the lack of any distinctly strong predictors, persistent IADL disability can be characterized as a complex and less well-understood state.

For persistent ADL disability, only one predictor is significant: prior ADL disability. The effect is sizeable, increasing the probability from about 37 percent to 56 percent. Compared to persistent IADL disability, persistent ADL disability appears to be a relatively more straightforward state.

Conclusions

This paper has addressed some gaps in the current literature on disability transitions by shedding light on the relative importance of various predictors, how predictors differ for independent and disabled people, and identifying predictors of stable states. By conducting a multivariate analysis with all possible disability transitions and comparing the magnitude of effects, this paper has demonstrated that health-related variables are the strongest predictors of disability transitions. Demographic characteristics play a relatively much smaller role.

What continues to be lacking in the literature is an overarching model of what drives disability transitions beyond specific variables. Empirical findings to support and disprove the various components of the disablement process theory (Verbrugge and Jette 1994) are needed to delineate the interactions between physical condition, physical environment, and social context. The findings from this paper would currently lead us to believe that physical conditions play a larger role in disability transitions than social contexts, although the models in this paper are inherently misspecified because of the inclusion of only social science variables (George 1995). The models in this paper were an initial attempt to understand the role of demographic and health predictors in disability transitions. Future research on disability transitions should incorporate additional predictors such as financial resources, social support, and depression, as well as draw from a variety of other disciplines such as

economics, medicine, and psychology. Understanding the nature of disability and disability trajectories will help in efforts to prevent decline, increase recovery, and make continued independence to be a more common experience in an aging population.

Appendix

Description of the LSOA II

The LSOA II is a collaborative effort of the National Center for Health Statistics (NCHS) and the National Institute on Aging (NIA). The study is designed to measure changes in health, functional status, living arrangements, and health services utilization in the older population in the United States.

Sample design

The first wave consists of the National Health Interview Survey (NHIS) in 1994 and the Second Supplement on Aging (SOA II) in 1995. All respondents from the NHIS who would be 70 years of age or older by the time of the SOA II interview in 1995 were eligible for the SOA II.

The NHIS is conducted according to a stratified multistage probability design. The first stage consists of selecting a sample of primary sampling units (PSU's) from approximately 1,900 geographically defined PSU's. A PSU consists of a county, small group of contiguous counties, or a metropolitan statistical area. The PSU's collectively cover the 50 states and the District of Columbia. The 1,900 PSU's are stratified using socioeconomic and demographic variables and then selected with a probability proportional to their population size within the stratum.

Within the PSU's, an iterative program is used to select a sample of geographically defined area segments. The sample segments are systematically selected so they are distributed throughout each of the PSU's. The segments are subdivided into clusters that contain a small number of housing units. The housing units may be grouped closely together

or spread over a small geographical area. Historically, the cluster size for the NHIS has ranged from four to nine households. All eligible persons in the occupied housing units within the sample clustered are interviewed (Massey, Moore, Parsons et al. 1989).

For the 1994 NHIS, the sample design oversampled the black population within PSU's.

Data collection method

The NHIS collected data via personal interviews, and the SOA II also collected data via personal interviews. Both follow-up waves were collected via computer-assisted telephone interview. Self-administered versions of the questionnaires were made available for respondents who did not have a telephone. The SAQ contained about one-half of the questions asked during the CATI interview. In some cases, the SAQ was administered over the telephone as a last resort to respondents who, because of the length of the CATI interview, would have otherwise refused to participate.

Response rates

The overall response rate for the SOA II was 87.4 percent (overall household response rate of the NHIS Core (94.1 percent) multiplied by the response rate of the SOA II (92.9 percent)). For Wave 2, 94.6 percent of eligible respondents were located, of whom 89.8 percent were interviewed. For Wave 3, 93.6 percent of eligible respondents were located, of whom 81.5 percent were interviewed.

Data file used

Two questionnaire versions were developed, one for respondents who were alive at the time of the interview and one for respondents who were deceased. The data being analyzed for this paper are derived from the survivor data files.

References

Anderson, Roger T., Margaret K. James, Michael E. Miller, Angela S. Worley, and Jr. Longino, Charles F. 1998. "The timing of change: Patterns in transitions in functional status among elderly persons." *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 53:S17-S27.

Branch, Laurence G., Sidney Katz, Kathleen Kniepmann, and Joseph A. Papsidero. 1984. "A prospective study of functional status among community elders." *American Journal of Public Health* 74:266-268.

Branch, Laurence G. and Leighton Ku. 1989. "Transition probabilities to dependency, institutionalization, and death among the elderly over a decade." *Journal of Aging and Health* 1:370-408.

Crimmins, Eileen M., Mark D. Hayward, and Yasuhiko Saito. 1994. "Changing mortality and morbidity rates and the health status and life expectancy of the older population." *Demography* 31:159-175.

—. 1996. "Differentials in active life expectancy in the older population of the United States." *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 51:S111-S120.

Crimmins, Eileen M. and Yasuhiko Saito. 1993. "Getting better and getting worse: Transitions in functional status among older Americans." *Journal of Aging and Health* 5:3-36.

Crimmins, EM, Y Saito, and SL Reynolds. 1997. "Further evidence on recent trends in the prevalence and incidence of disability among older Americans from two sources: The LSOA and the NHIS." *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 52:S59-71.

Freedman, Vicki A., Linda G. Martin, and Robert F. Schoeni. 2004. "Disability in America." *Population Bulletin* 59.

George, Linda K. 1995. "The last half-century of aging research -- and thoughts for the future." *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 50:S1-S3.

Gill, Thomas M., Susan E. Hardy, and Christianna S. Williams. 2002. "Underestimation of disability among community-living older persons." *Journal of the American Geriatrics Society* 50:1492-1497.

Gill, Thomas M., Julie T. Robison, and Mary E. Tinetti. 1997. "Predictors of recovery in activities of daily living among disabled older persons living in the community." *Journal of General Internal Medicine* 12:757-762.

Goldman, N., S. Korenman, and R. Weistein. 1995. "Marital status and health among the elderly." *Social Science & Medicine* 40:1717-1730.

Guralnik, JM, KC Land, D Blazer, GG Fillenbaum, and LG Branch. 1993. "Educational status and active life expectancy among older blacks and whites." *New England Journal of Medicine* 329:110-116.

Hardy, Susan E. and Thomas M. Gill. 2004. "Recovery from disability among community-dwelling older persons." *Journal of the American Medical Association* 291:1596-1602.

Hayward, Mark D., Eileen M. Crimmins, and Yasuhiko Saito. 1998. "Cause of death and active life expectancy in the older population of the United States." *Journal of Aging and Health* 10:192-213.

Himes, Christine L. 2001. "Elderly Americans." *Population Bulletin* 56.

Hurd, Michael. 1990. "Research on the elderly: Economic status, retirement, and consumption and savings." *Journal of Economic Literature* 28:565-637.

Kaplan, G.A. and T. Camacho. 1983. "Perceived health and mortality: A nine-year follow-up of the human population laboratory cohort." *American Journal of Epidemiology* 117:292-304.

Kaplan, GA, WJ Strawbridge, T. Camacho, and RD Cohen. 1993. "Factors associated with change in physical functioning in the elderly: A six-year prospective study." *Journal of Aging and Health* 5:140-153.

Katz, S., A.B. Ford, R.W. Moskowitz, B.A. Jackson, and M.W. Jaffe. 1963. "Studies of illness in the aged: The index of ADL, a standardized measure of biological and psychosocial function." *Journal of the American Medical Association* 185:914-919.

Laditka, Sarah B. and Douglas A. Wolf. 1998. "New methods for analyzing active life expectancy." *Journal of Aging and Health* 10:214-241.

Land, Kenneth C., Jack M. Guralnik, and Dan G. Blazer. 1994. "Estimating increment-decrement life tables with multiple covariates from panel data: The case of active life expectancy." *Demography* 31:297-319.

Lawton, MP and EM Brody. 1969. "Assessment of older people: Self-maintaining and instrumental activities of daily living." *The Gerontologist* 9:179-186.

Manton, K. 1990. "Population models of gender differences in mortality, morbidity, and disability risks." in *Gender, Health, and Longevity: Multidisciplinary Perspectives*, edited by M. Ory and H. Warner. New York: Springer.

Manton, K.G., L. Corder, and E. Stallard. 1993. "Estimates of change in chronic disability and institutional incidence and prevalence rates in the U. S. elderly population from 1982, 1984, and 1989 National Long Term Care Survey." *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 48:S153-S166.

Manton, Kenneth G. 1988. "A longitudinal study of functional change and mortality in the United States." *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 43:S153-S161.

Manton, Kenneth G. and Kenneth C. Land. 2000. "Active life expectancy estimates for the U.S. elderly population: A multidimensional continuous-mixture model of functional change applied to completed cohorts, 1982-1996." *Demography* 37:253-265.

Massey, J.T., T.F. Moore, V.L. Parsons, and W. Tadros. 1989. "Design and estimation for the National Health Interview Survey, 1985-94." *Vital and Health Statistics* 2.

Melzer, David, Grant Izmirlian, Suzanne G. Leveille, and Jack M. Guralnik. 2001. "Educational differences in the prevalence of mobility disability in old age: The dynamics of incidence, mortality, and recovery." *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 56:S294-S301.

Mendes de Leon, CF, TA Glass, LA Beckett, TE Seeman, DA Evans, and LF Berkman. 1999. "Social networks and disability transitions across eight intervals of yearly data in the New Haven EPESE." *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 54:S162-172.

Molla, M.T., J.H. Madans, D.K. Wagener, and E.M. Crimmins. 2003. "Summary measures of population health: Report of methodologic and data issues." National Center for Health Statistics, Hyattsville, Maryland.

Mor, V., V. Wilcox, W. Rakowski, and J. Hiris. 1994. "Functional transitions among the elderly: Patterns, predictors, and related hospital use." *American Journal of Public Health* 84:1274-1280.

Nagi, SZ. 1965. "Some conceptual issues in disability and rehabilitation." Pp. 100-113 in *Sociology and Rehabilitation*, edited by M. Sussman. Washington, DC: American Sociological Association.

Rakowski, W. and V. Mor. 1992. "Answering "don't know" DK to self-assessment questions abouth health status and physical activity: Associations with subsequent mortality." in *Annual Meeting of the American Public Health Association*. Washington, DC.

Strawbridge, W.J., G.A. Kaplan, T. Camacho, and R.D. Cohen. 1992. "The dynamics of disability and functional change in an elderly cohort: Results from the Alameda County Study." *Journal of the American Geriatrics Society* 40:799-806.

Uhlenberg, Peter. 1995. "A note on viewing functional change in later life as migration." *The Gerontologist* 35:549-552.

Verbrugge, Lois M. and Alan M. Jette. 1994. "The disablement process." *Social Science Medicine* 38:1-14.

Wiener, JM, RJ Hanley, and R Clark. 1990. "Measuring the activities of daily living: Comparisons across national surveys." *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 45:S229-S237.

Wolinsky, FD, CM Callahan, JF Fitzgerald, and RJ Johnson. 1993. "Changes in functional status and the risks of subsequent nursing home placement and death." *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 48:S94-S101.

Wolinsky, Fredric D., Eric S. Armbrecht, and Kathleen W. Wyrwich. 2000. "Rethinking functional limitation pathways." *The Gerontologist* 40:137-146.

Table 1. Frequency distribution of disability statuses at T1, T2, and T3 (n = 9,447).

Disability status	T1		T2		T3	
	Freq.	Weighted %	Freq.	Weighted %	Freq.	Weighted %
Independent	7401	78.8	4619	48.9	3825	40.8
IADL	1279	13.4	1497	16.0	926	9.8
ADL	766	7.9	797	8.2	737	7.8
Dead at T2			1183	12.6	1183	12.6
Dead at T3					1122	11.7
Alive, unknown disability	1	0.0	1076	11.4	1313	13.8
Unknown alive/dead			275	2.9	341	3.6

Table 2. Frequencies and proportions of disability transitions for first and second transitions.

		Weighted	
Transition	n	% of disability status	CI
T1 to T2			
Independent to:			
Independent	4237	66.9	[66.2, 67.6]
IADL	1076	17.3	[16.7, 17.8]
ADL	340	5.3	[5.0, 5.6]
Death	663	10.5	[10.1, 10.9]
IADL to:			
Independent	322	28.5	[27.1, 29.9]
IADL	252	29.9	[28.4, 31.4]
ADL	205	18.2	[16.9, 19.4]
Death	248	23.4	[22.1, 24.8]
ADL to:			
Independent	60	9.1	[8.0, 10.3]
IADL	93	12.9	[11.6, 14.2]
ADL	328	37.4	[35.3, 39.5]
Death	272	40.6	[38.6, 42.6]
T2 to T3			
Independent to:			
Independent	3111	75.2	[74.6, 75.9]
IADL	452	10.7	[10.2, 11.2]
ADL	204	5.0	[4.7, 5.4]
Death	373	9.0	[8.6, 9.5]
IADL to:			
Independent	455	38.4	[36.8, 40.0]
IADL	329	27.5	[26.2, 28.9]
ADL	175	14.2	[13.2, 15.2]
Death	252	19.9	[18.8, 21.0]
ADL to:			
Independent	49	7.3	[6.2, 8.4]
IADL	78	10.6	[9.4, 11.8]
ADL	307	43.2	[41.5, 44.9]
Death	278	38.9	[37.1, 40.8]

Table 3. Distribution of independent variables in the sample of analysis (n = 5,578).

Independent variable	Frequency	Weighted %
Age 70-79	3905	70.8
Age 80-89	1506	26.3
Age 90-99+	167	2.9
Female	3570	63.4
Male	2008	36.6
Less than high school	2106	36.7
High school graduate	2737	49.8
College graduate	735	13.6
Married	2426	44.1
Unmarried	3152	55.9
Independent at T1	4553	82.1
IADL at T1	704	12.3
ADL at T1	321	5.6
Self-rated health:		
Excellent/very good	2158	39.1
Good	1809	32.7
Fair/poor/missing	1611	28.2

Table 4. Odds ratios for multinomial logistic regressions of subsequent disability transitions on independent variables for different disability statuses at T2.

Transition from:	Variable	Transition to:			
		Independent	IADL	ADL	Death
Independent (n = 3,794)	Age	reference category	1.11 ***	1.13 ***	1.12 ***
	Female		1.59 ***	1.34	.49 ***
	Less than high school		1.53 *** ***	1.45 *	1.27 *
	College		.82	1.35	.72
	Married		1.06	.72	.78
	IADL at T1		3.35 *** ***	7.02 *** ***	2.82 *** ***
	ADL at T1		3.43 **	7.70 ***	2.93 **
	Good SRH		2.05 *** ***	2.04 *** ***	1.92 *** ***
	Fair/poor/missing SRH		4.22 ***	3.80 ***	2.87 ***
IADL (n = 1,140)	Age	.95 ***	reference category	1.04 *	1.05 ***
	Female	.73		1.06	.42 ***
	Less than high school	.66 * *		.81	.68
	College	1.03		1.14	.98
	Married	1.92 ***		1.22	1.14
	IADL at T1	.26 *** ***		1.25	.73
	ADL at T1	.36 *		2.56 *	1.74
	Good SRH	.81 ***		1.42	1.32
	Fair/poor/missing SRH	.34 ***		1.95 *	1.28
ADL (n = 644)	Age	.93 ***		reference category	1.03
	Female	1.35			.60 *
	Less than high school	.82			.92
	College	1.49			1.19
	Married	1.04			1.12
	IADL at T1	.89 ***			.91 **
	ADL at T1	.32 ***			.50 ***
	Good SRH	.96			1.12 *
	Fair/poor/missing SRH	.84			2.00 *

Table 5. Predicted probabilities (in percent) of subsequent disability transitions, given specified values of independent variables.

	Disability status at T3			
	Independent	IADL	ADL	Dead
Independent at T2 (n = 3,794)				
Age 70	87.7	5.7	2.1	4.5
Age 80	70.6	12.6	5.4	11.4
Age 90	44.6	21.7	11.1	22.6
Male	77.9	7.0	3.1	12.1
Female	78.6	11.2	4.2	6.0
Less than high school	74.3	12.1	4.3	9.3
High school	80.3	8.5	3.2	7.9
College	82.5	7.2	4.5	5.9
Married	79.9	9.8	3.2	7.1
Not married	77.8	9.0	4.3	8.9
Independent at T1	80.5	8.7	3.3	7.5
IADL at T1	52.4	18.9	15.0	13.8
ADL at T1	51.1	18.9	16.0	14.0
Excellent/very good SRH	85.6	6.1	2.5	5.7
Good SRH	74.9	11.0	4.5	9.6
Fair/poor/missing SRH	62.3	18.8	6.9	12.0
IADL at T2 (n = 1,140)				
Age 70	49.1	28.5	9.4	12.9
Age 80	31.3	30.6	14.8	23.3
Age 90	17.0	27.8	19.7	35.5
Male	34.8	24.5	10.5	30.2
Female	34.5	33.3	15.1	17.1
Less than high school	31.7	35.3	13.7	19.3
High school	37.4	27.4	13.1	22.0
College	37.5	26.8	14.6	21.1
Married	43.0	25.5	12.8	18.7
Not married	30.0	34.0	14.0	22.0
Independent at T1	44.0	26.6	10.7	18.8
IADL at T1	17.4	40.9	20.6	21.1
ADL at T1	15.6	25.9	26.6	31.9
Excellent/very good SRH	52.0	25.8	7.7	14.5
Good SRH	43.0	26.4	11.1	19.6
Fair/poor/missing SRH	23.2	33.4	19.3	24.1
ADL at T2 (n = 644)				
Age 70	32.2		41.0	26.8
Age 80	17.6		44.0	38.4
Age 90	8.6		42.3	49.1
Male	11.7		38.5	49.8
Female	18.8		45.6	35.6
Less than high school	15.5		45.7	38.8
High school	17.8		42.8	39.4
College	22.8		36.9	40.3
Married	16.7		42.4	40.9
Not married	16.8		44.6	38.6
Independent at T1	20.6		37.3	42.1
IADL at T1	19.5		39.7	40.8
ADL at T1	10.3		57.5	32.1
Excellent/very good SRH	21.7		50.3	27.9
Good SRH	20.4		49.1	30.5
Fair/poor/missing SRH	14.6		40.4	45.0

Table 6. Coefficients and odds ratios for logistic regressions of stable states on independent variables for different disability statuses at T2.

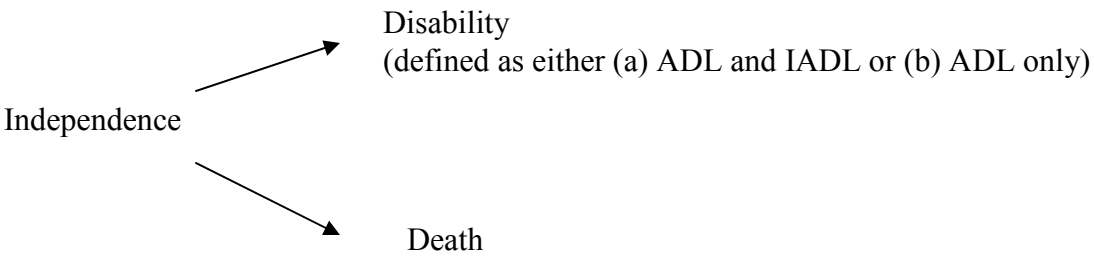
Stable state	Variable	Odds ratio	
Independence	Age	.90 ***	
	Female	1.04	
	Less than high school	.71 ***	***
	College	1.15	
	Married	1.14	
	IADL at T1	.26 ***	***
	ADL at T1	.25 ***	
	Good SRH	.50 ***	***
	Fair/poor/missing SRH	.28 ***	
IADL	Age	1.00	
	Female	1.52 *	
	Less than high school	1.45 *	*
	College	.96	
	Married	.65 **	
	IADL at T1	1.78 ***	**
	ADL at T1	.91	
	Good SRH	1.06	
	Fair/poor/missing SRH	1.44 *	
ADL	Age	1.00	
	Female	1.30	
	Less than high school	1.12	
	College	.80	
	Married	.90	
	IADL at T1	1.11	***
	ADL at T1	2.30 ***	
	Good SRH	.94	
	Fair/poor/missing SRH	.67	

Table 7. Predicted probabilities (in percent) of stable states, given specified values of independent variables.

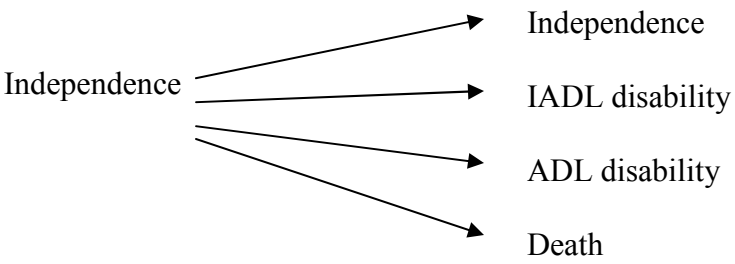
	Stable State		
	Independence	IADL	ADL
Age 70	87.3	27.5	42.2
Age 80	69.7	26.8	42.6
Age 90	43.6	26.1	43.0
Male	77.8	21.7	37.9
Female	78.4	29.7	44.3
Less than high school	73.5	31.4	44.2
High school	79.7	24.0	41.4
College	81.9	23.4	36.0
Married	79.3	22.2	40.7
Unmarried	77.1	30.6	43.3
Independent at T1	80.1	24.6	35.9
IADL at T1	51.2	36.7	38.4
ADL at T1	50.1	22.8	56.3
SRH: Excellent/very good	85.0	23.4	49.3
SRH: Good	74.0	24.5	47.6
SRH: Fair/poor/missing	61.3	30.6	39.5

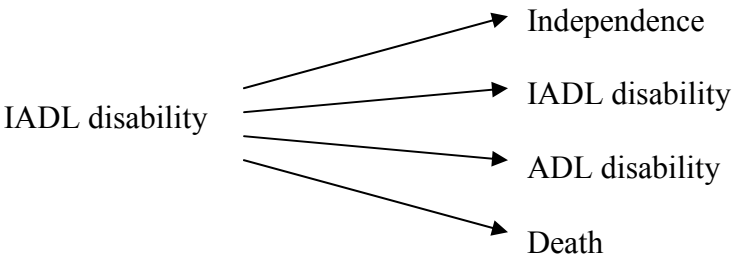
Figure 1. Disability transitions.

Previous literature primarily focuses on two transitions:



But there are twelve possible transitions:





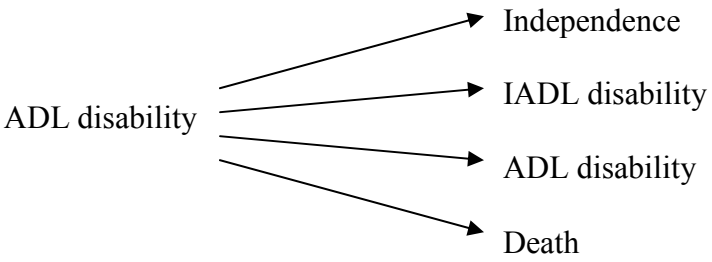


Figure 2. Predicted probabilites of disability transitions for independent people at T2, by age.

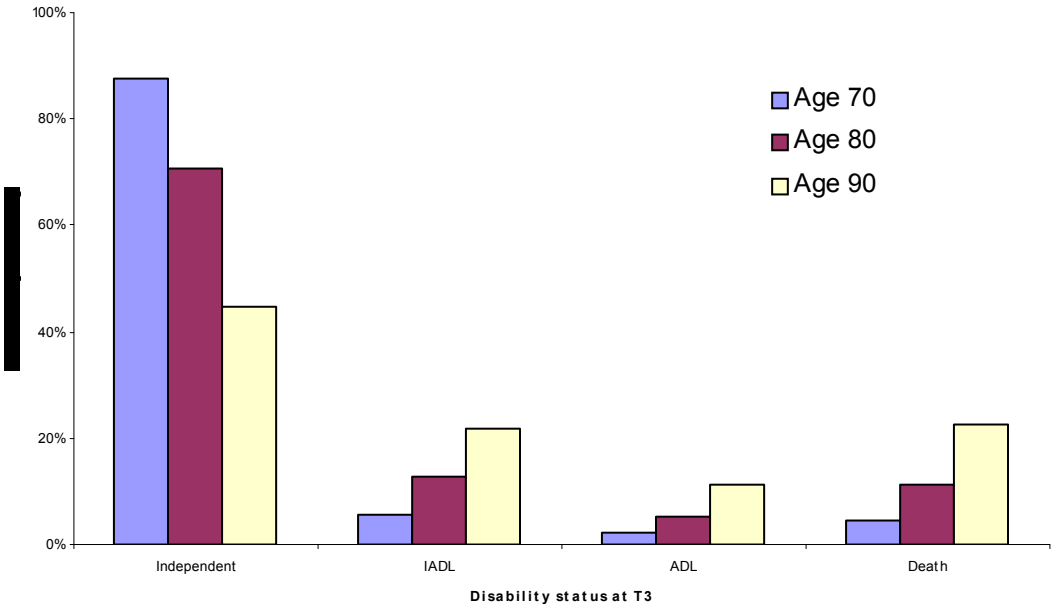


Figure 3. Predicted probabilites of disability transitions for IADL disabled people at T2, by prior disability status.