DISABILITY among elderly persons is a major personal, familial, and social concern. Documenting trends in disability and understanding their causes is important for how individuals, families, and societies plan for providing health care and long-term care in the future. This is particularly true for those planning for the provision of care to older age groups. Elderly persons will increasingly become the majority of the United States population needing long-term care because of chronic disability.

At any given time, the proportion of older persons disabled in a population is determined by past rates of incidence of disability, past rates of restoration in functioning, and the history of death rates of the disabled and nondisabled persons in the population. This study examines change from 1982 through 1993 in the prevalence of disability and the rates affecting this prevalence among the community-dwelling elderly population using data from the Longitudinal Study on Aging (LSOA) and the National Health Interview Survey (NHIS). Four questions are addressed: (1) is there any change during the 1980s and early 1990s in the prevalence of disability, (2) in the likelihood of older persons becoming disabled, (3) in the likelihood of recovery from disability, or (4) in the likelihood of dying when disabled or nondisabled? Thus, we are looking for evidence of change in the prevalence of disability in the older population and in the processes that affect this level of disability.

Background

Previous investigations of trends in the prevalence of disability in the adult population have indicated that, for most adult age groups, reported disability-prevalence increased in the U.S. through the 1970s and into the early 1980s (Colvez and Blanchet, 1981; Crimmins, Saito, and Ingegneri, 1989; Verbrugge, 1984). During these years, however, increases in disability were not observed among those aged 75 and above (Crimmins and Ingegneri, 1993; Schneider and Guralnik, 1987). While some have expressed skepticism about the validity of observed increases in the prevalence of disability (Waidmann, Bound, and Schoenbaum, 1995), others have noted that with declining mortality from chronic conditions it is possible that the prevalence of disability could increase (Crimmins, 1990; Crimmins, Hayward, and Saito, 1994; Verbrugge, 1989). Ycas (1987) has suggested that the general increase in adult disability in the 1970s may have been replaced by stability during the first part of the 1980s, and Manton, Corder, and Stallard (1993) report a decrease between 1982 and 1989 in the prevalence of disability in the population aged 65 and over. Trends in the incidence of disability are the most important determinant of trends in the prevalence of disability (Crimmins, Hayward, and Saito, 1994); however, there have been fewer studies of trends in the incidence of disability. Crimmins and Ingegneri (1993) report that the period of increased disability prevalence during the 1970s also was a time of increased incidence among the age groups whose prevalence increased. They also reported that for those 75 years of age and over there was no change in either prevalence or incidence during the 1969 to 1981 period. Using data from the National Long Term Care Survey (NLTCS), Manton, Corder, and Stallard (1993) report a decrease in the incidence of disability, as well as the prevalence of disability, among the noninstitutionalized population over 65 between 1982 and 1989.

Because understanding the current state of disability is imperative for predicting our future needs for long-term care, we use additional sources of information on disability...
in the older population to examine recent change. The annual prevalence of disability among those 70 years of age and over for each year from 1982 to 1993 is available from the NHIS. This annual survey of over 100,000 people of all ages is a source of reliable annual age-specific measures of the prevalence of disability. In addition, the LSOA — more similar in design to the NLTCS — is another source of prevalence information for four dates (1984, 1986, 1988, and 1990); it allows examination of change over three periods in the processes that determine prevalence. A pattern of systematic time change in prevalence as well as change in incidence and recovery rates from disability would provide greater understanding of the current and future level of disability among the older population.

Recent Improvement in the Incidence and Prevalence of Disability

Before presenting our results, we will discuss in some greater detail the findings of Manton, Corder, and Stallard (1993) from the National Long Term Care Survey (NLTCS). This is a third data source that has been used to examine recent change in prevalence of disability among the older population; it is the only source other than the LSOA of information on incidence change for the national population over this period of time. The 1982, 1984, and 1989 NLTCS samples are representative of the United States Medicare population, which provides the sampling frame for this survey. About 20,000 people are screened or interviewed at each wave, including a new sample of young respondents, to maintain the sample as one representative of the population 65 years of age and older. The screening is used to identify disabled people, who then receive a detailed interview. With three waves of data, the NLTCS allows the examination of the prevalence of disability at three dates and the incidence in two intervals.

Disability status in the NLTCS is defined using information on ability to perform 8 instrumental activities of daily living (IADLs: light housework, laundry, meal preparation, grocery shopping, getting around outside, getting to places outside of walking distance, money management, and using the telephone) and 6 activities of daily living (ADLs: eating, getting in or out of bed, getting around inside, dressing, bathing, getting to the bathroom, or using the toilet). For a person to be ADL-disabled in the NLTCS, it was necessary that the person report that the activity “had not been performed, or was not expected to be performed, without the aid of another person or the use of equipment for at least 90 days.” A person was IADL-disabled if he or she “could not perform one of the IADLS for 90 + days because of disability or health problems” (Manton, Corder, and Stallard, 1993). In the Manton and colleagues’ analysis, people are divided into those with IADL disability only, 1–2 ADLs, 3–4 ADLs, 5–6 ADLs, and the institutionalized population.

The findings of Manton, Corder, and Stallard indicate a very small (1.7%) but statistically significant decrease in the percentage with IADL disability among the noninstitutionalized. Change in the percentage of the population with a given level of ADL deficits was mixed. There was no significant change in the prevalence of 1–2 ADL disabilities; the percentage with ADL disabilities increased significantly (0.7%); and the percentage with 5–6 ADL disabilities declined significantly (0.9%). The decrease in the institutional population (0.4%) between 1982 and 1989 was just statistically significant, but there was no change in the percent institutionalized between 1984 and 1989.

Manton, Corder, and Stallard (1993) also report decreases in the incidence of disability among the noninstitutionalized population between the 1982–84 period and the 1984–89 period. For the nondisabled, the probability of becoming disabled decreased and that of remaining nondisabled increased. Both changes were statistically significant although the absolute values of these incidence changes were small, i.e., generally the likelihood of an outcome changed by 1 to 2 percent.

A more detailed look at some of the reported transition probabilities for the disabled group suggests that the evidence for reduction in disability is inconsistent. If disability were decreasing for all, transition probabilities for movements to better functioning states should increase, and probabilities toward deteriorating functioning should decrease, but this does not describe the findings from the NLTCS.

Because the NLTCS intervals between waves are 2 years and 5 years, the researchers make assumptions to translate 2-year rates into 5-year rates and 5-year rates into 2-year rates, and present results for both interval lengths. While results are not identical, generalizations drawn from either set are similar and the following discussion is based on the 2-year transitions.

Examination of the change in the 2-year disability transitions among the 65-and-over population indicates an increase in the likelihood of remaining in each of the four disability categories. This finding, coupled with an increase in the likelihood of remaining nondisabled, means the likelihood of staying in any functioning state, nondisabled or disabled, increased. On the other hand, the likelihood of making a shift to any other functioning state, either better or worse, decreased in almost all cases. In 75 reported comparisons of the age-specific percent changing disability state for two periods among those who began the period noninstitutionalized, only in six cases does the percent changing functioning state increase in the later period. Four are changes representing deteriorating functioning; the other two are change toward improving functioning (Manton, Corder, and Stallard, 1993). In general, in later years, the likelihood of becoming nondisabled was lower for all categories of the disabled; the likelihood of going from a more disabled to a less-disabled state was lower; and the likelihood of going from a less-disabled to a more-disabled state was lower. Thus, the evidence from the NLTCS on reduced disability for the older population in the 1980s is somewhat mixed. Given the lack of consistency in the pattern of change from the NLTCS, it seems appropriate to use other available data to examine the trends in disability for the older population in recent years.
This analysis will use two datasets: the NHIS, a repeated cross-sectional sample that provides annual data on prevalence from large samples of older persons, and the LSOA, a longitudinal sample that provides information on prevalence at four dates and incidence during three intervals. This combination of data provides a maximal number of data points for observation of trends in both prevalence and incidence.

The NHIS is a continuous household survey of the noninstitutionalized population of all ages in the United States, which has been ongoing since 1957 with the express purpose of monitoring population health and health-care usage. Over the years, the survey has been periodically modified to take advantage of new approaches toward the measurement of health and functioning. These modifications make analysis of time trends across years of major survey redesign difficult. Such a redesign took place between 1981 and 1982. Because the 1982 changes were particularly important in redefining disability for those 70 and older, we examine trends in disability among the population 70 years of age and over for the years from 1982 through 1993 (actually, from age 71 in 1982 and 70 in later years because of questionnaire wording in 1982). The annual sample of persons 70 years of age and over averages almost 9,000, providing a large sample for relatively precise estimates for each year.

For older persons, disability in the NHIS is defined by responses to general questions on needs for help with personal care and other routine needs. They can be viewed as shorthand versions of questions eliciting (a) ADL disability and (b) IADL disability without ADL disability. Respondents indicate whether "any impairment or health problem results in the need for help from another person with personal care needs, such as eating, bathing, dressing, or getting around the house." If they have no personal care needs, they are asked whether "health or impairment results in a need for help from other persons in handling routine needs, such as everyday household chores, doing necessary business, shopping, or getting around for other purposes."

Our other dataset, the LSOA, began in 1984 as a supplement to the NHIS. Those 70 years of age and over who participated in the 1984 interview became the basis for a longitudinal sample (N = 7,527). A subsample of the original group (5,151) was eligible for reinterview in 1986, 1988, and 1990. Because of limited funding, the other 2,376 members of the original sample were eligible for follow-up only in the 1988 and 1990 interviews. Further details on the LSOA are provided in Kovar, Fitti, and Chyba (1992). We use the sample of 5,151 respondents for the LSOA prevalence analysis and add the additional 2,376 for the transition analysis.

For the LSOA analysis, disability in ADLs is defined as being unable, because of health, to perform by oneself at least one of five ADL activities (bathing, dressing, eating, getting in and out of bed, toileting). IADL disability is an inability to perform at least one of five activities: preparing a meal, shopping for personal items, managing money, using the telephone, doing light housework.

In the LSOA the classification of the disabled involves the answers to two questions for each ADL and IADL function. Respondents first answer a question worded as follows: "Because of a health or physical problem, do you have any difficulty (specific ADL or IADL)?" If the answer is "yes," the next question is, "By yourself (and without using special equipment — ADL only) how much difficulty do you have (specific ADL or IADL)?" If the response is "unable to do" for one ADL or IADL function, the person is classified as disabled. In the analysis people are designated as having ADL disability, IADL disability without ADL disability, or not disabled.

Each of the three surveys, the NLTCS, the LSOA, and the NHIS, measure disability in two conceptual domains: personal care and independent living. The operationalization in individual surveys differs in the list of tasks included in each domain and whether disability is defined in terms of need or receipt of help, an inability to do a task alone, and how the use of assistive devices is included. In addition, the NLTCS includes a time dimension that limits disability to that of three-months duration. Differences in the operationalization of this measurement lead to different reported levels of disability (Wiener et al., 1990); our expectation, however, is that underlying trends should be evident with any of these operational definitions.

To use the LSOA data to examine change over time, we need to assure comparability of the LSOA results across time. Because the initial LSOA sample does not include the institutionalized population, we eliminate any institutionalized persons from the later prevalence figures and institutionalized persons at the beginning of the interval for the incidence comparisons. In the LSOA sample there is no addition of younger sample members after the initial interview; thus, the youngest sample members are age 76 in 1990, and we limit our analysis of the LSOA to those aged 76 through 96 at each wave.

Attrition in the LSOA, as in any longitudinal survey, must be taken into account for any analysis of time change in either prevalence or incidence. The percentage of the original 5,151 respondents not responding at later waves was 7.7 in 1986, 10.5 in 1988, and 12.0 in 1990. We have used a combination of imputation and weighting procedures to adjust for sample attrition. We recognize that sample loss is related to health status, and not correcting for it could affect the observed levels of disability prevalence and incidence at later waves. Therefore, we adjust for sample loss using techniques that should result in sample outcomes reflecting the incidence and prevalence of disability among the survivors of the initial sample.

We begin treatment of missing cases by imputing disability status for those assumed to be alive who had reported disability status in two waves prior, two waves after, or two waves surrounding the missing interview. Imputations of disability state are made probabilistically based on observed disability transition outcomes in datasets representing patterns of disability across waves. About three-quarters of the disability is adjusted for in this manner. The rest of the attrition is adjusted for by using an adjustment to the original sample weight based on the estimated probability of nonresponse from a regression equation including age, race, sex, education, living arrangements, and interval as the predictors of nonresponse. Because of the structure of the analyses,
weights differ for the prevalence and incidence analysis. Further details on the imputation and weighting procedures are provided in Crimmins, Hayward, and Saito, 1994.

Results presented from the LSOA data were tested for sensitivity to the analytic choices described above: the use of weights adjusting for attrition, the age range of the included sample (70+ or 76+), and the use of the 5,151 versus the 7,527 sample. Findings are very robust; none of these choices significantly influences either the substantive or the statistical conclusions. The findings are somewhat sensitive, however, to the imputation for missing data, and this is described later.

While the LSOA survey intervals are roughly two years in length, corrections still need to be made for small differences in actual interval length for the analysis of incidence of disability and restoration of functioning. This is accomplished through the inclusion of exposure time in the hazard models used in the analysis.

METHODS

Prevalence

The statistical significance of change over time in the prevalence of disability is tested by examining the regression coefficients indicating the time since the first observation in analyses in which observations are pooled for the 12 dates for the NHIS and for 4 dates for the LSOA. For the LSOA, the wave of the survey is indicated using dummy variables with the earliest year omitted as the reference category; for the NHIS, years since 1982 is entered as a continuous variable. In order to control for any compositional differences in the groups over time, age and sex are entered as controls. For the LSOA, these regressions take the form:

\[
\ln \left( \frac{P}{1-P} \right) = \alpha_0 + \alpha_1 \text{Age} + \alpha_2 \text{Female} + \alpha_3 Y_{1986} + \alpha_4 Y_{1988} + \alpha_5 Y_{1990}.
\]

For the NHIS, there is one time variable indicating the number of years since 1982. In these analyses, P equals the probability of being either ADL- or IADL-disabled versus no disability. Age is the age at the beginning of the interval in two-year age groups (76–96) for the LSOA and single year of age for the NHIS.

In addition, a multinomial logistic regression analysis is used to examine the prevalence of ADL and IADL disability separately. For the LSOA, this equation takes the form

\[
\ln \left( \frac{P(Y=j)}{P(Y=J)} \right) = \beta_0 + \beta_1 \text{Age} + \beta_2 \text{Female} + \beta_3 Y_{1986} + \beta_4 Y_{1988} + \beta_5 Y_{1990}
\]

where Y is the outcome variable, J is the number of categories in the outcome variable (3 for this study, i.e., ADL disability, IADL disability, and nondisabled), and j takes values from 1 to J-1. The natural log of the odds of being in a certain category relative to being in the reference category is estimated in the analysis. In this study, the natural log of the odds of having an ADL disability (P(Y = 1)) relative to being nondisabled (P(Y = 3)), and the natural log of the odds of having an IADL disability but no ADL disability (P(Y = 2)) relative to being nondisabled (P(Y = 3)) are estimated simultaneously. Once the model is estimated, the predicted probability of being in a particular outcome state can be easily computed (Roncek, 1991). Again, for the NHIS, there is one time variable indicating the years since 1982.

Incidence of Disability and Transitions to Nondisability

Following the prevalence analysis using both datasets, transitions of the following types are examined using the LSOA: from "nondisability to disability," from "disability to nondisability," and from the states of disability and nondisability to death. Discrete-time hazards models assuming mid-interval transitions which include age, sex, and interval as the independent variables are employed to test the significance of change over time in incidence of disability and death and the restoration of ability to function. The hazard models take the following form in this analysis:

\[
\ln h_{jt}(\text{Age}) = Y_{1986} + Y_{1988} \text{Age} + Y_{1990} \text{Female} + Y_{1986-88} + Y_{1988-90}
\]

where \( h_{jt} \) is the transition rate from state k (e.g., nondisabled or disabled) to state 1 (e.g., nondisabled, disabled, or death). The interval of time to which the data refer is entered as a dummy variable with the first interval (1984–1986) omitted as the reference category.

RESULTS

Prevalence

The NHIS. — The prevalence of personal care and routine need disability for men and women in each year is presented in Table 1. Graphs of the prevalence of both types of disability for men and women in each of four age groups at every year from 1982 to 1993 are shown in Figures 1 and 2. A visual examination of the figures and table gives us an indication of the consistency of these data and the fact that there is no dramatic trend. Visual examination of the data does not indicate any clear time trend in the need for personal care or the percentage reporting a need for help with other routine activities. In general, the percentage needing help with routine needs is somewhat lower in the later years, although the percentages needing help in 1993 are considerably higher than in 1992. The percentage needing help with personal care is somewhat lower in 1993 than in 1982, but if the comparison were between 1982 and 1992 the percentages would be virtually identical.

Statistical analysis, however, does indicate some significant reductions in disability over time. In interpreting the results, the large sample must be considered as well as statistical significance. When age and sex are controlled, there is a significantly lower relative likelihood of disability in later years when the two types of disability are combined (Table 2). When the two types of disability are separated, there is a lower relative likelihood of each type of disability in later years.

Using the results of the multinomial equations in Table 2, the probability of needing help with personal care, needing help with routine care, and of being nondisabled can be estimated for each sample member based on age, sex, and year of observation. In order to estimate the decrease in the prevalence of disability that would have occurred if there were no change in the composition of the sample but a linear
time trend in disability of the size represented by the coefficient, we compare the average estimated probabilities for 1982 sample members for 1982 and 1993 to indicate the projected effect of a linear time trend. The estimated probabilities in each state are:

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<th>1982</th>
<th>1993</th>
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<tr>
<td>Personal care disabled</td>
<td>.076</td>
<td>.074</td>
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<tr>
<td>Routine care disabled</td>
<td>.134</td>
<td>.121</td>
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<tr>
<td>Nondisabled</td>
<td>.789</td>
<td>.805</td>
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This projection indicates that the reduction in routine care disability and the increase in the nondisabled would have been 1.3 and 1.6 percent. While the decline in the relative likelihood of personal care disability was statistically significant, the predicted decline in the actual prevalence of this disability was quite small.

The LSOA. — The sex-specific prevalences of nondisability and IADL and ADL disability for the LSOA sample 76+ at each of the four dates are presented in Table 3. There appears to be no consistent change in the prevalence of disability over the four dates. The percent nondisabled seems to decrease between 1984 and 1986 and to increase slightly at the next two dates. Change in the components of disability appears equally irregular. Age-specific curves of the observed prevalence of IADL and ADL disability at the four dates are shown in Figure 3. Again, visual analysis does not indicate obvious consistent change over the period in the prevalence of disability in any age range.

The results of the logistic regression, however, indicate that the likelihoods of being disabled in 1986 and 1988 are significantly different from that in 1984 (Table 4, left column). The sign, however, is positive, indicating that once age and sex are controlled the odds of being disabled relative to nondisabled were significantly higher (by 20 and 15%) at these two dates. There is no significant difference between 1990 and 1984 in the likelihood of being disabled at the time of the interview.

When the disabled are divided into two categories — those with an ADL disability and those with only IADL disability — the results indicate that the increased likelihood of disability relative to nondisability described above for 1986 and 1988 is because of the increased likelihood of ADL disability. At each of the three dates after the first interview, the likelihood of having an ADL disability relative to being nondisabled is significantly higher than in 1984. Using the coefficients from Table 4 and the values of the independent variables to predict the probability that any sample observation is ADL disabled, the average probability of having an ADL disability for the 1984 sample would have increased between 1984 and 1990 by 1.6 percentage points.

There are no significant differences between 1984 and the other years in the likelihood of IADL disability relative to being nondisabled. Clearly, the analysis of time differences is sensitive to the year used as the basis of comparison. If difference relative to 1986 rather than 1984 is analyzed, 1990 IADL disability relative to nondisability is significantly lower.

As mentioned earlier, our results are somewhat sensitive to the imputation of missing data on disability status. This is not surprising given that the primary reason for worrying about sample attrition in this analysis is that unhealthy people are lost to the sample more frequently than healthy people; thus, attrition produces a healthier sample over time. If we had not imputed disability status for missing cases, we would not observe a significant increase from 1984 to 1988 in all disability; nor an increase in ADL disability between 1984 and 1988 or 1990. The significant increases between 1984 and 1986 are still found.

Table 1. Prevalence of Disability Among Community-Dwelling U.S. Population 70 Years and Over: NHIS 1982–1993

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<tr>
<td>Percent Nondisabled</td>
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</tr>
<tr>
<td>Both Sexes</td>
<td>77.3%</td>
<td>78.2%</td>
<td>79.1%</td>
<td>79.6%</td>
<td>81.1%</td>
<td>80.5%</td>
<td>80.2%</td>
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<td>80.9%</td>
<td>79.9%</td>
<td>79.4%</td>
<td>79.8%</td>
</tr>
<tr>
<td>Males</td>
<td>82.0%</td>
<td>83.1%</td>
<td>84.2%</td>
<td>83.5%</td>
<td>86.5%</td>
<td>85.7%</td>
<td>84.9%</td>
<td>83.8%</td>
<td>85.7%</td>
<td>84.4%</td>
<td>84.1%</td>
<td>85.0%</td>
</tr>
<tr>
<td>Females</td>
<td>74.3%</td>
<td>75.0%</td>
<td>75.9%</td>
<td>77.0%</td>
<td>77.5%</td>
<td>77.0%</td>
<td>77.2%</td>
<td>78.3%</td>
<td>77.7%</td>
<td>76.8%</td>
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<tr>
<td>Percent With Routine Need Disability But No Personal Care Disability</td>
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</tr>
<tr>
<td>Both Sexes</td>
<td>14.5%</td>
<td>14.2%</td>
<td>13.2%</td>
<td>13.5%</td>
<td>11.3%</td>
<td>12.5%</td>
<td>12.2%</td>
<td>12.3%</td>
<td>11.7%</td>
<td>11.7%</td>
<td>12.3%</td>
<td>13.8%</td>
</tr>
<tr>
<td>Males</td>
<td>11.0%</td>
<td>10.4%</td>
<td>9.9%</td>
<td>9.6%</td>
<td>8.1%</td>
<td>8.5%</td>
<td>8.7%</td>
<td>8.9%</td>
<td>7.9%</td>
<td>8.3%</td>
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<td>9.9%</td>
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<tr>
<td>Females</td>
<td>16.6%</td>
<td>16.7%</td>
<td>15.9%</td>
<td>16.0%</td>
<td>13.4%</td>
<td>15.2%</td>
<td>14.5%</td>
<td>14.2%</td>
<td>14.0%</td>
<td>14.6%</td>
<td>16.5%</td>
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<tr>
<td>Percent With Personal Care Disability</td>
<td></td>
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</tr>
<tr>
<td>Both Sexes</td>
<td>8.3%</td>
<td>7.6%</td>
<td>7.7%</td>
<td>6.9%</td>
<td>7.6%</td>
<td>7.0%</td>
<td>7.6%</td>
<td>7.2%</td>
<td>7.4%</td>
<td>8.5%</td>
<td>8.3%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Males</td>
<td>6.9%</td>
<td>6.5%</td>
<td>6.8%</td>
<td>6.9%</td>
<td>5.4%</td>
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<td>6.5%</td>
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<td>7.3%</td>
<td>6.9%</td>
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</tr>
<tr>
<td>Females</td>
<td>9.1%</td>
<td>8.3%</td>
<td>8.3%</td>
<td>6.9%</td>
<td>9.0%</td>
<td>7.8%</td>
<td>8.3%</td>
<td>7.2%</td>
<td>8.1%</td>
<td>9.2%</td>
<td>7.3%</td>
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</table>

aNon-disabled in either routine needs or personal care.

bThose with no personal care needs who have a health problem or impairment that results in a need for help from another person in handling routine needs, such as everyday household chores, doing necessary business, shopping, or getting around for other purposes. Conceptually similar to IADL disability, with no ADL disability.

cAn impairment or health problem resulting in the need for help from another person with personal care needs, such as eating, bathing, dressing, or getting around the house. Conceptually similar to ADL disability.

dIn 1982, 70-year-olds responded to different questions, so they are omitted for this year.

The results of the logistic regression, however, indicate that the likelihoods of being disabled in 1986 and 1988 are significantly different from that in 1984 (Table 4, left column). The sign, however, is positive, indicating that once age and sex are controlled the odds of being disabled relative to nondisabled were significantly higher (by 20 and 15%) at these two dates. There is no significant difference between 1990 and 1984 in the likelihood of being disabled at the time of the interview.

When the disabled are divided into two categories — those with an ADL disability and those with only IADL disability — the results indicate that the increased likelihood of disability relative to nondisability described above for 1986 and 1988 is because of the increased likelihood of ADL disability. At each of the three dates after the first interview, the likelihood of having an ADL disability relative to being nondisabled is significantly higher than in 1984. Using the coefficients from Table 4 and the values of the independent variables to predict the probability that any sample observation is ADL disabled, the average probability of having an ADL disability for the 1984 sample would have increased between 1984 and 1990 by 1.6 percentage points.

There are no significant differences between 1984 and the other years in the likelihood of IADL disability relative to being nondisabled. Clearly, the analysis of time differences is sensitive to the year used as the basis of comparison. If difference relative to 1986 rather than 1984 is analyzed, 1990 IADL disability relative to nondisability is significantly lower.

As mentioned earlier, our results are somewhat sensitive to the imputation of missing data on disability status. This is not surprising given that the primary reason for worrying about sample attrition in this analysis is that unhealthy people are lost to the sample more frequently than healthy people; thus, attrition produces a healthier sample over time. If we had not imputed disability status for missing cases, we would not observe a significant increase from 1984 to 1988 in all disability; nor an increase in ADL disability between 1984 and 1988 or 1990. The significant increases between 1984 and 1986 are still found.
Figure 1. Proportion with personal care disability: NHIS, 1982–1993, ages 70–74, 75–79, 80–84, 85+. Symbols: □ 70–74 △ 75–79 • 80–84 ○ 85+. 
Figure 2. Proportion with routine need disability: NHIS, 1982–1993, ages 70–74, 75–79, 80–84, 85+. Symbols: ■ 70–74 △ 75–79 * 80–84 ○ 85+.
Trends in Incidence, Recovery, and Death Rates

The results of the analysis of the effect of time interval on the rate of making transitions from "nondisability to disability," "disability to nondisability," and from either state to death are shown in Table 5. Coefficients on the 1988–1990 interval indicate that the rates of transition between the disabled and nondisabled states in 1988 to 1990 are significantly different from those in the 1984–1986 interval. The transition rates from "nondisability to disability" are 16 percent lower in the 1988 to 1990 interval, whereas the transition rates from "disability to nondisability" are 43 percent higher in this interval. This can be interpreted to mean that the rate of becoming disabled as well as the rate of overcoming disability changed in the direction of improving functioning among the older population. The death rate from either state does not change significantly over time. This is not surprising given the lack of consistent change in national mortality rates among the very old in the 1980s reported by the National Center for Health Statistics (1991), and similar findings in the NLTCS (Manton, Corder, and Stallard, 1993).

The meaning of the significant differences in the likelihood of disability change can perhaps be best grasped from age-specific disability transition schedules derived from the hazard models for the two significantly different periods (1984-1986 and 1988-1990). Estimated age-sex specific transition rates from "nondisabled to disabled" and from "disabled back to nondisabled" are shown in Figure 4. The effect of the later time period on the transition rates is not only statistically significant but noticeable in the figures. For instance, at age 80–81 the rate of changing from "nondisabled to disabled" is .061 in the 1984-1986 interval and .076 and .064 for males in the two intervals. The relative change in the rate of moving from the disabled state is even greater. At age 80–81 the rate of making such a change during the 1984–1986 interval was .083 for males. In the 1988–1990 interval, the same rate was .120. The curves are uniformly different across ages because we did not incorporate interactions between age and time into our models.

The results on time differences in disability onset and recovery in Table 5 are not sensitive to the imputation procedure. However, the time pattern of differences in death rates is affected by imputation. If we did not impute, we would observe higher death rates for the disabled in the 1986–1988 period than in the 1984–1986 period.

DISCUSSION

What evidence is there for a change in the prevalence of disability during recent years? We conclude that although the data indicate some statistically significant differences between years, there is no clear ongoing trend in the preva-
Table 4. Regression of Disability on Age, Sex, and Time: LSOA (76 ≤ Age ≤ 96)

<table>
<thead>
<tr>
<th>Risk of Disability vs Nondisability</th>
<th>Multinomial Logistic Regression</th>
<th>Risk of IADL Disability vs Nondisability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-12.90**</td>
<td>-14.80**</td>
</tr>
<tr>
<td>Age*</td>
<td>0.14**</td>
<td>0.15**</td>
</tr>
<tr>
<td>Female</td>
<td>0.16**</td>
<td>0.28**</td>
</tr>
<tr>
<td>1986 vs 1984</td>
<td>0.18*</td>
<td>0.26*</td>
</tr>
<tr>
<td>1988 vs 1984</td>
<td>0.14*</td>
<td>0.22*</td>
</tr>
<tr>
<td>1990 vs 1984</td>
<td>0.06</td>
<td>0.20*</td>
</tr>
<tr>
<td>N = 11,501</td>
<td>Chi square for covariates = 816.4</td>
<td>Likelihood ratio chi square = 184.8</td>
</tr>
<tr>
<td>Degrees of freedom</td>
<td>5</td>
<td>p-value = 0.0001</td>
</tr>
</tbody>
</table>

*p < .05; **p < .01.

Table 5. Hazard Model Results for Disability and Mortality Transitions: LSOA (76 ≤ Age ≤ 96)

<table>
<thead>
<tr>
<th>From Disability (ADL + IADL) to Nondisability</th>
<th>to Dead</th>
<th>From Nondisability to Disability (ADL + IADL) to Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient</td>
<td>Anti-log</td>
<td>Coefficient</td>
</tr>
<tr>
<td>Intercept</td>
<td>-3.62**</td>
<td>-11.58**</td>
</tr>
<tr>
<td>Age*</td>
<td>0.02**</td>
<td>0.12</td>
</tr>
<tr>
<td>Female</td>
<td>-0.28**</td>
<td>0.76</td>
</tr>
<tr>
<td>1986–1988 vs 1984–1986</td>
<td>0.18</td>
<td>1.20</td>
</tr>
<tr>
<td>1988–1990 vs 1984–1986</td>
<td>0.15</td>
<td>1.16</td>
</tr>
<tr>
<td>N = 2,153</td>
<td>658</td>
<td>7,437</td>
</tr>
<tr>
<td>Number of events</td>
<td>287</td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-884.3</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05; **p < .01.

lence of disability among older Americans in the latter part of the 1980s and the early 1990s. Our findings from the NHIS are quite similar to those from the NLTCS, indicating a statistically significant decrease in overall disability in later years arising primarily from a decrease in IADL disability. The estimated size of the effects is quite similar from these two surveys; however, the use of the NHIS indicates that the change does not arise from a clear time trend. With a sample as large as the NHIS, an ongoing time trend should be more evident in the data.

The LSOA provides quite different results from the other two surveys: an increase in ADL disability between 1984 and 1986 and 1988 and no change in IADL disability. If we used 1986 as the reference year, the findings would be quite different and very similar to those from the NLTCS: a significant decrease in overall disability between 1986 and 1990, no change in ADL disability, and a significant decrease in IADL disability. In the NHIS, we could also find somewhat different results by varying the base year. The relationship of the significance of change to the base year points out the importance of having multiple points of observation over which to examine change. A more regular time change in any of the datasets would provide stronger evidence of a trend.

Is there evidence of changing incidence of disability and restoration of functioning during the 1980s? Both the LSOA and the NLTCS datasets indicate significant declines in the level of onset of disability. We find evidence of significant decrease in the most recent years (1988–1990) in the LSOA. The size of the reported reduction appears to be of the same order of magnitude in the two datasets. In the NLTCS data there was a 31 percent reduction in the two-year transition probability from nondisabled to disabled for 75- to 84-year-olds (Manton, Corder, and Stallard, 1993, calculated from Table 3). In the LSOA we observe a reduction of 16 percent in the estimated one-year transition rate of the same type.
The results from the LSOA provide stronger evidence of favorable change in disability transitions over the 1980s. There was an increased likelihood of recovering from disability at the end of the 1984–1990 period in the LSOA but a decrease in this likelihood in the NLTC. Precise comparisons of the size of the change in the likelihood of going from disabled to nondisabled cannot be made for the two datasets, but both appear to be proportionately quite large.

The lack of immediate translation of incidence changes into prevalence differences, as observed in the LSOA, is not unexpected (Crimmins, Hayward, and Saito, 1994). If the healthier incidence rates of the 1988–1990 period observed in the LSOA were sustained for some years, the prevalence of disability should decrease as well. The similarity of the recent incident changes from "nondisabled to disabled" from the two surveys with incident information provides the first replicated evidence that we are potentially at the beginning of a period of improvement in disability among the old. Evidence of sustained change beyond 1990 is needed before we can confidently say that improvement has begun.

Differences in the findings across datasets collected to monitor changes in disability in old age in the 1980s indicate a need for further evidence before drawing conclusions about clear trends toward improving health among the older population. The differences in results from the three studies could reflect numerous design differences in the NHIS, the NLTC, and the LSOA. We will not discuss these differences in detail because this has been done extensively by others (Corder and Manton, 1991; Wiener et al., 1990), but potential sources of varying results include: coverage of the institutional and nondisabled populations, re-interview versus new sample, sample size, age coverage, sampling complexity, survey interval, mode of interview on some waves, the use of a sample screen, the frequency of proxy response, and the format and content of the questions used to define the disabled.

Some differences do not affect our comparisons because we limit the comparisons to samples with similar characteristics (e.g., coverage of institutional population) or if we did limit the analysis to comparative groups the results would not change (e.g., age restricted to the 75 plus). Other differences could cause variable results. For instance, different definitions of ADL and IADL disability could be a cause of differences in findings between the two surveys.

The most dramatic difference across surveys is in the findings about trends in ADL disability prevalence. This may also be the place where the difference in definition is greatest. Both the NHIS and the NLTC use "needing" or "getting personal assistance" in performing tasks as central to the definition of ADL disability. In the LSOA, if we were to include those among the "ADL-disabled" who receive assistance but report themselves physically able to perform functions, the prevalence of ADL disability would increase by 83 percent in the 1984 LSOA sample.

While the receipt of assistance is commonly used as an indicator of old age disability, we think that this is not a good practice. One of the major problems with these definitions is that the receipt of assistance is highly related to living arrangements. Those who live with others are more likely to get assistance. If we employed the use-of-assistance definition with the LSOA sample, among those who live with others, the increase in ADL disability would be 101 percent; among those who live alone, the increase would be only 27 percent. We think that disability is better measured by functioning deficits due to health than by the use of assistance in the older population.

Any explanation of the finding from the NHIS and the NLTC of a decrease in IADL disability and not ADL disability needs to be evaluated in light of what might affect IADL ability but not ADL ability. Verbrugge and Jette (1994) have cogently clarified the role that health and environment potentially play in various types of disabilities. IADL disability which arises from difficulty doing housework, meal preparation, shopping, other household chores, and getting around outside the house can be affected by the ability to drive, the provision of transportation services, the availability of prepared foods and microwave ovens, as well as other factors that are not related to the intrinsic health status of a population. ADL ability represents more basic ability and is less likely to be affected by factors extrinsic to the individual.

While we have examined changes in the age-specific prevalence of disability, we have not discussed the burden of disability on those who are preparing for the aging of the population in the next century. The dramatic increase in the numbers of older persons results in a predicted increase in the burden of disability in the population even when the most optimistic projections of current findings are employed. However, reducing the incidence of disability or raising the age at which people become disabled is the most effective mechanism for reducing the future numbers of disabled in the population (Crimmins, Hayward, and Saito, 1994). Because of this, public policies should be directed toward the prevention and delay of onset of disabling diseases and conditions and in the provision of technology and services to compensate for disability.

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