WAS THERE COMPRESSION OF DISABILITY FOR OLDER AMERICANS FROM 1992 TO 2003?*

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Medical advances and the growth of the elderly population have focused interest on trends in the health of the elderly. Three theories have been advanced to describe these trends: compression of morbidity, expansion of morbidity, and dynamic equilibrium. We applied multistate life table methods to the Medicare Current Beneficiary Survey to estimate active and disabled life expectancy from 1992 to 2003, defining disability as having difficulty with instrumental activities of daily living or activities of daily living. We found increases in active life expectancy past age 65 and decreases in life expectancy with severe disability. These trends are consistent with elements of both the theory of compression of morbidity and the theory of dynamic equilibrium.

Life expectancy for older Americans has risen substantially over the past five decades. For 65-year-olds, life expectancy has increased more than 30% from 13.9 years in 1950 to 18.2 years in 2002 (National Center for Health Statistics 2004). Whether these gains are concentrated in years that are free of disability has been a focus of debate. Different views of population aging have been proposed in three theories: compression of morbidity (Fries 1980), expansion of morbidity (Gruenberg 1977; Olshansky et al. 1991), and dynamic equilibrium (Manton 1982).

Compression of morbidity, proposed by Fries (1980), holds an optimistic view of aging. It asserts that the onset of chronic, irreversible illness will be delayed toward the end of a fixed life span so that morbidity is compressed into a shorter period before death. He stated that both the mortality (i.e., survival) and the morbidity curves would become more rectangularized and closer together because premature onset of mortality and morbidity would be eliminated. He also stated that the variability around mean morbidity onset and mean age at death would be reduced. In his earlier articles, Fries expressed the idea that the limit of human life expectancy would soon be reached, but in his later articles (Fries 1988, 2000, 2003), he emphasized morbidity compression and somewhat relaxed the idea of limits to life expectancy. Thus, a more general formulation of his theory states that compression occurs if the postponement of the onset of morbidity is greater than the increases in life expectancy. As a result, the average time spent in an active state will increase, both in absolute values and as a proportion of total life expectancy (TLE). Fries cited evidence from a number of studies to show that healthy life styles reduce the period between disease onset and death (Fries 1988; Hubert et al. 2002; Vita et al. 1998).

The opposite theory, expansion of morbidity, holds that gains in longevity are associated with longer periods of morbidity (Gruenberg 1977; Olshansky et al. 1991; Schneider and Brody 1983). This theory states that the drop in old-age mortality resulting from medical advances has two effects: extending life for those suffering from chronic, disabling diseases yet leaving age at onset unchanged; and allowing people to live to older ages, at which the risks of chronic, nonfatal diseases of aging are higher. As a result, the elderly

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spend more time in a morbid state, in both absolute terms and as a proportion of TLE. Active life expectancy was not expected to increase. An increase in the variation around average life expectancy has been cited as evidence against rectangularization of the survival curve (Rothenberg, Lentzner, and Parker 1991). A historical view of variability in age at death revealed a pronounced decline from 1900 to 1950 but not much change after that in the United States, Sweden, and Japan (Wilmoth and Horiuchi 1999).

A third theory, dynamic equilibrium, holds that mortality and morbidity (and hence disability) are not independent and that the same forces that reduce mortality also reduce the severity and rate of progression of chronic diseases (Manton 1982). Manton criticized the proponents of both expansion and compression of morbidity for underestimating the links between the forces (e.g., lifestyle changes and medical advances) that change both mortality and morbidity. He considered it unlikely for most diseases that mortality would be reduced without also reducing morbidity. Therefore, TLE and its components—years spent with and without disability—would likely increase over time. By implication, age at initial onset of disability would also increase. How these forces play out to affect longevity and disability depends on their specific effects on disease incidence and severity as well as on the effects of disease on disability. As a result, the theory made no prediction about the years with and without disability as a percentage of TLE. Freedman and Martin (2000) found support for dynamic equilibrium in their study: although the prevalence of chronic diseases increased from 1984–1994, the disabling effects of these diseases decreased. The likely effects of these theories on life expectancy in different disability states are also summarized in Agree and Freedman (1999: table 53.2).

These theories of population aging were all proposed in terms of morbidity, which is more difficult to quantify than functional disability, a related concept. Following earlier precedents, we use functional disability measures ". . . as surrogates for the less easily quantified morbidity rates" (Fries 2003:455) to test the compression of morbidity hypothesis. Functional disability usually refers to difficulty in performing activities typical of a person's daily life as a result of health or physical problems (Verbrugge and Jette 1994). In many cases, old-age disability is caused by chronic illness (such as arthritis and heart disease), although disability and morbidity often identify different subsets of the older population (Fried et al. 2004).

Over the past three decades, studies have found that disability prevalence increased during the 1970s (Colvez and Blanchet 1981), likely reflecting increased incidence (Crimmins and Ingegneri 1993). Starting in the early 1980s and continuing into the 1990s, the percentage of persons aged 65 and older with instrumental activities of daily living (IADL) limitations has been decreasing (Freedman, Martin, and Schoeni 2002). Beginning in the mid-1990s, consistent declines were seen in the percentage of the elderly with activities of daily living (ADL) limitations (Freedman et al. 2004). Evidence also exists that the rate of decline in chronic disability (both IADL and ADL) accelerated in late 1990s (Manton and Gu 2001).

Other studies examined trends in active life expectancy and disabled life expectancy (ALE and DLE, respectively) as well as their relations to trends in TLE. ALE, the average duration of life free of disability between a certain age and death, is commonly used as a measure of healthy aging. From the National Health Interview Survey, Crimmins, Saito, and Ingegneri (1989) found that much of the gain in TLE in the 1970s occurred in time with chronic (three months or longer) limitations of common activities of life (e.g., working and keeping house), with some reductions in time with severe (i.e., bed-ridden) disability. Based on a similar definition of disability, Crimmins, Saito, and Ingegneri (1997) reported that ALE rose along with TLE in the 1980s. However, as a *proportion* of TLE, ALE changed little except that it increased among persons with higher educational attainment (Crimmins and Saito 2001). Overall, the experience of the United States and other developed countries in the 1980s supports the theory of dynamic equilibrium (Robine, Romieu, and Michel 2003). In France and the United States, the prevalence of disabling chronic diseases increased while the severity of disability decreased (Crimmins and Saito 2000; Robine, Mormiche, and Sermet 1998). Studies attributed these findings to a weakened link between chronic diseases and disability (Freedman and Martin 2000).

In the population aged 65 and older, a greater percentage of women reported limitations across a variety of measures, including IADLs and ADLs (Waidman and Liu 2000). Studies also have found that at age 65, women have both a higher ALE and a higher DLE than men (Crimmins et al. 1997). The well-known paradox of a longer life but with more disabled years for women reflects a higher prevalence of fatal disease among men, a stronger relation of certain chronic diseases to mortality among men, and a higher prevalence of nonfatal but disabling diseases (such as arthritis) among women (Verbrugge 1989; Case and Paxson 2005). Higher ALE and DLE for women at age 65 is attributed to lower death rates among disabled women compared with disabled men, not to higher incidence of disability among women (Crimmins, Hayward, and Saito 1996; Ferrucci et al. 2003; Oman, Reed, and Ferrara 1999). On the other hand, Leveille et al. (2000) attributed differences in mobility limitations to the greater incidence of disability among women, with differences in mortality and recovery playing a lesser role. As far as trends in ALE, Crimmins et al. (1997) found that for both men and women, most of the increase in TLE from 1970–1980 was in disabled years and that most of the increase from 1980–1990 was in years free of disability.

What is the latest evidence in the United States? This study builds on previous research to investigate trends in various aspects of functional disability and mortality for Americans aged 65 and older from 1992 to 2003. We examine the extent to which our results support the three theories of the relation of population-level changes in life expectancy to changes in disability among persons aged 65 and older.

DATA

This study focuses on the 1992–2003 period using the Medicare Current Beneficiary Survey (MCBS). This survey is a nationally representative, multistage, longitudinal survey of the Medicare population, sponsored by the Centers for Medicare and Medicaid Services, and conducted continuously since 1991. The survey gathers data on a wide range of topics, such as health status, sociodemographic information, and use and costs of medical services. Survey records are linked to administrative data on use and expenditures of Medicare-covered services (such as hospital and physician) and on vital status. Interested readers can go to its Web site (http://www.cms.hhs.gov/mcbs) for more information.

The MCBS follows a rotating panel design with three in-person interviews per year. Health status information is gathered once per year in the fall. For each of the six ADLs (bathing, dressing, eating, getting in or out of bed or chairs, walking, and using the toilet) and each of the six IADLs (using the telephone, doing light and heavy housework, preparing meals, shopping, and managing money),[1] we define persons as disabled for an IADL or ADL limitation if they either respond "Yes" to having difficulty with an activity or respond that they do not do the activity because of a health or physical problem. Some studies use needing help from another person to categorize respondents as disabled. This identifies a smaller, sicker group of persons than those with only difficulty (Gill, Robinson, and Tinnetti 1998). Another common way to define disabled persons is to identify those who receive human help or use special equipment for an activity. However, with this definition, the extent to which changes in the prevalence of disability reflect changes in the underlying health of the population, on the one hand, and the extent that they reflect changes in the availability of paid or unpaid help, on the other, can be unclear (Freedman et al. 2004;

1. For institutionalized respondents, the questionnaire includes only three IADLs: using the telephone, shopping, and managing money.

Spillman 2004). The MCBS does not ask about needing help. Therefore, we chose to define disability based on one's difficulty or inability to perform IADLs or ADLs.

Freedman et al. (2004) compared trends in the percentage of the 70-and-older population with ADL limitations among five national surveys for the early 1980s to 2001. The trends shown by the MCBS were similar to trends from most of the other surveys.

Based on a person's level of disability, we constructed four, mutually exclusive disability states: (1) active health (no IADL or ADL disability); (2) IADL disability (disabled in at least one IADL but in no ADL); (3) moderate ADL disability (disabled in one or two ADLs); and (4) severe ADL disability (disabled in at least three ADLs). Death is the fifth and absorbing state.

The preceding classification is motivated by a number of considerations. Our IADL-only category is motivated by research suggesting that trends in IADL limitations may reflect not only changes in health but also secular trends in the environment, which can make performing certain tasks easier (Spillman 2004). The separation of moderate and severe disability is motivated by research showing that trends in ALE evolved differently depending on the severity of disability (Robine, Romieu, and Michel 2003). Limitations in three or more ADLs have been used to identify frail elders who are nursing home–certifiable and have substantial long-term care needs (Stone 2000). Many of these severely disabled elderly are institutionalized. The National Nursing Home Survey in 1999 found that three-quarters of nursing home residents require assistance with three or more ADLs (Jones 2002). At the same time, many continue to live in the community, relying on a combination of formal and informal care provided by paid, home health-care workers and unpaid relatives or friends (Stone 2000). Trends in severe disability, therefore, should be related to future demand for long-term care services.

Classifying a heterogeneous population into mutually exclusive subgroups always involves some level of arbitrariness, and complex models have been proposed to rationalize the selection of categories (e.g., Manton and Land 2000). A recent study by Lynch, Brown, and Harmsen (2003) suggested that altering the threshold for measuring ADL disability has a significant effect on population-based ALE estimates at age 65, but not at older ages. Significant differences also exist for DLE estimates at age 85.

The original design of the MCBS planned to track sampled beneficiaries indefinitely. Under the revised design, implemented in 1994, an interview is conducted each fall for four years to gather information on health status for sample persons who neither drop out of the survey nor die. In order to maintain consistency throughout the 1992–2003 period, the number of observations per person is limited to four in the analysis sample. We excluded 9,787 respondents who have only one observation or who missed one or more interviews between two observations. This includes the 4,160 respondents who entered the survey in 2003 who do not have follow-up observations for analyzing transitions. Observations for persons dying within a year after an interview are included. The final analysis sample consists of 43,891 beneficiaries aged 65 and older, with 144,278 person-years of observations and 100,387 pairs of functional status observations.

METHODS

The longitudinal design of the MCBS enables us to fit a multistate life table (MSLT) model (Schoen 1987). The MSLT model uses longitudinal, person-level data on changes in disability status to develop estimates of first-order Markov transition probabilities. Because the MSLT model allows both disability onset and recovery, it is considered superior to the Sullivan method (Sullivan 1971) for studies of ALE (e.g., Guralnik et al. 1993; Land, Guralnik, and Blazer 1994; Rogers, Rogers, and Branch 1989) and for evaluating the theories of population aging (Rogers, Rogers, and Belanger 1990).

Estimates from the MSLT method are analogous to those from a period life table. In our study, we use age- and gender-specific probabilities of disability transitions (e.g., estimated from 2002–2003) to simulate the paths of 65-year-olds to disability and to death. This implies, for example, that the experience of a 65-year-old in 20 years will be the same as an 85-year-old in 2002–2003. Although this is unlikely to be the case, life table methods allow us to summarize and track trends in important measures of health, such as ALE and DLE. In contrast, the predictions in the three theories are cohort based: they predict the experience through time of birth cohorts of current and future elderly persons.

The age-specific MSLT estimates of transition probabilities do not reflect changes in the age composition of the elderly population. Our concern is to summarize changes in the experience of "typical" individuals during our study period. We do not estimate the percentage of the total population who will be disabled—a percentage that is likely to grow in the future as the population aged 65 and older, as a percentage of the whole population, grows from 12% in 2005 to an estimated 20% in 2030 (Boards of Trustees 2005).

A discrete-time MSLT model is estimated in this study using a multinomial, logistic regression because of the imprecise measurement of event time in the MCBS. Interviews are scheduled at discrete time intervals so that events are known only to have occurred between follow-ups instead of at an exact time. Pairs of functional status observations from one year to the next are the basic unit of analysis in the MSLT model. We placed the pairs into 11 groups (1992–1993, 1993–1994, . . . , 2002–2003), according to the year in which the pair begins. In the following sections, we use the beginning year to denote the corresponding year group (i.e., 1992 for 1992–1993, 1993 for 1993–1994, and so on). The response variable is the functional state at the end of each pair; the covariates include age at the beginning of each pair, age squared, and the corresponding year group. The regression is estimated separately for each functional state at the beginning year of the observation pair and by gender. The covariates are statistically significant in all estimated regressions.

The logistic regression implicitly assumes only one transition per interval. This assumption is unrealistic (Laditka and Wolf 1998), especially for younger elderly persons (i.e., those aged 65–74) who are more likely to experience short episodes of disability and quick recovery. However, the estimates of ALE and DLE appear to be unaffected by the potential downward bias in estimates of the number of transitions. This result is also confirmed by Gill et al. (2005), whose findings imply that the annual interval in MCBS is relatively short and not likely to bias estimates of life expectancy.

Year (1992–2002) is treated as a continuous variable to smooth the trend estimates in this analysis. An alternative approach, which allows more year-to-year variations, is to use dummy variables for each year. Our analysis shows that the life expectancy estimates for 65-year-olds are similar between the two approaches. Although the dummy variable approach yields greater variation in the life expectancy estimates, the trends in life expectancy between 1992 and 2002 are nearly identical. Therefore, we treat calendar year as a continuous variable in our trend analysis.

After age-specific transition probabilities are estimated, we simulate a cohort of 500,000 65-year-olds, by year and sex, and record their complete trajectories of changes in disability status until death. The starting distribution of functional status at age 65 for each cohort is predicted by using the coefficients estimated in a multinomial logistic regression fitted, by year and sex, on all sampled persons of aged 65 and older from the MCBS. We do not use the observed prevalence at age 65 directly because the entering cohorts of 65-year-olds are small and vary in size each year. The dependent variable in the logistic regression is functional status, and the independent variables are age and the square of age. Thus, changes in our estimates of TLE, ALE, and DLE reflect changes in the functional status of entering cohorts of 65-year-olds as well as changes in post–age-65 transition probabilities. All results (e.g., TLE, ALE, incidence, recovery, and so on) presented in this analysis are based on the simulated lifetime trajectories. Microsimulation has already been used to generate estimates of ALE (Laditka and Wolf 1998; Lubitz et al. 2003) as well as trends in ALE (Robine, Mathers, and Brouard 1996). The simulation is conducted in a manner similar to that in Lubitz et al. (2003), where a uniform random number between 0 and 1 is repeatedly generated for comparison with the transition probabilities that correspond to the simulated person's age and disability status to determine disability status one year later.

Measures of disability that are evaluated in this study include DLE and age at initial disability onset. DLE—total years of life spent in disability from age 65 until death—is the difference between TLE and ALE. Nusselder (2003) identified various aging patterns based on the changes in DLE in both absolute and relative terms: absolute compression or absolute expansion, and relative compression or relative expansion. Absolute expansion of disability occurs if DLE increased, and relative expansion occurs if the ratio of DLE to TLE increased; the opposite is true for absolute and relative compression.

Delay in age at onset of illness and disability is the primary factor behind morbidity compression in Fries' theory. If we had assumed no recovery from disability as well as fixed life expectancy, onset delays would be equivalent to falls in DLE. Because life expectancy has been rising and because the elderly enjoy substantial recovery from disability (Manton 1988), we expect that the relation between trends in age at initial disability onset and DLE will be more complicated. Further, examining the age at onset of and recovery from disability will yield useful insights into the disability transition process. The use of simulation enables onset age to be estimated. For those in active health at age 65, we record the age at initial onset of IADL, moderate, and/or severe ADL disability and then average them from all who experienced such episodes. For those who are IADL-disabled at age 65, we estimate the initial onset age of moderate and severe ADL disability. For those who are moderately ADL-disabled at age 65, we estimate the initial onset age of severe ADL disability. For those who are already severely disabled at age 65, no such estimates are obtained. We also estimate the ages of initial onset of any disability for all 65-year-olds, excluding any spells of disability that are already in progress at age 65.

We use the bootstrap method to estimate standard errors. Following the steps in Lohr (1999), we first sample $n_h - 1$ primary sampling units (PSUs) with replacement from each of the 113 strata in the MCBS, where n_h is the number of PSUs in stratum h. For the ith PSU sampled from stratum h, we multiply the full-sample weight by $(n_h / (n_h - 1)) \times m_i$, where m_i is the number of times that PSU_i is selected. For each bootstrapped sample, we fit a separate discrete-time hazard model, by year and sex, and simulate a separate 100,000-person cohort of 65-year-olds, by year and sex, to estimate life expectancy and other statistics of interest. We repeat the bootstrap procedure 250 times. The standard deviations of the 250 estimates are the standard errors.[2] All relative standard errors of estimates presented in this analysis are less than 10%. Statistical significance of the difference between two estimates is evaluated by using two-sample t tests; the significance level of the two-sided test is set at 5%. The hypothesis of a statistically significant monotonic trend is evaluated by taking into account the variability of point estimates at all time points (Sirken et al. 1992). The significance level is also set at 5%.

RESULTS

Overall Estimates for All Persons at Age 65

Table 1 shows unweighted estimates of selected sociodemographic characteristics of the analysis sample in 1992 and 2002. Compared with the 1992 sample, the 2002 sample is older and better educated, and more are in active health and have some chronic conditions.

Table 2 presents trends in TLE, ALE, and DLE. For all 65-year-olds, TLE increased 0.5 years from 16.8 years in 1992 to 17.3 years in 2002. ALE increased 0.8 years from 9.5 to 10.3 years; the increase was statistically significant. Meanwhile, a small, statistically

2. Standard errors are not shown in the tables, but they are available from authors upon request.

Table 1. Selected Characteristics of Study Sample of Persons Aged 65 and Older in 1992 and 2002 (percentages)

Measure	1992	2002
Sex Is Male	39.2	41.9
Race		
Non-Hispanic white	84.3	81.3
Non-Hispanic black	9.1	8.2
Hispanic	5.0	6.7
Education		
0–11 years	46.3	33.4
High school	29.2	29.2
College or more	24.6	37.4
Average Age	76.8	77.5
Have One or More Chronic Conditions	85.3	90.5
Disability Status		
Active health	48.2	50.0
IADL disability	14.1	13.9
Moderate ADL disability	21.3	20.8
Severe ADL disability	16.4	15.4
Mortality Rate		
Active health	2.5	2.5
IADL disability	6.0	5.4
Moderate ADL disability	7.3	9.4
Severe ADL disability	20.1	23.1

Source: Medicare Current Beneficiary Survey.

Note: Sample sizes are 9,291 for 1992 and 13,337 for 2002.

insignificant decrease occurred in total DLE, reflecting a small but significant decrease in severe ADL DLE (0.4 years) and an insignificant increase in moderate ADL DLE. IADL DLE did not change. All the gains in TLE between 1992 and 2002 are in ALE. As a percentage of TLE, total DLE fell from 43.5% in 1992 to 40.5% in 2002; severe ADL DLE, as a percentage of TLE, fell from 12.5% in 1992 to 9.8% in 2002. Both the increasing trend in ALE and decreasing trend in severe ADL DLE were statistically significant.

The age of initial onset of any disability and of IADL and moderate ADL disability showed small increases from 1992 to 2002 (see Table 3). The average age of first onset of severe ADL disability for all 65-year-olds was postponed by 0.9 years from age 78.5 in 1992 to 79.4 in 2002. If we assumed no recovery from disability, DLE would be calculated as the duration of life between age at initial onset and death. Given the fairly stable onset age of any disability (70.9 in 1992 and 71.1 in 1997 and 2002), fairly stable incidence of any disability (shown later in Table 3), and increasing TLE, these results imply that almost all the gains in TLE between 1992 and 2002 (0.5 years) were in years with disability. In fact, all the gains in TLE were in ALE, as shown in the first two rows of data in Table 2. This highlights the importance of examining recovery in evaluations of the changes in disability.

Across all the groups defined by disability status at age 65, the largest delays in onset occurred for severe ADL disability. The average age at the first onset of severe ADL

Table 2. Trends in Disabled Life Expectancy for 65-Year-Olds: 1992, 1997, and 2002

Measure, by Disability Status at Age 65	Both Sexes			Men			Women		
	1992	1997	2002	1992	1997	2002	1992	1997	2002
All Persons									
Total life expectancy	16.8	17.1	17.3	15.0	15.5	15.8	18.3	18.5	18.6
Active life expectancy	9.5	10.0	10.3	9.9	10.4	10.8	9.2	9.7	9.9
Disabled life expectancy	7.3	7.1	7.0	5.1	5.1	5.0	9.1	8.8	8.7
IADL disability	2.3	2.3	2.3	1.6	1.6	1.6	2.9	2.9	3.0
Moderate ADL disability	2.9	2.9	3.0	2.2	2.3	2.3	3.5	3.5	3.5
Severe ADL disability	2.1	1.9	1.7	1.3	1.2	1.1	2.7	2.4	2.2
Active Health									
Total life expectancy	17.3	17.5	17.8	15.4	15.9	16.2	18.8	18.9	19.1
Active life expectancy	10.4	10.7	11.1	10.5	11.0	11.4	10.2	10.5	10.8
Disabled life expectancy	6.9	6.8	6.7	4.8	4.8	4.8	8.6	8.4	8.3
IADL disability	2.2	2.2	2.2	1.5	1.5	1.5	2.8	2.8	2.8
Moderate ADL disability	2.8	2.8	2.8	2.1	2.2	2.2	3.3	3.3	3.3
Severe ADL disability	2.0	1.8	1.6	1.2	1.1	1.0	2.5	2.3	2.1
IADL Disabled									
Total life expectancy	16.5	16.7	17.0	14.4	14.9	15.3	18.2	18.3	18.4
Active life expectancy	8.4	8.8	9.3	8.5	9.1	9.6	8.2	8.6	8.9
Disabled life expectancy	8.2	8.0	7.8	5.9	5.8	5.7	10.0	9.7	9.5
IADL disability	3.1	3.1	3.1	2.3	2.3	2.3	3.7	3.7	3.8
Moderate ADL disability	3.0	3.0	3.0	2.3	2.4	2.4	3.6	3.5	3.6
Severe ADL disability	2.1	1.9	1.7	1.3	1.2	1.1	2.7	2.4	2.2
Moderately ADL Disabled									
Total life expectancy	15.9	16.1	16.4	14.0	14.4	14.5	17.5	17.7	18.0
Active life expectancy	7.7	8.1	8.6	8.0	8.4	8.7	7.5	8.0	8.5
Disabled life expectancy	8.2	8.0	7.8	6.1	5.9	5.7	10.0	9.7	9.5
IADL disability	2.3	2.3	2.3	1.5	1.5	1.5	2.9	2.9	3.0
Moderate ADL disability	3.7	3.8	3.8	3.1	3.1	3.1	4.3	4.3	4.3
Severe ADL disability	2.2	2.0	1.8	1.4	1.3	1.1	2.8	2.5	2.3
Severely ADL Disabled									
Total life expectancy	13.2	13.5	13.6	11.0	11.4	12.1	15.2	15.4	15.5
Active life expectancy	5.3	5.7	6.1	5.3	5.8	6.5	5.4	5.8	6.1
Disabled life expectancy	7.9	7.8	7.5	5.8	5.6	5.6	9.8	9.6	9.4
IADL disability	1.8	1.8	1.8	1.1	1.1	1.2	2.3	2.4	2.4
Moderate ADL disability	2.8	2.8	2.8	2.0	2.1	2.2	3.5	3.5	3.5
Severe ADL disability	3.4	3.2	2.9	2.6	2.4	2.2	4.1	3.8	3.5

Source: Microsimulation results from the Medicare Current Beneficiary Survey.

Table 3. Age of Initial Disability Onset for 65-Year-Olds: 1992, 1997, and 2002

Disability Status at Age 65	Disability	Age at Disability Onset		
		1992	1997	2002
All Persons[a]	Any disability	70.9	71.1	71.1
	IADL disability	72.9	73.0	73.2
	Moderate ADL disability	73.2	73.5	73.6
	Severe ADL disability	78.5	79.0	79.4
Active Health	Any disability	71.4	71.5	71.6
	IADL disability	73.1	73.2	73.4
	Moderate ADL disability	73.8	73.9	74.0
	Severe ADL disability	79.3	79.7	80.0
IADL Disabled	Moderate ADL disability	71.6	71.9	72.1
	Severe ADL disability	77.6	78.0	78.6
Moderately ADL Disabled	Severe ADL disability	75.7	76.3	76.9

Source: Microsimulation results from the Medicare Current Beneficiary Survey.

[a]To calculate the onset ages for this group, we excluded any spells of disability that were already in progress at age 65.

disability increased 0.7 years for persons in active health at age 65, 1.0 year for those who were IADL-disabled at age 65, and 1.2 years for those with moderate ADL disability at age 65. Smaller delays occurred in the age at onset of IADL and moderate ADL disability.

Under the health conditions observed from 1992–2002, the rate of recovery to active health from an episode of disability increased, with the majority of recoveries occurring within one year. In 1992, 31.4% of those disabled returned to active health at least once during their lifetimes after age 65; in 2002, 35.4% regained active health at least once (data not shown). The probability of improving from any disability category to a less-disabled category or to active health also increased under the health conditions observed between 1992 and 2002.

Estimates of DLE at age 65 are the product of three components: the percentage of the population having one or more disability episodes after age 65 (incidence), the average number of episodes per person with at least one episode, and the average length of an episode for those with an episode (see Table 4). For total DLE, the percentage of persons with an episode increased, and the number of episodes and the average episode length changed little between 1992 and 2002.

The incidence of severe ADL disability declined from 58.2% in 1992 to 54.4% in 2002. The average duration of an episode shortened slightly. The number of episodes of severe ADL disability changed little. These results suggest that the fall in severe ADL DLE is attributable to a combination of factors, including delayed onset, reduced incidence, shorter episodes, and increased probability of recovery. The incidence, number of episodes, and episode length of IADL and moderate ADL disability showed little or no change during the study period. There was practically no change in average number of episodes or episode length for IADL and moderate ADL disability.

Estimates by Disability Status at Age 65

All subgroups defined by disability status at age 65 experienced statistically significant increases in ALE and decreases in severe ADL DLE (Table 2). Moderate ADL DLE and

Table 4. Characteristics of Disability Episodes for 65-Year-Olds: 1992, 1997, and 2002

Type of Episode	Measure	1992	1997	2002
Total Disabled Life Expectancy	% of cohort having at least one episode after age 65	92.4	92.4	93.1
	Average number of episodes per person with at least one episode	4.7	4.6	4.6
	Average length of episode (yrs.)	1.7	1.7	1.7
IADL Disabled Life Expectancy	% of cohort having at least one episode after age 65	74.6	74.5	74.7
	Average number of episodes per person with at least one episode	2.1	2.1	2.2
	Average length of episode (yrs.)	1.5	1.5	1.5
Moderate ADL Disabled Life Expectancy	% of cohort having at least one episode after age 65	79.7	79.8	80.8
	Average number of episodes per person with at least one episode	2.3	2.2	2.2
	Average length of episode (yrs.)	1.7	1.7	1.7
Severe ADL Disabled Life Expectancy	% of cohort having at least one episode after age 65	58.2	55.9	54.4
	Average number of episodes per person with at least one episode	1.5	1.5	1.4
	Average length of episode (yrs.)	2.3	2.2	2.1

Source: Microsimulation results from the Medicare Current Beneficiary Survey.

IADL DLE did not change significantly in any of the groups. For persons who are severely disabled at age 65, TLE rose by 0.4 years, total DLE fell by 0.4 years, and severe ADL DLE fell by 0.5 years. For this group, total and severe DLE as a percentage of TLE fell from 59.8% and 25.8%, respectively, in 1992 to 55.1% and 21.3% in 2002.

Estimates by Gender

As expected, women live longer but spend more years in disability than men (Table 2), continuing a pattern noted earlier (Manton 1988). From 1992 to 2002, men had more active years than women in every year. The difference was almost significant in 1992 (p value = .053) and became significant in 2002 (p value = .001). This is a new finding; past studies found longer ALE for women (although active years as a percentage of total years were less for women). This may reflect the greater gains in total life expectancy for men in the last decade. This finding should be confirmed by research with other surveys.

From 1992 to 2002, men experienced larger gains in TLE (0.8 years versus 0.3 years) and similar gains in ALE (0.9 year versus 0.7 years). For both men and women, gains in ALE are statistically significant. Total DLE for men remained steady, which is a reversal from the increase in the 1980s reported in Crimmins et al. (1997). IADL and moderate ADL DLE changed little for both men and women. Severe ADL DLE fell for both sexes; the decrease for women was twice as large as the decrease for men.

Estimates for 85-Year-Olds

In the 1980s, no change in TLE, ALE, or DLE was found for persons aged 85 (Crimmins et al. 1997). In contrast, we found that between 1992 and 2002, respondents of both sexes combined who were aged 85 and women aged 85 experienced statistically significant gains in ALE and reductions (both absolute and relative) in severe ADL DLE (Figure 1, Panels A and B). Men's increase in ALE was not significant, but their decrease in severe ADL DLE was significant. TLE rose by 0.1 years for 85-year-olds from 5.7 years in 1992 to 5.8 years in 2002, and ALE rose by 0.4 years. ALE as a percentage of TLE increased from 21.3% to 26.9% in the study period, and severe ADL DLE as a percentage of TLE decreased from 36.9% to 29.3%.

CONCLUSIONS

We found that all of the increase in TLE during the study period was accounted for by an increase in ALE. The DLE decrease was attributable to a decrease in severe ADL DLE; moderate ADL and IADL DLE did not change. The results of our study do not coincide completely with any of the three theories about the relation of increases in life expectancy to changes in ALE and DLE in the population aged 65 and older. Certainly, our findings do not support the theory of expansion of morbidity (disability) because both TLE and ALE increased while DLE decreased a little. This contradicts the idea that most of the increase in TLE would be in DLE.

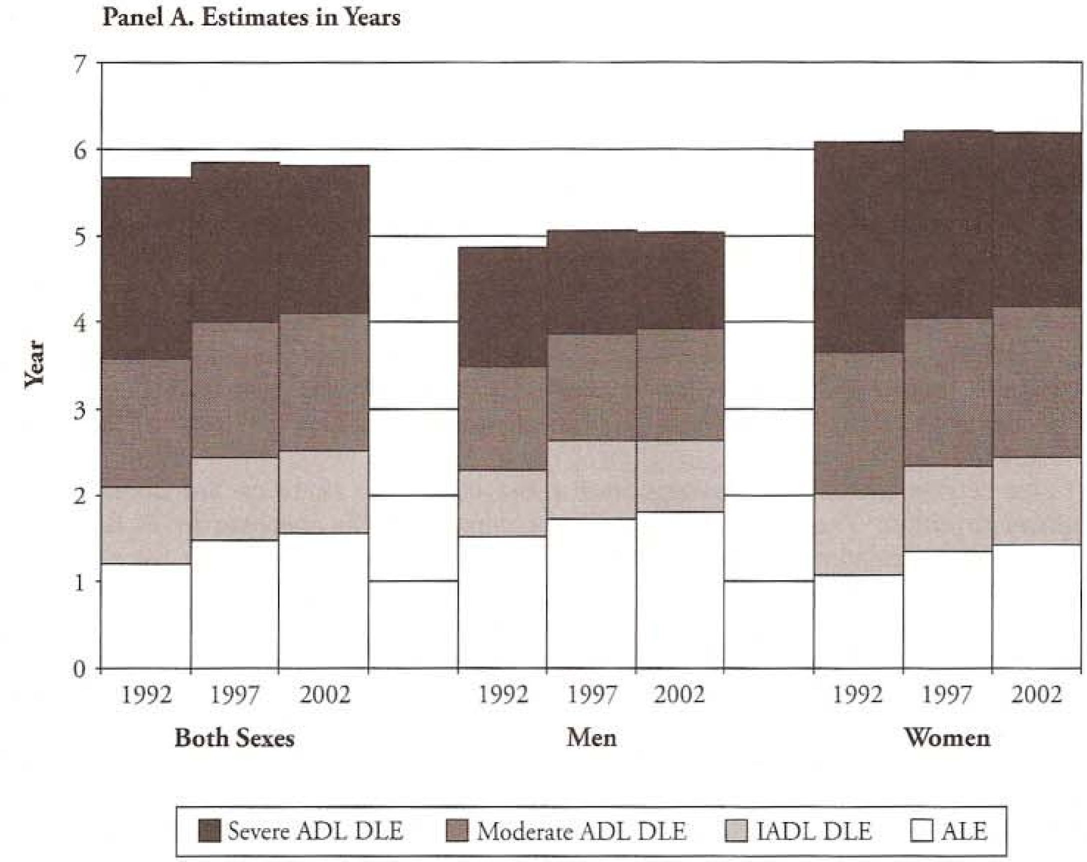
Our results provide some support for the other two theories but do not exactly conform to either. The increase in ALE, accompanying the increase in TLE, is in accord with both compression of morbidity and dynamic equilibrium. On the other hand, both theories predict an increase in the age at onset of disability, but we found little change in onset. The decrease in DLE is in accord with compression of morbidity; dynamic equilibrium would predict some increase in DLE as TLE increases. The increase in ALE as a percentage of TLE, albeit small, also accords with compression of morbidity. However, the increase in TLE accords more with dynamic equilibrium, given the uncertainty in the compression of morbidity theory about whether limits to life expectancy are being reached.

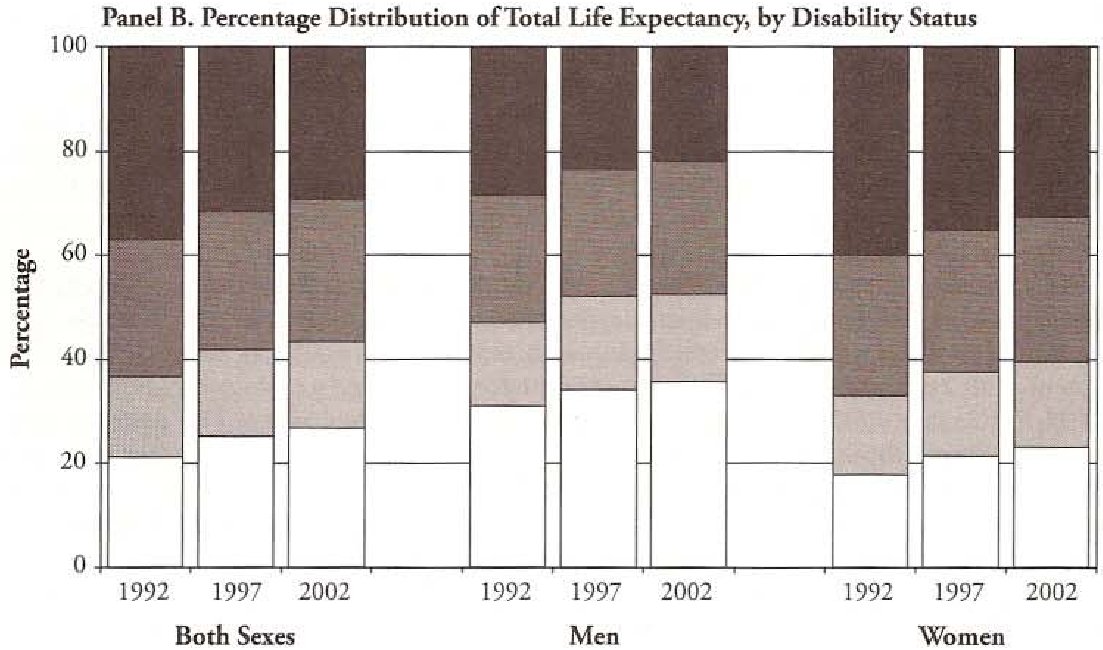
Our estimates of trends in age at onset, the percentage of persons with a disability episode, and recovery rates reveal the complexity of trends in disability. Both compression and expansion of morbidity focus on age at onset of illness and disability. Compression of morbidity predicted a delay in the onset of a person's final illness, with the preceding period characterized by generally good health, and little or no growth in life expectancy (Fries 2003). Expansion foresaw no increase in age at onset of illness but increases in life expectancy. We found only a small delay in onset. The idea that theories of aging need to be tested by ". . . an examination of cohort trends in the duration of time between age at onset of fatal and non-fatal diseases of aging and death" (Olshansky et al. 1991:209) may be too simple, given the interplay of trends in disability incidence and recovery and the overall increase in TLE that we found.

Separating disability states into IADL, moderate ADL, and severe ADL disability reveals additional complexity because these states have shown different trends. If we look only at severe disability (difficulty with three or more ADLs), the results are consistent with compression of morbidity (except for the theory's ambiguity about increases in TLE). Severe ADL DLE has fallen, and age at onset has risen. The delay in age at onset of severe disability may reflect better management of chronic diseases with fewer debilitating effects (Freedman and Martin 2000). For example, improvements in mobility among arthritis patients have been credited to joint-replacement surgery and the use of antirheumatic drugs (Ward and Fries 1998).

The improvement in survival and active life expectancy for 85-year-olds is encouraging because this group will experience the greatest relative growth of any age group in the coming decades. They are projected to make up a quarter of the elderly population in 2050 (U.S. Census Bureau 2004). Because this age group is the highest user of long-term care services, the improvement in ALE may temper the demand for such services.

Figure 1. Active and Disabled Life Expectancy (ALE and DLE) at Age 85, by Gender: 1992, 1997, and 2002





Source: Microsimulation results from Medicare Current Beneficiary Survey.

A limitation of our study is that cognitive ability is not addressed. A large part of remaining life expectancy for the elderly, especially the oldest-old, is in a cognitively impaired state (e.g., 26% at age 85; Suthers, Kim, and Crimmins 2003). Trends in cognitive functioning are unclear (Rodgers, Ofstedal, and Herzog 2003). Our optimistic picture of trends in ALE must be tempered because we could not measure cognitive functioning. Another limitation is that our estimates are period based, not cohort based. They do not reflect the experience of cohorts through time. Instead, they reflect simulated paths from age 65 or 85 for simulated individuals, based on health conditions observed from 1992 to 2003.

There are some reasons to believe that ALE will continue to increase. Proponents of the compression of morbidity theory believe that a favorable health-risk profile can compress morbidity. They cite studies that show that persons with good health habits not only live longer but have less disability in their final years (Hubert et al. 2002; Leveille et al. 1999; Vita et al. 1998). The risk profile of the U.S. population has been improving in many areas (e.g., reduced cholesterol levels and less smoking) but not in others (being obese, and recent hypertension trends; NCHS 2004).

Evidence of the benefits of medical advances, particularly for cardiovascular diseases, is accumulating. Cutler and McClellan (2001) estimated that over 40% of the recent improvement in mortality from cardiovascular diseases is attributable to treatment advances and that the remainder is from roughly equal parts of primary and secondary prevention. Evidence also exists of a broad, historic trend for improved health that reflects better nutrition, control of infectious diseases, and medical advances (Fogel and Costa 1997). Also, advances in specialized equipment and aids should help the elderly adapt to the demands of community and independent living. Another factor is the new Medicare drug benefit, which started in 2006 and is likely to enhance the health and functioning of the elderly by expanding access to treatment (Bierman and Bell 2004; Federman et al. 2001; Heisler et al. 2004).

On the other hand, concern exists that the obesity epidemic will slow or reverse the trends in reduced disability and mortality among the older population (Lakdawalla, Bhattacharya, and Goldman 2004; Olshansky 2005; Reynolds, Saito, and Crimmins 2005). Also, the magnitude of the favorable impact of higher education levels on the health of future elderly cohorts may be reduced as increases in educational levels of the elderly slow (Freedman and Martin 1999).

Some of the improvement in functional status may be due to improvements in the environment in which the elderly live and not to improvements in underlying health. The prevalence of housing modifications that help the elderly to get around better at home has increased (Newman 2003). Environmental improvements can enhance the ability of the elderly to function independently and make them less likely to report difficulties, even when their physical capacity has not changed (Spillman 2004).

The interactions of these and other factors will take time to play out. Our findings suggesting increases in ALE for the elderly must be tempered by our relatively short 11-year observation period. It is useful to recall that the pessimism in the 1970s and 1980s about future trends in disability among the elderly was also based on a short observation period (Brody and Brock 1986; Colvez and Blanchet 1981; Gruenberg 1977). This makes following ALE trends extremely important; fortunately, the MCBS offers an opportunity to track ALE year by year.

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