Compression of Disability for Older Americans, 1992-2002

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Introduction

Life expectancy for older Americans has risen substantially over the past five decades due in part to reductions in mortality from fatal diseases such as cardiovascular disease. For 65-year old Americans, total life expectancy (TLE) has increased nearly 30% from 14.1 years in 1950 to 17.9 years in 2000 (NCHS, 2004). Whether these gains are concentrated in years of life free of disability has been the focus of debate. Different views of population aging have been proposed in three competing hypothesis: compression of morbidity (Fries, 1980), expansion of morbidity (e.g., Gruenberg, 1977; Olshansky et al., 1991) and dynamic equilibrium (Manton, 1982).

Compression of morbidity holds an optimistic view of "healthy aging". It asserts that the onset of chronic, irreversible illness will be delayed so that the period of infirmity will be compressed into a shorter period of time before death (Fries, 1980; 1988). The opposite view, expansion of morbidity, holds that longer life is associated with prolonged period of morbidity and disability (e.g., Gruenberg, 1977; Olshansky et al. 1991). It states that the drop in old-age mortality either extends the life of those suffering from chronic diseases, or allows people to live to older ages where the risks of chronic diseases and frailty are higher. An intermediate scenario, dynamic equilibrium, predicts an increase of moderate or light morbidity and disability as medical advances delay the onset and reduce the incidence of chronic diseases and increase the survival and improve the health of the chronically ill (Manton, 1982).

Over the last three decades, studies have found that the prevalence of disability increased during the 1970s (Colvez and Blanchet, 1981), which is likely the result of increased disability incidence (Crimmins and Ingegneri, 1993). Starting in early 1980s and continuing into the 1990s, Instrumental Activities of Daily Living (IADL) disability have been decreasing (Freedman, Martin and Schoeni, 2002). Beginning in the middle of the 1990s, studies observed consistent declines in Activities of Daily Living (ADL) disability. There is also evidence that the rate of decline in chronic disability (both IADL and ADL) has accelerated in late 1990s (Manton and Gu, 2001).

But cross-sectional estimates of the prevalence of disability do not provide the measures to test which of the three scenarios of aging best characterizes recent experience (Guralnik, 2004; Nusselder, 2003). For this purpose, researchers have examined trends in active life expectancy (ALE) (e.g., Crimmins, Saito & Ingegneri, 1997; Crimmins and Saito, 2001; Doblhammer and Kytir, 2001; Davis, Mathers & Graham, 2002). ALE has been used widely as a composite measure of both the quality and quantity of life in studies of healthy aging. Studies have found that much of the gains in life expectancy in the 1970s were concentrated in moderate disability (Robine and Ritchie; 1991), with reductions in severe (i.e., bed-ridden) disability (Crimmins, Saito and Ingegneri, 1989). In the 1980s, ALE rose along with TLE, although as a *proportion* of TLE it changed little (Crimmins, Saito & Ingegneri, 1997), except among those of higher education status where the proportion increased (Crimmins and Saito, 2001). Overall, the experience of U.S. and other developed countries in 1980s supports the hypothesis of dynamic equilibrium (Robine, Romieu and Michel, 2003). Studies have attributed expansion of moderate and light disability to a weakened link between chronic diseases and disability (Robine, Mormiche and Sermet, 1998). In France and the

United States morbidity has increased while the level and severity of disability have decreased over time (Crimmins & Saito, 2000; Freedman & Martin, 2000).

What is the latest evidence in the U.S.? The present study will investigate trends in functional disability for older Americans in the 1990s (i.e., 65-year old and over). We will use the term "compression of disability", instead of "compression of morbidity", to clarify what we will measure. Morbidity typically refers to the presence of medically diagnosed diseases, although in discussions of the compression of morbidity hypothesis, it often refers to functional ability. By disability we mean difficulty in doing activities typical to one's daily life as a result of health or physical problems (Verbrugge and Jette, 1994). Although in many cases old-age disability is caused by chronic illness such as arthritis and heart disease, disability and morbidity often identify different subsets of the older population (Fried et al., 2004). With advances in early detection of chronic disease and its management, morbidity may also have less debilitating consequences (Mor & Perls, 2004).

Data

This study will focus on the 1992-2002 period using the Medicare Current Beneficiary Survey (MCBS). The MCBS 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, socio-demographic information, and use and costs of medical services. Survey records are linked to administrative data on use and expenditures of Medicare-covered services (hospital, physician, etc.) and on vital status.

The MCBS follows a rotating panel design with three in-person interviews per year. Health status information is gathered once each year in the Fall. For the six ADLs (bathing, dressing, eating, transferring, walking, and using the toilet) and six IADLs (using the telephone, doing light and heavy housework, preparing meals, shopping and managing money),[1] the questions ask “Do you have any difficulty (e.g. dressing) because of a health or physical problem” and the respondents can answer “Yes”, “No” or “Doesn’t do”. If the answer is “Yes” or “Doesn’t do”, then the interviewer asks, for the IADLs, “Do you *receive* help from another person?”, or, in the case of ADLs, “Do you *receive* help from another person” and “Do you *use* special equipment or aids to help”. Some studies have defined disability based on the need for help (e.g., Guralnik et al, 1993), which may indicate a more severe level of disability and is more closely related to their demand for informal and formal care. While the terms “receive” and “use” imply the need for care, they may exclude those who are truly in need but cannot afford or find help. For this reason, we will define disability based on one’s difficulty or inability to perform any of the IADLs and ADLs. This definition more closely tracks the changes in intrinsic levels of functional limitation of the elderly. We will, however, present estimates based on the receipt of help as a comparison to those based on difficulty.disability.

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

Based on a person's level of disability, we constructed three mutually exclusive disability states:

- 1: Active health (no IADL or ADL disability)
- 2: Moderate disability (disabled in at least one IADL, or in less than three ADLs)
- 3: Severe disability (disabled in at least three ADLs)

For life table modeling, a fourth state, death, is used as the absorbing state. The classification of disability into moderate and severe form is motivated by research which has shown that trends in ALE have evolved differently depending on the severity of disability (Robine, Romieu and Michel, 2003).

The original design of the MCBS planned to track sampled beneficiaries indefinitely. Under the revised design, implemented in 1994, sample persons who neither drop out of the survey nor die will have four Fall interviews from which information on health status is gathered. In order to maintain consistency throughout the 1992-2002 period, the number of observations per person is limited to four in the analysis sample. We excluded 9,279 respondents who have only one observation or have missed interview(s) between two observations. This includes the 4,140 respondents who entered the survey in 2002 because they do not have follow-up observations for analyzing transitions. The final analysis sample consists of 40,320 beneficiaries age 65 and over, with 131,141 person-years of observations and 90,821 pairs of observations.

Methods

The longitudinal design of MCBS enables us to fit a multi-state life table (MSLT) model to the data (Schoen, 1987). The MSLT model uses longitudinal person-level data on changes in disability status to develop estimates of first-order Markov transition probabilities. Since it allows both disability onset and recovery, it is considered superior to the Sullivan method (Sullivan, 1971), and has been used in many ALE-related studies where data on transitions are available (e.g., Rogers, Rogers and Branch 1989; Guralnik et al. 1993; Land, Guralnik and Blazer 1994).

A discrete-time MSLT model is estimated in this study using a multinomial logistic regression because of the imprecise measurement of event time in MCBS. Interviews are scheduled at discrete time intervals so that events are only known to have occurred between follow-ups, rather than 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 grouped the pairs into 10-year groups (1992-93, 93-94, 94-95..., 2000-2001), according to the year in which the pair begins. The response variable is the functional state at the end of each pair and the covariates include age at the beginning of each pair and the corresponding year group. The regression is estimated separately for each functional state at the beginning of observation pair and by gender.

In this analysis year is treated as a continuous variable to smooth the trend estimates. An alternative approach, which allows more year-to-year variations, is to use dummy variables for each year. Figure 1 shows the estimates of TLE and DLE (moderate and severe) for average 65-year olds from two different regressions: one treating year as a continuous variable and the other as a set of dummy variables. As expected, the second approach yields greater variations in TLE estimates. However, the difference between 1992 and 2001 are almost identical (0.6 years vs. 0.5 years). The DLE estimates are more similar, especially severe DLE. For a trend analysis like ours, we therefore, treat year as continuous variable.

[Figure 1 about here]

After age-specific transition probabilities are estimated, we simulate a cohort of 100,000 65-year olds for each year group and record their complete trajectories of changes in disability status until death. The starting distribution of disability at 65 for each cohort is the same as that observed from the MCBS. All results presented in this analysis are based on the simulated data. Simulation 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 to compare with the transition probabilities that correspond to the simulated person’s current age and disability status in order to determine disability status at next age.

Two measures of compression of disability are evaluated in this study: disabled life expectancy (DLE) and age at initial disability onset. DLE – total years of life spent in disability 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 has increased; relative expansion occurs if the ratio of DLE to TLE has increased and vice versa for compression. With disability classified by levels of severity, the hypothesis of dynamic equilibrium amounts to a decrease in the ratio of severe DLE to TLE and an increase in the ratio of moderate DLE to TLE (Manton, 1982).

Age at onset is the primary indicator of morbidity compression in Fries' work. Had we assumed no recovery from disability and fixed longevity, onset delays would obviously be equivalent to falls in DLE. Since life expectancy has been rising and there is in fact substantial recovery among the elderly (Manton, 1988), we expect the estimates of age at initial disability onset will be different from estimates of DLE, and the combination of both estimates will yield useful insights into the disability transition process. The use of simulation enables onset age to be estimated. We simply record the age at initial onset of moderate or severe disability for each simulated person who experiences such an episode, and then average them for each subgroup of the older population.

Results

Estimates for all at 65

Table 1 shows unweighted estimates of selected socio-demographic characteristics of the 1992 and 2002 sample. The 2002 sample is older, and better educated. Fewer of them suffer disability, but more have some chronic conditions.

[Table 1 about here]

Table 2 presents trends in DLE and in the age of disability onset. For all 65-year olds, TLE has increased 0.6 years from 16.7 years in 1992 to 17.3 years in 2001. Meanwhile, there has been little change in total DLE, due to opposite trends in moderate DLE (a 0.3 years increase), and in severe DLE (a 0.3 years decrease). As a result, almost all of the gains in TLE between 1992 and 2001 are concentrated in ALE. As a proportion of TLE, total and severe DLE have fallen from 42.5% and 12.6% in 1992 to 40.5% and 10.4% in 2001.

[Table 2 about here]

Age at initial onset of moderate disability remained relatively stable. Onset of severe disability has been postponed by 0.3 years. If we assumed no recovery from disability, these results would imply that almost all the gains in TLE accrue to moderate disability and time spent in severe disability would increase from 4.6 to 4.9 years between 1992 and 2001. In fact, moderate DLE rose slightly and severe DLE fell from 2.1 to 1.8 years. This different conclusion highlights the importance of incorporating recovery into evaluations of the changes in the disability burden.

Estimates of DLE can be thought of as the product of three components: the percent of population that have one or more disability episode after age 65, average number of episodes and the average length of an episode for those with an episode. Table 3 presents an example of such decomposition for the 100,000 65-year olds. For total DLE, there are notable increases in incidence between 1992 and 2001, while the average number and duration of a typical episode has remained relatively constant. In the case of moderate disability, the probability of having at least one episode has increased while the average number of episodes has remained steady. But the average duration of an episode of moderate disability has declined, reflecting the improved odds of recovery. For severe disability, not only the average duration of an episode but also the incidence has declined. These findings suggest that the expansion of moderate DLE is due in part to stable age of onset and more frequent, but shorter, episodes of moderate disability. The fall in severe DLE, on the other hand, is due to delayed onset, reduced incidence and increased odds of recovery.

Between 1992 and 2001, more 65-year olds recovered from an episode of disability and recovery took place sooner. For those who are moderately disabled, 57.5% recovered and 46.3% of them recovered within a year in 2001; while in 1992 53.7% recovered and 45.1% of them did so within a year. The probability of recovery from severe disability is approximately the same in 1992 and 2001; but for those who recovered, it occurred sooner: in 2001, 47.4% of those recovered did so within a year, as compared to 43.3% in 1992.

[Figures 2A and 2B here]

Estimates by disability status and gender at 65

Improvement was not evenly distributed among subgroups defined by disability status at age 65 (Table 2). Gains in TLE and reductions in severe DLE between 1992 and 2001 were greater among those severely disabled at 65. For persons in active health at 65, severe DLE fell 0.3 years, while TLE rose 0.6 years. The proportion of total and severe DLE for this subgroup fell from 39.8% and 11.7% in 1992 to 37.9% and 9.6% in 2001. For those severely disabled at 65 severe DLE has fallen 0.5 years, while

TLE has risen 0.8 years. The proportion of total and severe DLE fell from 58.7% and 24.6% in 1992 to 54.1% and 19.9% in 2001.

Age at initial onset of moderate disability has changed little for those in either active health or moderate disability at 65; while onset of severe disability has shown substantial delay. For those in active health at 65, the initial onset of severe disability is postponed by more than the gains in TLE (0.8 years vs. 0.6 years). For those in moderate disability at 65, the postponement of severe disability onset is more substantial. The delay is 1.2 years, much larger than the gains in TLE (0.7 years).

The results by gender vary both in absolute and in relative terms. As expected, women live longer and spend more years in disability. From 1992 to 2001, men experienced larger gains in TLE than women (0.7 vs. 0.4 years) continuing a pattern that began in the 1980s. Men’s total DLE fell 0.2 years, however, indicating a reversal from the increase in the 1980s reported in Crimmins, Saito and Ingegneri (1997).

Changes in moderate and severe DLE by gender mirror the pattern for the overall population. Moderate DLE has remained steady or increased slightly, while severe DLE has fallen and its reduction increase with the severity level of disability status at 65. Furthermore, men seem to experience greater improvement in severe DLE, in both absolute and relative terms, than women of comparable disability status at 65. Severe DLE fell by 0.4 years or 27% for moderately-disabled men, compared to 0.3 years or 11% for moderately-disabled women. For those severely disabled men at 65, severe DLE fell 0.5 years or 19%, compared to a 0.3 years or 8% reduction for severed disabled women.

In contrast to the 1980s where no change in TLE or DLE was found for the oldest-old, we found that between 1992 and 2001 persons 85 years of age experienced both gains in TLE and reductions (both absolute and relative) in severe DLE (Figures 3A and 3B). TLE has risen 0.4 years (6%) for 85-year olds from 5.6 years in 1992 to 6.0 years in 2001. Most of the increase in TLE was concentrated in ALE, which rose from 1.2 to 1.6 years. Reductions in DLE are concentrated in severe disability, which fell from 2.2 to 1.8 years. Moderate DLE rose from 2.2 to 2.5 years. ALE as a percent of TLE increased 21 to 27 percent in the study period. Women 85 years of age live longer than men, but men spend a larger proportion of their lives in active health—the same pattern noted for 65 year old women and men.

[Figure 3A and 3B about here]

When disability is defined on the basis of receiving help or using equipment to carry out an ADL, instead of just having difficulty with the activity, the pattern of the estimates was similar, but the level of the estimates was naturally lower, since many people reporting difficulty do not need or receive help (Figure 3). ALE has increased from 10.8 years in 1992 to 11.4 years in 2001 for 65 years olds. Severe DLE has declined from 1.7 years to 1.4 years over the same period. Total and severe DLE as a proportion of TLE have fallen from 12.4% and 10.1% in 1992 to 10.3% and 8.4% in 2001.

[Figure 4 about here]

Conclusions

Our study, covering the years 1992-2002 supports the hypothesis of dynamic equilibrium; moderate DLE has increased slightly, while severe DLE has decreased both absolutely and proportionally. As described by Manton (1982) the emergence of dynamic equilibrium results from medical advances which extend life and at the same time reduce the morbid effects of chronic illnesses. Treatment may prevent or delay severe disability in persons who are moderately disabled and who might have progressed quickly to severe disability a few decades ago.

Nearly all of the gains in total life expectancy were concentrated in active life, a continuation of the trends in 1980s (Crimmins, Saito and Ingegneri, 1997). The degree of improvement varied by sex and health status at 65. Men experienced greater improvement than women; ALE increased more, both absolutely and relatively for those severely disabled at age 65 than for persons who were moderately disabled or in active health at 65.

Our estimates of trends in age at onset, the percent of persons with a disability episode, and recovery rates reveal how complex the question of compression of disability is. Fries hypothesis was straightforward – a trend for delay in the onset of a person's final illness, with the preceding period characterized by generally good health (Fries, 2003). In fact, we have not produced estimate of the time of onset of the final illness. Such estimates are probably only available from studies that closely follow cohorts until death, and even then, identifying the onset of the final illness would be complicated by issues of comorbidity and sub-clinical illness. But if we define compression more loosely as a reduction in the time spend in a disabled state in the period from age 65 until death, we find that delay of onset is only one factor behind the decrease in disabled years after age 65. Age at onset of overall disability (moderate or severe) actually fell a bit.

Separating disability states into moderate and severe reveals additional complexity, because moderate and severe disability have shown opposite trends. The percent of the population 65 and over with an episode of moderate disability has increased, while there has been little change in other measures of moderate disability, such as age at onset. On the other hand decreases in the percent of the 65 and over population with an episode of severe disability, combined with a trend for delay in age at onset of severe disability and a decrease in the length of severe disability episodes are behind the fall in severe DLE.

The improvement in survival and active life expectancy for 85 year olds is encouraging because this age group will experience the greatest relative growth of any age group in the coming decades, with the oldest old project to make up a quarter of the elderly in 2050 (U.S. Census Bureau, 2004). Life expectancy for 85 year olds has also increased, though there is controversy about whether this increase will continue into the future (Olshansky, Carnes, Desquelles, 2001; Lee, 2001; Vaupel, 1997). An earlier study of trends for the 85 and over from 1970 to 1990 found little change in active or disabled life expectancy for community dwellers and in increase in expected years in an institution using the NHIS (Crimmins, Saito and Ingegneri, 1997). Because this age group is the highest user of expensive long term care services the improvement in ALE may somewhat temper the demand for such services if it continues.

We noted a trend for an increase in the odds of becoming moderately disabled and a decrease in the odds of becoming severely disabled. Regarding recovery, we found improved chances of recovery from disability, particularly moderate disability. Past studies on trends in incidence and recovery have yielded mixed findings. A study that examined data from 1982-1993 using the Longitudinal Study of Aging and found improved chances of moving from a disabled to a non-disabled state and decreased odds of moving from a non disabled to disabled state and speculated that if these trends continued, there would be an drop in the prevalence of disability (Crimmins, Saito and Reynolds, 1997) Crimmins et al. compared their results with those of Manton, Corder and Stallard (1993) who used the NLTCS for 1982, 84 and 89 and state that Manton et al. found a decline in the odds of becoming disabled, but, contrary to their findings also found a decrease in the odds of recovery from disability.

However, for those who are already disabled (IADLs only, 1-2 ADLs, 3-4 ADLs or 5-6 ADLs) at baseline, the probability of becoming worse off has significantly increased in the later 1980s (1984-1989). This is consistent with the hypothesis in Wolf (2004) where he found both lower incidence and recovery rates between 1982 and 1994. Given the categories of disability used in our study, a direct comparison of our results with these past studies is not possible.

Much remains to be known about the causes of these changes in incidence and recovery. There is a question of the extent to which improved recovery from moderate disability really reflects better health. Spillman (2004) noted that decreases in the prevalence of individual IADL limitations (e.g., grocery shopping and managing money) are associated with the greater availability of services and accommodations and wondered whether the reported declines in IADL limitations represent real improvement in health.

The decline in severe DLE is a key component in the dynamic equilibrium hypothesis (Manton, 1982). Our findings attribute it to substantial delays in age of onset, among other factors, which may be due to better management of chronic diseases (Freedman and Martin, 2000). Progress in disease management and treatment has also been found to lead to fewer debilitating effects of chronic illness. For example, arthritis patients have increased the use of joint replacements surgery and disease-modifying antirheumatic drugs. These treatments have been credited for the improvement in mobility limitations (Ward and Fries, 1998).

Our study takes advantage of microsimulation to produce a variety of estimates on trends in functional status, including information on the number and length of spells, estimated previously from microsimulation by Laditka and Wolfe (1998) from the first Longitudinal Study of Aging (1984-90). Microsimulation yields a year by year record of functional status between a specified age and death for simulated individuals, enabling estimates of the timing of events past age 65 and of the distribution of years in good and ill health across the simulated population.

The MSLT model likely underestimates the amount of disability transitions because some short episodes between follow-up interviews are missed (Laditka and

Wolf, 1998). We do not know if the downward bias also affects estimates of *trends* in DLE in this analysis. In addition, an important aspect of trends in functioning of the elderly not addressed in our study is cognitive ability. A large proportion of remaining life expectancy for the elderly, especially the oldest old, is in a cognitively impaired state (e.g. 26 percent at age 85) (Suthers, Kim and Crimmins, 2003). Trends in cognitive functioning are not clear (Rodgers, Ofstedal, Herzog, 2003). Our optimistic picture of trends in functional, therefore, must be tempered by the fact that we could not measure trends in cognitive functioning. As surveys collect better data on cognitive functioning it will be important to add this dimension to estimates of active life expectancy.

Proponents of the compression of morbidity hypothesis believe that a favorable health risk profile can compress morbidity. They cite studies that show that persons with good health habits (proper weight, exercise, no smoking) not only live longer, but have less disability in their final years than others (Vita, Terry, Hubert and Fries, 1998; Hubert, Bloch, Oehlert and Fries, 2002; Leveille, Guralnik, Ferrucci and Langlois, 1999). The risk profile of the U.S. population has been improving in many (e.g. cholesterol levels, smoking), but not all (overweight, recent hypertension trends) areas (Health US 2002, 2004). In addition, evidence of the benefits of medical advances, particularly for cardiovascular diseases is accumulating. It has been estimated that over 40 percent of the recent improvement in mortality from cardiovascular diseases is due to treatment advances and the remainder due in roughly equal parts to primary and secondary prevention (Cutler and McClellan, 2001). The importance of curative medicine in reducing mortality and morbidity for a broad range of diseases as been documented (Bunker, Frazier, Hosteller, 1994). Certainly many new treatments for cardiovascular disease, the leading causes of death, such as coronary revascularization have been shown in clinical studies to reduce symptoms and improve functioning. The rate of revascularization procedures has more than doubled for persons 65 and over in just the last decade. Additionally, prompt treatment of heart attacks and of strokes can now improve outcomes. In the treatment of arthritis, the most common chronic condition reported by the elderly, there has also been a large increase (nearly 3-fold in the last two decades) in knee and hip replacements for arthritic joints among the elderly, as well as the introduction of new medicines to treat arthritis pain. Advances in specialized equipment and aids will continue to help the elderly adapt to the demands of community and independent living. In fact, some advances, like the great improvement in cataract surgery techniques over the last four decades are taken for granted and we forget how disabling cataracts were two generations ago. There is evidence of a broad, historic trend for improved health that reflects better nutrition, control of infectious diseases and medical advances (Fogel and Costa, 1977). Another factor is the new Medicare drug benefit starting in 2006 which is likely to enhance the health and functioning of the elderly by expanding access to treatment. (Beirman and Bell, 2004, Heisler et al, 2004; Federman et al, 2001).

On the other hand, there are indications that recent improvements may be undermined. Concerns include higher disability associated with the obesity epidemic in today's younger population (Lakdawalla, Bhattacharya and Goldman, 2004) and the reduced magnitude of the impact of higher education levels in future elderly cohorts (Freedman and Martin, 1999).

The interactions of these and other factors will take time to play out. Our finding 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 1979s and 80s about future trends in disability, a pessimism based on an even shorter observation period than our study. (Gruenberg, 1977; Brody and Brock, 1986). This makes following ALE trends extremely important; fortunately the MCBS offers an opportunity to track ALE year by year.

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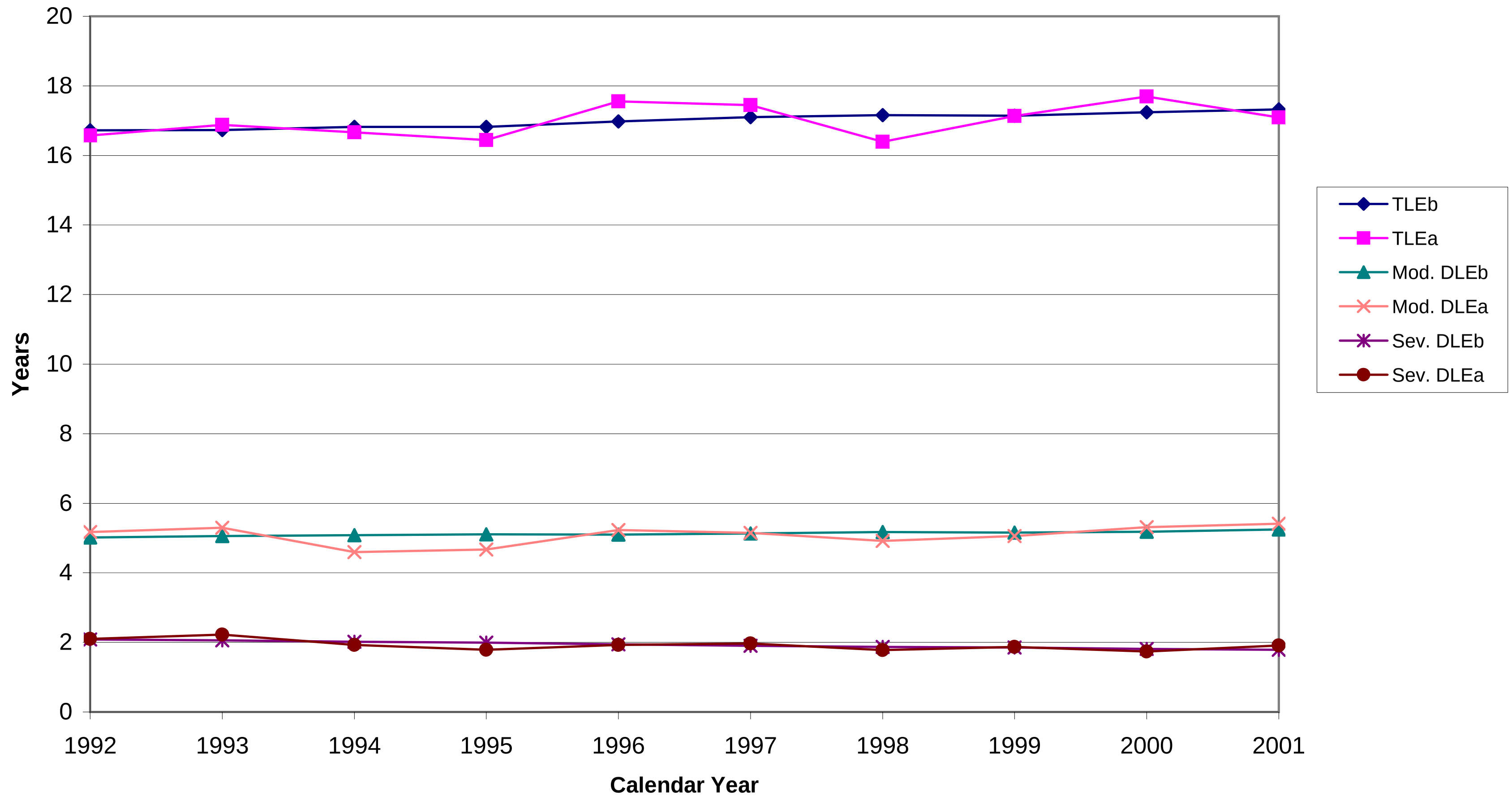
Table 1 Comparison of selected characteristics in 1992 and 2002

	1992	2002
Sample size	**9,258**	**9,114**
	(percent of sample)	
Sex		
Male	39.2%	41.2%
Race		
White non-Hispanic	84.3%	81.0%
Black non-Hispanic	9.1%	8.5%
Hispanic	5.0%	7.0%
Avg. age	76.8	77.9
Education		
0-11 years	46.3%	33.4%
High School	29.2%	28.8%
College or higher	24.6%	37.8%
Have 1+ chronic conditions	85.3%	91.8%
Disability status		
Active health	48.1%	51.9%
Moderately disabled	28.2%	27.6%
Severely disabled	23.7%	20.6%

Notes:
1. Disability is defined as having difficulty or inability to perform any of the six IADLs or six ADLs. Active health is free of IADL or ADL disability. Moderate disability is disability with 1+ IADLs or 1~2 ADLs. Severe disability is disability with 3~6 ADLs.
2. Chronic conditions include hypertension, heart disease, stroke, cancer, diabetes, arthritis, mental disorder, osteoporosis and pulmonary disease.

Figure 1 Comparison of TLE and DLE (moderate and severe) estimates at age 65 from two approaches: a-year as dummy var., b-year as continuous var.



Notes: TLE is total number of years expected to live at age 65. Moderate DLE is expected years spent in moderate disability (i.e., disability with 1+ IADLs or 1~2 ADLs) between age 65 and death. Severe DLE is expected years spent in severe disability (i.e., disability with 3~6 ADLs) between age 65 and death.

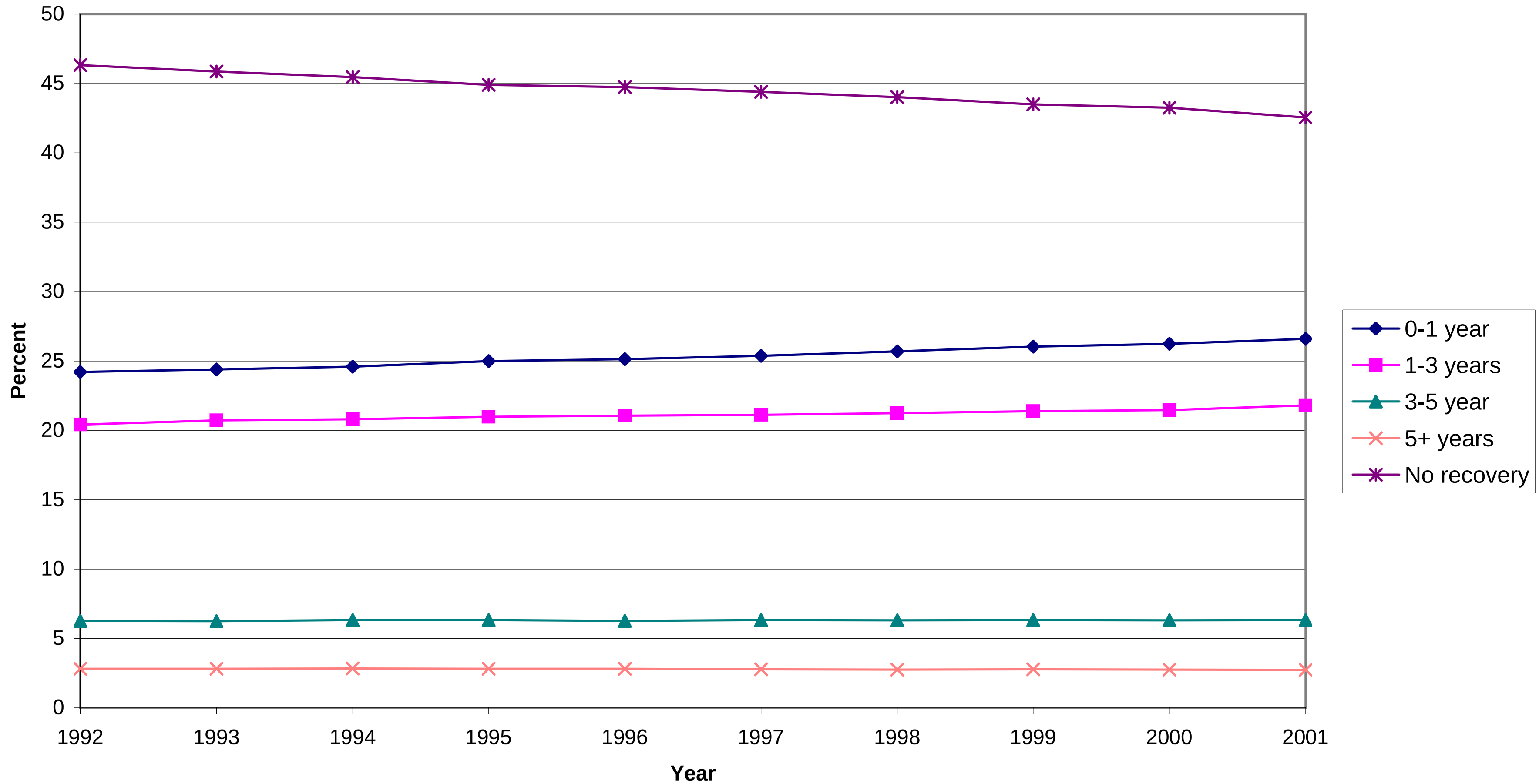
Table 2 Trends in indicators of compression of disability for the 65-year old in the U.S., 1992-2002

Baseline Condition	Measure	Both Sexes 1992	Both Sexes 1995	Both Sexes 1998	Both Sexes 2001	Male 1992	Male 1995	Male 1998	Male 2001	Female 1992	Female 1995	Female 1998	Female 2001
All	TLE	16.7	16.8	17.2	17.3	14.9	15.1	15.5	15.6	18.3	18.4	18.6	18.7
	ALE	9.6	9.7	10.1	10.3	9.8	10.0	10.6	10.7	9.4	9.5	9.8	9.9
	DLE												
	Total	7.1	7.1	7.0	7.0	5.1	5.1	5.0	4.9	8.8	8.9	8.8	8.9
	Moderate	5.0	5.1	5.2	5.3	3.7	3.8	3.8	3.8	6.2	6.3	6.3	6.5
	% having an episode	*88.5*	*89.2*	*89.7*	*90.5*	*82.7*	*83.9*	*84.4*	*85.8*	*92.8*	*92.8*	*93.3*	*93.6*
	# of episodes	*2.5*	*2.5*	*2.5*	*2.6*	*2.2*	*2.3*	*2.3*	*2.3*	*2.7*	*2.7*	*2.8*	*2.9*
	avg. duration	*2.3*	*2.3*	*2.3*	*2.2*	*2.0*	*2.0*	*2.0*	*1.9*	*2.5*	*2.5*	*2.4*	*2.4*
	Severe	2.1	2.0	1.9	1.8	1.4	1.3	1.2	1.1	2.6	2.6	2.5	2.4
	% having an episode	*58.5*	*58.9*	*57.2*	*56.9*	*48.3*	*48.4*	*45.4*	*44.6*	*66.3*	*66.9*	*66.1*	*66.1*
	# of episodes	*1.5*	*1.5*	*1.5*	*1.5*	*1.3*	*1.3*	*1.3*	*1.3*	*1.6*	*1.6*	*1.6*	*1.6*
	avg. duration	*2.3*	*2.2*	*2.1*	*2.1*	*2.0*	*1.9*	*1.8*	*1.7*	*2.4*	*2.3*	*2.3*	*2.2*
	Age at disability onset												
	All	69.9	69.6	70.0	69.7	70.4	70.2	70.8	70.5	69.4	69.1	69.3	69.1
	Moderate	70.1	69.9	70.2	70.0	70.7	70.5	71.0	70.8	69.7	69.5	69.6	69.4
	Severe	77.1	76.7	77.5	77.4	76.8	76.5	77.5	77.1	77.0	76.7	77.4	77.3
Active	TLE	17.1	17.3	17.5	17.7	15.3	15.6	15.9	16.1	18.6	18.8	18.9	19.1
	ALE	10.3	10.5	10.8	11.0	10.4	10.7	11.1	11.4	10.1	10.3	10.5	10.7
	DLE												
	Total	6.8	6.8	6.8	6.7	4.9	4.8	4.8	4.7	8.4	8.5	8.4	8.5
	Moderate	4.8	4.9	5.0	5.1	3.6	3.6	3.7	3.7	5.9	6.1	6.1	6.2
	Severe	2.0	1.9	1.8	1.7	1.3	1.2	1.1	1.0	2.5	2.4	2.3	2.2
	Age at disability onset												
	All	71.5	71.6	71.6	71.6	71.9	72.1	72.2	72.3	71.1	71.1	71.1	71.0
	Moderate	71.6	71.6	71.6	71.7	72.0	72.1	72.2	72.3	71.2	71.2	71.1	71.1
	Severe	79.1	79.3	79.6	79.9	78.6	79.0	79.2	79.5	79.0	79.3	79.7	79.9
Moderately Disabled	TLE	16.2	16.4	16.6	16.9	14.0	14.3	14.6	14.8	17.9	18.0	18.3	18.5
	ALE	8.1	8.4	8.6	9.0	8.0	8.4	8.7	9.2	8.0	8.3	8.5	8.7
	DLE												
	Total	8.1	8.0	8.0	7.9	6.0	5.9	5.8	5.7	9.9	9.7	9.7	9.8
	Moderate	6.0	6.0	6.1	6.1	4.6	4.6	4.6	4.6	7.2	7.2	7.3	7.4
	Severe	2.1	2.0	1.9	1.8	1.5	1.3	1.2	1.1	2.7	2.5	2.5	2.4
	Age at disability onset												
	All	*NA*				*NA*				*NA*			
	Moderate	*NA*				*NA*				*NA*			
	Severe	76.6	76.9	77.3	77.8	75.9	76.4	76.8	77.1	77.0	77.2	77.6	78.0
Severely Disabled	TLE	13.8	14.0	14.4	14.6	10.8	11.4	11.7	11.8	16.2	16.2	16.3	16.5
	ALE	5.7	6.0	6.4	6.7	5.2	5.6	6.2	6.5	6.1	6.2	6.4	6.7
	DLE												
	Total	8.1	7.9	8.0	7.9	5.6	5.8	5.5	5.3	10.1	10.0	9.9	9.8
	Moderate	4.7	4.8	4.9	5.0	3.1	3.3	3.3	3.2	6.2	6.2	6.2	6.2
	Severe	3.4	3.2	3.1	2.9	2.6	2.5	2.2	2.1	3.9	3.8	3.7	3.6

Note: Moderate disability is defined as having difficulty with or being unable to perform for health reasons at least one IADL or 1~2 ADLs. Severe disability is defined as having difficulty with or being unable to perform for health reasons at least three ADLs. For 65-year olds, TLE is defined as the estimated number of years remaing before death. It is the sum of ALE, the estimated time spent in active health, and DLE, the estimated time spent in disability.

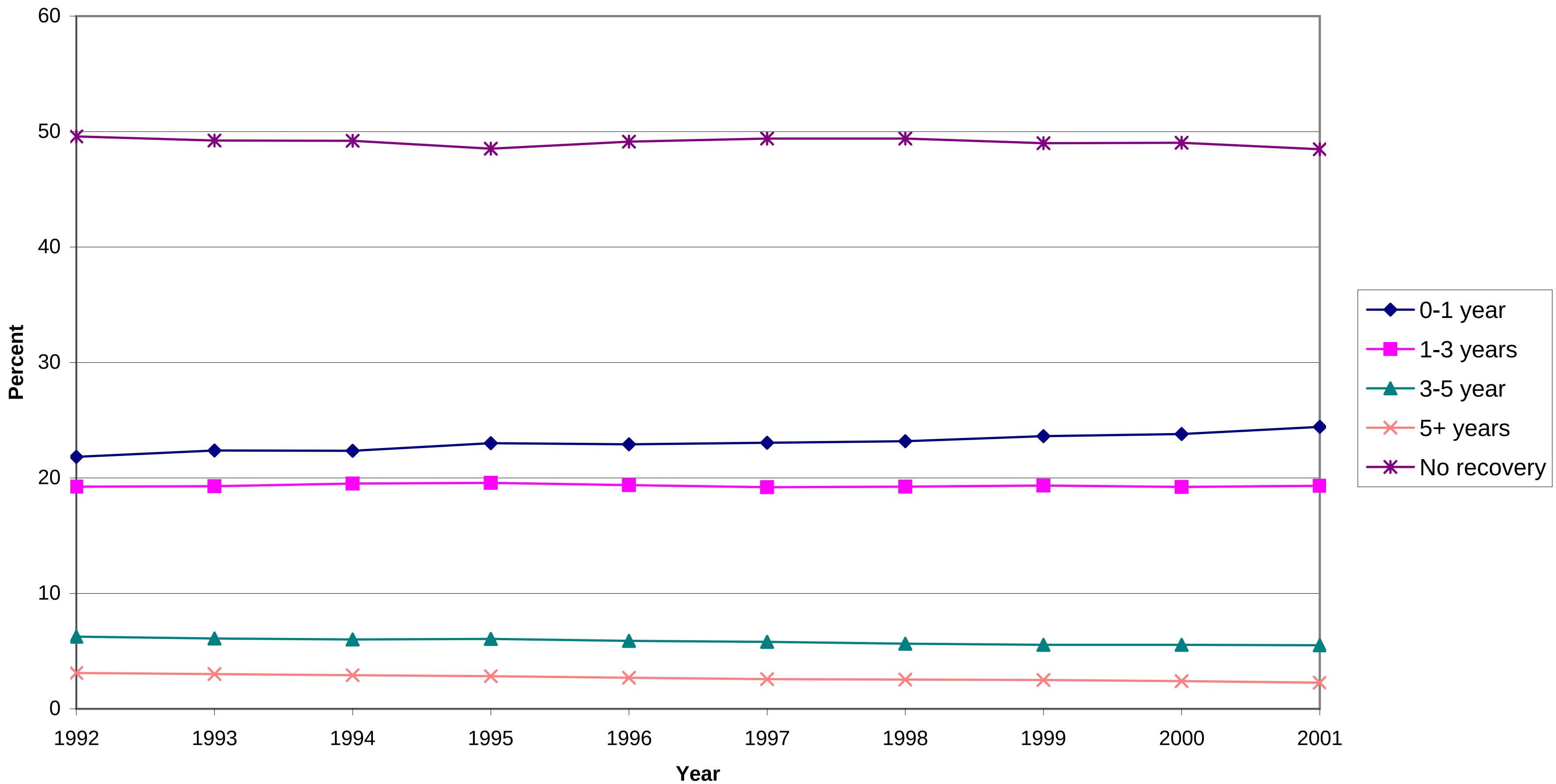
Sources: Medicare Current Beneficiary Survey (1992-2002)

Figure 2A Trends in probability of recovery from moderate disability for 65-year old Americans of average health, both sexes combined



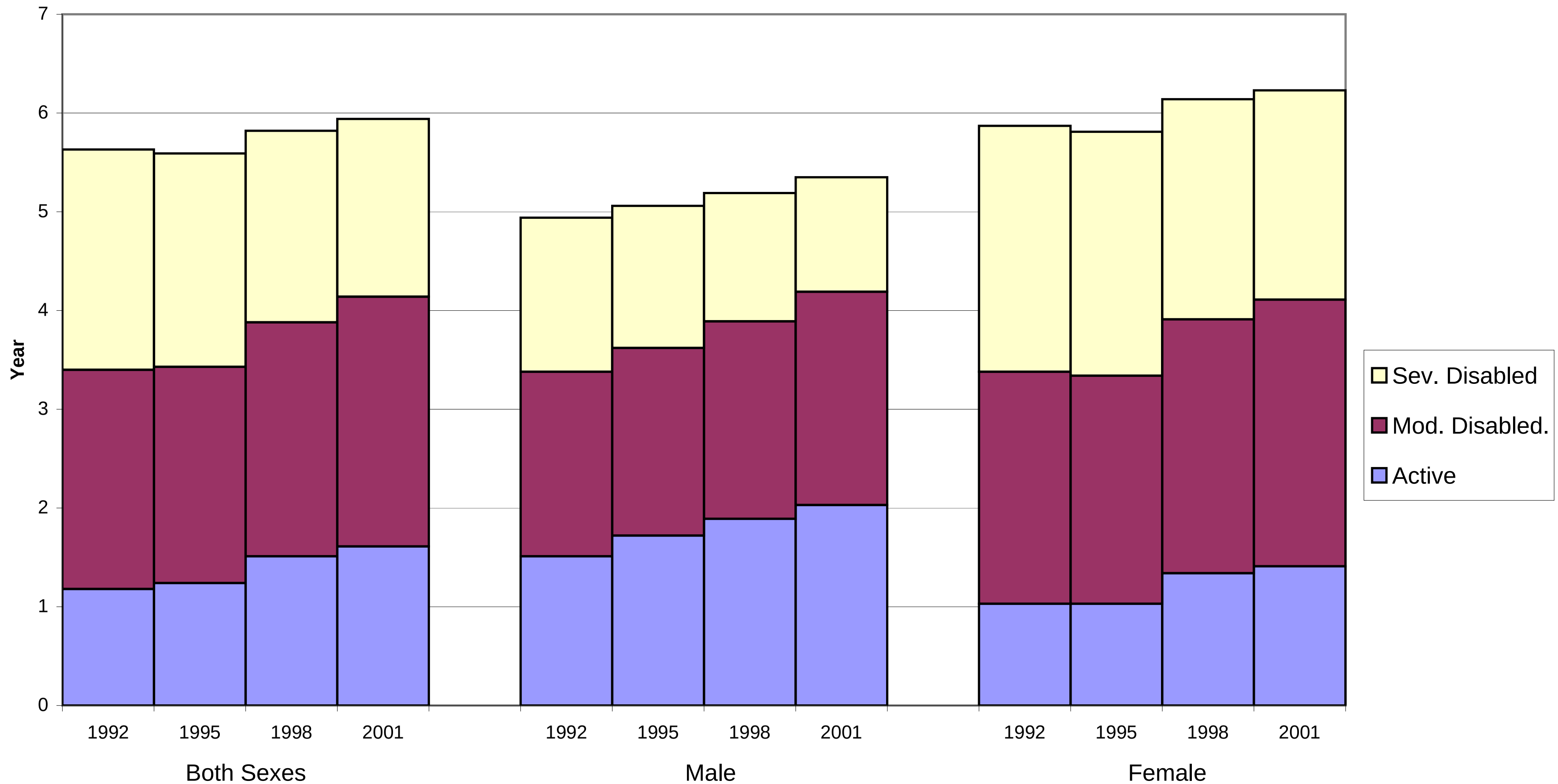
Notes: Moderate disability is defined as having difficulty or being unable to perform at least one IADL or 1~2 ADLs. Recovery is defined as transitioning into active health (i.e., free of IADL or ADL limitations).

Figure 2B Trends in probability of recovery from severe disability for 65-year old Americans of average health, both sexes combined



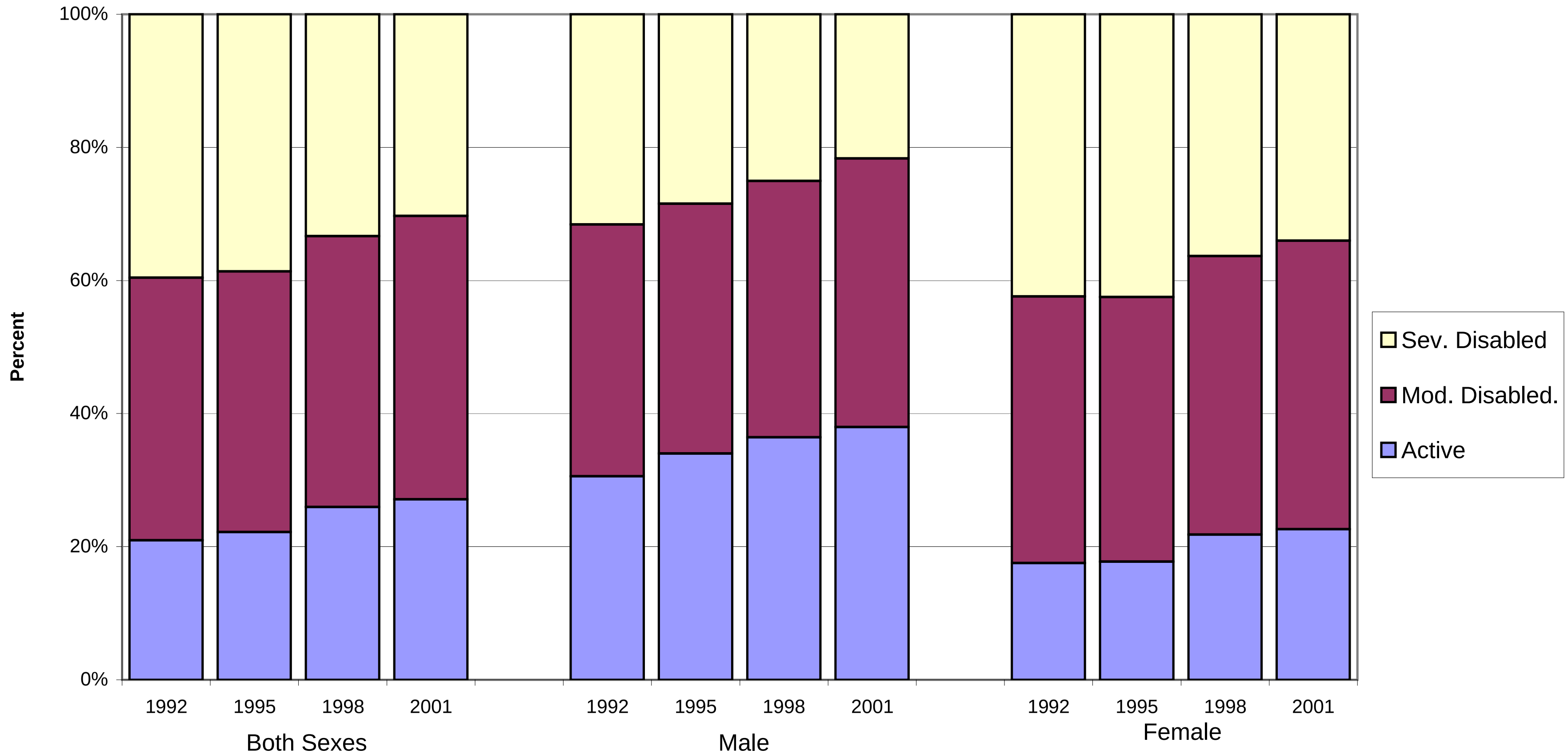
Notes: Severe disability is defined as having difficulty or being unable to perform at least three ADLs. Recovery is defined as transitioning into active health (i.e., free of IADL or ADL limitations), or moderate disability.

Figure 3A Trend in LE estimates (absolute) for 85-year old Americans of average health



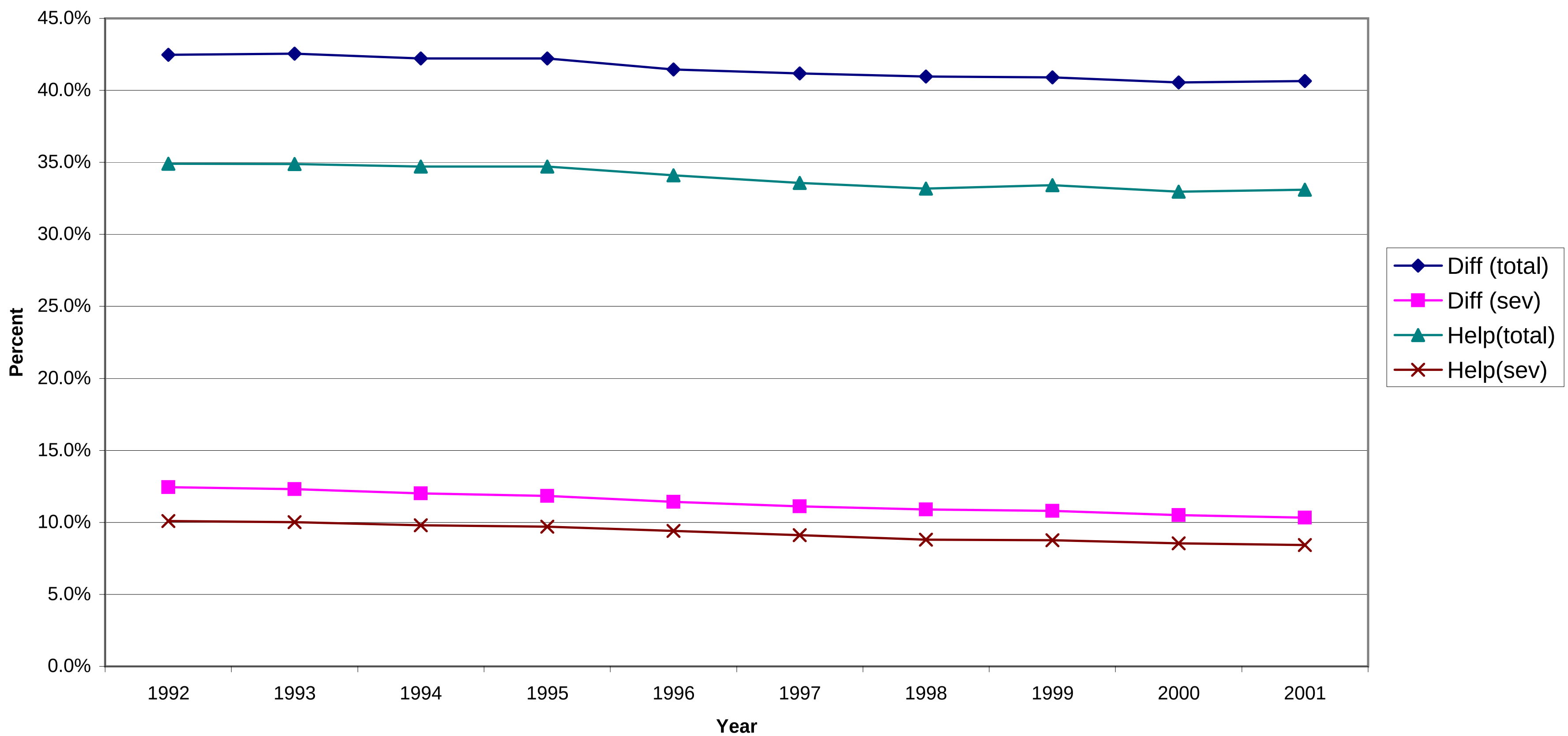
Notes: Active health is defined as no IADL or ADL limitations. Moderate disability is defined as having difficulty or being unable to perform at least one IADL or 1~2 ADLs. Severe disability is defined as having difficulty or being unable to perform at least three ADLs.

Figure 3B Trend in LE estimates (relative) for 85-year old Americans of average health



Notes: Active health is defined as no IADL or ADL limitations. Moderate disability is defined as having difficulty or being unable to perform at least one IADL or 1~2 ADLs. Severe disability is defined as having difficulty or being unable to perform at least three ADLs.

Figure 4 Changes in disabled (total and severe) DLE at age 65 as percent of total life expectancy



Notes: Estimates of total and severe DLE are based on two different definitions of disability. One is based on one's difficulty with or inability to perform at least one IADL or ADL only. The other is based on, in addition to one's difficulty or inability, receiving help, under supervision or using equipment. Total DLE is defined as expected years spent in either moderate or severe disability between age 65 and death; while severe DLE is expected years spent in severe disability only.