Chronic Conditions and the Decline in Late-Life Disability

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ABSTRACT

Using the 1997-2004 National Health Interview Survey (NHIS), we examine changes in chronic conditions as explanations for recent declines in late-life disability prevalence. Building on prior studies, we decompose disability declines into changes in the prevalence of chronic conditions and in the risk of disability given a condition. In doing so, we extend traditional decomposition techniques to take advantage of the annual data points in the NHIS. We then repartition these traditional decomposition components into causal and co-morbid components based on respondents' reports of conditions causing disability. We find a general pattern of increases in many chronic conditions accompanied by declines in their association with disability. However, only 2 of the 7 condition groups that we examined—heart and circulatory conditions and sensory impairments (specifically, vision impairments)—were less likely to *cause* disability in 2004 than they were in 1997. Out of a total decline in disability prevalence of 1.45 percentage points, declines in heart/circulatory conditions causing disability account for .92 percentage points and declines in vision impairments causing disability account for .59 percentage points. We discuss our findings in light of improvements in treatments and changes in the environments of older adults.

INTRODUCTION

Evidence continues to mount that the prevalence of disability in late life has been declining in the United States (Crimmins 2004; Cutler 2001; Freedman, Martin and Schoeni 2002; Manton and Gu 2001), despite increases in reports of chronic diseases (Crimmins and Saito 2000; Freedman and Martin 2000). Most of the decline has been in limitations in instrumental activities of daily living (IADLs), particularly for activities such as managing money, shopping for groceries, and doing laundry (Spillman 2004), although declines in difficulty and help with activities of daily living (ADLs) have also been identified (Freedman et al. 2004).

Two of the most commonly cited frameworks for thinking conceptually about disability—the disablement process (Institute of Medicine 1991) and the International Classification of Functioning, Disability, and Health (World Health Organization 2002)—both recognize that health conditions intersect with the environment to cause activity limitations. Yet only a few studies to date have attempted to link trends in health conditions and limitations. For example, using the Supplements on Aging to the National Health Interview Survey, Freedman and Martin (2000) found that despite increases in reports of chronic conditions, the percentage of older Americans with upper and lower body limitations declined from 1984 to 1995. The study concluded that associations between several major diseases—arthritis most prominently—and functional limitations have waned during that time period and that functional limitations would have decreased even more had obesity not also risen. Using the same data sources, Crimmins and Saito (2000) found increases in reports of chronic conditions but declines in reports of

limitations in activities of daily living (ADLs) and instrumental activities of daily living (IADLs) among women reporting such conditions.

Although consistent with a slowing of the progression of disease, these empirical patterns could also be generated by a trend toward diagnosis of conditions at earlier, and therefore less debilitating, stages. However, with few exceptions, national survey data generally do not have detailed measures of disease progression measured consistently over time. One way to avoid confounding as a result of earlier diagnosis is to track the subset of the population who report that a given condition causes disability. Selection of less severe cases into the condition pool should not affect the proportion of the population reporting that a given condition causes disability.

The approach that we propose requires distinguishing conditions that *cause* disability from those that simply *co-occur* with disability. The distinction is not merely one of semantics. Consider two older women who both report having diabetes and arthritis and who both report limitations in daily activities. One may have arthritis that is debilitating to the point of interfering with mobility (which we refer to as a "causal" condition), but her heart disease may be mild and controlled with oral medication (which we refer to as a "co-morbid" condition that simply co-occurs with disability). The other may have mild arthritis that flares up from time to time but does not interfere with activities (a "co-morbid" condition), but also has diabetes that has progressed to the point where poor vision and neuropathy make it difficult to carry out daily activities without help (a "causal" condition). In practice, there may be multiple causal and contributing conditions acting together to create the circumstances under which a disability may occur (Verbrugge, Lepkowski and Imanaka 1989).

Introducing the notion of causal conditions also helps to establish some directionality between an individual's disease and disability status. In the absence of such directionality, researchers have generally interpreted data on the co-occurrence of disease and disability as the former causing the latter, ignoring the fact that disability may bring about secondary conditions (Institute of Medicine 1991). Consider the case in which an individual has a disabling accident that leads to severe depression or another with mobility limitations that lead to heart disease because of lack of physical activity. In these cases, declines in disability may lead to concurrent declines in chronic disease. Thus far, decomposition analyses of chronic disease's role in disability have not addressed these complexities.

An additional shortcoming of prior analyses on this topic is that they typically rely on only two cross-sections. Previous studies have cautioned about drawing conclusions about trends from only two data points, in part because there is substantial year-to-year variation in disability rates. Crimmins and colleagues (Crimmins, Saito and Reynolds 1997), for example, have pointed out that analysis of changes in disability rates using the NHIS are sensitive to the base year, and that ignoring intra-interval data can lead to conclusions that are not robust.

Using 8 years of data from the National Health Interview Survey (NHIS), this paper updates analyses of linkages between chronic disease and disability among older Americans. Building on prior studies, we decompose disability declines into changes in the prevalence of chronic conditions and in the risk of disability given a condition. In doing so, we extend traditional decomposition techniques to take advantage of the annual

data points in the NHIS. Based on reports of conditions causing disability, we then repartition traditional components to isolate conditions' causal contributions.

METHODS

Data

We used the 1997 to 2004 National Health Interview Survey (NHIS). Conducted by the National Center for Health Statistics, the NHIS is a repeated cross-sectional survey of the non-institutionalized U.S. population.[1] Data were collected for all respondents in the household during a core interview; in addition, one randomly selected adult per household received more in-depth questions on chronic conditions and functioning. Final response rates, calculated by cumulating rates for household (88%), family (98%) and adult samples (94%), averaged 74% for 1997 to 2004 (range: 70%-80%).

This analysis uses self-reported data from the NHIS adult sample ages 65 and older (N=48,585; ranging from 5,577-6,972 per year). The sampling plan follows a multistage area probability design that permits representative sampling of the adult population. The adult sample weights allow generalization to the civilian non-institutional population. Proxy responses to the adult questionnaire were not allowed in 1997-1999 but were subsequently introduced in 2000. To make estimates comparable over time, we eliminated proxy reports in 2001-2004 (N=693 or 1% of the sample, ranging from 169-189 per year; note these cases could not be identified in 2000) and re-stratified the adult sample weights in later years to match the strategy used in earlier years.

[1] The survey underwent a major design change in 1997 that made condition-related information not comparable with earlier years. We therefore focus on the 1997-2004 period.

Although our sample is generalizable to the noninstitutionalized older adult population, about 1.5 million older adults lived in nursing homes in 2000, a decline of about 2% from 1990 (He et al. 2005). Omitting the institutionalized from our analysis could bias estimates of aggregate changes toward *understating* improvements in disability and *overstating* increases in disease. The omission of respondents who need to complete interviews via proxies may also bias estimates, most likely in a downward direction; however, we have taken steps to ensure that proxies are treated the same in each year and the percentage of older adults requiring proxy interviews was very small in the later years.

Measures

The NHIS asked about both ADL and IADL disability. Limitations in ADLs were assessed with a question "Because of a physical, mental, or emotional problem, does ___ need help of other persons with personal care needs, such as eating, bathing, dressing, or getting around this home?" Limitations in IADLs were assessed with "Because of a physical, mental, or emotional problem, does ___ need help of other persons in handling routine needs, such as everyday household chores, doing necessary business, shopping, or getting around for other purposes?" We considered positive responses to either the ADL or IADL disability item as having a disability.

The NHIS then asked what condition(s) or health problem(s) caused family members to have difficulty with [previously named activities]. Respondents were given a response card with 18 categories and allowed to report multiple causes. We focus here on the 12 causes for which NHIS has also collected consistent information as part of their

questions about chronic conditions and impairments: cancer, heart problems, stroke, lung/breathing problems, depression/anxiety/emotional problems, diabetes, hypertension/high blood pressure, weight problem, arthritis, back/neck problem, hearing problem, and vision problem. Although far from exhaustive, this list includes the most frequently cited causes of disability and 81% of older adults with ADL or IADL limitations reported one or more of these causes. The most salient omissions for our purposes are fractures and injuries, which we found in analyses not shown remained relatively flat over this period as a cause of disability, and dementia, which was not assessed (although we found that senility remained stable as a cause of disability).[2]

Because some causes were already quite aggregated (e.g., 'lung/breathing problem,' 'cancer,' and 'depression/anxiety/emotional problems), we chose to begin by combining the remaining conditions into groups according to either body systems (e.g., heart disease, hypertension, and stroke as heart and circulatory conditions; arthritis/joint pain and pain in the back or neck as musculoskeletal conditions) or conditions that were meaningfully related in other ways (e.g., hearing and vision problems as sensory limitations; weight problem, which we combine with information about obesity, and diabetes as metabolic conditions). The resulting 7 condition groups are listed in table 1 along with the corresponding reported causes of limitations (see columns 1 and 2).

[Table 1 about here.]

Information on the presence of chronic conditions was taken from responses to the adult questionnaire. For all but joint-related conditions, identical questions were

[2]Changes in the assessment of the prevalence of fractures and injuries precluded our use of these measures. We also omit birth defects and mental retardation because we did not have information on prevalence of these causes. These causes, while important in younger age groups, are very low prevalence in the older population.

asked in each year (see column 3 of Table 1 for details, including reference period). For joint-related conditions, we used for 1997 through 2001 an indicator of joint pain in the last 12 months that was not the result of only an injury, and in 2002 through 2004 we used ever having a diagnosis of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia. We assessed the likely influence of this change in wording by comparing the joint pain indicator in 2001 (56%) with an item asking about ever having arthritis in the same year (52%) and by reviewing studies of the prevalence of gout (3% among older adults), lupus (<.05% among adults), and fibromyalgia (3%-4% among older adults) (Lawrence et al. 1998). Based on this evidence we believe that on balance estimates of arthritis/joint pain in 2002-2004 may be about 3-4 percentage points higher than they would have been had the wording not changed; however such wording changes are unlikely to influence estimates of arthritis as a cause of disability.

Two additional conditions deserve comment: mental distress and obesity. Our measure of severe mental distress was based upon responses to the 'K6,' a six-item scale reflecting symptoms in the last 30 days (sadness, restlessness, nervousness, hopelessness, and feeling worthless and that everything was an effort), which we coded using a cut point of 13 or higher (range 0-24) (Kessler et al. 2002). Although not a chronic disease per se, but instead a reflection of an imbalance among physical activity, nutrition, and metabolic activity, we also include a measure of obesity, based on reports of height and weight. We used a cutoff of greater than 30 body mass index (BMI) to indicate obese. We also explored whether being overweight (25<BMI<30) or underweight mattered (BMI <=18.5) and only a handful of individuals with BMI at these levels reported a

weight problem caused their disability, so we ultimately excluded these variables from the analysis.

Other studies have found that older adults are able to accurately report causes of their disability (Ettinger et al. 1994). Indeed, we found that cross-tabulations of these causal condition indicators by reports of chronic disease suggest that inconsistencies were quite low; that is, for any given condition, less than 1% of individuals without the condition reported it as a cause of their ADL or IADL limitation. We resolved these inconsistencies by considering a condition or impairment as a cause of disability only if the respondent also reported having that condition or impairment. Sensitivity analyses that assumed the opposite (that the individual had all chronic conditions reported as causes of their disability) led to substantively identical conclusions.

Analyses

We first assessed changes in the *prevalence* of each of the conditions, in the probability of disability given each condition, and in the probability of disability being reported as *caused* by each condition. We tested for trends in each of these outcomes individually using linear regression models with year entered as a continuous variable. All statistical tests were based on adjusted standard errors that accounted for the complex NHIS sampling design.

We then implemented two approaches to decompose the change in disability into its condition-related components. We first modified the traditional approach based on Kitagawa's formula (Kitigawa 1955), which partitions disability declines into changes in the prevalence of conditions and in the probability of disability given a condition, to take

advantage of annual data in the NHIS. Second, in order to isolate conditions' causal contributions, we incorporated into the decomposition additional information on the probability an individual had a disability caused by a given condition. Each of these approaches is described in more detail below.

Traditional decomposition using annual data. According to Kitagawa (Kitigawa 1955), the contribution of a change in the prevalence of a given condition, say ever having diabetes, to aggregate changes in disability, is a multiple of the proportion ever having diabetes (denoted X_{year}) differenced over the two years and the probability of having disability given diabetes (denoted β_{year}) averaged over the two years $((X_{1997} - X_{2004})\frac{\beta_{1997} + \beta_{2004}}{2})$. The contribution of a change in the probability of having disability given diabetes is a multiple of the difference in diabetes' effects on disability over time and the average proportion ever having diabetes $((\beta_{1997} - \beta_{2004})\frac{X_{1997} + X_{2004}}{2})$. The two pieces summed together represent a condition's total contribution to the change in disability. Typically values of β_{year} would be taken from a stratified linear regression model predicting disability based on information for only the end point years (in this case 1997 and 2004). X_{year} would be simple prevalence estimates for each covariate in 1997 and 2004.

Kitagawa's approach was originally developed to compare rates across two populations, but has been adopted for use in the comparison of the same population at two different points in time. Although some demographers have taken advantage of intervening data points by creating multiple comparisons, most often the approach is applied by replicating the two-population decomposition for shorter time periods (e.g.,

comparing 1970 to 1975, and 1975 to 1980, rather than just 1970 to 1980). Firebaugh (1989) has suggested a linear regression method that takes advantage of intervening time points to sort out intra-cohort change from cohort succession effects, although he did not explicitly introduce covariates or allow their effects to vary over time.

In this application, we built upon these well-established approaches to take advantage of annual time points in the NHIS. We pooled all years from 1997 to 2004 and estimated a model with year specified as a continuous variable from 0 (=1997) to 7 (=2004), with coefficients for each demographic and socioeconomic variable of interest, each of the 7 condition groups, and interactions between year and each of the other variables. In this model the main effects represented the βs for 1997. We then calculate the βs for 2004 by adding seven times the appropriate interaction term to the 1997 βs.[3] Values of X were obtained in a similar fashion, by regressing each of the demographic and socioeconomic variables individually and each of the 7 condition groups individually on year, with the intercepts representing X_{1997} and the intercepts added to 7 times the year coefficients representing X_{2004}.[4]

Regression models predicting disability included age (in broad groups), sex, race/ethnicity (white, non-Hispanic and other combined; black, non-Hispanic; Hispanic), completed education (0 to 8 years, 9 to 11 years, 12 years or GED, 13 or more years), marital status (married, separated/divorced, widowed, never married), and reports of the 7 condition groups described previously. In a subsequent model that we used to investigate

[3] Alternatively, we could re-estimate the model with year specified in the reverse from 0 (=2004) to 7 (=1997), and with the main effects and interactions with year. In this second model the main effects represent the βs for 2004.

[4] Standard errors for βs and Xs were calculated using STATA's svy: reg, which adjusts for the complex sample design of the NHIS.

the effects of more specific conditions, we replaced 4 of the 7 condition groups (heart and circulatory conditions, metabolic conditions, musculoskeletal conditions, sensory impairments) with indicators of 9 more specific conditions (heart disease, stroke, hypertension, diabetes, obesity, arthritis/joint pain, back or neck pain, vision limitation, hearing limitation). We also investigated logistic regression models but results were essentially identical, and the linear probability models lend themselves more readily to decomposition analysis.

A word about interactions is in order. The majority of respondents reported more than one of the conditions considered here and 40% of respondents who reported that they had disability provided more than one cause. Although the model described above used information on all conditions reported by respondents, it assumed that these conditions operate independently on disability. We therefore explored the usefulness of including interactions between pairs of conditions. We first looked to existing studies and found that when conditions co-occur they most often do not have synergistic effects on disability (Fried et al. 1999; Verbrugge et al. 1989). We also found in a series of exploratory analyses (not shown) that only a few of the most prevalent pairs were significant predictors of disability (having both arthritis and heart disease). We ultimately chose to exclude these interactions from the final models because the associations between having these pairs of conditions and reporting disability did not change significantly over time and there was no significant change in reporting these pairs of conditions as causes of disability. Their exclusion is unlikely to change the substantive conclusions of our analysis.

Decomposition into causal and co-morbid components. After we decomposed the change in disability rates into its traditional components, we re-partitioned the total contribution of each condition group into "causal" and "co-morbid" components. This second decomposition analysis takes advantage of information respondents provide about conditions that cause their disability.

Specifically, we calculated the causal component by taking the differences in the predicted values of X_{1997} and X_{2004}, in the same manner as previously described, but where X_{year} represents the proportion of the older population reporting disability in a given year *and* that a particular condition caused it. We then obtained the co-morbid contribution by subtracting the causal component from the previously calculated total contribution for the given condition group.[5]

RESULTS

Trends in Disability and Conditions

The percentage of older Americans needing help with ADLs or IADLs declined by 1.45 percentage points from 12.69% in 1997 to 11.24% in 2004 (p=.01). This is equivalent to a decline of 11% over the 8-year period, or an average annual decline of 1.4% per year.

During the same period, reports of the presence of many of the potentially disabling chronic conditions and sensory impairments increased significantly (left panel of Table 2). Older Americans were increasingly likely to report that a doctor ever told

[5] In a decomposition framework, the co-morbid component can also be considered the sum of the contribution of changes in the prevalence of the non-causal condition and the probability of disability given a co-morbid condition. Because these components are not straightforward to interpret, however, we instead focus on the 'causal component' and treat the co-morbid component as a residual term.

them they had cancer, heart and circulatory conditions (specifically, hypertension), metabolic conditions (specifically, diabetes and obesity), and musculoskeletal conditions (specifically, arthritis/joint pain). Only the prevalence of severe mental distress and vision limitations declined significantly over the period.

[Table 2 about here.]

Also consistent with prior studies, the probability of disability given a chronic condition was lower in 2004 than in 1997. As shown in the right panel of Table 2, the probability of needing help with personal or routine care activities declined among those with heart and circulatory conditions (specifically, heart disease and hypertension), mental distress, metabolic conditions (specifically, diabetes and obesity), and musculoskeletal conditions (specifically for arthritis/joint pain). Large declines were also evident for stroke (-6.9 percentage point decline), but these declines were significant at the .10 level (p=.08).

Compositional Changes

Table 3 shows that between 1997 and 2004 the composition of the older population changed significantly with respect to age, education, ethnicity, and marital status (see first two columns of Table 3). Educational increases were particularly noteworthy, with the percentage with 8 or fewer years and 9-11 years of completed education both declining and the percentage with 13 or more years (not shown) increasing. Shifts in the prevalence of the 7 condition groups considered here mirror those in Table 2, although they differ slightly because the estimates in Table 3 are predicted values based on information throughout the entire period.

[Table 3 about here.]

Changes in the Conditional Probability of Disability

The influence of age, sex, and education on disability also changed over this period (columns 3 and 4 of Table 3). The risk of disability associated with being 80 to 84 declined as did the risks associated with being female. In addition, relative to having more than 12 years of school, the risks associated with having 8 or fewer years of education *increased*, as did the risks associated with having 12 years of education.

Of the 7 condition groups that we examined, only heart and circulatory conditions became significantly less debilitating over this period (denoted by column labeled 'p+'). In a model in which we replaced the 7 condition groups with all 12 conditions (not shown), none became significantly less debilitating.

Traditional Decomposition of Changes in Disability

The right hand side of Table 3 decomposes changes in disability into its traditional components: the contribution of changes in prevalence and in the probability of disability given a particular demographic characteristic or condition group. Focusing on the contribution of changes in prevalence (column 5), clearly age, education, and marital status have had an important influence on disability prevalence. The aging of the 65 and older population into the oldest age groups had an upward influence (0.23 percentage points for the 80-84 year old group and 0.45 percentage points for the 85 and older group); however, shifts away from the lowest education group made significant contributions toward the decline (-0.25 for 8 or fewer years of education).

Looking at shifts in the prevalence of condition groups, 4 of the condition groups that we examined contributed significantly toward increases in disability: cancer (.05

percentage points), heart and circulatory conditions (.15), metabolic conditions (.32) and musculoskeletal conditions (0.12) whereas severe mental distress contributed toward declines (-0.23). Overall, demographic risk factors and condition groups contributed positively to changes in the prevalence of disability (.27 and .38 percentage points, respectively).

Changes in disability associated with shifts in the debilitating effects of demographic factors and condition groups are shown in column 6 of Table 3. Shifts in the probability of having disability among those ages 80-84 and women contributed -.49 and -1.24 percentage points toward the decline in disability over this period. At the same time, increases in the disadvantage associated with 8 or fewer years of education and with 12 years of education almost completely offset these improvements (0.68 and 0.96, respectively).

Of the 7 condition groups that we examined, only heart and circulatory conditions contributed significantly to the decline, accounting for reductions in disability of 1.45 percentage points—as large as the entire disability decline over this period. Because of this extraordinarily large contribution, on balance changes in the probability of disability among chronic condition groups had a larger influence on the disability decline than changes in the probability of disability among demographic groups (-1.37 vs -.70 percentage points.)

Focusing on the total contributions (see final column), three findings are noteworthy. Changes in heart and circulatory conditions made the largest contribution to the disability decline (-1.29 percentage points), followed by gender (-1.25). Severe mental distress appeared to contribute significantly to the decline (-0.38). Surprisingly,

education contributed to *increases* in disability: 0.96 percentage points was accounted for by changes among those with 12 years of education.

Distinguishing Causal versus Co-morbid Components

Are the declines attributable to heart and circulatory conditions and to mental distress causal in nature? As shown in Table 4, the probability of reporting disability caused by heart and circulatory conditions declined from 5.54% to 4.83% ($p<.05$) but the percentage reporting mental distress caused disability did not change significantly. Also of note is that disability caused by vision limitations declined by .52 percentage points. Disability caused by obesity doubled over this period (from 0.15% to 0.37%; $p<.05$), although still remained low relative to other causes.

[Table 4 about here.]

When this information is used to reapportion the contribution of chronic conditions into causal and co-morbid components, two condition groups emerge as important in explaining the disability decline: heart and circulatory conditions and sensory impairments (column 3 of Table 5). Declines in heart and circulatory conditions as the cause of disability account for -.92 percentage points of the disability decline whereas declines in sensory impairments account for -.57 percentage points. The contribution of mental distress to the disability decline is mainly the result of significant declines in distress as a co-morbid condition. Altogether these 7 condition groups are causally linked to declines of -1.88 percentage points. However, increases of 0.89 percentage points due to shifts in co-morbid conditions partially offset these gains.

[Table 5 about here]

When we re-estimate the model with specific chronic conditions, several additional findings emerge (Table 6). (Note that the results in Table 6 also control for demographic factors shown in Table 3 and cancer, lung problems, and mental distress; these additional conditions are not shown because they are identical to findings in Table 5). First, despite extraordinary large contributions to the disability decline of heart and circulatory conditions, hypertension, heart disease and stroke did not *individually* make significant contributions to the disability decline. Second, increases in obesity as a cause of disability pushed disability prevalence up, but only by 0.19 percentage points. Third, declines in vision limitations as a cause of disability account for declines in disability of -.59 percentage points whereas hearing did not decline as a cause of disability.

[Table 6 about here]

DISCUSSION

Consistent with studies of the late 1980s and early 1990s (Crimmins and Saito 2000; Freedman and Martin 2000), the percentage of older Americans living in the community with disability continued to decline from 1997 to 2004 despite increases in reports of many chronic conditions and impairments. Unlike prior studies, however, our analysis suggests that declines in heart and circulatory conditions and vision limitations as causes of disability appear to have played a major role in the declines in disability prevalence. We also found that mental distress is declining but this trend is not causing disability to decline and that obesity is shifting disability upward, albeit by a relatively small amount. At the same time, shifts in the relationship between gender and disability are contributing

to declines and on balance education is not contributing to disability declines for this period due to increases in the disadvantage associated with fewer years of education.

This study is limited by the fact that consistent information on causal conditions has been available in the NHIS for only 8 years. This relatively short time horizon may not reflect longer-term trends. Unlike prior studies, however, we minimized variation that can result from analyzing endpoints by modifying the traditional decomposition technique to take advantage of information for the intervening years. Although our approach explicitly relies on assumptions of linearity over the period, the same assumption is implicit in the 2-year approach. Moreover, our examination of the data suggests that the linear assumption is in most cases reasonable. Had we limited our analysis to only 1997 and 2004 our results would have been different in two potentially important ways (results not shown). We would have exaggerated the effects of being female and found significant declines in the probability of disability given a stroke (due to what appears to be an outlier in 2004, rather than a continuation of a trend).

Our findings provide important clues to explain the late-life disability decline. In particular, the substantial decline in heart and circulatory conditions as a cause of disability point to the possibility that continued expansion of medical and rehabilitative treatments for these conditions has contributed to the decline. Indeed, during the study period there has been continued expansion of pharmacologic treatment of cardiovascular disease (e.g., beta blockers, ace inhibitors, anti-cholesterol agents, and anti-hypertensive combinations) (Moeller, Miller and Banthin 2004). Surgical procedures such as stent insertion to hold open narrowed arteries, first introduced in the early 1990s, and balloon angioplasty have also increased substantially during the study period (National Center for

Health Statistics 2003). And older adults' use of in-patient rehabilitation services and receipt of therapy visits under Medicare's home health benefit have also increased over this period as well (Medicare Payment Advisory Committee 2004). Thus far attempts to link declines in disability to shifts in cardiovascular treatment have provided only minimal evidence. For example, a recent study using a different data source and different measures (Cutler, Landrum and Stewart 2006), which found that cardiovascular disease made significant contributions to declines in late-life disability for the period 1984 to 1999,[6] estimated that area-level use of pharmaceutical treatments and related surgical procedures explained only 3.5% of the decline in disability among those hospitalized for cardiovascular disease. Studies linking declines in disability prevalence to cardiac and stroke rehabilitation have not been undertaken. Given the salience of heart and circulatory conditions to the declines in disability, further investigation of these linkages, including the role of physical, occupational, and speech therapies, is warranted.

We also found large declines in vision as a cause of disability. The major causes of vision impairment in late life are age-related macular degeneration, glaucoma, cataracts, and diabetic retinopathy (US Department of Health and Human Services 2000). For one of these conditions—cataracts—outpatient surgery more than doubled between 1984 and 1995 (Desai et al. 2001) and this trend has likely continued. Treatments for glaucoma and for glycemic control of diabetes also expanded during the 1990s, although the extent to which these have contributed to vision improvements has not been explored. Older adults also may be more likely in recent years to accommodate their vision

[6] That study found that among older adults admitted to the hospital with cardiovascular disease in a prior 5-year window, disability declined by 1.4 percentage points, or 22% of the 6.3 percentage point decline in disability over that period.

impairments with visual devices (such as magnifiers) and adaptive devices (such as large print materials). Importantly, although we found vision problems were less likely to cause disability, they were only slightly less prevalent in 2004 than in 1997; hence, vision impairment remains an important area for future interventions.

In addition, we found that severe mental distress declined among older adults. By decomposing trends into causal and co-morbid components, however, we demonstrated that this trend did not appear to be driving declines in disability. Although increases in treated mental conditions have been documented among older adults (Crystal et al. 2003; Zuvekas 2001), it may be that treatment is not increasing or improving for the most severe cases of mental distress that cause disability. Moreover, with our data we were unable to sort out whether mental distress is declining as a consequence of disability declines. Given the highly debilitating influence of mental health conditions on older adults, further investigation of this complex relationship is warranted.

The finding that obesity is causally linked to increases in disability prevalence is notable. Other papers focusing on the adult population up to age 69 have found that since the mid-1980s, obesity has been increasing for the near- or young-old (Lakdawalla, Bhattacharya and Goldman 2003; Sturm, Ringel and Andreyeva 2004), and Freedman and Martin (2000) found that for the 70 and over population from 1984 to 1995, the increased prevalence of obesity was associated with poorer lower body functioning. But this study is the first to show a causal relation of obesity with disability for the population ages 65 and over. The causal obesity-disability link that we find is driven by the increase in prevalence of obesity among the 65 and over and not by changes in the probability that someone who is obese reports that obesity causes disability, which although increasing is

relatively rare. From 1997 to 2004, the proportion of the 65 and over population that was of normal BMI declined, while the proportion overweight remained relatively flat, and the proportions obese and morbidly obese increased. It is unclear whether this trend reflects increasing weight gain after age 65 or increasing survival among those with above-normal weight.

Gender emerged as a key demographic factor in explaining disability trends. The disability gap between men and women declined, which continues a trend identified by Crimmins and Saito (2000) for the mid-1980s to mid-1990s. It is not clear why women are experiencing less disability than they were relative to men. It may be a change in factors not measured in our model relative to men over time—for example, women increasingly may be living in more supportive environments relative to men or the socioeconomic gap between men and women in late life may be closing. Further research should probe reasons for the gender differences in declines by stratifying analyses by gender.

Consistent with earlier predictions of the lessening of education's effects on disability prevalence (Freedman and Martin 1999), we found that education did not on balance contribute to declines in disability prevalence. Although a declining percentage of the older population has fewer than 12 years of education, the disadvantage associated with having less than a college education has grown, so that on balance shifts in education pushed disability rates up over this period. This finding is also consistent with recent studies that have pointed to growing disparities in disability by education (Schoeni et al. 2005). It may be that those in the less advantaged education groups (with less than a high school degree) may be increasingly negatively selected on a variety of factors

related to late-life disability. Ross and Wu (1995), for example, suggest three types of mechanisms linking education and health, which are easily extended to apply to disability: economic resources, psycho-social resources, and health behaviors. In addition, those with fewer years of education are less likely to use assistive technology to carry out daily activities, although there is no evidence that these gaps have been increasing (Freedman et al. 2005).

Finally, our findings provide insights into the continuing debate on the implications of population aging for the compression or expansion of morbidity. At face value the general pattern of findings, like earlier studies, appears to be consistent with the dynamic equilibrium perspective of Manton (1982). For instance diabetes, hypertension, and arthritis all appear to be more prevalent and less debilitating. Upon closer examination, however, there were no changes in the probability of an older individual reporting that one of these conditions caused disability. In the case of diabetes, for example, such a selection mechanism could be directly the result of changes in definition, since the threshold for diabetes was lowered in 1997 from a fasting plasma glucose level of 140 to 126 mg/dL. Our analysis underscores the critical importance of sorting out selection effects—caused by identifying more cases, particularly less severe cases—from true causal effects. A fruitful area for future work would be to integrate clinical measures of severity into analyses of disease-disability linkages. Until those data are available, however, using information on cause of disability to distinguish conditions that cause disability from those that simply co-occur is a useful starting point.

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Table 1. Condition Measures, 1997-2004 National Health Interview Survey

Assigned Condition Group	Conditions Respondents Report as Cause of Disability	Conditions Respondents Report Having (Reference period)
Cancer	Cancer	Cancer (ever)
Heart and circulatory disease	Heart problem; Stroke; Hypertension	Heart disease: coronary heart disease, angina, heart attack, any other heart condition or heart disease (ever); Stroke (ever); Hypertension/high blood pressure(ever)
Lung disease	Lung/breathing problem	Asthma (ever); Emphysema (ever)
Mental distress	Depression/anxiety/emotional problem	Symptoms of severe mental distress (30 days)
Metabolic conditions	Diabetes; Weight problem	Diabetes (ever); Obesity (BMI > 30)
Muskuloskeletal conditions	Arthritis/rheumatism; Back/neck problem	Arthritis/joint pain (ever/12 months)[a]; Neck or low back pain (3 months)
Sensory impairments	Hearing problem; Vision problem	A lot of trouble hearing or deaf (current); Trouble seeing even when wearing glasses or contacts (current)

[a]Doctor ever told you that you had some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia assessed for 2002-2004 and joint pain due to cause other than injury assessed in last 12 months for 1997-2001. See text for details.

Table 2. Trends in the prevalence of select chronic conditions and in reports of disabiltiy among those with select chronic conditions, 65 and older population, 1997-2004 (N=48,585)

	% reporting chronic condition									% reporting disability among those with chronic condition								
Condition Group	1997	1998	1999	2000	2001	2002	2003	2004	1997-2004 Change	1997	1998	1999	2000	2001	2002	2003	2004	1997-2004 Change
Cancer	19.3	17.8	19.5	20.1	19.6	21.4	19.6	21.3	2.0 **	13.7	16.3	14.7	17.1	13.4	13.9	16.5	13.3	-0.4
Heart and circulatory conditions	64.5	63.7	62.1	64.0	65.3	65.2	67.0	67.7	3.2 **	16.1	16.7	15.2	15.2	14.9	14.1	14.2	13.8	-2.3 **
Heart disease	31.5	32.0	28.9	30.2	31.1	30.8	31.1	31.7	0.2	20.4	19.5	19.7	19.2	18.9	18.4	17.6	18.0	-2.4 *
Hypertension	51.4	50.8	50.3	52.4	53.4	54.5	56.0	56.4	5.0 **	14.9	16.7	14.9	15.1	14.6	13.7	13.8	13.6	-1.2 **
Stroke	7.8	8.3	7.8	8.3	8.4	7.8	8.4	8.9	1.1	37.5	31.2	34.4	35.8	31.1	34.9	30.9	30.7	-6.9
Lung conditions	11.2	11.5	10.2	12.0	11.9	11.1	11.2	12.6	1.4	20.2	22.4	19.8	22.1	17.5	17.8	20.2	18.5	-1.7
Mental distress	3.4	2.8	2.1	2.6	2.4	1.9	2.2	2.1	-1.3 **	49.1	45.2	41.4	39.4	43.7	35.1	37.3	41.8	-7.3 *
Metabolic conditions	25.1	26.0	26.5	28.6	29.1	31.4	29.4	32.1	6.9 **	17.7	17.9	15.7	17.3	17.2	15.1	15.0	14.2	-3.6 **
Diabetes	13.1	13.2	13.2	14.6	15.2	15.8	15.8	17.1	4.0 **	22.3	23.1	19.1	21.3	21.1	17.9	18.2	18.2	-4.1 **
Obesity	16.0	16.8	17.7	19.0	19.4	21.1	19.5	21.6	5.6 **	15.4	16.3	15.5	16.5	15.4	14.2	13.5	12.6	-2.8 **
Musculoskeletal conditions	57.4	58.7	54.6	55.9	57.8	58.0	59.9	60.7	3.3 **	16.5	16.5	15.2	15.8	14.4	14.8	15.1	14.6	-1.9 *
Arthritis/joint pain*	44.5	45.0	41.8	43.4	43.3	47.3	48.4	50.6	6.1 **	17.7	17.4	16.1	16.3	15.0	15.5	16.0	15.0	-2.7 **
Pain in back or neck	34.7	36.7	33.4	34.9	36.7	33.7	34.6	34.5	-0.2	17.9	18.6	16.0	16.9	16.3	16.0	17.2	17.1	-0.8
Sensory impairments	24.6	25.4	23.2	24.6	25.6	24.5	23.1	23.9	-0.7	24.6	25.3	23.6	26.7	23.5	24.0	24.8	22.6	-2.0
Hearing limitation	9.8	10.4	10.1	10.5	10.9	10.5	9.8	10.4	0.6	22.1	24.2	17.1	25.9	19.9	23.2	22.8	23.1	1.0
Vision limitation	18.0	18.0	15.7	17.4	17.4	17.1	15.9	16.3	-1.7 **	28.4	28.3	28.6	29.8	28.3	26.6	28.4	25.7	-2.7

* p<.05 ** p<.01

Table 3. Decomposition of estimated change in disability prevalence 1997-2004 into demographic and chronic condition components

	Prevalence (X)			Probability of disability given X			Contribution of change in:		Total contribution
	1997 (1)	2004 (2)	p+	1997 (3)	2004 (4)	p+	Prevalence (5)	Probability of disability (6)	(7)
Demographic risk factors									
Age 70 to 74	27.3	24.6	**	0.01	0.01		-0.02	0.12	0.10
Age 75 to 79	21.9	21.4		0.03 **	0.03 **		-0.02	-0.09	-0.11
Age 80 to 84	13.0	15.4	**	0.12 **	0.08 **	*	0.23 **	-0.49 *	-0.26
Age 85 or older	8.7	10.6	**	0.25 **	0.21 **		0.45 **	-0.37	0.08
Female	57.8	57.4		0.05 **	0.02 **	*	-0.01	-1.24 *	-1.25 *
8 or fewer yrs education	18.6	13.4	**	0.03 **	0.07 **	**	-0.25 **	0.68 **	0.43
9-11 yrs education	16.5	12.9	**	0.01	0.02 **		-0.06	0.22	0.17
12 yrs education	33.9	34.7		-0.01	0.02 **	**	0.00	0.96 **	0.96 **
Black, non-hispanic	8.1	8.3		0.05 **	0.02 *		0.01	-0.21	-0.20
Hispanic	5.3	6.3	**	0.02	0.01		0.01	-0.08	-0.07
Widowed	33.3	31.0	**	0.06 **	0.06 **		-0.14 **	-0.16	-0.30
Divorced	7.0	8.4	**	0.06 **	0.06 **		0.08 **	-0.05	0.04
Never married	3.8	3.5		0.06 **	0.06 **		-0.02	0.01	-0.01
Condition groups									
Cancer	18.7	21.0	**	0.02 *	0.03 **		0.05 **	0.19	0.24
Heart and circulatory conditions	62.8	67.0	**	0.05 **	0.03 **	*	0.15 **	-1.45 *	-1.29 *
Lung conditions	11.0	11.9		0.07 **	0.05 **		0.06	-0.16	-0.10
Mental distress	2.9	1.9	**	0.25 **	0.19 **		-0.23 **	-0.15	-0.38 **
Metabolic conditions	25.2	31.9	**	0.05 **	0.04 **		0.32 **	-0.21	0.11
Muskuloskeletal conditions	56.1	59.6	**	0.03 **	0.03 **		0.12 **	0.08	0.20
Sensory impairments	24.8	23.9		0.10 **	0.11 **		-0.10	0.33	0.24
Summary:									
Demographic risk factors							0.27	-0.70	-0.43
Chronic conditions groups							0.38	-1.37	-0.99
Residual[a]									-0.02
Total							0.65	-2.07	-1.45

p+ indicates test for difference between 1997 and 2004; all other tests are for difference from 0.

* p<.05 ** p<.01

[a]Includes intercept and residual due to use of predicted values in decomposition.

Table 4. Trends in the prevalence of disability caused by select chronic conditions, 65 and older population, 1997-2004 (N=48,585)

	% reporting disability caused by chronic condition								
Condition group	1997	1998	1999	2000	2001	2002	2003	2004	1997-2004 Change
Cancer	0.67	0.74	0.77	0.83	0.89	0.94	0.91	0.70	0.03
Heart and circulatory conditions	5.54	6.04	5.06	5.34	5.16	4.65	5.09	4.83	-0.70 *
Heart disease	3.24	3.41	2.64	2.98	2.97	2.81	2.94	3.03	-0.21
Hypertension	2.01	2.70	2.05	2.29	2.33	1.90	2.11	1.97	-0.04
Stroke	1.68	1.52	1.72	1.85	1.33	1.61	1.42	1.51	-0.17
Lung conditions	1.09	1.23	0.99	1.29	0.87	0.98	1.25	0.88	-0.21
Mental distress	0.17	0.16	0.23	0.31	0.17	0.09	0.11	0.11	-0.06
Metabolic conditions	2.02	2.16	1.78	2.24	2.3	1.81	1.72	1.89	-0.14
Diabetes	1.92	2.04	1.64	2.11	2.15	1.71	1.57	1.70	-0.21
Obesity	0.15	0.18	0.21	0.18	0.26	0.28	0.27	0.37	0.22 *
Muskuloskeletal conditions	4.60	4.83	4.47	4.31	3.67	4.41	4.59	4.82	0.22
Arthritis/joint pain*	3.87	4.04	3.82	3.48	3.01	3.57	3.95	4.12	0.26
Pain in back or neck	1.47	1.44	1.24	1.37	1.12	1.59	1.48	1.65	0.17
Sensory limitations	2.66	2.59	2.09	2.75	2.50	2.29	1.91	2.12	-0.53 *
Hearing limitation	0.62	0.83	0.53	0.89	0.81	0.66	0.69	0.71	0.09
Vision limitation	2.25	2.04	1.80	2.16	1.98	1.87	1.36	1.73	-0.52 **

* p<.05 ** p<.01

Table 5. Decomposition of estimated change in disability prevalence 1997-2004 into causal and co-morbid condition components[a]

	Prevalence of Causal Condition			Contribution of change in:		
	1997	2004	p+	Causal Component	Co-Morbid Component	Total Contribution
Condition group	(1)	(2)		(3)	(4)	(5)
Cancer	0.74	0.87		0.13	0.10	0.24
Heart and circulatory conditions	5.67	4.76	*	-0.92 *	-0.38	-1.29 *
Lung conditions	1.15	1.00		-0.15	0.05	-0.10
Mental distress	0.22	0.12		-0.10	-0.27 *	-0.38 **
Metabolic conditions	2.12	1.86		-0.25	0.36	0.11
Muskuloskeletal conditions	4.48	4.45		-0.02	0.22	0.20
Sensory impairments	2.65	2.08	*	-0.57 *	0.81 **	0.24
Total				-1.88	0.89	-0.99

[a]Model controls for demographic factors shown in Table 3. p+ indicates test for difference between 1997 and 2004; all other tests are for difference from 0.

* p<.05 ** p<.01

Table 6. Decomposition of estimated change in disability prevalence 1997-2004 into causal and co-morbid condition components: select conditions

	Prevalence of Causal Condition			Contribution of change in:		
Condition	1997 (1)	2004 (2)	p+	Causal Component (3)	Co-Morbid Component (4)	Total Contribution (5)
Heart and circulatory conditions						
Heart disease	3.14	2.87		-0.26	0.17	-0.09
Hypertension	2.32	2.01		-0.31	-0.06	-0.37
Stroke	1.68	1.47		-0.21	0.06	-0.15
Metabolic conditions						
Diabetes	2.01	1.70		-0.30	0.36 **	0.06
Obesity	0.14	0.33	*	0.19 *	-0.29	-0.10
Musculoskeletal conditions						
Arthritis/Joint pain	3.72	3.75		0.04	-0.17	-0.14
Pain in the back or neck	1.32	1.51		0.19	0.02	0.21
Sensory impairments						
Hearing difficulty	0.71	0.72		0.02	0.30 *	0.32
Vision difficulty	2.19	1.60	**	-0.59 **	0.67 **	0.08

[a]Model controls for demographic factors shown in Table 3, cancer, lung problems, and mental distress.
p+ indicates test for difference between 1997 and 2004; all other tests are for difference from 0.
* p<.05 ** p<.01