Title

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Journal

Population Research and Policy Review, 34(1)

ISSN

0167-5923

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Publication Date

2015-02-01

DOI

10.1007/s11113-014-9337-6

Peer reviewed

Popul Res Policy Rev (2015) 34:1–18
DOI 10.1007/s11113-014-9337-6

Are Differences in Disability-Free Life Expectancy by Gender, Race, and Education Widening at Older Ages?

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Received: 12 October 2012 / Accepted: 19 May 2014 / Published online: 1 June 2014

Abstract To examine change from 1991 to 2001 in disability-free life expectancy in the age range 60–90 by gender, race, and education in the United States. Mortality is estimated over two 10-year follow-up periods for persons in the National Health Interview Surveys of 1986/1987 and 1996/1997. Vital status is ascertained through the National Death Index. Disability prevalence is estimated from the National Health and Nutrition Examination Surveys of 1988–1994 and 1999–2002. Disability is defined as ability to perform four activities of daily living without difficulty. Disability-free life expectancy increased only among white men. Disabled life expectancy increased for all groups—black and white men and women. Racial differences in disability-free life expectancy widened among men; gender differences were reduced among whites. Expansion of socioeconomic differentials in disability-free life at older ages occurred among white men and women and black women. The 1990s was a period where the increased years of life between ages 60 and 90 were concentrated in disabled years for most population groups.

Electronic supplementary material The online version of this article (doi:10.1007/s11113-014-9337-6) contains supplementary material, which is available to authorized users.

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Keywords Disability-free life expectancy · Disabled life expectancy · Socio-economic differences · United States

Introduction

There are marked differences in health in the United States (U.S.) by gender, by race, and by socioeconomic status (SES). Women live longer than men but are thought to be less healthy than men (Read and Gorman 2010; Bird and Rieker 2008; Verbrugge 1984); whites generally live both longer and in better health than blacks (Haas and Rohlfsen 2010; Williams and Mohammed 2009; Hayward and Heron 1999); and persons of higher SES live longer and have fewer health problems than those with lower status (Dupre 2007; Geruso 2012; Lantz et al. 1998; Williams and Collins 1995).

As the U.S. continues to have an increasingly older population, it is imperative to understand how the expected lifecycles of the population and its more vulnerable subgroups are changing. Trends in disability-free life provide an assessment of trends in the average length of life of a certain health quality, while trends in disabled life can provide an indication of trends in the length of life with need for assistance and support (Wagener et al. 2001). Because mortality and disability trends can differ and because both sets of trends can be differential for subgroups of the population, we investigate how recent changes in mortality and morbidity interact to change disability-free and disabled life expectancy by gender, race, and education for older American adults (aged 60–90). Differentials in the length of disability-free and disabled life provide important indicators of the relative welfare of population subgroups, while changes provide an indicator of change in relative welfare. It is important to monitor such welfare changes in order to evaluate the need for potential intervention and amelioration of differences.

Background

While life expectancy has generally increased over time for all subgroups of the population, some groups have gained more than others. For instance, in the last 30 years, U.S. males had a faster rate of mortality decline than females, resulting in a narrowing of sex differences in life expectancy (Pampel 2002; Kindig and Cheng 2013; Crimmins et al. 2011). While life expectancy for blacks has always been lower than that of whites up to the oldest ages (Rogers et al. 2000), there appears to have been a narrowing of the Black–White mortality gap in recent years (Harper et al. 2007; Harper et al. 2012).

A large body of literature shows a strong link between SES and health (Dupre 2007; Ross and Wu 1995). The resources and life conditions associated with low SES are regarded as a fundamental cause of the enduring health inequalities in the U.S. (Phelan et al. 2010). Empirical evidence consistently shows SES differentials in health and life expectancies in which those with low SES experience shorter life

and more years in poor health (Crimmins and Cambois 2003; Lievre et al. 2008). Educational differences in active life expectancy appear even greater than race differences in the older American population (Crimmins et al. 1996). Moreover, recent evidence suggests an increasing gap in adult life expectancy across educational groups over the past 20 years (Montez et al. 2011; Meara et al. 2008; Olshansky et al. 2012), mainly because of increases in life expectancy being limited to those with higher education (Meara et al. 2008). For instance, the education gap in mortality risk appears to have widened more for women than for men (Cutler et al. 2010; Meara et al. 2008; Miech et al. 2011; Montez et al. 2011; Jemal et al. 2008).

Empirical evidence regarding trends in disability in recent decades has been mixed. Some research indicates reductions in disability and in functional limitations among the elderly during the 1990s but recent trends appear to be variable by age (Freedman et al. 2013; Schoeni et al. 2008). Disability among the very old may have continued to decrease but a number of researchers report increased disability among younger old, or baby boomers, and most markedly among non-Whites (Alley and Chang 2007; Seeman et al. 2010). On the other hand, Schoeni et al. (2009) reported a narrowing of disability between minority group members and non-Hispanic whites from 1992 to 2002.

As life expectancy has increased, the evidence is mixed on whether additional years of life are accompanied by increases in healthy life years. Three decades ago, Fries and others put forth diverging views on the consequences on healthy life of improving medical care and increasing life expectancy. While Fries (1980) believed that the same forces that reduced mortality and increased life expectancy would delay the onset of major chronic disease and disability leading to a reduced time spent in bad health, Gruenberg (1977) argued that improvements in medical technology would be accompanied by an increase in the duration and prevalence of disease and disability. Manton (1982), on the other hand, posited that mortality and disability would change together resulting of reduction in the severity and progression of chronic disease as well as mortality decline. Using a model to investigate the effect of changes in mortality and disability, Crimmins et al. (1994) have shown that increases in disability-free life will occur when disability onset is reduced because health has improved; but when only mortality improves, disability-free life does not increase along with life expectancy because generally the disabled are kept alive longer.

While examination of earlier periods did not produce empirical evidence of increasing life expectancy without disability, it appears to have been increasing across the age range in the U.S. since the 1980s (Crimmins and Saito 2001; Crimmins et al. 1997). Studies limited to the older population have reported that with increasing life expectancy, there has been a recent increase in active or disability-free life expectancy and some studies report a decrease in disabled life (Cai and Lubitz 2007; Crimmins et al. 2009; Manton et al. 2008). Varying definitions of disability and age of the samples across studies are one source of the variability in results. Examination of differential change across race and education groups showed that educational differences in active life among the adult population of the U.S. increased from the 1970s through the 1990s due to widening of the

differences in both mortality and morbidity (Crimmins and Saito 2001). Crimmins and Saito (2001) reported that only the highly educated experienced a compression of morbidity in the 1980s, whereas those of lower status experienced expansion of morbidity.

The current analysis examines how recent complex trends in mortality and disability have interacted to change the length of disability-free and disabled life among older Americans over the decade from 1991 to 2001, and how these changes affect differentials by gender, race, and education. Given recent trends, our hypotheses are that not all subgroups will experience increases in life expectancy, that increases in disability-free life expectancy will be limited to those of higher SES and men, and that some groups are likely to experience increases in the length of disabled life expectancy. Overall we expect that men and women will become more similar in their expected lifecycles; and that persons with higher education will become less similar into those of lower education in their expected lifecycles as there is a widening of socioeconomic disparities over this period.

Methods

Data

We use data from the National Health Interview Survey (NHIS) to estimate mortality and life expectancy by age, gender, race, and education. NHIS mortality follow-up is based on linkage to the National Death Index (NDI). Estimates of the completeness of coverage of the NDI range from 93 to 100 % (Boyle and Decouflé 1990; Kraut et al. 1992).

We use two years of baseline data from the NHIS for each period in order to have a sample size that will produce reliable mortality estimates by education: 1986/1987 and 1996/1997. Non-Hispanic black and non-Hispanic white sample members aged 60 through 89 with information on education and who could be followed in the NDI were included in our analysis. We do not include people aged 90 years or older because the NHIS top codes age at 90 and we cannot determine the exact age at death for these people. We eliminated Hispanics, and persons without information on education. The sample sizes for mortality estimation are 27,515 (11,663 males and 15,852 females) in 1986/87 and 19,041 (8,211 males and 10,830 females) in 1996/1997. The NDI match identified 8,707 and 6,011 deaths in the samples during the two 10-year follow-up periods (Table 1).

Because of changes in survey procedures for collecting disability measures in the NHIS beginning in 1997, we cannot use disability data from this source to study disability trends over this time period. Disability data for this analysis are from the National Health and Nutrition Examination Surveys (NHANES) III (1988–1994) and NHANES 1999–2002. Sample sizes for constructing measures of disability include 5,138 individuals in NHANES III and 2,713 in NHANES 1999–2002. Using disability data from NHANES and mortality data from NHIS means that the corresponding estimates for the first cohort are centered in 1991 and for the second

Table 1 Characteristics of non-Hispanic black and white participants 60–89 in NHIS samples for 1986–1987 and 1996–1997

Variables	1986–1987			1996–1997		
	Total (n = 27,515)	Blacks (n = 3,417)	Whites (n = 24,098)	Total (n = 19,041)	Blacks (n = 2,489)	Whites (n = 16,552)
Mean age (years)	70.0	69.5	70.0	70.7	69.7	70.8
Women (%)	57.0	57.8	57.0	56.3	59.5	55.9
Education (%)						
2 Education categories						
Less than HS	42.7	71.0	39.9	30.3	52.4	28.1
HS or more	57.3	29.0	60.1	69.7	47.6	71.9
3 education categories						
Less than HS	–	–	39.9	–	–	28.1
HS	–	–	35.5	–	–	21.8
More than High School	–	–	24.6	–	–	50.1
ADL disability (%)	20.0	24.0	19.6	23.0	28.5	22.9
Person-years lived period 1986/1987–1995 and 1996/1997–2005	223,758	27,303	196,455	156,264	20,063	136,201
Number of deaths	8,707	1,184	7,523	6,011	850	5,161

Note Percent with ADL disability from NHANES. Means and percentages were estimated using sample weights; n corresponds to the actual analytic sample size.

Source Mortality NHIS, 1986–1987 and 1996–1997; Disability, NHANES III (1988–1994) and NHANES 1999–2002

cohort in 2001. Sample data were weighted in all analyses to represent the non-institutionalized U.S. adult population.

Measures

Disability status is based on ability to perform four activities of daily living (ADLs) and is determined by responses to the question "By yourself and without using special equipment, how much difficulty do you have in: (1) walking from one room to another on the same level, (2) getting in or out of bed, (3) eating, like holding a fork, cutting food or drinking from a glass, and (4) dressing yourself, including tying shoes, working zippers, and doing buttons?" Response categories are "no difficulty, some difficulty, much difficulty, and unable to do." Disability is defined as reporting at least some difficulty (some difficulty, much difficulty, or unable to do) with at least 1 of these basic self-maintenance tasks.

Education is used as the indicator of SES because it is relatively well reported and stays constant throughout adult life for most people. Importantly, there is less likely to be reverse causation between education and health at older ages than with other measures of SES such as income, wealth, or occupation. Respondents are categorized into two groups using completed years of education: less than high school (11 years of schooling or less) and high school or more (12 or more years of schooling). For whites, for whom the sample size is larger and educational levels are higher, we conducted additional analyses dividing the higher education group into two categories, high school (12 years) and more than high school (13 years of schooling or more). The sample sizes for blacks are too small to replicate this.

Methodology

First, we estimated the association of education and age with mortality by fitting log-linear hazard models within race and gender groups for the two 10-year periods. We use the results from these models to estimate age-specific mortality rates for 10-year age groups and then construct life tables for ages 60 through 90 by gender, race, and education for each period using standard demographic techniques (Preston et al. 2001). As indicated above, age is top-coded at 90 years in the NHIS, so the hazard models were fitted up to this age and life expectancy is estimated to this age. Our measure of life expectancy is temporary life expectancy between ages 60 and 90[1], i.e., the average number of years lived in the 30-year age range. A comparison of the estimated life expectancies with those from the national vital statistics is available from the authors upon request. Disability prevalences and standard errors by age, gender, and race are obtained from NHANES taking into account the complex survey-sampling design.

Disability-free life expectancy is estimated using the *Sullivan* method (Jagger 1999; Sullivan 1971), a prevalence-based method of dividing life-table years lived in an age interval into years with and without disability based on the disability

[1] In 1997, the NHIS data are top-coded at age 85, requiring us to estimate mortality for those 85–89 from only the 1996 data.

prevalence of that age group. We combined disability prevalence from NHANES with estimated life-table years from NHIS to estimate life expectancies with and without disability. We also estimate 95 % confidence intervals for life expectancy with and without disability taking into account the two sources of sampling variation—NHIS and NHANES. A bootstrap approach is implemented to estimate standard errors for all life-table values in NHIS as proposed by Schenker et al. (2011); we then combine the variance estimates from the bootstrap method with those from the prevalence estimates from NHANES (see Appendix A for details). Expected years lived without disability at age 60 were computed by summing the years lived without disability from age 60 up to age 90. Years lived with disability were estimated in the same way. Analyses were conducted using Stata software, version 12 (StataCorp), and R software.

Results

Characteristics of the sample used to estimate mortality are shown in Table 1. Individuals average about 70 years of age, with non-Hispanic whites less than one year older on average than non-Hispanic blacks in both time periods. The sample includes somewhat more women than men, 57.0 % in 1986/1987 and 56.3 % in 1996/1997. At the later date, more people are in the high education category and fewer in the low education category. Non-Hispanic blacks experienced a 19.3 % increase and non-Hispanic whites an 11.7 % increase in the percentage of people with the highest educational category over the 10 years. The three-education categorization for whites shows how the highest education group significantly increased from 24.6 to 50.1 % in this period.

Disability Trends

The proportion of the population with ADL difficulties for each age, gender, race, and education group in 1991 and 2001 is shown in Fig. 1. The prevalence of ADL difficulties among most groups increased over time, although not significantly. Increases in disability among 60- to 69-year-old males are significant among both whites and blacks with low education as well as black males with high education. There are no significant decreases in ADL difficulty within any group.

Mortality Trends

Life expectancy between ages 60 and 90 increased over time for white men, black men, and black women; however, only for white males life expectancy is the increase significant (Table 2). There was no change among white women. The gender difference in life expectancy among whites was reduced as white females saw no improvement and white men experienced an increase of 1.3 years. The increase for black males and females is similar, so there is no change in the sex differential in life expectancy.

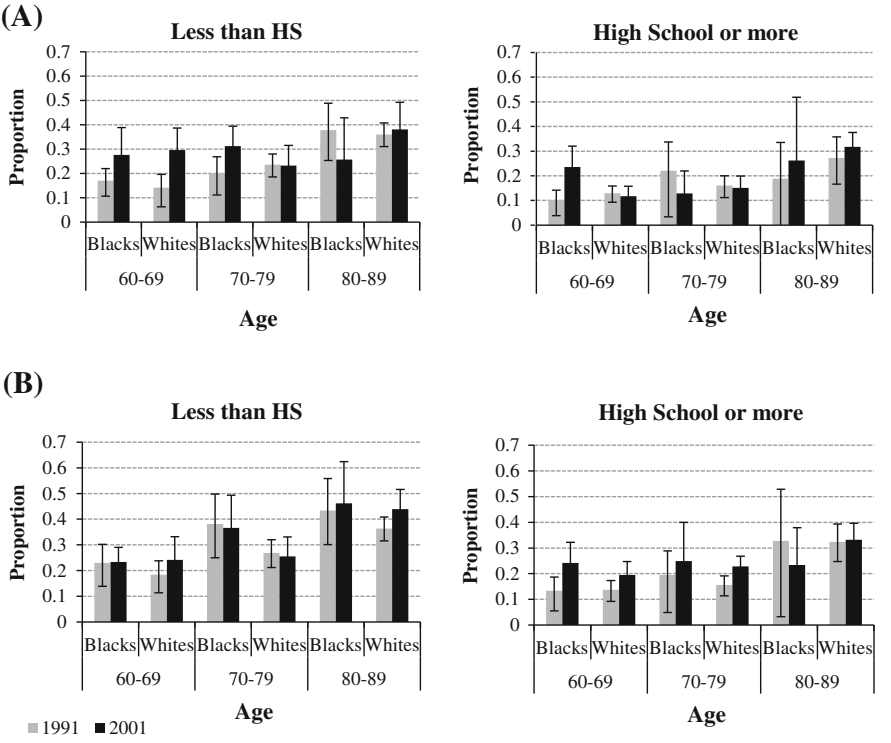

Fig. 1 Proportion with ADL difficulties in 1991 and 2001 by sex, race, age, and education groups. **a** Men, **b** women. *vertical bars* represent 95 % confidence intervals. *Source* NHANES III and NHANES 1999–2002

Every subgroup had educational differences in life expectancy. Educational differences widened somewhat over time for whites and black women, although the differences are generally not significant. In 2001, educational differences in temporary life expectancy for all groups were in the 2.0–1.4 range; over time there was some widening of the life expectancy educational differential among white men and women and black women. Temporary life expectancy among those with low education increased for white men and it decreased for white women and black women. For those in the higher education category, the increases were greatest for white men, while there were decreases among more highly educated black men.

Trends in Disability-Free and Disabled Life Expectancy in 1991 and 2001

Values of temporary disability-free life and disabled life expectancy from ages 60 to 90 for the two time periods are also presented for gender, race, and educational groups in Table 2. White males benefitted the most from trends in mortality and disability over the two decades, as they are the only gender–race group with increases in the length of disability-free life; and had the smallest increase in

Table 2 Temporary life expectancy, disability-free life expectancy, and disabled life by race, sex, and education at age 60–90: 1991 and 2001

	Temporary life expectancy				Disability-free life expectancy				Disabled life expectancy			
	Males		Females		Males		Females		Males		Females	
	Whites	Blacks	Whites	Blacks	Whites	Blacks	Whites	Blacks	Whites	Blacks	Whites	Blacks
Panel A: 1986/1987–1995 (centered in 1991)												
Total	18.7 (18.6,18.9)	16.4 (16.1,16.8)	22.5 (22.4,22.7)	20.9 (20.5,21.3)	15.3 (14.9.15.7)	13.2 (12.6,13.8)	17.7 (17.3,18.2)	15.0 (14.0,16.0)	3.5 (3.1,3.9)	3.2 (2.7,3.7)	4.8 (4.4,5.3)	5.9 (4.9,6.8)
Education												
0–11 years	17.9 (17.7,18.1)	16.0 (15.6,16.5)	22.1 (21.8,22.3)	20.6 (20.1,21.1)	14.2 (13.5,14.8)	12.7 (11.9,13.4)	16.5 (15.8,17.2)	13.9 (12.7,15.2)	3.7 (3.1,4.3)	3.3 (2.7,4.0)	5.6 (4.9,6.3)	6.7 (5.5,7.9)
12+ years	19.3 (19.1,19.5)	17.5 (16.5,18.6)	22.8 (22.6,23.1)	21.5 (20.8,22.2)	16.1 (15.6,16.6)	14.8 (13.5,16.1)	18.5 (17.9,19.2)	17.2 (15.6,18.8)	3.2 (2.7,3.7)	2.7 (1.6,3.9)	4.3 (3.7,4.9)	4.3 (2.7,5.8)
Within race Ed Diff	1.4	1.5	0.7	0.9	1.9	2.1	2.0	3.3	−0.5	−0.6	−1.3	−2.4
Panel B: 1996/1997–2005 (centered in 2001)												
Total	20.0 (19.8,20.2)	16.6 (16.2,17.1)	22.5 (22.3,22.7)	21.0 (20.6,21.5)	15.9 (15.3,16.5)	12.3 (11.3,13.2)	16.6 (16.0,17.2)	14.4 (13.2,15.6)	4.1 (3.5,4.7)	4.4 (3.5,5.3)	5.9 (5.3,6.5)	6.6 (5.5,7.8)
Education												
0–11 years	18.7 (18.3,19.1)	16.0 (15.3,16.6)	21.0 (20.7,21.4)	20.3 (19.6,20.9)	13.4 (12.2,14.5)	11.4 (10.1,12.8)	15.0 (13.8,16.1)	13.7 (12.4,15.0)	5.4 (4.3,6.5)	4.5 (3.3,5.8)	6.0 (4.9,7.2)	6.6 (5.3,7.9)
12+ years	20.5 (20.3,20.7)	17.4 (16.7,18.2)	23.0 (22.7,23.2)	21.8 (20.9,22.4)	17.0 (16.4,17.7)	13.8 (12.0,15.7)	17.5 (16.8,18.2)	16.5 (14.5,18.4)	3.4 (2.8,4.1)	3.5 (1.7,5.4)	5.5 (4.8,6.2)	5.2 (3.4,7.2)
Within race ed diff	1.8	1.4	2.0	1.5	3.6	2.4	2.5	2.8	−2.0	−1.0	−0.5	−1.4
Time change 0–11	0.8	0.0	−1.1	−0.3	−0.8	−1.3	−1.5	−0.2	1.7	1.2	0.4	−0.1
Time change 12+	1.2	−0.1	0.2	0.3	0.9	−1.0	−1.0	−0.7	0.2	0.8	1.2	0.9
Time change for total	1.3	0.2	0.0	0.1	0.6	−0.9	−1.1	−0.6	0.6	1.2	1.1	0.7

95 % Confidence intervals in parenthesis. *"Ed Diff"*: Educational differences between the higher and the lower educational groups. All results take into account the complex sampling design including sample weights to represent the non-institutionalized adult U.S. population

Source Mortality NHIS, 1986–1987 with mortality follow-up through 1995 and 1996–97 with mortality follow-up through 2005, disability NHANES III (1988–1994) and NHANES 1999–2002

Table 3 Percent of total life expectancy spent disability-free between ages 60 and 90

	Males		Females	
	Whites	Blacks	Whites	Blacks
Panel A: 1986/1987–1995 (centered in 1991)				
Total	0.82	0.80	0.79	0.72
Education				
0–11 years	0.79	0.79	0.75	0.67
12+ years	0.83	0.85	0.81	0.80
Panel B: 1996/1997–2005 (centered in 2001)				
Total	0.80	0.74	0.74	0.69
Education				
0–11 years	0.72	0.71	0.71	0.67
12+ years	0.83	0.79	0.76	0.76

Source Mortality: NHIS, 1986–1987 with mortality follow-up through 1995 and 1996–1997 with mortality follow-up through 2005, disability: NHANES III (1988–1994) and NHANES 1999–2002

disabled life expectancy. White females, black males, and black females experienced relatively large decreases in disability-free life but large increases in disabled life. For example, for white males, about half of the increase in total life expectancy is in disability-free life (0.6 years out of 1.3 years). White females experienced no increase in temporary life expectancy and a decrease in disability-free life expectancy (−1.1 years) that was the same as the size of the increase in disabled life (1.1 years). Black men and women experienced decreases in disability-free life (−1.1 and −0.6) and increases in disabled life (1.2 and 0.7 years). It is noteworthy that disabled life increased for all groups: black and white, men and women. The largest increases were for black men (1.2 years) and white women (1.1 years), and the smallest for white men (0.6 years).

We can estimate the overall change in expected burden of disability for groups by examining the percentage of years spent disability-free (Table 3). For all four groups, black and white, men and women, there was a decline. Overall it declined the least for white males (2 percentage point reduction) and the most for black males (6 percentage point reduction). The percentage remained constant for white men with high education and black women with low education; while it declined for all other groups.

Summary of Changes in Differences

The effect of the changes over time in mortality and disability for whites was to reduce the female advantage in life expectancy from age 60 to 90 (from 3.8 to 2.5 years); to reduce the female advantage in years of disability-free life (from 2.4 to 0.7 years) and to increase the female excess in disabled life (from 1.3 to 1.8 years) (Fig. 2). This means that at the earlier date, most of the additional years lived by white women relative to white men were in disability-free years but most of

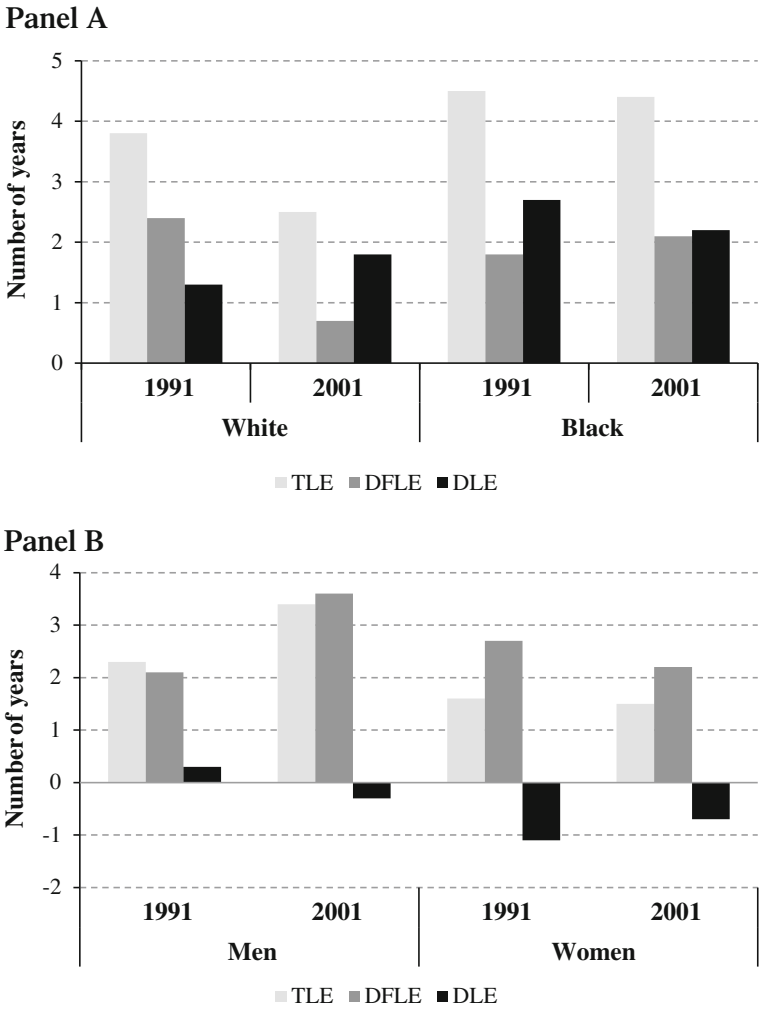

Fig. 2 Differences between women and men, and whites and blacks in total life expectancy 60–90, disability-free life expectancy, and disabled life**. a** Gender differences-(female–male), **b** race differences-(white–black). *TLE* Temporary Life Expectancy, *DFLE* Disability-free Life Expectancy, *DLE* Disabled Life Expectancy. *Source* Table 1

the excess life expectancy of white women is in disabled years at the later date. Among blacks, the gender difference in overall temporary life expectancy remains unchanged (4.5 and 4.4 years); with some reduction in the number of excess years of disability expected for women (from 2.7 to 2.2 years) and a small increase in the female advantage in disability-free years (1.8–2.1).

Race differences in total life expectancy between ages 60 and 90 increased for men (from 2.3 to 3.4 years—more years expected for white men); this resulted from increases in the size of the white male advantage in disability-free life expectancy (from 2.1 to 3.6 years) with a decline in race difference in disabled life expectancy

(from 0.3 to −0.3—more years expected to be disabled for black men). There was no increase in the white advantage in overall life expectancy for women (1.6–1.5 years); although there was a reduction in the advantage for white women in disability-free years (from 2.7 to 2.2); this was accompanied by a reduction in the excess years of disability lived by black women (from 1.1 to 0.7).

For white men, the educational difference in disability-free life increased by 1.7 years over this time period (Table 2). While white men in the lower education category experienced a decrease in disability-free life expectancy (−0.8 years), white men in the higher education category had an increase (0.9 years). White females had a small increase in the educational difference in disability-free life; although both educational groups experienced decreases in disability-free life expectancy, the decrease was larger among women with less education (1.5 vs 1.0 years). Black males had a small increase in the educational differential in disability-free life expectancy (0.3 years) due to declines among both the low and the high educational groups. Education differentials in disability-free life among black females decreased as a result of a larger reduction for the higher educational group (0.7 years). Women of both races increased in disabled life so the educational differential became somewhat smaller for white women (−0.5 years in 2001 vs −1.3 years in 1991) and black women (−1.4 vs −2.4 years). Black men experienced an increase in both educational groups in disabled life expectancy resulting in an increase in the differential in disabled life expectancy (from −0.6 to −1.0 years). For white men, the educational differential in disabled life expectancy was increased because of a large increase in disabled life among the lower education group (1.7 years) and a smaller increase among the higher education group (0.2 years).

Is Life Expectancy, Disability-Free, and Disabled Life Expectancy Widening at Higher Educational Categories for Whites?

For the white population, it is possible to divide the highest educational group into those whose education stopped at high school and those who received more education to examine how socioeconomic change has occurred within this segment of the population (Table 4). When three educational groups are considered for white men, all three educational groups experienced similar increases in total temporary life expectancy between ages 60 and 90 during the period (from 0.8 to 1.0) but for those with the most education, this increase was concentrated in disability-free life expectancy (0.8 years); those with a high school education experienced a small increase in disability-free life (0.3 years) and a much larger increase in disabled years (0.7 years); while for those with the lowest education, the decrease in disability-free life was large (−1.0 year) with an even larger increase in disabled years (1.8 years). Thus, for males, there was a gradient in the change with those in the highest group doing best, and those in the lower education groups doing progressively worse.

For white females, the pattern of change within education groups differs from that of males. The two higher education groups maintain relatively constant overall life expectancy (change of 0.2 and −0.1), but with very different change in the

Table 4 Temporary life expectancy, disability-free life expectancy, and disabled life for whites, by sex and education at age 60–90: 1991 and 2001

	Temporary life expectancy		Disability-free life expectancy		Disabled life expectancy	
	Males	Females	Males	Females	Males	Females
Panel A: 1986/1987–1995 (centered in 1991)						
Education						
0–11 years	17.9 (17.7,18.1)	22.1 (21.83,22.33)	14.2 (13.5,14.8)	16.5 (16.8,17.2)	3.7 (3.1,4.3)	5.6 (4.9,6.3)
12 years	18.7 (18.5,19.0)	22.6 (22.36,22.92)	15.7 (15.1,16.4)	18.5 (17.8,19.2)	3.0 (2.4,3.6)	4.2 (3.5,4.9)
13+ years	20.0 (19.6,20.3)	23.2 (22.83,23.55)	16.6 (15.8,17.4)	18.7 (17.7,19.6)	3.4 (2.6,4.2)	4.5 (3.6,5.5)
Educational differences	2.1	1.1	2.4	2.2	−0.3	−1.1
Panel B: 1996/1997–2005 (centered in 2001)						
Education						
0–11 years	18.7 (18.3,19.0)	21.0 (20.7,21.4)	13.2 (12.1,14.3)	14.8 (13.6,15.9)	5.5 (4.4,6.6)	6.2 (5.0,7.4)
12 years	19.7 (19.2,20.2)	22.8 (22.3,23.3)	16.0 (14.9,17.2)	16.2 (15.3,17.3)	3.7 (2.6,4.9)	6.6 (5.6,7.6)
13+ years	20.8 (20.5,21.0)	23.1 (22.8,23.4)	17.4 (16.6,18.1)	18.3 (17.2,19.4)	3.4 (2.6,4.1)	4.8 (3.7,5.9)
Educational Differences	2.1	2.0	4.2	3.5	−2.1	−1.4
Time Change 0–11	0.8	−1.1	−1.0	−1.7	1.8	0.6
Time Change 12	1.0	0.2	0.3	−2.3	0.7	2.4
Time Change 13+	0.8	−0.1	0.8	−0.4	0.0	0.3

95 % Confidence intervals in parenthesis. Educational differences between the highest and the lowest educational groups

Source Mortality: NHIS, 1986–1987 with mortality follow-up through 1995 and 1996–1997 with mortality follow-up through 2005; disability: NHANES III (1988–1994) and NHANES 1999–2002

components. For women who graduate from high school and do not go on, years of disability free-life decrease by 2.3 and disabled years increase by 2.4; women with higher education also have offsetting changes but they are much smaller (−0.4 and 0.3). For women with less than high school, years of disability-free life decrease by 1.7 and disabled years increase by 0.6. Thus, it is white women who have not gone beyond high school who seem to suffer the largest deterioration over the decade; women in the highest education category do not deteriorate as much but they do not improve as men do.

Discussion

During the 1990s in the U.S. older population, gender differentials in life expectancy narrowed; race differentials in life expectancy expanded for men but not women; and socioeconomic differences increased especially for women. Our results also find that only white men have experienced improvements in disability-free life expectancy. This differs from earlier findings that did not separate men and women, used older samples, and used somewhat different definitions of disability (Cai and Lubitz 2007; Crimmins et al. 2009).

While others have documented declines in life expectancy for low educated women (Olshansky et al. 2012), we find growing educational differences in disability-free life expectancy—except for black females. It may be that poor health behaviors are becoming more concentrated among low educated women resulting in some of their relative health deterioration (Crimmins et al. 2010). During the 10-year period from 1991 to 2001, disability-free life increased only for white males; it decreased for blacks and white women. Our findings indicate that blacks continue to live shorter lives with more disabled years than whites (Hayward and Heron 1999). On the other hand, average disabled life expectancy increased for all groups. White women spend one more year disabled between age 60 and 90 compared to white men; black men experienced the largest increase in disabled life. The situation of white women deteriorated relative to white men, while the gender differentials remained relatively similar among blacks. Race differences in total and disability-free life expectancy have gotten wider for men but not for women. Within race–gender groups, educational differences in disability-free life expectancy have widened, except for black females. Our results show that in this period, widening educational differences extend trends documented for before 1990 (Crimmins and Saito 2001).

Disaggregating life expectancy into disability-free and disabled life has made it clear that, over this decade, trends in disability and mortality have combined to produce a deteriorating health situation for much of the older population. In the past, trends toward improving health have often been attributed to increases in population educational level. In this period, there were major increases in the average educational level but they were not enough to counterbalance the deteriorating health conditions leading to decreases in disability-free life expectancy and increases in the time spent disabled.

We have presented our analysis in terms of changes in average years of life spent with disability and free of disability, which provides an indicator of change in an average expected individual life cycle. The population effect of the burden of disability increase is better indicated by years of life lived with disability. The effect of the increase in years of life lived with disability from age 60 to 90 on the total population of the U.S. is related to the increasing size of these age groups. For example, if we multiply the estimated years spent disabled from 60 to 90 in the life table population by the number of people in the age range, we get an estimate of the actual impact of disability at the two dates, as well as the increase. The increase in the total number of disabled years that would be lived by the actual population as it ages from 60 to 90 in the U.S. and as conditions changed from those in 1991 to those in 2001 would be about 43.5 million person-years of disability.

Our analysis was limited by only being able to consider life expectancy between age 60 and 90; it is possible that trends at other ages would differ. In addition, the disability that we examine is fairly severe disability as it is indicative of having difficulty in providing self-care. It is possible that trends in life expectancy with more mild disability would differ from those observed here.

In conclusion, this analysis documents widening gender and educational differences that extend trends begun before 1990. We show increasing racial and educational differences in disability-free life expectancy between ages 60 and 90 through the 1990s up to the early years of this century. Similarly, average disabled life expectancy increased for all groups during the period. Moreover, within race–gender groups, educational differences in disability-free life expectancy have widened, except for black females. We suggest that for the potential of increased in life expectancy in improving human welfare to be more fully realized, it is important to develop programs, policies, and promote behaviors that directly affect the delay and reduction of disability. For instance, higher levels of education are directly associated with the adoption of healthier lifestyles and more effective management of chronic diseases (Goldman and Smith 2002) which are precursors of disability. Thus, implementing public policies that encourage continuing learning of health priorities for older people could raise awareness of disease management and may delay the progression of the disease. There is also the need for population-level interventions to reduce the incidence and prevalence of major health risk factors such as obesity, hypertension, and dyslipidemias. The Patient Protection and Affordable Care Act (2010) has the potential to prevent and delay the progression of these conditions by providing access to health care to a large sector of the U.S. population. To the extent that the Affordable Care Act improves the health of those at the bottom of the SES distribution, there is likely to be a reduction in the SES differences in disability as those with low SES are losing ground with respect to disability-free life expectancy. Without the implementation of these policy approaches, disparities in health by gender, race, and education may continue to increase.

Acknowledgments The authors gratefully acknowledge the funding provided from the Spanish Ministry of Science and Innovation (ECO2010-21787-C03-01); the Beatriu de Pinós grant 2010–2012; the U.S. National Institute on Aging (P30AG017265; T32AG000037); the David E. Bell Fellowship

(Center for Population & Development Studies, Harvard University) and the Center for Demography of Health and Aging at the University of Wisconsin-Madison.

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