Different Paths to Extreme Old Age: Examining Morbidity and Disability Profiles of U.S. Adults Who Survive to Age 90 and 100

Jennifer A. Ailshire, Hiram Beltran-Sanchez, Eileen M. Crimmins
Andrus Gerontology Center
University of Southern California

* Corresponding Author contact information:
Jennifer Ailshire
University of Southern California
Andrus Gerontology Center
3715 McClintock Avenue, Room 218C
Los Angeles, CA 90089-0191
Phone: 734.763.4098
Fax: 213.821.2093
E-mail: ailshire@usc.edu

Abstract
Reaching advanced old age is becoming an increasingly common experience in the U.S. There are very few studies of health and functioning of exceptionally long-lived individuals and relatively little is known about the health trajectories of those who survive to extreme old age. The current study uses data from a nationally representative sample of older U.S. adults to examine: 1) differences in social and health characteristics between those who survive to age 90 and 100 and those who do not survive to exceptional old age; and 2) variation in morbidity and disability trajectories of older adults who survive to age 90 or 100. This study contributes to the growing body of research on longevity in the U.S. and globally. Our findings suggest that morbidity and disability trajectory profiles can be used to understand variability in the paths to longevity.

Background

Reaching advanced old age is becoming an increasingly common experience in the United States. Among those born in 1920 who reached age 65, 14% of men and 27% of women survived to age 90 and lived, on average, an additional 4 years.[1] As a result of gains in life expectancy at older ages a growing segment of the U.S. population is experiencing exceptional longevity (i.e. living to 90 and 100 years of age).[2,3]

There are very few studies of exceptionally long-lived individuals, particularly in the U.S., and research findings on the health and functioning of exceptional survivors are inconsistent. Some studies of exceptional survivors find that physical health declines dramatically with advanced old age,[4] and that those who achieve exceptional longevity are generally unhealthy.[5] However, there is evidence that exceptional survivors are relatively healthy and high-functioning for most of their lives,[6] a robustness necessary for survival to very old age,[7] and experience rapid health declines only near the end of their lives. Although death is often preceded by declining health, the timing of health declines varies and some exceptionally long-lived individuals may be able to delay health declines and remain relatively healthy and high-functioning in advanced old age. In a study of men and women aged 97-119, Evert et al. found that there are multiple routes to achieving exceptional longevity and that while the most typical experience involves surviving into advanced old age with disease, there are a number of individuals who achieve exceptional longevity with little or no burden of age-related diseases. They present morbidity profiles of individuals who survived to age 100 that differentiate between those who had an age of disease onset of less than 80 years (Survivors), those who had an age of onset between 80 and 100 years of age (Delayers), and those who had not yet been diagnosed with any diseases by age 100 (Escapers).

While some exceptionally long-lived individuals will experience diminished health and functioning, others may remain relatively healthy and functional, suggesting there is variability in the experience of exceptional longevity. However, we still have limited understanding of the paths to longevity in the U.S. The current study uses data from a nationally representative sample of older U.S. adults to examine: 1) differences in social and health characteristics between those who survive to age 90 and 100 and those who do not survive to exceptional old age; and 2) variation in morbidity and disability trajectories of older adults who survive to age 90 or 100.

Data and Measures

We use data from the ongoing Health and Retirement Study, using the portion of the sample that began as the study of Asset and Health Dynamics Among the Oldest Old (AHEAD), which is designed to provide a representative sample of the community-based U.S. resident population aged 70 and older (i.e. born in 1923 or earlier) in 1993. Baseline interviews were conducted in 1993/1994, with follow-up interviews conducted in 1995/1996 and every other year from 1998 to 2008, the last interview year for which data are fully available (analyses will include 2010 data when the complete data have been released). The objective of AHEAD is to monitor changes in physical, functional, and cognitive health in advanced old age. Due to extensive on-going follow-up, AHEAD provides an ideal opportunity to study U.S. adults as they reach very old age and to gain insights into the health trajectories of exceptionally long-lived individuals.

For the purpose of our analyses we focus on two subsamples of respondents. The first sample includes (n=498) individuals who were 75 years of age at baseline and could have survived to age 90 by the end of the 15-year follow-up period. The second sample includes (n= 209) individuals who were 85 years of age at baseline and could have survived to age 100 by the end of the 15-year follow-up period.

We determine age at death from respondent reported birth year and survey tracking of year of death. Birth year is self-reported in the baseline interview by the respondent or their proxy. Birth year was reported by proxies for n=44 of those who could have survived to 90 and n=26 for those who could have survived to

100. Age validation is an important issue in studies of extreme longevity because age misreporting escalates in older cohorts. Age misreporting is more likely to occur among the very old due to lack of birth records documenting year of birth.[9,10] This study only included individuals born after 1900, who are more likely to be able to accurately report their birth year.[11,12] Furthermore, birth year was reported accurately by 90% of those who were 75 years of age at baseline and 87% of those who were 85 years of age at baseline according to Medicare data, a reliable administrative source of birth year information.[13]

Sociodemographic Characteristics
Demographic factors include gender, race/ethnicity, education, and marital status. Race/ethnicity is composed of four groups; White, Black, Hispanic, and Other. Respondent education is categorized to distinguish among those with 0-8 years, 9-11 years, 12 years, and 13-17 years of educational attainment. Marital status is measured with separate categories for married/partnered, divorced/separated, widowed, and have never been married. We also examine parental longevity. From respondents' reports of their parents' age at death we created separate measures for mother and father indicating that the parent survived to at least 85 years of age.

Physical Health
Our measures of physical health include a count of chronic conditions and limitations with activities of daily living (ADLs). Number of comorbidites counts the number of six doctor diagnosed diseases and chronic conditions reported by respondents: high blood pressure or hypertension; diabetes or high blood sugar; cancer or a malignant tumor of any kind except skin cancer; chronic lung disease, such as chronic bronchitis or emphysema (excluding asthma); heart attack, coronary heart disease, angina, congestive heart failure, or other heart problem; and stroke. ADL limitations were assessed with a count of the number of six major life activities the respondent had difficulty performing: walking across a room; dressing; bathing; eating; getting in and out of bed; and using the toilet.

Analytic Strategy
We first examined baseline differences in sociodemographic and health characteristics between non-survivors and those who survived to age 90 or 100. We then examine mean trajectories of chronic conditions and ADLs over time by survivorship. Finally, we examine changes in chronic conditions and ADLs over time for those who survived to age 90 or age 100. We model our morbidity and disability profiles on those presented in prior research.

Preliminary Results
Descriptive statistics by survival to age 90 and age 100 are presented in Table 1. The first two columns present weighted means (s.d.) and percents for those who could have survived to age 90. A higher proportion of those who survived to age 90 were women. Race/ethnic composition was similar between non-survivors and survivors. Survivors had a higher proportion of highly educated individuals, widows, and individuals with parents who lived to at least age 85. On average, those who survived to age 90 had fewer diagnosed chronic conditions and ADLs. The second two columns present statistics for those could have survived to age 100. A higher proportion of those who survived to age 100 were women. Only white and black respondents survived to age 100. Survivors had a higher proportion of highly educated individuals, widows. Those who survived to age 100 had a higher proportion of individuals with a mother who lived to at least age 85, but none of the survivors had a father who lived to age 85. On average, those who survived to age 100 had fewer diagnosed chronic conditions and ADLs.

Health trajectories by survivorship to age 90 are presented in Figures 1 and 2. Figure 1 shows the mean number of diagnosed chronic conditions over time by survivorship. Those who survive to age 90 have fewer chronic conditions, on average at baseline, but the trajectories appear to track each other closely, suggesting that survivors have an onset of disease over time that is similar to that of non-survivors. Figure

2 shows the mean number of ADLs over time by survivorship. Survivors to age 90 had fewer ADL limitations at baseline, on average, compared to non-survivors and accumulated ADL limitations at a slower rate over time.

Health trajectories by survivorship to age 100 are presented in Figures 3 and 4. Figure 1 shows the mean number of diagnosed chronic conditions over time by survivorship. Survivors to age 100 had fewer conditions at baseline, compared to non-survivors but accumulated more conditions over time. Figure 2 shows the mean number of ADLs over time by survivorship. The average number of ADL limitations was similar for survivors and non-survivors at baseline. Initially non-survivors accumulated more ADL limitations than survivors did, but around the mid-point of the study period survivors to 100 begin to accumulate ADL limitations at a more rapid rate so that by the near end of the study period non-survivors and survivors again have similar levels of ADL limitations.

We examine pathways to age 90 figures 5 and 6 and pathways to age 100 in figures 7 and 8. Consistent with prior research we find distinct classes represented by escapers who survive to age 90 or 100 with no chronic conditions, delayers who initially did not have and conditions but were then diagnosed with at least one condition, and survivors who live through to old age with diseases. We also examined the disability pathways and found similar patterns. However, because individuals can recover from disability we also found a distinct class of people who began the study with more ADL limitations than when they reached age 90 or 100.

Conclusion

This study contributes to the growing body of research on longevity in the U.S. and globally. Our findings suggest that morbidity and disability trajectory profiles can be used to understand variability in the paths to longevity. The result presented here were not adjusted for mortality, but we plan to do so in future iterations of the work. In addition, we plan to also examine depression and cognition trajectories. Finally, we focused on a narrow age range and will expand our analyses to other ages as well.

References
1. Bell FC, Miller ML. Life tables for the United States social security area, 1900-2100. Social Security Administration, Office of the Chief Actuary; 2002.
2. Annual Estimates of the Resident Population by Sex and Five-Year Age Groups for the United States: April 1, 2000 to July 1, 2009 (NC-EST2009-01). U.S. Census Bureau, Population Division. 2010.
3. Projections of the Population by Age and Sex for the United States: 2010 to 2050 (NP2008-T12). U.S. Census Bureau, Population Division. 2008.
4. Andersen-Ranberg K, Christensen K, Jeune B et al. Declining physical abilities with age: a cross-sectional study of older twins and centenarians in Denmark. Age Ageing 1999;28:373-377.
5. Andersen-Ranberg K, Schroll M, Jeune B. Healthy centenarians do not exist, but autonomous centenarians do: a population-based study of morbidity among Danish centenarians. J Am Geriatr Soc 2001;49:900-908.
6. Hitt R, Young-Xu Y, Silver M et al. Centenarians: the older you get, the healthier you have been. Lancet 1999;354:652.
7. Smith DW. Centenarians: human longevity outliers. Gerontologist. 1997;37:200-206.
8. Evert J, Lawler E, Bogan H et al. Morbidity profiles of centenarians: survivors, delayers, and escapers. J Gerontol A Biol Sci Med Sci 2003;58:232-237.
9. Elo IT, Turra CM, Kestenbaum B, Ferguson BR. Mortality among elderly Hispanics in the United States: past evidence and new results. *Demography*. 2004;41(1):109-128.

10. Elo IT, Preston SH. Estimating African-American mortality from inaccurate data. Demography 1994;31:427-458.

11. Kestenbaum B. A Description of the Extreme Aged Population Based on Improved Medicare Enrollment Data. Demography 1992;29:565-580.

12. Preston SH, Elo IT, Rosenwaike I et al. African-American Mortality at Older Ages: Results of a Matching Study. Demography 1996;33:193-209.

13. Kestenbaum B. and Feguson B.R. Mortality of the Extreme Aged in the United States in the 1990s, based on Improved Medicare Data. North American Actuarial Journal 2002: 6:38-44.

| Table 1. Baseline characteristics by survival to age 90 and 100		Survival to Age 90			Survival to Age 100	
		Died before Age 90 (N=308)	Survived to Age 90 (N=189)		Died before Age 100 (N=191)	Survived to Age 100 (N=18)
		Mean (s.d)/%	Mean (s.d)/%		Mean (s.d)/%	Mean (s.d)/%
Demographic Characteristics						
Gender						
Female		56.0	64.7		67.4	76.9
Male		44.0	35.3		32.6	23.1
Race/Ethnicity						
White		86.6	87.9		87.1	95.5
Black		9.4	7.2		7.1	4.5
Hispanic		3.0	4.6		4.1	0.0
Other		0.9	0.3		1.7	0.0
Education						
0-8 years		20.6	18.2		32.4	22.1
9-11 years		19.5	19.8		18.3	3.6
12 years		34.9	27.6		24.8	28.4
13-17 years		25.1	34.4		24.6	45.8
Marital Status						
Married		57.4	37.4		36.8	24.3
Divorced/Separated		6.2	16.4		2.3	7.1
Widowed		34.2	56.0		57.5	60.9
Never Married		2.2	4.7		3.4	7.7
Parent longevity						
Mother's age at death 85+		29.2	39.0		20.9	42.1
Father's age at death 85+		13.5	15.9		14.0	0.0
Health Status						
Chronic Conditions (0-6)		1.25 (1.01)	0.87 (0.91)		1.28 (1.16)	0.37 (0.62)
ADLs (0-6)		0.37 (0.97)	0.16 (0.70)		0.60 (1.17)	0.46 (0.87)
Note: Standard deviations (s.d.) are presented in parenthesis for continuous variables.						
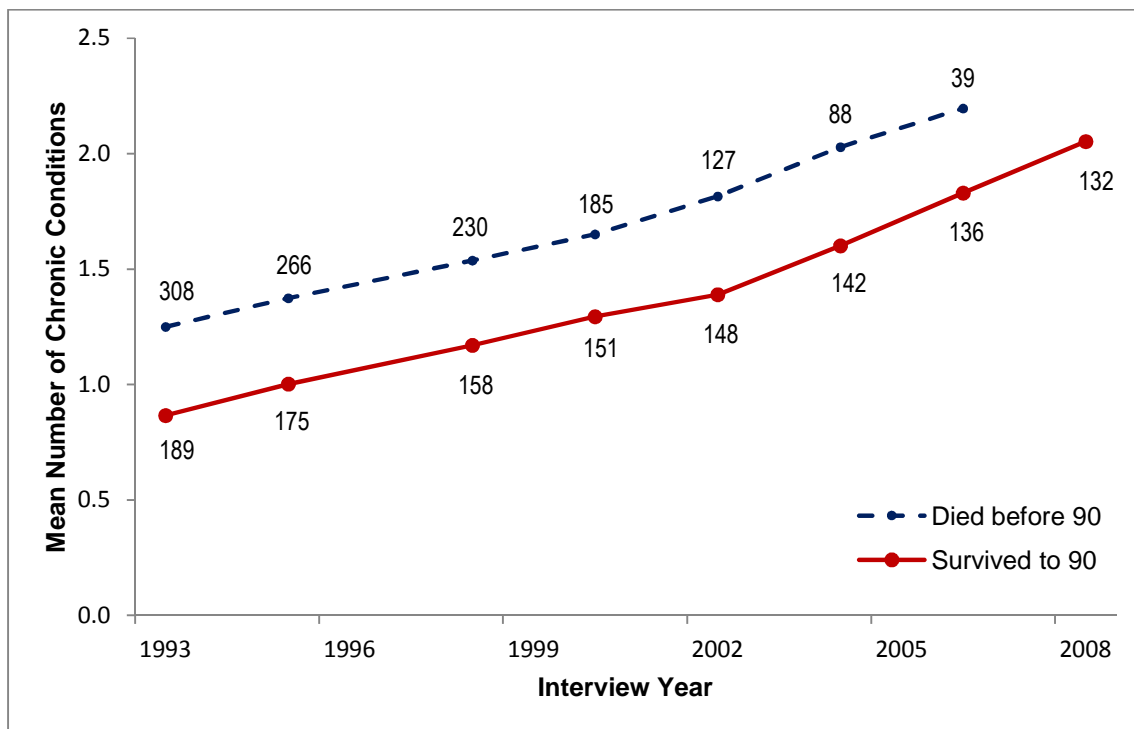
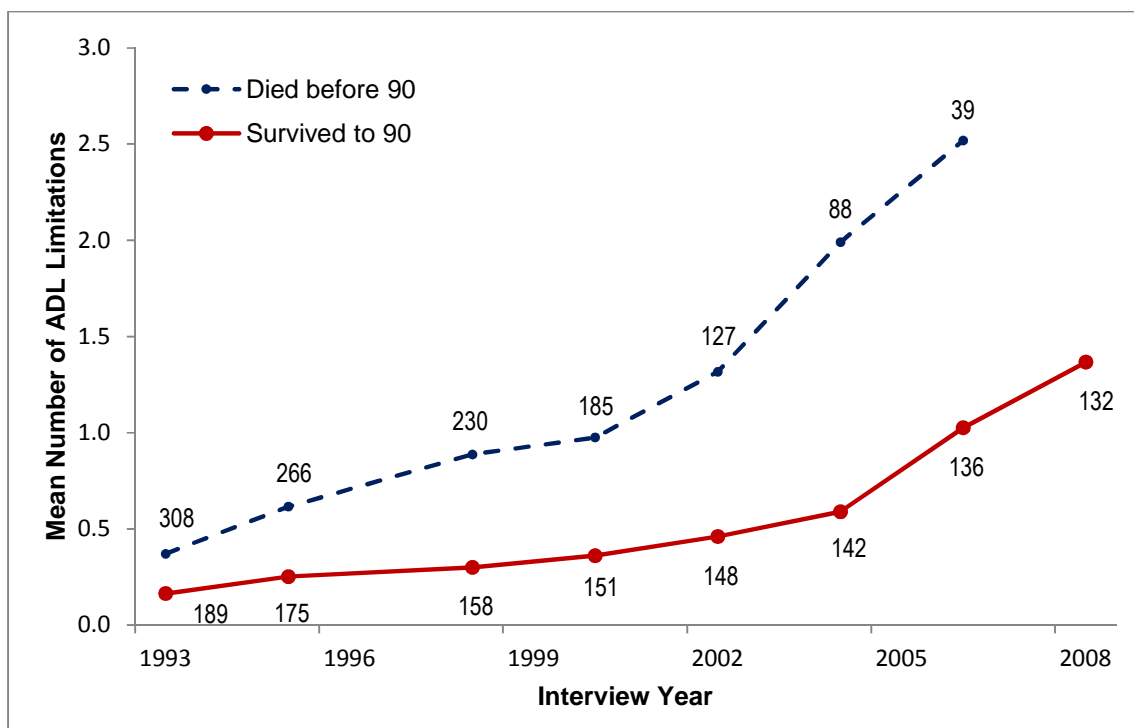Figure 1. Mean number of chronic conditions over time by survivorship to age 90

Figure 2. Mean number of ADL limitations over time by survivorship to age 90
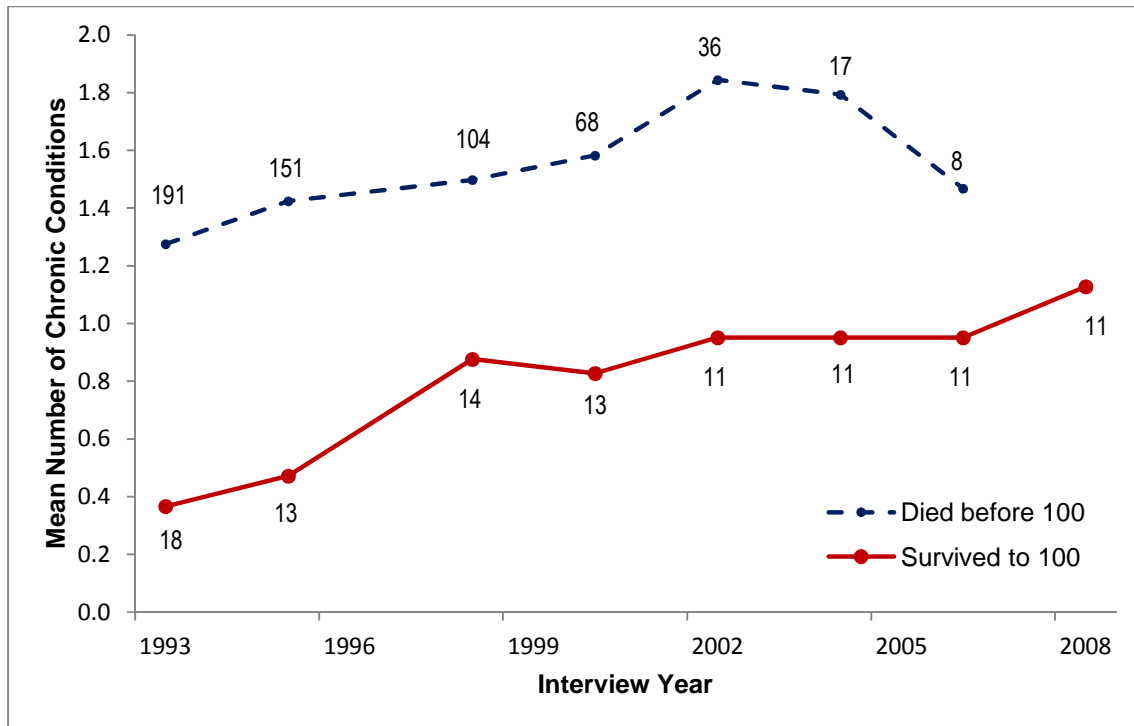
Figure 3. Mean number of chronic conditions over time by survivorship to age 100
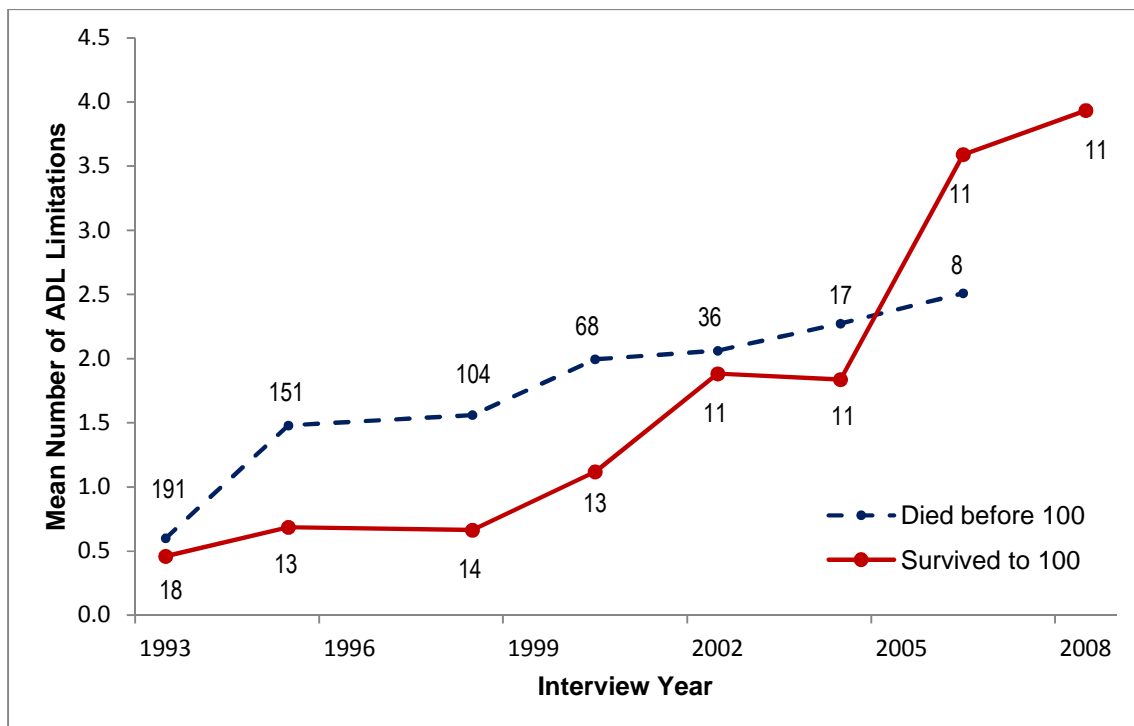

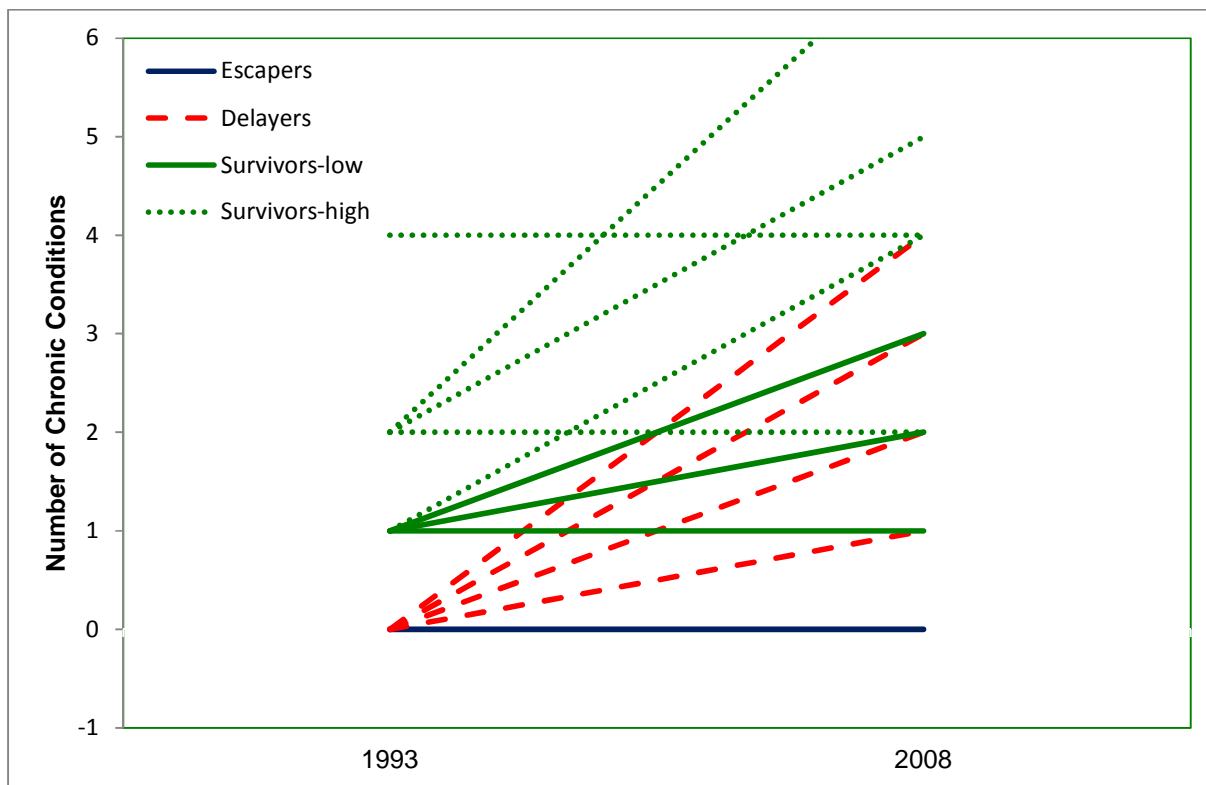Figure 4. Mean number of ADL limitations over time by survivorship to age 100

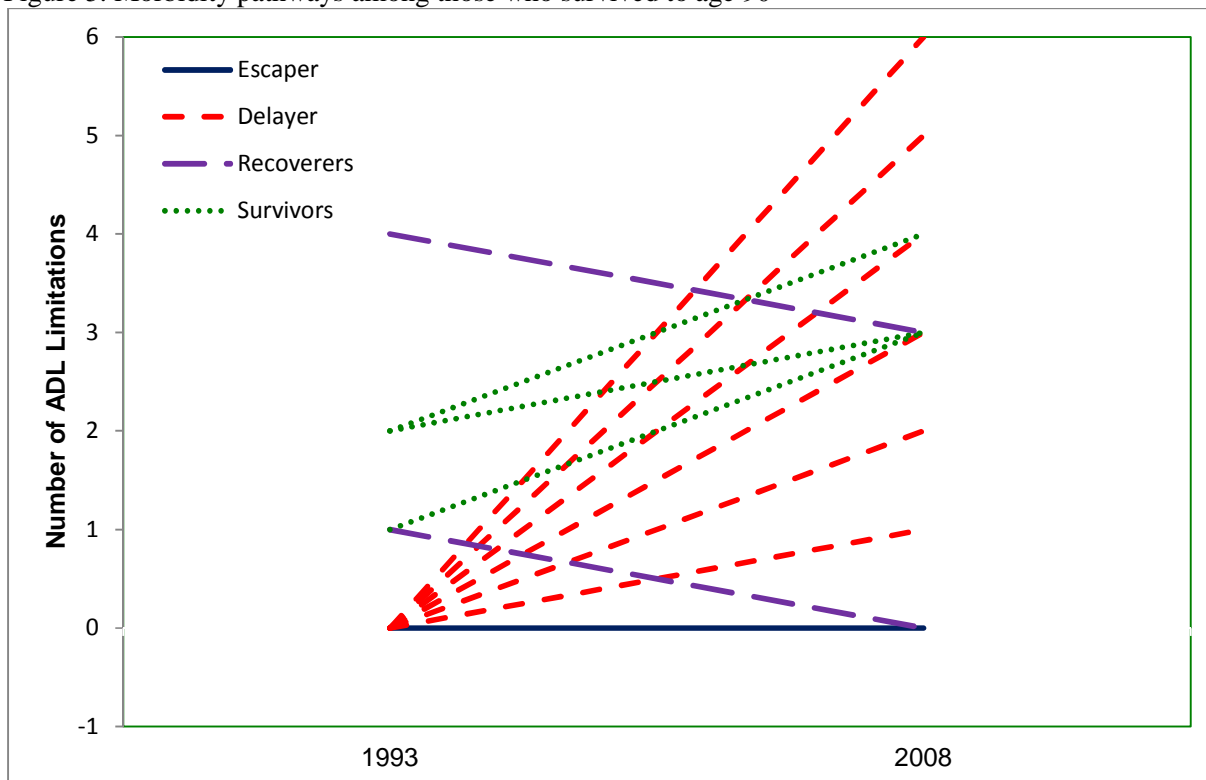Figure 5. Morbidity pathways among those who survived to age 90

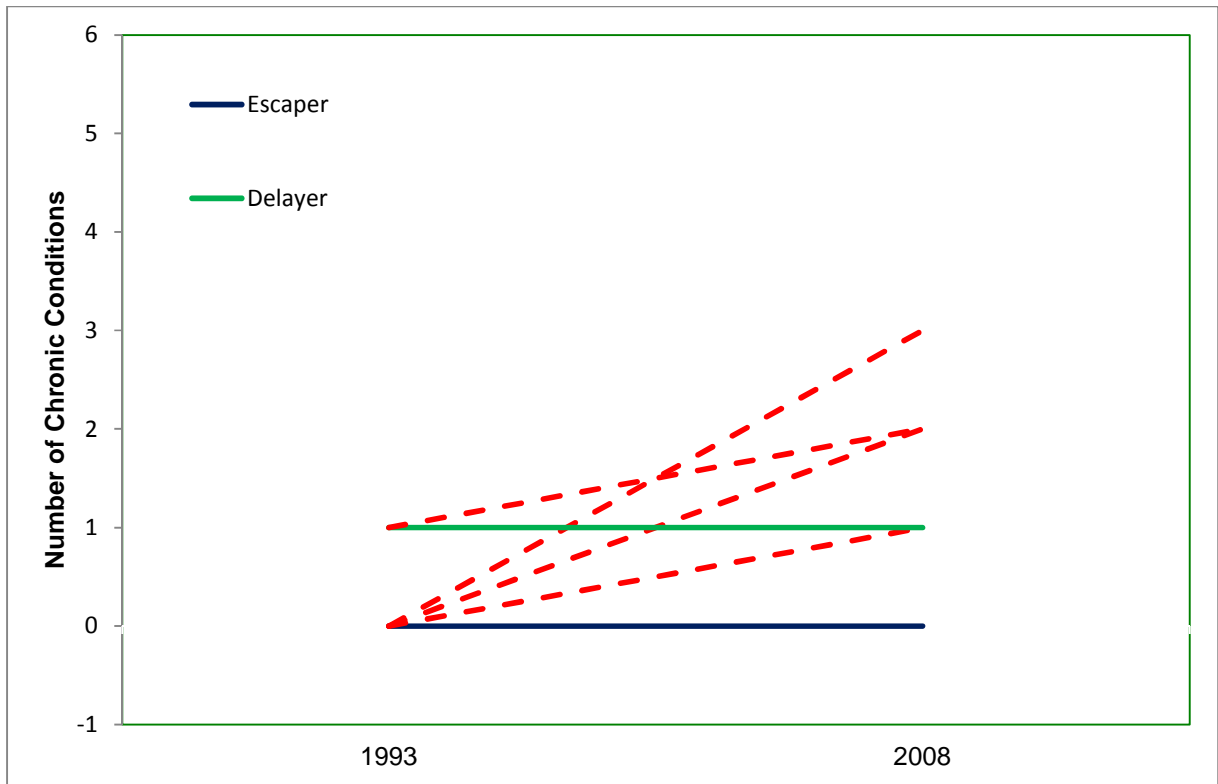Figure 6. Disability pathways among those who survived to age 90

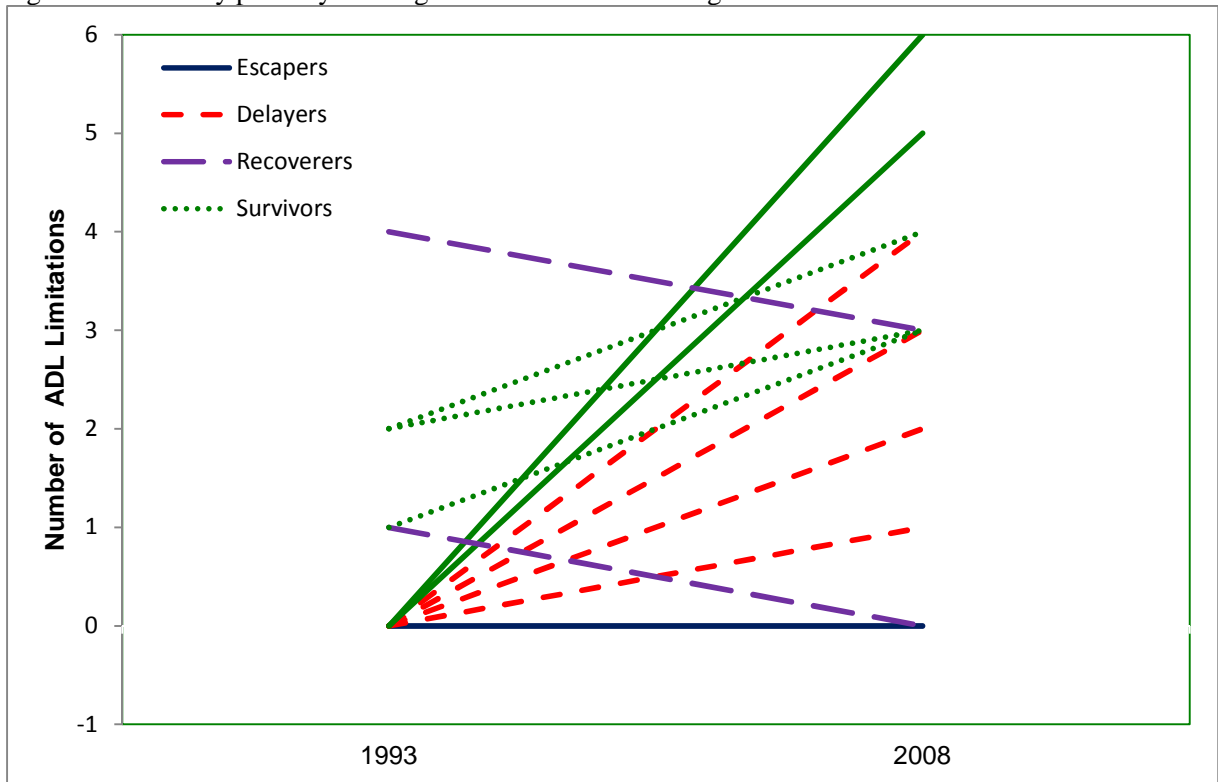Figure 7. Morbidity pathways among those who survived to age 100

Figure 8. Disability pathways among those who survived to age 100