The Cardiovascular Revolution in the United States

A Geographic Perspective

Magali Barbieri[1,2], Nadine Ouellette[3], Tim Riffe[2] and Celeste Winant[2]

PRELIMINARY VERSION

April 2015

Presented at the Annual Meeting of the Population Association of America
San Diego, California, May 2-4, 2015

[1] Department of Demography, University of California, Berkeley
[2] Institut national d'études démographiques (INED), Paris

ABSTRACT

The range of life expectancy at birth across the states of the United States is as wide as the range across all high-income countries. We examine whether current geographic differentials reflect state-wide variations in past mortality trends. We are specifically interested in the period when infectious diseases were replaced by cardiovascular diseases and cancer as the leading causes of death. The analysis is based on a massive effort to reconstruct cause-specific and age-standardized death rates as well as life tables by sex for every calendar year from 1959 through 2010 in each of the 50 U.S. states and D.C. It demonstrates that the change in survival trends that started at the end of the 1960s was not only sudden, unexpected and ominous but that it was also generalized and driven everywhere by a major decline in cardiovascular mortality. Implications for theories of mortality change are discussed.

Last Revised: April 27, 2015

Introduction

In a recent article, Ouellette, Barbieri, and Wilmoth showed that like many other high-income countries and after a decade of little progress in survival, the United States experienced a major change in mortality trend at the end of the 1960s (Ouellette, Barbieri, Wilmoth, 2014). While earlier increases in life expectancy had been largely driven by a decline in infant and child mortality, the renewed progress concentrated towards more and more advanced ages. The control of cardiovascular diseases[3] was instrumental in explaining the decline in adult mortality.

The issue investigated here is whether the transition experience of the country as a whole, both in terms of its timing and its cause-of-death structure, is an accurate representation of the changes that occurred in each of the 50 U.S. states and D.C. since around 1970 or whether it is the aggregate of a variety of state-level patterns. The main aim of our study is to provide a better understanding of how the health transition process diffuses within a national population, a topic which has received surprisingly little attention so far in spite of its potential to shed light on current geographic inequalities in health and mortality. Based on a massive effort to reconstruct cause-specific and age-standardized death rates as well as life tables by sex for single calendar years from 1959 through 2010 in each of the 50 U.S. states and D.C., our analyses seek to answer the three following questions: 1) whether the general pattern of stable and then rapidly declining rates of all-cause adult mortality for males and that of accelerated decline in adult mortality for females exhibited at the national level in the United States was observed in every state with similar timing and magnitude; if not, 2) whether there was a statistical relation between the level of adult mortality in 1959 and the timing and/or magnitude of the decline; and 3) whether the causes of death contributing to the gains in adult survival over the period 1959 to 2010 were similar across all states.

Background

There are several reasons why the United States provides an ideal setting to uncover regularities in adult mortality patterns within a national population in the "Age of degenerative diseases", the stage of the transition from high to low mortality when infectious diseases were replaced by cardiovascular diseases and cancer as the leading causes of death (Omran 1971).

First, the country has entered this stage of the epidemiologic transition several decades ago, providing enough chronological depth to investigate long-term trends in mortality by cause over the most recent stage of the health transition. Trends in life expectancy at birth in the United States since the beginning of the 20th century reflect the successive stages of the transition (Figure 1). The rapid increase from 1900 to 1954 corresponds to the first stage of the epidemiologic transition, when major gains were achieved against infectious diseases. A plateau

[3] In this paper, we use the terms "diseases of the circulatory system" (as defined by the International Classification of Diseases) and "cardiovascular diseases" indifferently, i.e. cardiovascular diseases include heart diseases, cerebrovascular diseases, and all other disorders of the circulatory system.

followed, from 1954 to 1968. During these 14 years, life expectancy at birth remained stable at 66.7 years for males and increased very little for females, from 72.7 to 74.1 (compared to a gain of 5.4 and 7.1 years for males and females, respectively, over the previous 14 years period and in spite of World War II. Progress suddenly resumed in 1968 and the following 14 years corresponded to a gain of 4.2 and 4.0 years in male and female life expectancies. The renewed increase in life expectancy after 1968 is attributable to the decline in mortality due to heart and cerebrovascular diseases, resulting in nearly equal parts from changes in lifestyle (especially those associated with reduced levels of serum cholesterol and tobacco cessation) and medical treatment (with the multiplication of intensive care units, more widespread and efficient drugs, and progress in surgery) (Goldman and Cook, 1984; Capewell, Morrison and McMurray, 1999; Ford and Capewell, 2007). While before the mid-20th century progress in survival disproportionately benefited children, this second period of rapid gains in life expectancy concentrated among older adults and is characterized by an onset of disease occurring at increasingly older ages (Olshansky and Ault, 1986): the mortality decline at ages 40 to 84 years contributed about two-third of the total gain in life expectancy at birth for each sex between 1968 and 2010 (over three-fourth when excluding the first year of life for which the story is very different).

The United States also provides a convenient setting to study how changes in mortality spread through a national population for the following practical reasons. With over 300 million inhabitants, the U.S. population is large enough for differences in level and trends of detailed mortality indicators to remain statistically significant when disaggregating the population in geographic units smaller than the national level. In addition, the United States has established a centralized statistical system early in the 20th century (reaching full national coverage in 1933) providing data of high quality and comparability over time and across all administrative units, a feature that is particularly valuable when investigating change in the structure of deaths by cause. Indeed, periodic changes in the International Classification of Diseases can result in irreconcilable difficulties when the timing of implementation of each successive classification differs across countries or regions. An important caveat that remains with U.S. vital statistics data, however, is the issue of age misstatement at older ages, which appears to have been fairly prevalent until the most recent decades and would result in an underestimation of mortality at ages 80-85 and above (Coale and Kisker, 1986; Preston et al., 1996). We have addressed this problem by restricting our analysis to adult ages below 85.

Last but not least, the United States is a highly diverse country, culturally and socio-economically as well as demographically, which leads to important geographic differences in factors typically associated with large variations in mortality risks, as indicated by a growing body of literature (see in particular Ezzati et al., 2008; Kulkarni et al., 2011; Lochner et al., 2001; Murray et al., 2006; NCHS, 1975 and 1999; Pickle et al., 1999; Wang et al., 2013). The larger incidence of cardiovascular mortality among the black population and its role in geographic differences, for instance, is now well established (Howard et al., 2004; Liao et al., 2009). In addition, socioeconomic characteristics play a part in the higher level of mortality observed in South Eastern states of the U.S., and more specifically as regards cardiovascular mortality (Wing et al., 1988; Casper et al., 1995) though this has been disputed (Howard et al., 1997). These variations in population composition, to which much of the inter-state variability in U.S. mortality has been attributed, could also explain geographic differences in the pattern of mortality change over the past 50 years, in terms of both its timing and magnitude. Up until now, however, a detailed understanding of this issue has been hampered by the lack of homogeneous and continuous mortality series by state over an extended period. Much of the existing literature on the variability of outcomes is thus usually restricted to a single point in time or to a very specific cause of death and rarely considers how overall patterns have changed over time.

Data

The data used in this study were taken from the National Center for Health Statistics (NCHS) and the United States Census Bureau. The NCHS has produced electronic files of exhaustive death counts in the U.S. by sex, age and the underlying cause of death for each calendar year since 1959. Information on the state of residence is only available in the public files for years up to 2004 included, due to increasing concerns over privacy by NCHS. We have therefore requested and obtained access to the restricted-use files with geographic information at the finest level of detail for years after 2004. The Census Bureau has released annual time series of July 1st U.S. state population estimates by single year of age and sex for each calendar year since 1980 and by five-year age group starting in 1970. From these data on death and population counts, we calculated all-cause and cause-specific mortality rates by age group for each state, year, and sex for years 1970 through 2010. In order to extend the all-cause and cause-specific mortality rates back to 1959, we reconstructed annual time series of July 1st population estimates by age and sex for each U.S. state for the period 1959-1969. The estimates were computed from population counts in the 1950, 1960 and 1970 U.S. censuses and 1959 through 1970 vital statistics data, following the approach developed in the Human Mortality Database Methods Protocol (Wilmoth et al., 2007, p.16-27).

For ease of interpretation, detailed causes of death were combined into a set of 5 broad categories. These categories were determined based on the similarity of their risk factors and on their nosologic consistency over time. Indeed, the original cause-of-death data were coded into the International Classification of Disease scheme, which has been revised four times since 1959 (from ICD-7 to ICD-10[4]). The five broad cause-of-death categories are: 1) Heart diseases, 2) All other diseases of the circulatory system (mostly cerebrovascular diseases), 3) smoking-related

[4] In the United States, ICD-7 was first implemented in 1958, ICD-8 in 1968, ICD-9 in 1979, and ICD-10 in 1999.

cancer, 4) Other malignant neoplasms, and 5) All other diseases. The smoking-related cancer category includes most cancers of the respiratory and digestive tracts, namely cancers of the lip, oral cavity, pharynx, esophagus, larynx, trachea, bronchus, and lung. The predominant role of cigarette smoking in the incidence of these cancers is well documented (Doll et al. 2004; Rogers et al. 2005; Thun et al. 1997; U.S. Department of Health and Human Services 2004). Smoking also has some impact on the other types of cancers but a host of additional factors are known to increase their risks independently from smoking. The concordance table used for bridging the four revisions of the ICD is presented in Appendix Table A1, with specific codes for each category in each time period.

Methods

The aim of the methods implemented in this study is to quantify the rate of mortality change, to identify the major turning points in trends, and to compare these indicators across all states and, within each state, across age groups and disease categories. The goal is to uncover differential patterns of epidemiologic change in relation to current mortality conditions. The analysis focuses on adults aged 40-84. Below age 40, mortality trends and determinants in the United States are quite different from those in other high-income countries, with very high rates of mortality from external causes in particular. Trends in mortality among young adults are thus not very informative for the present analysis of geographic trends in degenerative diseases. As we discussed earlier, U.S. mortality data at ages 85 and above are not as reliable due to inaccurate reporting of age. This could introduce a measurement bias in our study since the quality of mortality statistics at older ages might vary simultaneously with the overall level of mortality across states, especially in the early years of the period covered.

As a first step, we analyzed all-cause mortality data to identify the onset of mortality decline over the study period for the various states. We computed age-standardized death rates by single calendar year, sex, and state using the total (both sexes) population of the United States by five-year age groups in 1980 as the standard. To assess the timing and magnitude of the turning point in mortality trends, we fitted trend lines to these sex-specific age-standardized death rates over time in each of the 50 states and D.C. Experimenting with a range of statistical approaches, we found that fitting such trend lines using a grid-search algorithm based on R^2 goodness-of-fit criteria not only led to fits that were as good as those obtained with more sophisticated methods but also that this simple approach was less arbitrary.

More specifically, we estimated two- and (where relevant) three-slope regression models by sex for each state and the turning points for the slope were assimilated to years of the dominant discontinuities in mortality trends. Since the aim was to identify major turning points in mortality series rather than to describe detailed trends, four (and higher) slope regression models were not implemented. Turning points were allowed to occur in any calendar year throughout the entire study period though, for three-slope regression models, the two turning points were constrained to occur at least three years apart. Within each series of two- and three-slope regressions, we selected the model providing the best description of the data, that is, the model maximizing the goodness-of-fit in R^2. The results of these statistical analyses yielded one estimated two-slope regression model and one estimated three-slope regression model per state/sex combination. We chose the three-slope model over the two-slope model for a given state only if its Bayesian Information Criterion (BIC) was lower and if all parameter estimates were statistically significant ($p \leq .01$). The model selected at the end of this process is hereafter referred to as the *optimal model*.

For example, Figure 2a shows that based on female mortality data in the state of Montana over the period 1959-2010, the dominant turning point for the slope in all-cause age-standardized death rate (ASDR) occurred in 1982, yielding the following regression model:

$$ASDR = \beta_0 + \beta_1 \text{ (year – 1959) } + \beta_2 \text{ (year – 1982) } I_{year>1982} + \varepsilon, \qquad (1)$$

where $I_{year>1982}$ is an indicator variable that equals one after 1982 and zero otherwise. Of the three model parameters in Eq. (1), β_2 is the most important one for our purpose since it corresponds to the change in the slope of the mortality trend before and after the turning point. Therefore, a higher estimate for β_2 (in absolute value) indicates a sharper mortality change and vice-versa and the parameter can be used to assess the magnitude of the discontinuity in trend, as described below. The parameter β_0 corresponds to the level of mortality at the beginning of the study period (1959) and β_1 to the value of the slope of the mortality trend between 1959 and the first turning point, corresponding to year 1982 in this example.

Three-slope regression models are only slightly more complicated. For instance, Figure 2b shows two major discontinuities in the male all-cause mortality trend for Washington State. The discontinuities occurred in years 1969 and 1979. The model thus corresponds to:

$$ASDR = \beta_0 + \beta_1 \text{ (year – 1959) } + \beta_2 \text{ (year – 1969) } I_{year>1969} + \beta_3 \text{ (year – 1979) } I_{year>1979} + \varepsilon. \qquad (2)$$

In Eq. (2), parameters β_0, β_1, and β_2 should be interpreted as in the two-slope model, and β_3 corresponds to the change in slope of the mortality trend before and after the second turning point (i.e., $(\beta_1 + \beta_2 + \beta_3) – (\beta_1 + \beta_2)$).

We used parameters β_2 and β_3 in our optimal models to assess the magnitude of the first and (where applicable) second discontinuities in trend. Discontinuities were classified as of "high", "moderate", or "low" magnitude depending on the sex-specific empirical distribution of $|\beta_2|$ and $|\beta_3|$ combined, using the Fisher-Jenks algorithm (Fisher 1958; Slocum et al. 2005).

In a second step, we analyzed cause-specific mortality data to identify the disease categories that mostly contributed to the all-cause mortality changes observed across all states. We identified the main causes of death responsible for increased survival using the decomposition technique proposed by Evgueni Andreev, Vladimir Shkolnikov, and Alexander Begun (2002). In addition, we used the multiple-slope regression model described above to look for the dominant turning point(s) in U.S. states' age-standardized death rate trends over time by sex for each cause-of-death category separately. As for the all-cause mortality analysis, the magnitude ("high", "moderate", or "low") of the turning point(s) was assessed from the estimates for β_2 and β_3. More precisely, for each sex and cause combination, the cut-off points were determined using the Fisher–Jenks algorithm on $|\beta_2|$ and $|\beta_3|$ estimates across all states.

Results

An overall pattern very similar across all U.S. states

Figures 3a and 3b display state-specific trends in all-cause age-standardized death rates over time since 1959 for each sex. The rates recorded at the start of the study period are much higher for males than for females: from about 50 % higher in Hawaii to over twice as high in Nevada (65 % on average) in 1959. For either sex, however, they vary widely across states: from a low of 25 per 1,000 in Florida to a high of 37 in the District of Columbia for males, and from 14 per 1,000 also in Florida to 22 in South Carolina for females [Figure 4a and 4b]. At the time, mortality by sex was diverging: while for males, death rates had reached a plateau in most states or was even increasing in the Southern States (those of the South Atlantic, East South Central and West South Central regions), they were already declining for females everywhere (except in Nevada), though more or less depending on the state.

A key finding of the all-cause analysis is that a first significant turning point in mortality trend occurred everywhere around 1970 and marked the onset of a rapid decline for males and an acceleration of the decline for females. Between 1959 and 2010, the gain in survival between the ages of 40 and 85 translated into an additional 2.8 to 7.2 years of life for males (in Oklahoma and in the District of Columbia, respectively) and 0.7 to 5.1 years for females (in Oklahoma and in New York State) (Figure 5).

Both the timing and the magnitude of the decline were strikingly similar across all states. In fact, the regression results indicate that a statistically significant discontinuity in the age-standardized death rate series took place in every state sometime between 1963 and 1974, with 80 % of the states experiencing the change in the time window between 1967 and 1972 for males and between 1966 and 1974 for females (Tables 1a and 1b). The few exceptions to this pattern were females in the following states: North Dakota, Montana, Alaska, and the District of Columbia. In these four states, the decline that was initiated prior to 1959 continued throughout the 1960s and the 1970s with no statistically significant change in slope.

In all states, a second turning point in trends occurred, generally in the late 1970s or early 1980s, and was followed by a period of slower decline in mortality. For men, there were only two exceptions to this pattern: in New York State and the District of Columbia, the second discontinuity took place in the mid-1990s (in 1994 and 1995, respectively) and inaugurated a period of accelerated decline (especially marked in D.C.). This was also the case for women in North Dakota, California, Oregon, and the District of Columbia, with faster declines in mortality after 1996, 2000, 2002, and 1997, respectively. In addition, in the states of Montana and Alaska, there was only one turning point and the decline in female mortality continued uninterrupted after the first change in trend, which took place later than most in both these states (in 1982 and 1980). Overall, the deceleration was also much more pronounced for women than for men after this second disruption, and in many of the Southern states (Alabama, Kentucky, Mississippi, Tennessee, and Arkansas), it was followed by a plateau, mortality declining at a crawling pace, if at all, or even increasing slightly (Oklahoma), starting in the 1980s.

A weak relationship between initial mortality, and the onset and rate of decline

For men, the initial level of mortality is weakly related to the timing of the first turning point in trend (Pearson's correlation coefficient of -0.427 with $p = 0.0018$), so that states with the highest age-standardized death rates in 1959 tended to experience an earlier transition into lower mortality than those with the lowest death rates initially. For women, the two parameters were unrelated (correlation coefficient of -0.167 with $p = 0.2427$), though the relationship might have been obscured by the fact that mortality decline had clearly started before 1959 in nearly all states, rendering us unable to identify previous patterns and a possible transition from an increasing or stagnating trend as for men.

There is a lightly stronger relationship (correlation coefficients of 0.500 and 0.602 with $p = 0.0002$ and $p < 0.0001$ for males and females, respectively) between the level of mortality in 1959 and the decline in the death rate in the subsequent period across the states, suggesting that progress in survival was somewhat faster where mortality was initially higher. The slightly earlier transition into a declining trend combined with a faster rate of decline in states with higher levels of initial mortality resulted in a convergence in the level of mortality by state and a reduced variance in the age-standardized death rate across the 50 states and D.C. over the 1959-2010 period, from 6.6 per 1,000 to 4.4 per 1,000 for males and from 3.2 per 1,000 to 2.0 per 1,000 for females. It is worth noting that the timing of the convergence strongly differed by gender: it occurred exclusively in the period after 1985 for men (the variance remaining at 6.6 per 1,000 until that year) and in the period before 1985 for women (with the variance actually increasing slightly from 1.7 per 1,000 in 1985 to 2.0 per 1,000 in 2010).

The massive role of cardiovascular mortality everywhere

The changes in the epidemiologic profile that have accompanied the renewed mortality decline of the 1970s have also been remarkably similar across all U.S. states. Diseases of the circulatory system and cancers were the leading causes of death in 1959. Taken together, these two groups of diseases accounted for 63 to 84% of the age-standardized death rate at 40-85 years for both sexes (Supplementary Tables S1a and S1b). As well documented in the literature, much of the decline in mortality over the 1970s and 1980s is attributable to progress in the control of coronary heart diseases and stroke (Gordon and Thom, 1975; Horiuchi, 1999; Jones and Green, 2013; Olshansky and Ault, 1986). Our analyses of cause-specific mortality trends demonstrate that what is true for the United States as a whole is also true for each of the 50 states and D.C. This is clearly reflected in the closely parallel decline in all-cause mortality and in mortality from cardiovascular diseases as indicated by the regression models. The decomposition of gains in years of life by cause also shows that cardiovascular diseases contributed by far the largest share of the overall gain during the period 1959-2010. Figure 6 displays the contribution of the five broad cause-of-death categories to years of life added between ages 40 and 85 for each sex. These contributions are presented for two periods separately, i.e. 1959-1985 and 1985-2010, with year 1985 selected as roughly the mid-point of the study period to differentiate between the years of rapid mortality decline and the following years, when the rate of decline slowed considerably in many states. The number of additional years lived between ages 40 and 85 in 2010 compared to 1959 exclusively attributable to the diseases of the circulatory system ranged between 2.9 years (in Mississippi) and 6.5 years (in Rhode Island) for men and between 2.6 years (in Oklahoma) and 6.2 years (in South Carolina) for women. The decline in the age-standardized mortality rate between the ages of 40 and 85 from cardiovascular diseases represents at least 73 % of the decline in the all-cause death rate for men and 81 % for women in each state.

Important differences by sex are noticeable in terms of the contribution of the various diseases to the mortality decline. These differences are particularly striking over the period since 1985. During the years of fastest decline, i.e. up to the mid-1980s, the decomposition of gains in years lived between ages 40 and 85 by broad cause-of-death category produces very similar results for men and women. For both sexes, cardiovascular diseases drove most of the increase in survival. Mortality from heart disease exhibited the largest decline, with the other diseases of the circulatory system (mainly cerebrovascular diseases) playing a smaller part (though larger for females than for males). For women, neoplasms others than smoking-related also played a beneficial role in the mortality decline during this first period. All diseases other than those of the circulatory system and than cancer also declined but more so for men than for women. These favorable trends largely compensated for the detrimental impact of the rising mortality from smoking-related cancer, which affected both sexes to the same extent during these early decades.

During the period from 1985 to 2010, the pattern is different for men and for women. For men, gains were very similar in size to those in the previous period, except for Hawaii where they were significantly lower (2.6 years compared to 4.0 years). Cardiovascular diseases continued to account for the lion share of survival gains, though the fraction attributable to heart disease increased while that attributable to other diseases of the circulatory system (mostly cerebrovascular diseases) became considerably smaller. The most striking difference with the previous period was the strong gains in years lived between 40 and 85 due to all forms of cancers, including those related to tobacco consumption.

For women, by contrast, the overall gains in survival were much smaller than during the period from 1959 to 1985. In Oklahoma, women actually lost about one month of life. In Alabama, Arkansas, Mississippi, and Wyoming, the gains reached half a year at best. A few states did well, experiencing declines in mortality comparable to those of the previous period (California, Delaware, the District of Columbia, Florida, Massachusetts, Nevada, New Hampshire, New Jersey, New York, and Vermont). For the vast majority however, gains in survival during the period 1985-2010 represented only 40 to 80 % to their level in 1959-1985. Though mortality from smoking-related cancer levelled off after 1985 and though significant gains were achieved through declining rates of mortality from other cancers, the much smaller gains attributable to cardiovascular diseases hardly compensated for the significant losses in years lived in the 40-85 year age group due to the unfavorable trend in mortality from diseases in the residual categories.

Discussion

The major decline in mortality that started around 1970 was sudden, particularly for men as it followed a period when the death rates had reached a plateau. It was also unexpected. Some scholarly literature at the time speculated that, with the decline of infectious diseases, the biological limit to life had been reached and that any further progress would be difficult to achieve (Omran 1971; Spiegelman 1968; Gordon and Thom 1975). The increase in survival is mostly attributable to a decline in cardiovascular mortality and had lasting consequences on overall mortality. Our analysis demonstrates that it was also generalized within the United States. Its timing and magnitude were only weakly related to states initial level of mortality, whether we look at all causes combined or at cardiovascular diseases only. It seems thus appropriate to use the term “cardiovascular revolution” to describe the major mortality shift that took place throughout the 1970s and lasted well into the 1980s, 1990s, and 2000s.

In the future, we plan to further investigate the factors behind this shift. Such factors must have affected all states simultaneously and to the same extent. Changes in individual behavior, medical progress (cholesterol and blood pressure control, new drugs and surgery) and improved access to health care (through the Medicare and Medicaid programs) have been identified in the literature as responsible for the rapid decline in mortality occurring in the United States after 1968 (see for instance Jones and Greene 2013, for a recent reference). We need to understand whether the same factors operated throughout the United States.

Acknowledgments

This study was made possible by awards from the United States National Institute on Aging (through grants R01-AG011552 and R01-AG040245) as well as from support provided by the French and German governments through the joint ANR-DFG project "From Disparities in Mortality Trends to Future Health Challenges" (DIMOCHA), and from a grant received from the AXA Research Fund (through the project "Mortality Divergence and Causes of Deaths", or MODICOD). The authors are solely responsible for the content of this manuscript, which does not necessarily represent the official views of the National Institutes of Health and other funders.

References

Andreev, Evgueni M., Vladimir M. Shkolnikov, and Alexander Z. Begun. "Algorithm for decomposition of differences between aggregate demographic measures and its application to life expectancies, healthy life expectancies, parity-progression ratios and total fertility rates." *Demographic Research* 7, no. 14 (2002): 499-522.

Casper, M. L., Wing, S., Anda, R. F., Knowles, M., & Pollard, R. A. (1995). The Shifting Stroke Belt Changes in the Geographic Pattern of Stroke Mortality in the United States, 1962 to 1988. *Stroke*, *26*(5), 755-760.

Coale, A. J., & Kisker, E. E. (1986). Mortality crossovers: Reality or bad data?. *Population studies*, *40*(3), 389-401.

Doll, R., R. Peto, J. Boreham, and I. Sutherland. 2004. “Mortality in relation to smoking: 50 years' observations on male British doctors,” *British Medical Journal* 328(7455): 1519-1528.

Ezzati, M., A.B. Friedman, S.C. Kulkarni, and C.J.L. Murray. 2008. “The reversal of fortunes: Trends in county mortality and cross-county mortality disparities in the United States.” *PloS Medicine* 5(4): 0557-0568.

Fisher W.D. 1958. “On grouping for maximum homogeneity.” *Journal of the American Statistical Association* 53: 789–798.

Frenk J., J.L. Bobadilla, C. Stern, T. Frejka, and R. Lozano. 1991. “Elements for a theory of the health transition”. *Health Transition Review* 1(1): 21-38.

Gordon, Tavia, and Thomas Thom. "The recent decrease in CHD mortality." *Preventive Medicine* 4, no. 2 (1975): 115-125.

Horiuchi, S. 1999. “Epidemiological transitions in human history.” Pp.54-71 in *Health and Mortality Issues of Global Concern*, Proceedings of the Symposium on Health and Mortality, edited by the Department of Economic and Social Affairs, Population Division. New York: United Nations.

Howard, G., Anderson, R., Johnson, N. J., Sorlie, P., Russell, G., & Howard, V. J. (1997). Evaluation of social status as a contributing factor to the stroke belt region of the United States. *Stroke*, *28*(5), 936-940.

Howard, V. J., Cushman, M., Pulley, et al. (2004). The reasons for geographic and racial differences in stroke study: objectives and design. *Neuroepidemiology*, *25*(3), 135-143.

Jones, D.S., and J.A. Greene, 2013. “The Decline and Rise of Coronary Heart Disease. Understanding Public Health Catastrophism”, *American Journal of Public Health*, 103(7): 1207-1218.

Kindig, D.A., and E.R. Cheng. 2013. “Even as Mortality Fell in Most US Counties, Female Mortality Nonetheless Rose in 42.8 Percent of Counties from 1992 to 2006.” *Health Affairs* 32(3): 451-458.

Kulkarni, S. C., Levin-Rector, A., Ezzati, M., & Murray, C. J. (2011). Falling behind: life expectancy in US counties from 2000 to 2007 in an international context. *Popul Health Metr*, *9*(1), 16.

Liao, Y., Greenlund, K. J., Croft, J. B., Keenan, N. L., & Giles, W. H. (2009). Factors explaining excess stroke prevalence in the US Stroke Belt. *Stroke*, *40*(10), 3336-3341.

Lochner, K., Pamuk, E., Makuc, D., Kennedy, B. P., & Kawachi, I. (2001). State-level income inequality and individual mortality risk: a prospective, multilevel study. *American Journal of Public Health*, *91*(3), 385.

Murray, C. J., Kulkarni, S. C., Michaud, C., Tomijima, N., Bulzacchelli, M. T., Iandiorio, T. J., & Ezzati, M. (2006). Eight Americas: investigating mortality disparities across races, counties, and race-counties in the United States. *PLoS Medicine*, *3*(9), e260.

National Center for Health Statistics. (1975). Some trends and comparisons of United States life-table data: 1900-1971. *US Decennial Life Tables for 1969-71*, 1(4).

National Center for Health Statistics. (1989). Some trends and comparisons of United States life table data: 1900–1991. *US decennial life tables for 1989-1991*, 1(3).

Olshansky, S. J., & Ault, A. B. (1986). The fourth stage of the epidemiologic transition: the age of delayed degenerative diseases. *The Milbank Quarterly*, 355-391.

Olshansky, S.J., B.A. Carnes, R.G. Rogers, and L. Smith. 1998. "Emerging infectious diseases: the Fifth stage of the epidemiologic transition?" *World Health Statistics Quarterly* 51(2-4): 207-217.

Omran, A.R. 1971. "The epidemiologic transition: a theory of the epidemiology of population change." *Milbank Memorial Fund Quarterly* 49: 509-538.

Ouellette N., Barbieri M., Wilmoth J.R. 2014. "Period-based mortality change: Turning points in trends since 1950", *Population and Development Review* 40(1): 77-106.

Pickle, L. W., Mungiole, M., Jones, G. K., & White, A. A. (1999). Exploring spatial patterns of mortality: the new atlas of United States mortality. *Statistics in Medicine*, *18*(23), 3211-3220.

Preston, S. H., Elo, I. T., Rosenwaike, I., & Hill, M. (1996). African-American mortality at older ages: Results of a matching study. *Demography*, *33*(2), 193-209.

Rogers, R.G., R.A. Hummer, P.M. Krueger, and F.C. Pampel. 2005. "Mortality attributable to cigarette smoking in the United States," *Population and Development Review* 31(2): 259-292.

Slocum, T.A., R.B. McMaster, F.C. Kessler, and H.H. Howard. 2005. *Thematic Cartography and Geographic Visualization*, 2nd Edition, Upper Saddle River, NJ: Prentice Hall.

Spiegelman, Mortimer. "Mortality in the United States: A review and evaluation of special reports of the National Center for Health Statistics." *Demography* 5, no. 1 (1968): 525-538.

Thun, M.J., C. Day-Lally, D.G. Myers, E.E. Calle, W.D. Flanders, B.-P. Zhu, M.M. Namboodiri, and C.W. Heath. 1997. "Trends in tobacco smoking and mortality from cigarette use in Cancer Prevention Studies I (1959 through 1965) and II (1982 through 1988)," in D. Shopland, D. Burns, L. Garfinkel, and J. Samet (eds.), Changes in Cigarette-Related Disease Risks and Their Implication for Prevention and Control: Smoking and Tobacco Control, Bethesda, MD: National Institutes of Health, Monograph 8. NIH publication 97-4213, pp. 305-382.

U.S. Department of Health and Human Services. 2004. The health consequences of smoking: A report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, Center for Disease Control.

Vallin, J. and F. Meslé. 2004. "Convergences and divergences in mortality. A new approach to health transition." *Demographic Research*, Special Collection 2(2): 11-44.

Wang, H., A.E. Schumacher, C.E. Levitz, A.H. Mokdad, and C.J.L. Murray. 2013. "Left behind: widening disparities for males and females in US county life expectancy, 1985-2010". *Population Health Metrics* 11:8.

Wilmoth, J.R., K. Andreev, D. Jdanov, and D.A. Glei. 2007. "Methods Protocol for the Human Mortality Database." http://www.mortality.org/Public/Docs/MethodsProtocol.pdf.

Wilmoth, J.R., C. Boe, and M. Barbieri. 2011. "Geographic Differences in Life Expectancy at Age 50 in the United States Compared with Other High-Income Countries". Pp. 333-366 in E. M. Crimmins, S. H. Preston, and B. Cohen (Eds.), *International Differences in Mortality at Older Ages: Dimensions and Sources*, Panel on Understanding Divergent Trends in Longevity in High-Income Countries, Committee on Population, Division of Behavioral and Social Sciences and Education, Washington, D.C.: The National Academies Press.

Wang, H., Schumacher, A. E., Levitz, C. E., Mokdad, A. H., & Murray, C. J. (2013). Left behind: widening disparities for males and females in US county life expectancy, 1985–2010. *Popul Health Metr*, *11*(1), 8.

Wing, S., Casper, M., Davis, W. B., Pellom, A., Riggan, W., & Tyroler, H. A. (1988). Stroke mortality maps. United States whites aged 35-74 years, 1962-1982. *Stroke*, *19*(12), 1507-1513.

Table 1a Timing and magnitude of dominant turning point(s)[a] in the all-cause and cause-specific age-standardized death rate trend since 1959, US states, males

Region/ State	All causes of death: Year of 1st discontinuity	All causes of death: Year of 2nd discontinuity	Heart diseases: Year of 1st discontinuity	Heart diseases: Year of 2nd discontinuity	All other cardiovascular diseases: Year of 1st discontinuity	All other cardiovascular diseases: Year of 2nd discontinuity	Smoking-related cancers[b]: Year of 1st discontinuity	Smoking-related cancers[b]: Year of 2nd discontinuity	All other cancers: Year of 1st discontinuity	All other cancers: Year of 2nd discontinuity
New England										
Connecticut	1966 (M)	1978 [ζ] (L)	1963 (M)	1990 [ζ] (L)	1972 (L)	1983 [ζ] (L)	1977 (L)	1990 (L)	1988 (L)	—
Maine	1972 (H)	1977 [ζ] (M)	1972 (H)	1977 [ζ] (H)	1973 (M)	1979 [ζ] (M)	1980 (M)	1991 (M)	1993 (M)	—
Massachusetts	1970 (M)	1977 [ζ] (L)	1968 (M)	1997 [ζ] (L)	1972 (L)	1981 [ζ] (L)	1973 [ε] (M)	1988 (M)	1993 (H)	—
New Hampshire	1969 (H)	1979 [ζ] (L)	1968 (H)	1972 [ζ] (M)	1970 (M)	1982 [ζ] (M)	1972 (H)	1991 (L)	1996 (M)	—
Rhode Island	1965 (M)	1978 [ζ] (L)	1965 (M)	1991 [ζ] (L)	1968 (L)	1982 [ζ] (L)	1970 [ε] (M)	1989 (M)	1989 (L)	—
Vermont	1969 (M)	1975 [ζ] (L)	1965 (H)	1999 [ζ] (L)	1972 (H)	1978 [ζ] (H)	1969 [ε] (M)	1987 (M)	1990 (M)	—
Middle Atlantic										
New Jersey	1968 (M)	1976 [ζ] (L)	1966 (M)	1992 [ζ] (L)	1973 (M)	1979 [ζ] (M)	1978 (L)	1989 (M)	1972 [ζ] (L)	1993 (H)
New York	1966 (L)	1994 (L)	1968 (M)	1974 [ζ] (L)	1971 (L)	1981 [ζ] (L)	1977 (L)	1990 (L)	1994 (M)	2005 [ζ] (L)
Pennsylvania	1968 (M)	1979 [ζ] (L)	1968 (M)	1991 [ζ] (L)	1972 (L)	1982 [ζ] (L)	1976 [ε] (L)	1988 (M)	1991 (M)	—
East North Central										
Illinois	1968 (M)	1978 [ζ] (L)	1968 (M)	1990 [ζ] (L)	1972 (M)	1981 [ζ] (L)	1981 (M)	1993 (M)	1994 (M)	—
Indiana	1969 (M)	1980 [ζ] (L)	1969 (M)	1991 [ζ] (L)	1971 (M)	1983 [ζ] (M)	1980 [ε] (M)	1990 (M)	1993 (M)	—
Michigan	1968 (M)	1979 [ζ] (L)	1969 (M)	1995 [ζ] (L)	1972 (L)	1983 [ζ] (L)	1977 [ε] (M)	1991 (M)	1981 [γ] (L)	1991 (M)
Ohio	1969 (M)	1981 [ζ] (L)	1968 (H)	1992 [ζ] (L)	1972 (L)	1983 [ζ] (L)	1982 (H)	1993 (L)	1993 (M)	—
Wisconsin	1972 (M)	1977 [ζ] (L)	1970 (M)	1991 [ζ] (L)	1972 (L)	1981 [ζ] (L)	1982 [ε] (L)	1991 (L)	1986 [γ] (M)	1990 (H)
West North Central										
Iowa	1972 (H)	1977 [ζ] (L)	1972 (H)	1977 [ζ] (M)	1971 (L)	1983 [ζ] (L)	1976 [ε] (L)	1988 (M)	1983 (L)	1999 (L)
Kansas	1972 (M)	1978 [ζ] (L)	1972 (M)	1978 [ζ] (M)	1973 (M)	1981 [ζ] (M)	1976 [ε] (L)	1989 (M)	1972 (L)	1993 (L)
Minnesota	1969 (L)	1978 [ζ] (L)	1969 (M)	2003 [ζ] (L)	1972 (M)	1979 [ζ] (M)	1981 (M)	1998 (L)	1981 [γ] (L)	1991 (M)
Missouri	1972 (H)	1976 [ζ] (M)	1973 (H)	1976 [ζ] (H)	1972 (M)	1981 [ζ] (M)	1979 [ε] (L)	1991 (M)	1993 (M)	—
Nebraska	1972 (H)	1975 [ζ] (M)	1964 (M)	1971 (L)	1972 (L)	1983 [ζ] (L)	1977 [ε] (L)	1989 (M)	1990 (L)	—
North Dakota	1974 (H)	1977 [ζ] (H)	1974 (H)	1977 [ζ] (H)	1973 (L)	1981 [ζ] (M)	1988 (M)	2001 (L)	1978 [γ] (M)	1989 (H)
South Dakota	1972 (M)	1975 [ζ] (L)	1970 (M)	—	1974 (L)	1982 [ζ] (L)	1977 [ε] (L)	1993 (M)	1979 [γ] (L)	1992 (H)
Mountain										
Arizona	1963 (H)	1978 [ζ] (L)	1963 (H)	1976 [ζ] (L)	1969 (L)	1981 [ζ] (L)	1965 [ε] (H)	1991 (M)	1972 [γ] (L)	1990 (M)
Colorado	1968 (M)	1983 [ζ] (L)	1968 (M)	1991 [ζ] (L)	1970 (L)	1983 [ζ] (L)	1980 [ε] (L)	1991 (M)	1987 [γ] (H)	1990 (H)
Idaho	1972 (M)	1978 [ζ] (L)	1973 (H)	1977 [ζ] (M)	1975 (H)	1979 [ζ] (H)	1976 [ε] (L)	1997 (L)	1995 (L)	—
Montana	1972 (M)	1979 [ζ] (L)	1971 (L)	1990 [ζ] (L)	1971 (L)	1985 [ζ] (L)	1977 [ε] (L)	1998 (M)	1975 [γ] (L)	1991 (M)
Nevada	1967 (M)	1978 [ζ] (L)	1978 [ζ] (L)	—	1973 (H)	1980 [ζ] (H)	1967 [ε] (H)	1987 (H)	1994 (M)	—
New Mexico	1967 (H)	1981 [ζ] (L)	1970 (H)	1976 [ζ] (M)	1972 (M)	1981 [ζ] (M)	1972 [ε] (L)	1990 (L)	1994 (M)	—
Utah	1971 (L)	1982 [ζ] (L)	1984 (M)	1990 [ζ] (M)	1973 (M)	1980 [ζ] (M)	1975 (L)	2004 (L)	1979 [γ] (L)	1991 (M)
Wyoming	1974 (H)	1981 [ζ] (M)	1973 (M)	1988 [ζ] (M)	1975 (H)	1981 [ζ] (H)	1976 [ε] (M)	1995 (L)	1997 (M)	—
Pacific										
Alaska	1972 (H)	1975 [ζ] (H)	..	..	1983 [ζ] (L)	—	1988 (H)	—	1964 (H)	—
California	1966 (M)	1977 [ζ] (L)	1965 (H)	1979 [ζ] (L)	1971 (L)	1981 [ζ] (L)	1974 [ε] (L)	1987 (M)	1986 (L)	1992 (L)
Hawaii	1972 (M)	1976 [ζ] (H)	1968 (L)	1977 [ζ] (M)	1973 (L)	1979 [ζ] (L)	1992 (L)	—	1971 [ζ] (M)	1985 (L)
Oregon	1968 (M)	1978 [ζ] (L)	1966 (M)	1992 [ζ] (L)	1972 (M)	1979 [ζ] (M)	1979 [ε] (M)	1990 (M)	1983 [γ] (L)	1991 (M)
Washington	1969 (H)	1979 [ζ] (L)	1969 (H)	1979 [ζ] (M)	1970 (L)	1982 [ζ] (L)	1974 [ε] (M)	1991 (L)	1983 [γ] (L)	1992 (M)

Table 1a (continued)

Region/ State	All causes of death: Year of 1st discontinuity	All causes of death: Year of 2nd discontinuity	Heart diseases: Year of 1st discontinuity	Heart diseases: Year of 2nd discontinuity	All other cardiovascular diseases: Year of 1st discontinuity	All other cardiovascular diseases: Year of 2nd discontinuity	Smoking-related cancers[b]: Year of 1st discontinuity	Smoking-related cancers[b]: Year of 2nd discontinuity	All other cancers: Year of 1st discontinuity	All other cancers: Year of 2nd discontinuity
South Atlantic										
Delaware	1968 (H)	1978 ζ (L)	1968 (H)	1989 ζ (M)	1972 (L)	1980 ζ (L)	1974 σ (M)	1989 (H)	1986 (M)	—
Dist. of Columbia	1966 (L)	1995 (L)	1970 (H)	1974 ζ (H)	1974 (M)	1982 ζ (M)	1980 (H)	1989 (H)	1963 ν (H)	1987 (H)
Florida	1969 (H)	1977 ζ (L)	1963 (H)	—	1970 (L)	1982 ζ (L)	1971 σ (M)	1990 (M)	1963 σ (L)	1992 (M)
Georgia	1972 (H)	1975 ζ (H)	1969 (M)	1991 ζ (L)	1969 (M)	1983 ζ (H)	1981 σ (L)	1989 (H)	1963 σ (M)	1992 (H)
Maryland	1966 (H)	1978 ζ (L)	1963 (H)	1991 ζ (L)	1971 (L)	1982 ζ (L)	1972 σ (M)	1988 (H)	1989 (H)	—
North Carolina	1969 (H)	1979 ζ (L)	1968 (M)	1994 ζ (L)	1972 (M)	1981 ζ (M)	1978 σ (L)	1990 (H)	1978 σ (L)	1993 (M)
South Carolina	1969 (H)	1979 ζ (L)	1968 (H)	1979 ζ (L)	1968 (H)	1981 ζ (H)	1980 σ (M)	1990 (H)	1992 (M)	—
Virginia	1968 (M)	1978 ζ (L)	1966 (H)	1992 ζ (L)	1971 (L)	1982 ζ (L)	1972 σ (L)	1986 (H)	1992 (H)	—
West Virginia	1972 (H)	1979 ζ (L)	1963 (M)	1972 (M)	1973 (M)	1981 ζ (M)	1971 σ (L)	1990 (H)	1985 ν (L)	1992 (H)
East South Central										
Alabama	1969 (M)	1979 ζ (L)	1973 (H)	1976 ζ (H)	1972 (H)	1981 ζ (H)	1979 σ (L)	1988 (H)	1993 (H)	—
Kentucky	1973 (H)	1976 ζ (M)	1973 (H)	1976 ζ (H)	1973 (H)	1981 ζ (M)	1978 σ (L)	1991 (H)	1993 (M)	—
Mississippi	1969 (H)	1977 ζ (L)	1968 (M)	1996 (L)	1969 (H)	1982 ζ (M)	1987 (H)	2000 (L)	1982 ν (L)	1992 (H)
Tennessee	1970 (M)	1978 ζ (L)	1969 (H)	1979 ζ (L)	1972 (M)	1982 ζ (M)	1982 σ (M)	1992 (H)	1991 (M)	—
West South Central										
Arkansas	1969 (M)	1978 ζ (L)	1968 (M)	—	1971 (H)	1982 ζ (M)	1982 σ (L)	1992 (H)	1990 (M)	—
Louisiana	1968 (H)	1980 ζ (L)	1968 (M)	1994 ζ (L)	1969 (M)	1987 ζ (L)	1970 σ (L)	1990 (H)	1996 (M)	—
Oklahoma	1970 (M)	1981 ζ (L)	1963 σ (M)	1969 (M)	1970 (L)	1982 ζ (L)	1981 σ (M)	1993 (M)	1985 ν (M)	1989 (H)
Texas	1972 (H)	1976 ζ (L)	1972 (H)	1975 ζ (M)	1972 (M)	1983 ζ (M)	1973 σ (M)	1993 (H)	1984 ν (L)	1993 (H)

Notes: ".." indicates that the two-slope regression model did not provide a better description of the data than the comparable one-slope model (F-tests for nested models resulting in $p > .01$).

"—" indicates that the three-slope regression model did not provide a better description of the data than the comparable two-slope model (Bayesian Information Criterion of the three-slope model is greater that that of the two-slope model and/or not all parameter estimates of three-slope model are statistically significant ($p > .01$)).

"ζ" indicates that the death rate for the specific cause-of-death category declined less rapidly after the turning point.

"σ" indicates that the death rate for the specific cause-of-death category increased less rapidly after the turning point.

"ν" indicates that the death rate for the specific cause-of-death category increased more rapidly or started to increase after the turning point.

The absence of "ζ", "σ" or "ν" indicates that the death rate for the specific cause-of-death category decreased more rapidly or began to decrease after the turning point.

The letters in parentheses indicate the magnitude of the discontinuity, with sex- and cause-specific cut-off points determined using the Fisher–Jenks algorithm: (H) high, (M) moderate, and (L) low.

[a]Calendar years (up to two) that maximize goodness-of-fit (in R^2) in the two- or three-slope regression model for each disease category and state.

[b]Includes all deaths from malignant neoplasms of lip, oral cavity, pharynx, esophagus, larynx, trachea, bronchus, and lung as the underlying cause.

Sources: Authors' calculations using data from the National Center for Health Statistics and the Census Bureau.

Table 1b Timing and magnitude of dominant turning point(s)[a] in the all-cause and cause-specific age-standardized death rate trend since 1959, US states, females

Region/ State	All causes of death: Year of 1st discontinuity	All causes of death: Year of 2nd discontinuity	Heart diseases: Year of 1st discontinuity	Heart diseases: Year of 2nd discontinuity	All other cardiovascular diseases: Year of 1st discontinuity	All other cardiovascular diseases: Year of 2nd discontinuity	Smoking-related cancers[b]: Year of 1st discontinuity	Smoking-related cancers[b]: Year of 2nd discontinuity	All other cancers: Year of 1st discontinuity	All other cancers: Year of 2nd discontinuity
New England										
Connecticut	1965 (L)	1977 [ς] (L)	1965 (M)	1975 [ς] (L)	1968 (L)	1983 [ς] (M)	1966 [v] (L)	1992 (M)	1970 [v] (M)	1976 (M)
Maine	1972 (H)	1975 [ς] (H)	1972 (H)	1975 [ς] (H)	1964 (H)	1983 [ς] (M)	1978 [v] (M)	1991 (H)	1993 (L)	—
Massachusetts	1969 (L)	1977 [ς] (L)	1968 (L)	1976 [ς] (L)	1974 (M)	1979 [ς] (H)	1971 [v] (L)	1993 (M)	1991 (M)	—
New Hampshire	1969 (H)	1977 [ς] (M)	1968 (H)	1975 [ς] (M)	1965 (H)	1982 [ς] (M)	1975 [v] (L)	1993 (H)	1992 (M)	—
Rhode Island	1967 (L)	1978 [ς] (M)	1963 (H)	1982 [ς] (L)	1968 (L)	1981 [ς] (L)	1967 [v] (L)	1996 (M)	1992 (L)	—
Vermont	1965 (M)	1977 [ς] (L)	1963 (H)	1976 [ς] (L)	1977 (M)	1980 [ς] (H)	1967 [v] (L)	1993 (M)	1979 [v] (H)	1983 (H)
Middle Atlantic										
New Jersey	1972 (H)	1975 [ς] (H)	1971 (H)	1976 [ς] (H)	1972 (L)	1981 [ς] (M)	1965 [v] (L)	1993 (M)	1978 [ς] (L)	1994 (M)
New York	1968 (M)	1975 [ς] (L)	1978 [v] (H)	1981 (M)	1970 (L)	1982 [ς] (L)	1967 [v] (L)	1992 (M)	1994 (L)	—
Pennsylvania	1968 (M)	1978 [ς] (M)	1968 (M)	1978 [ς] (M)	1972 (L)	1982 [ς] (H)	1971 [v] (L)	1993 (M)	1975 [ς] (L)	1991 (M)
East North Central										
Illinois	1972 (H)	1976 [ς] (H)	1969 (M)	1978 [ς] (M)	1972 (M)	1981 [ς] (M)	1971 [v] (L)	1993 (M)	1980 [ς] (L)	1992 (M)
Indiana	1972 (H)	1977 [ς] (H)	1972 (H)	1975 [ς] (H)	1971 (H)	1982 [ς] (H)	1969 [v] (L)	1995 (M)	1999 (L)	—
Michigan	1968 (L)	1977 [ς] (L)	1969 (L)	1975 [ς] (L)	1973 (L)	1982 [ς] (M)	1969 [v] (L)	1993 (M)	1978 [ς] (L)	1989 (M)
Ohio	1968 (L)	1979 [ς] (L)	1968 (M)	1977 [ς] (L)	1971 (L)	1984 [ς] (M)	1969 [v] (L)	1994 (M)	1972 [ς] (L)	1994 (L)
Wisconsin	1972 (L)	1978 [ς] (M)	1963 (L)	1991 [ς] (L)	1973 (L)	1981 [ς] (H)	1972 [v] (L)	1996 (M)	1992 (L)	—
West North Central										
Iowa	1973 (H)	1977 [ς] (H)	1971 (L)	1977 [ς] (L)	1973 (L)	1982 [ς] (M)	1974 [v] (L)	1994 [ε] (M)	1994 (L)	—
Kansas	1973 (L)	1979 [ς] (M)	1973 (L)	1977 [ς] (L)	1970 (L)	1983 [ς] (M)	1973 [v] (L)	1996 (M)	2000 (L)	—
Minnesota	1972 (M)	1976 [ς] (H)	1972 (L)	1976 [ς] (L)	1970 (L)	1981 [ς] (M)	1973 [v] (L)	1995 (M)	1981 [v] (L)	1988 (M)
Missouri	1970 (M)	1978 [ς] (M)	1973 (H)	1976 [ς] (H)	1970 (M)	1982 [ς] (M)	1973 [v] (L)	1994 (M)	1979 [ς] (L)	1991 (L)
Nebraska	1974 (M)	1977 [ς] (H)	1980 [v] (L)	1983 (L)	1972 (L)	1985 [ς] (L)	1972 [v] (L)	1990 [ε] (L)	1999 (L)	—
North Dakota	1986 [v] (L)	1996 (L)	1984 [ς] (L)	—	1985 [ς] (L)	—	1970 [v] (L)	2003 (H)	1992 (L)	—
South Dakota	1972 (L)	1977 [ς] (M)	..	..	1980 [ς] (L)	1989 [ς] (L)	1974 [v] (L)	1992 [ε] (L)	..	..
Mountain										
Arizona	1963 (H)	1977 [ς] (L)	1963 (M)	1977 [ς] (L)	1966 (M)	1981 [ς] (L)	1972 [v] (L)	1991 (M)	1977 [v] (L)	1989 (M)
Colorado	1973 (H)	1976 [ς] (H)	1973 (H)	1976 [ς] (H)	1973 (M)	1979 [ς] (H)	1967 [v] (L)	1994 (M)	1963 [ς] (M)	1993 (L)
Idaho	1973 (L)	1978 [ς] (M)	1963 (M)	1978 [ς] (L)	1973 (L)	1982 [ς] (M)	1982 [v] (M)	1990 (H)	1991 (L)	—
Montana	1982 [ς] (L)	—	1991 [ς] (L)	—	1970 (L)	1983 [ς] (M)	1966 [v] (L)	2001 (H)	1976 [v] (H)	1981 (H)
Nevada	1966 (H)	1976 [ς] (M)	1970 (H)	1973 [ς] (H)	1972 (H)	1981 [ς] (H)	1966 [v] (M)	1991 (H)	1963 (H)	1994 (L)
New Mexico	1970 (H)	1977 [ς] (H)	1964 (H)	1976 [ς] (L)	1970 (M)	1981 [ς] (M)	1993 (L)	—	1988 (L)	—
Utah	1963 (M)	1980 [ς] (L)	1996 [ς] (L)	—	1963 (H)	1984 [ς] (L)	1998 (L)	—	1994 (L)	—
Wyoming	1974 (L)	1982 [ς] (M)	1974 (L)	1987 [ς] (L)	1972 (H)	1981 [ς] (H)	1985 [v] (M)	1994 (H)	1966 [v] (H)	1996 (M)
Pacific										
Alaska	1980 [ς] (L)	—	1967 (H)	1970 [ς] (H)	1987 [ς] (L)	—	1968 [v] (H)	1988 (H)	1968 [v] (H)	1971 (H)
California	1979 [ς] (L)	2000 (L)	1963 (H)	1977 [ς] (L)	1972 (L)	1981 [ς] (M)	1988 [ε] (M)	1995 (L)	1988 (L)	—
Hawaii	1968 (L)	1977 [ς] (M)	1977 [ς] (M)	2000 (L)	1980 [ς] (L)	—	1991 (L)	—	..	..
Oregon	1981 [ς] (L)	2002 (L)	1971 (L)	1976 [ς] (L)	1973 (M)	1979 [ς] (H)	1971 [v] (L)	1992 (H)	1975 [ς] (L)	1994 (L)
Washington	1969 (L)	1978 [ς] (L)	1968 (M)	1977 [ς] (L)	1972 (L)	1981 [ς] (M)	1969 [v] (L)	1992 (H)	1992 (L)	—

Table 1b (continued)

Region/ State	All causes of death		Heart diseases		All other cardiovascular diseases		Smoking-related cancers[b]		All other cancers	
	Year of 1st discontinuity	Year of 2nd discontinuity	Year of 1st discontinuity	Year of 2nd discontinuity	Year of 1st discontinuity	Year of 2nd discontinuity	Year of 1st discontinuity	Year of 2nd discontinuity	Year of 1st discontinuity	Year of 2nd discontinuity
South Atlantic										
Delaware	1968 (M)	1976 ζ (M)	1968 (H)	1978 ζ (M)	1973 (M)	1979 ζ (H)	1972 ν (L)	1992 (H)	1991 (M)	—
Dist. of Columbia	1981 ζ (L)	1997 (L)	1970 (M)	1975 ζ (H)	1973 (L)	1983 ζ (M)	1994 (H)	—	1990 (H)	—
Florida	1973 (H)	1976 ζ (H)	1972 (M)	1975 ζ (M)	1971 (L)	1983 ζ (M)	1966 ν (L)	1992 (M)	1993 (L)	—
Georgia	1970 (M)	1978 ζ (M)	1972 (M)	1975 ζ (M)	1972 (M)	1982 ζ (H)	1974 ν (L)	1995 (M)	1976 ν (L)	1993 (M)
Maryland	1968 (M)	1975 ζ (M)	1977 ζ (L)	1994 ζ (L)	1970 (L)	1981 ζ (L)	1965 ν (L)	1992 (H)	1972 ζ (L)	1988 (M)
North Carolina	1969 (M)	1978 ζ (M)	1965 (M)	1977 ζ (L)	1972 (M)	1981 ζ (H)	1974 ν (L)	1996 (M)	1983 ν (L)	1988 (H)
South Carolina	1968 (M)	1979 ζ (M)	1968 (M)	1975 ζ (M)	1966 (H)	1981 ζ (H)	1975 ν (L)	1996 (M)	1978 ν (L)	1993 (M)
Virginia	1972 (M)	1976 ζ (H)	1966 (M)	1976 ζ (L)	1973 (L)	1983 ζ (M)	1967 ν (L)	1992 (M)	1977 ν (L)	1991 (M)
West Virginia	1971 (M)	1979 ζ (M)	1970 (L)	1980 ζ (L)	1971 (M)	1982 ζ (M)	1981 ν (M)	1993 (H)	1980 ν (L)	1995 (M)
East South Central										
Alabama	1969 (L)	1979 ζ (M)	1979 ζ (M)	1985 (L)	1971 (M)	1983 ζ (H)	1968 ν (L)	1996 σ (L)	1976 ν (L)	1993 (M)
Kentucky	1972 (M)	1979 ζ (M)	1972 (H)	1975 ζ (H)	1973 (M)	1983 ζ (M)	1974 ν (L)	1994 σ (M)	1993 (L)	—
Mississippi	1969 (M)	1978 ζ (H)	1980 ζ (L)	1995 (L)	1971 (M)	1982 ζ (H)	1970 ν (L)	1999 (M)	1979 ν (M)	1994 (M)
Tennessee	1969 (L)	1979 ζ (M)	1970 (M)	1977 ζ (L)	1973 (M)	1983 ζ (H)	1973 ν (L)	1995 σ (M)	1979 ν (L)	1995 (M)
West South Central										
Arkansas	1973 (H)	1977 ζ (H)	1972 (M)	1975 ζ (M)	1973 (M)	1982 ζ (H)	1981 ν (M)	1991 σ (H)	1986 ν (H)	1989 (H)
Louisiana	1968 (M)	1979 ζ (M)	1969 (M)	1977 ζ (L)	1971 (M)	1986 ζ (M)	1975 ν (L)	1993 (M)	1979 ν (L)	1995 (M)
Oklahoma	1972 (L)	1980 ν (L)	1972 (M)	1976 ζ (L)	1974 (M)	1981 ζ (H)	1966 ν (M)	1997 (M)	1981 ν (L)	1994 (L)
Texas	1973 (H)	1977 ζ (H)	1972 (M)	1975 ζ (L)	1973 (M)	1983 ζ (M)	1978 ν (L)	1994 (H)	1987 ν (M)	1992 (H)

Notes: ".." indicates that the two-slope regression model did not provide a better description of the data than the comparable one-slope model (F-tests for nested models resulting in $p > .01$).

"—" indicates that the three-slope regression model did not provide a better description of the data than the comparable two-slope model (Bayesian Information Criterion of the three-slope model is greater that that of the two-slope model and/or not all parameter estimates of three-slope model are statistically significant ($p > .01$)).

"ζ" indicates that the death rate for the specific cause-of-death category declined less rapidly after the turning point.

"σ" indicates that the death rate for the specific cause-of-death category increased less rapidly after the turning point.

"ν" indicates that the death rate for the specific cause-of-death category increased more rapidly or started to increase after the turning point.

The absence of "ζ", "σ" or "ν" indicates that the death rate for the specific cause-of-death category decreased more rapidly or began to decrease after the turning point.

The letters in parentheses indicate the magnitude of the discontinuity, with sex- and cause-specific cut-off points determined using the Fisher–Jenks algorithm: (H) high, (M) moderate, and (L) low.

[a]Calendar years (up to two) that maximize goodness-of-fit (in R^2) in the two- or three-slope regression model for each disease category and state.

[b]Includes all deaths from malignant neoplasms of lip, oral cavity, pharynx, esophagus, larynx, trachea, bronchus, and lung as the underlying cause.

Sources: Authors' calculations using data from the National Center for Health Statistics and the Census Bureau**Appendix Table A1** Cause-of-death categories and their ICD codes, ICD-7 through ICD-10

Cause-of-death category	**ICD Revision and ICD codes**			
	ICD-7 (1958-1967)	ICD-8 (1968-1978)	ICD-9 (1979-1998)	ICD-10 (1999-present)
Heart diseases	400-447, 465	390-429, 450	390-429	I00-I51
Other diseases of the circulatory system	330-334, 450-464, 466-468	430-449, 451-458	430-459	I60-I99, G45
Smoking-related malignant neoplasms[a]	140-150, 161-163	140-150, 161-162	140-150, 161-162	C00-C15, C32-C34
Other malignant neoplasms	151-160, 164-205	151-160, 163-209	151-160, 163-208	C16-C31, C35-C97
All other diseases and conditions	001-138, 210-326, 340-398, 470-795, E800-E999	000-136, 210-389, 460-796, E800-E999	001-139, 210-389, 460-796, E800-E999	A00-B99, D00-G44, G46-H95, J00-R99, V01-Y98

[a]Malignant neoplasms of lip, oral cavity, pharynx, esophagus, larynx, trachea, bronchus and lung.
Source: Assembled by the authors from various sources.

Fig. 1 Life expectancy at birth for males and females in the United States, 1900-2010

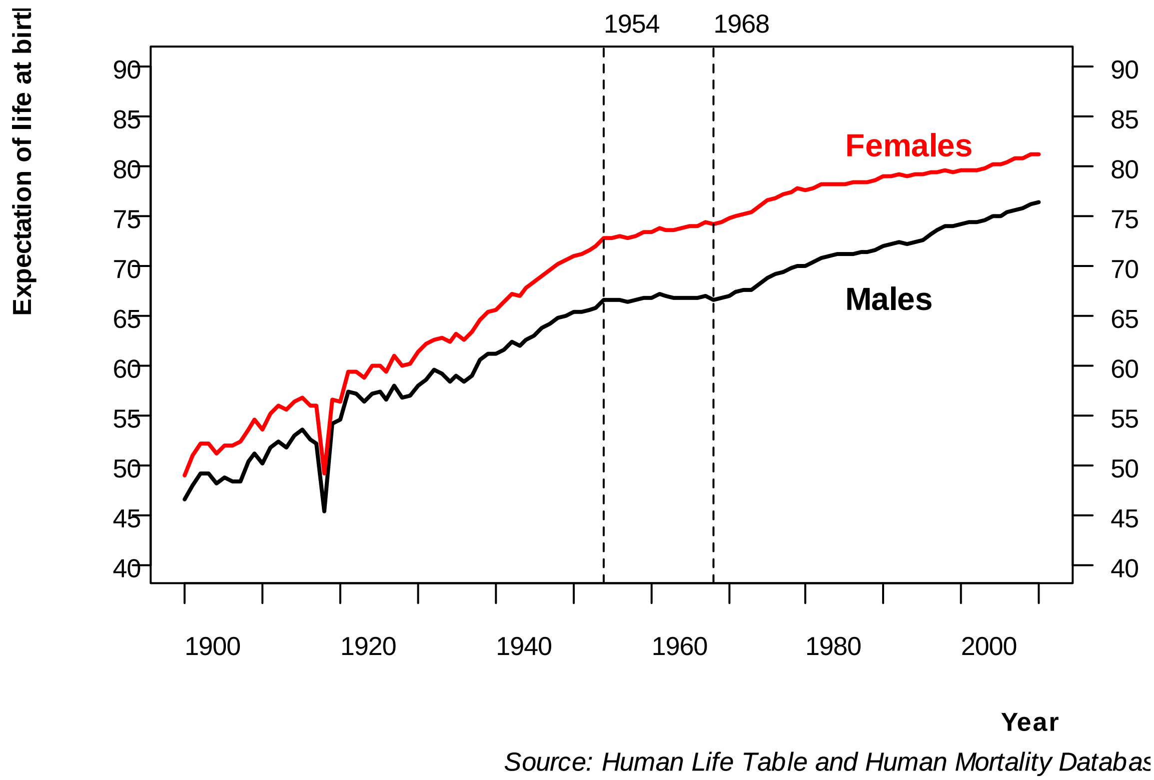
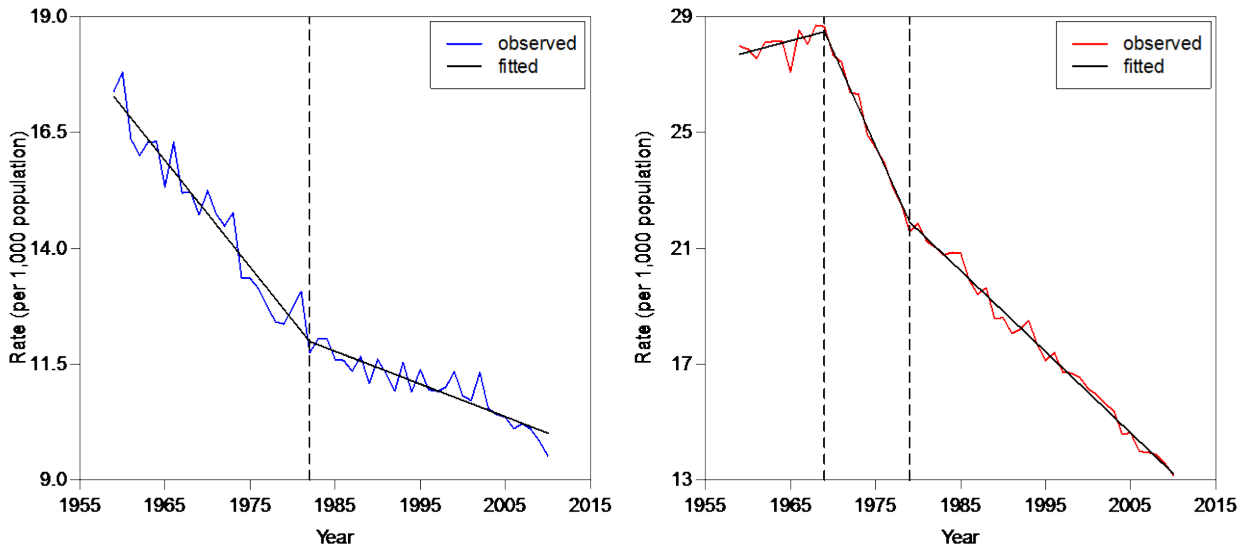


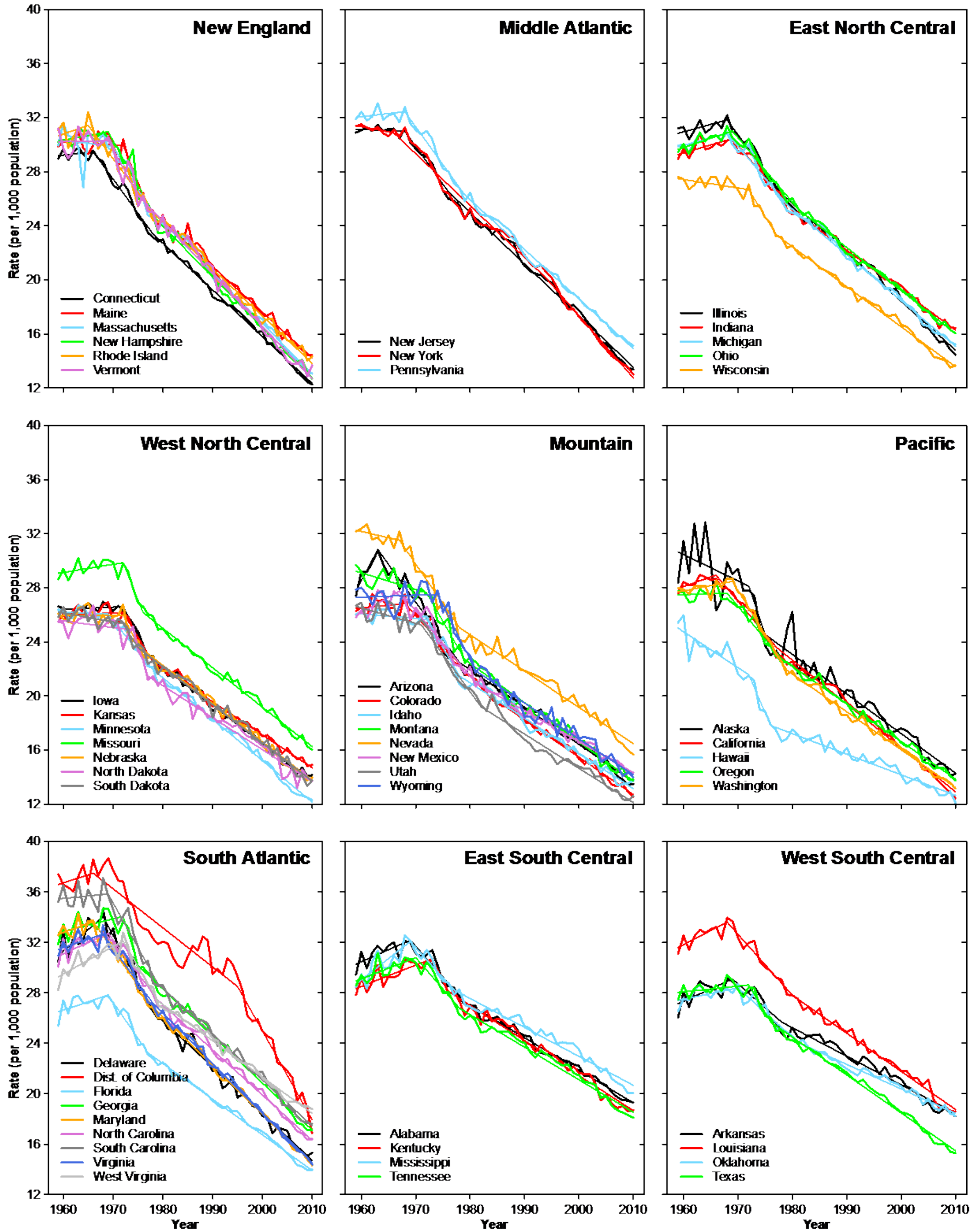
Fig. 2 Age-standardized death rates with trend line, ages 40–84, 1959–2010

(a) Montana state, females **(b) Washington state, males**



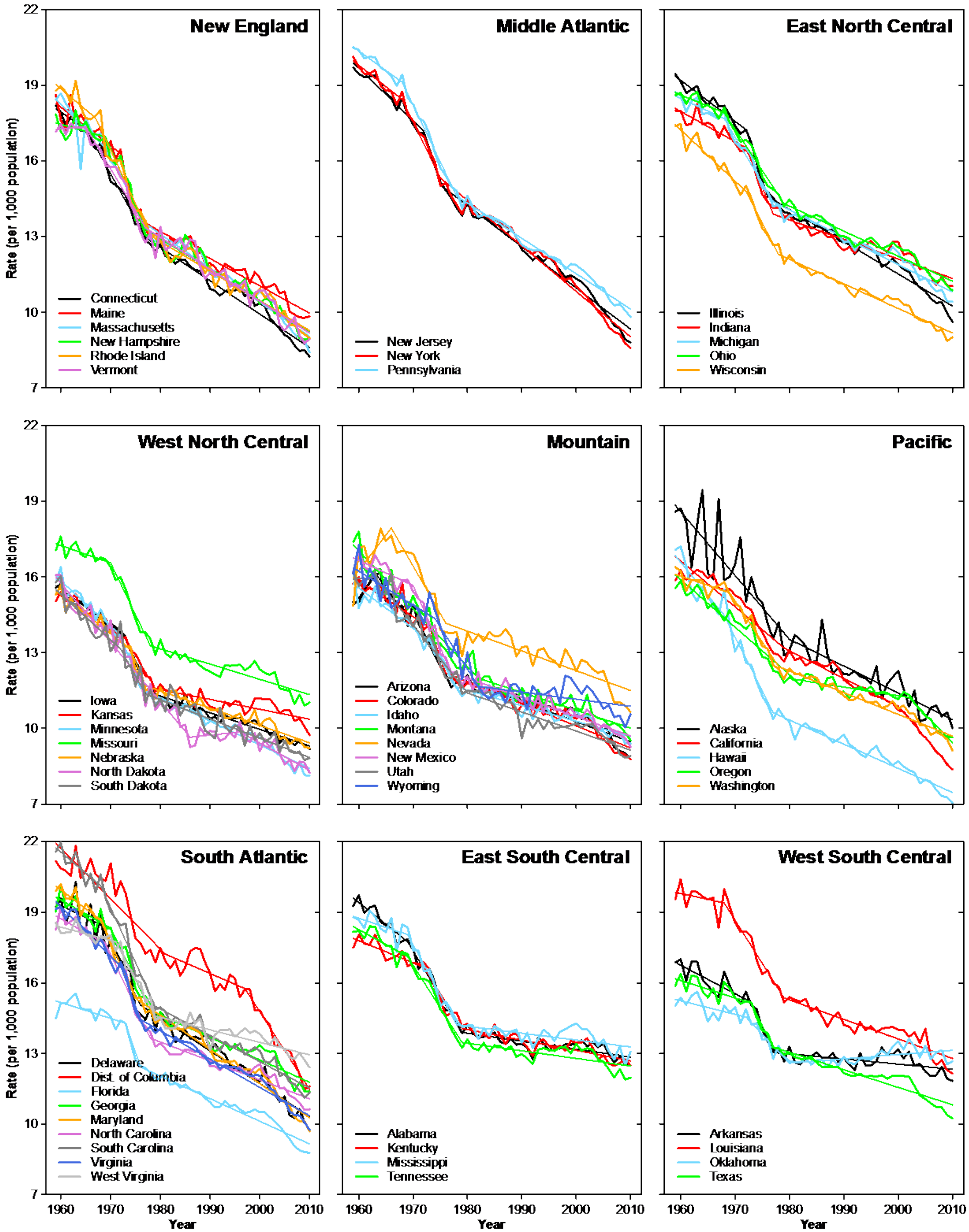
Notes: The standard population corresponds to the total population (both sexes) of the United States at the 1980 Census. The vertical dashed line(s) indicate(s) the year of the dominant turning point(s) in the trend, according to the best-fitting two- (Figure 2a) or three- (Figure 2b) slope regression model (by a criterion of maximum R^2).

Fig. 3a All-cause age-standardized death rates in U.S. States with trend line, males aged 40–84, 1959–2010



Notes: The standard population corresponds to the total population (both sexes) of the United States at the 1980 Census. Trend lines correspond to the best-fitting two- or three-slope regression model (by a criterion of maximum R2). For a given state, the three-slope model is selected over the two-slope model only if its Bayesian Information Criterion (BIC) is lower and its parameter estimates are statistically significant (p \u2264 .01).

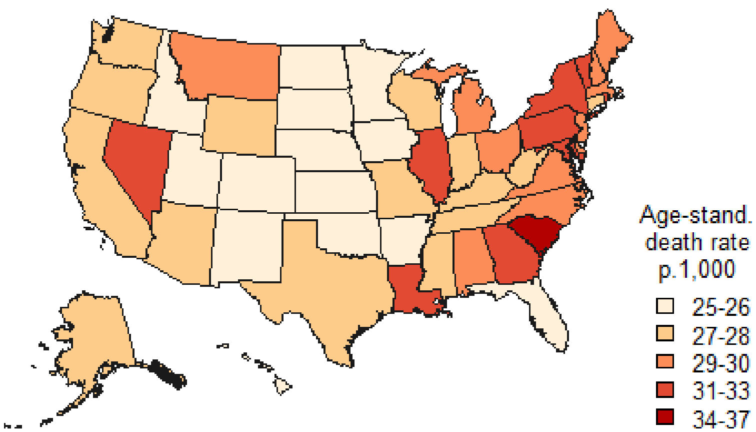
Fig. 3b All-cause age-standardized death rates in U.S. States with trend line, females aged 40–84, 1959–2010



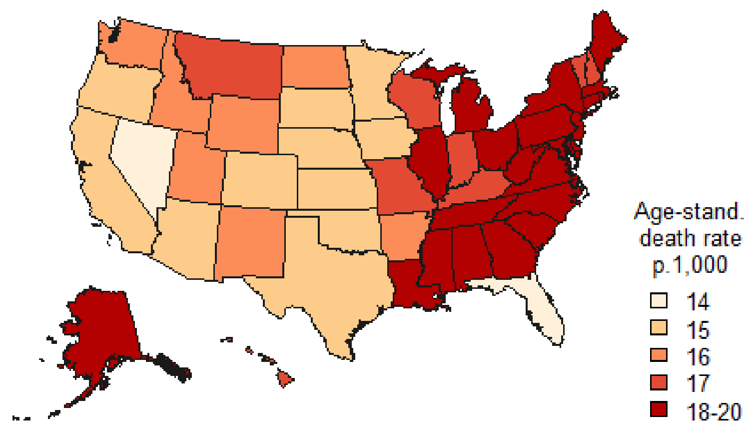
Notes: The standard population corresponds to the total population (both sexes) of the United States at the 1980 Census. Trend lines correspond to the best-fitting two- or three-slope regression model (by a criterion of maximum R2). For a given state, the three-slope model is selected over the two-slope model only if its Bayesian Information Criterion (BIC) is lower and its parameter estimates are statistically significant (p \u2264 .01).

Fig. 4a-4d. Age-standardized death rate per 1,000 at 40-84 years, United States, each sex, 1959 and 2010

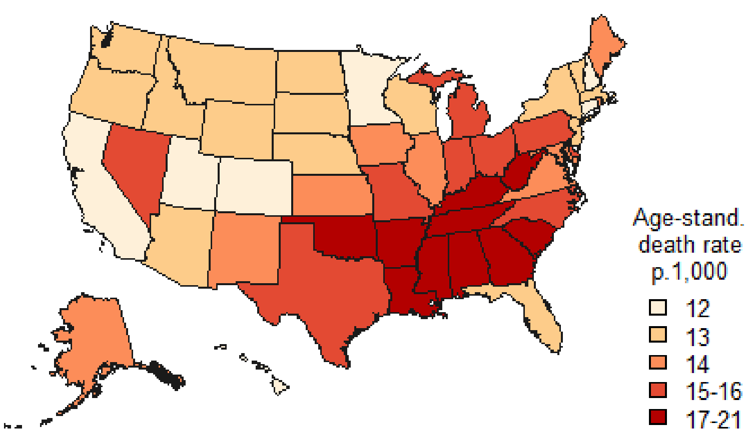
4a. Males, 1959



4b. Females, 1959



4c. Males, 2010



4d. Females, 2010

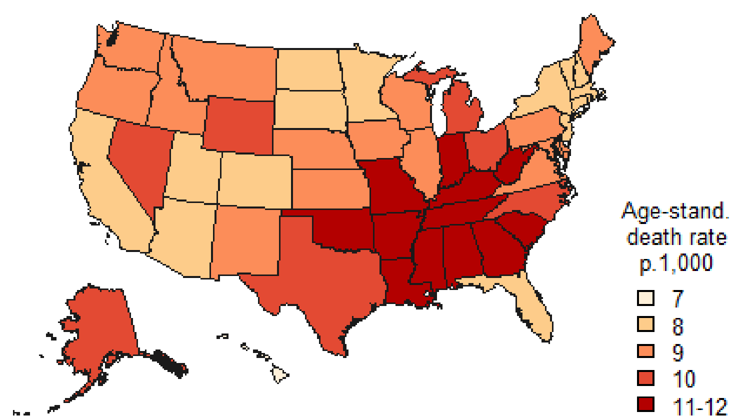


Fig. 5 Years of life gained between the ages of 40 and 85 years by sex in each state between 1959 and 2010

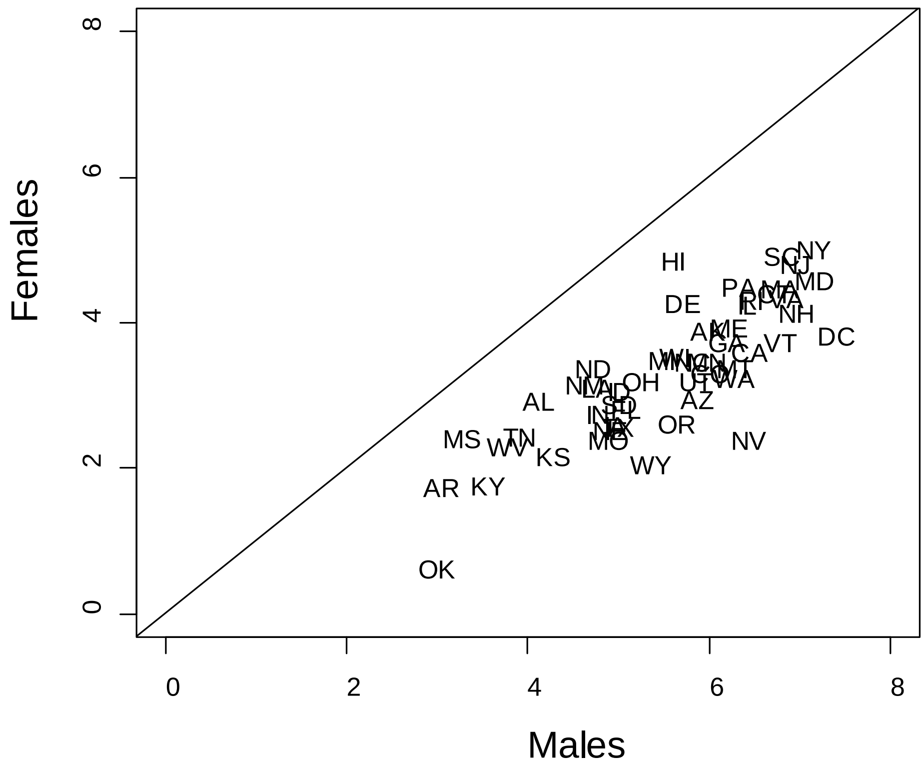
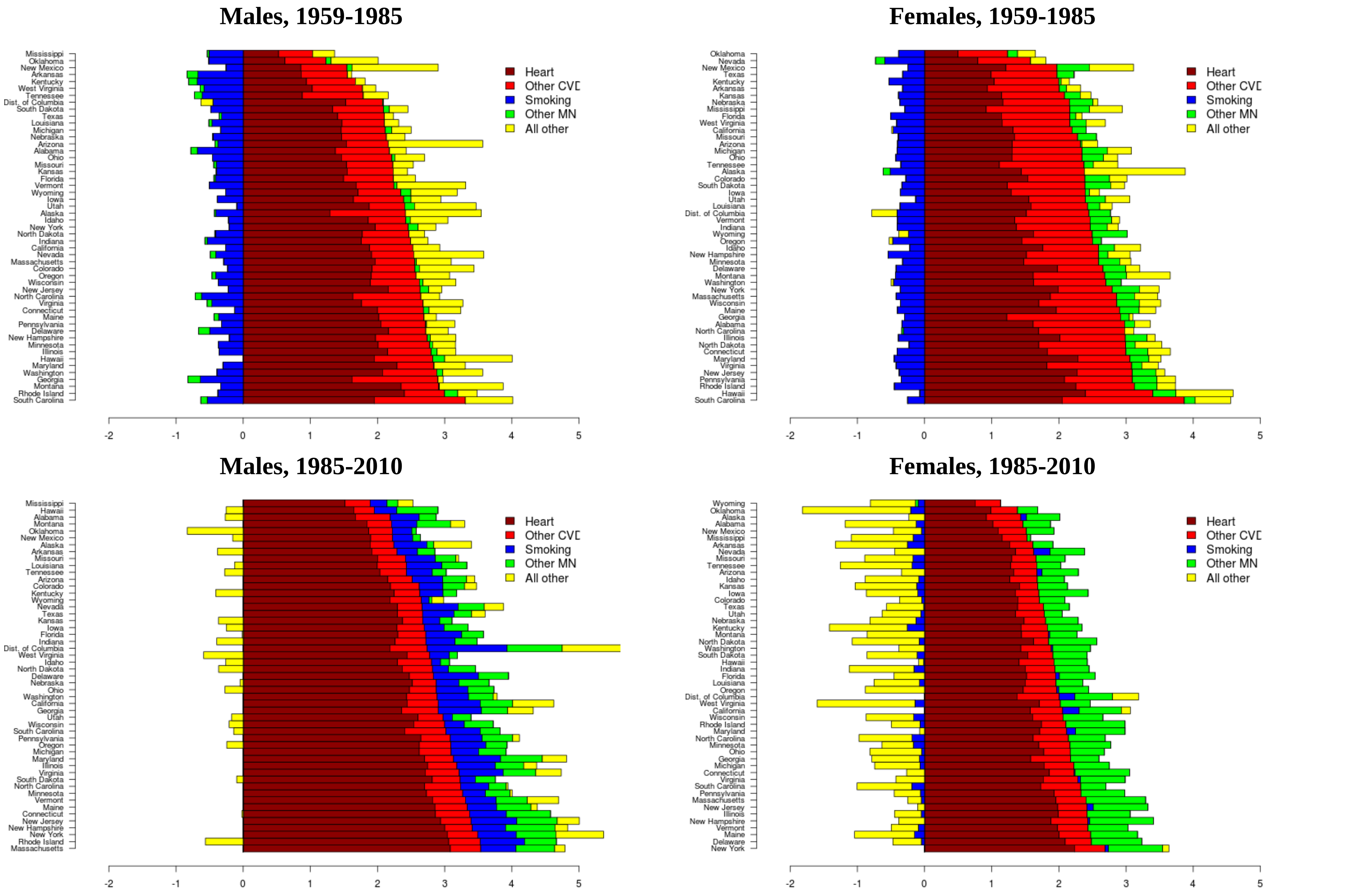


Fig. 6 Contribution of five large cause-of-death categories to the gain in years lived between ages 40 and 85 by sex between 1959 and 1985 and between 1985 and 2010
(States ranked for each sex and time period on the total number of years of life gained from CVDs at ages 40-85 during the period)


Males, 1959-1985
Females, 1959-1985
Males, 1985-2010
Females, 1985-2010
Heart
Other CVD
Smoking
Other MN
All other

Supplementary Tables.

Table S1A. All-cause age-standardized death rate at 40-84 and cause-of-death fractions for four selected categories by sex in 1959, All U.S. states

Region/State	All-cause death rate (per 1,000)		Proportion of all-cause death rate (%): Heart diseases		Other diseases of the circulatory system		Smoking-related cancers		All other cancers		Total proportion of selected causes	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
East North Central												
Illinois	31.21	19.45	50.8	47.4	13.3	17.2	5.3	1.2	11.9	18.2	81.2	84.0
Indiana	28.96	18.00	48.2	41.0	15.7	20.9	4.5	1.1	11.3	18.3	79.8	81.3
Michigan	29.93	18.72	46.5	41.5	14.7	18.8	5.1	1.3	12.6	19.1	78.9	80.7
Ohio	29.47	18.59	46.0	41.8	15.4	19.2	5.0	1.3	12.3	18.7	78.7	81.0
Wisconsin	27.61	17.38	48.4	41.6	15.0	20.2	3.8	0.9	12.9	19.7	80.0	82.4
East South Central												
Alabama	29.44	19.26	44.2	40.7	17.7	22.7	3.6	1.2	10.4	15.3	75.9	79.9
Kentucky	27.84	17.49	45.9	41.4	16.2	19.1	4.2	1.3	10.7	17.5	77.0	79.4
Mississippi	28.47	18.78	40.4	37.0	15.8	21.2	3.5	1.2	10.8	15.8	70.6	75.2
Tennessee	28.60	18.16	42.6	38.9	18.0	22.0	4.4	1.4	10.6	15.9	75.6	78.2
Middle Atlantic												
New Jersey	30.89	19.70	50.7	48.3	11.3	14.9	6.2	1.4	13.1	19.1	81.3	83.7
New York	31.38	20.13	50.7	48.1	11.0	14.7	5.6	1.4	12.6	18.6	79.9	82.8
Pennsylvania	31.88	20.49	48.6	45.9	13.4	16.9	4.9	1.1	11.7	18.2	78.7	82.1

Mountain												
Arizona	27.40	15.00	40.9	37.9	12.3	18.8	3.9	1.5	10.9	17.3	68.0	75.5
Colorado	26.27	15.73	43.3	38.9	13.5	17.2	3.9	1.3	11.3	19.1	71.9	76.4
Idaho	26.01	16.24	47.2	41.1	13.6	18.7	3.6	1.7	11.9	16.6	76.4	78.1
Montana	29.67	17.39	45.9	38.8	12.5	19.4	3.5	0.9	11.9	16.9	73.8	76.0
Nevada	32.17	14.85	46.4	39.8	12.9	17.8	4.0	1.9	9.8	15.6	73.0	75.2
New Mexico	25.83	16.19	34.7	33.4	14.0	15.9	3.6	1.3	11.0	19.5	63.3	70.1
Utah	26.70	16.16	45.3	40.3	12.1	17.7	2.9	0.9	12.1	16.2	72.3	75.1
Wyoming	27.87	16.11	44.5	39.9	14.4	18.5	2.9	1.5	10.9	18.9	72.7	78.7
New England												
Connecticut	28.97	18.19	47.4	43.1	13.3	18.5	6.6	1.3	13.1	19.4	80.4	82.3
Maine	29.85	18.62	49.1	45.4	14.5	17.2	4.9	1.4	12.3	19.0	80.8	83.0
Massachusetts	29.95	18.43	48.5	43.4	12.0	16.9	5.4	1.2	12.5	19.3	78.4	80.9
New Hampshire	30.19	17.84	48.1	40.8	13.9	19.5	5.4	1.0	12.7	19.6	80.1	81.0
Rhode Island	31.09	18.78	51.3	47.1	11.8	15.3	5.5	0.9	13.1	19.8	81.7	83.0
Vermont	31.18	17.16	45.6	39.8	12.4	19.9	3.4	1.2	12.5	19.2	73.9	80.1
Pacific												
Alaska	28.39	18.58	34.5	32.8	17.9	17.1	5.0	1.3	10.0	12.3	67.4	63.5
California	27.58	15.86	45.8	40.7	13.8	19.0	5.4	1.6	12.1	19.6	77.1	80.9
Hawaii	25.43	17.08	40.9	41.8	13.5	16.9	6.7	2.7	14.9	16.3	75.9	77.7
Oregon	27.71	15.55	47.0	40.1	15.1	21.3	4.3	1.5	11.0	18.5	77.4	81.5
Washington	27.98	16.39	46.5	40.4	15.2	20.3	4.3	1.4	12.2	18.8	78.2	80.9
South Atlantic												
Delaware	30.46	19.24	49.9	48.1	12.7	13.6	5.4	1.5	10.7	17.8	78.7	81.1
Dist. of Columbia	37.40	21.16	43.4	42.9	12.7	18.8	6.7	1.5	12.7	18.4	75.5	81.5
Florida	25.38	14.48	44.4	39.4	14.3	20.0	5.8	1.6	12.2	18.8	76.7	79.8

Georgia	31.85	19.03	44.5	38.2	20.5	25.9	3.9	1.5	9.0	15.1	77.8	80.7
Maryland	32.55	19.90	50.5	48.0	11.4	14.3	5.4	1.3	11.7	18.1	79.1	81.8
North Carolina	30.07	18.24	46.8	42.7	18.2	22.0	3.3	1.0	9.7	15.0	77.9	80.7
South Carolina	35.22	21.57	45.0	41.6	20.4	24.0	3.5	1.3	9.1	13.2	78.0	80.0
Virginia	30.93	19.13	45.7	42.6	16.3	21.0	4.7	1.1	10.5	16.7	77.1	81.4
West Virginia	28.24	18.56	47.0	42.4	15.2	19.0	4.6	1.4	10.5	17.2	77.3	79.9
West North Central												
Iowa	26.63	15.57	46.0	40.4	15.9	20.9	4.5	1.2	12.9	20.0	79.3	82.4
Kansas	25.47	15.04	47.3	39.4	14.8	18.8	4.3	1.3	11.5	19.5	77.9	79.0
Minnesota	26.39	15.78	47.1	39.0	15.9	20.5	3.6	1.0	13.0	20.4	79.5	80.9
Missouri	28.63	17.06	45.8	41.9	14.6	18.6	5.5	1.3	11.5	18.9	77.3	80.8
Nebraska	26.08	15.30	46.2	39.3	14.6	19.6	4.1	1.0	13.0	20.3	77.9	80.1
North Dakota	25.50	16.08	49.2	41.3	15.2	21.0	2.9	1.3	13.2	18.4	80.5	82.0
South Dakota	25.83	15.78	45.0	38.6	16.3	20.4	2.7	1.2	13.5	21.2	77.5	81.3
West South Central												
Arkansas	26.05	16.86	45.0	39.6	16.4	21.1	3.9	1.4	11.6	16.4	76.8	78.5
Louisiana	31.09	19.54	45.7	44.4	14.1	17.0	5.6	1.5	12.1	16.8	77.5	79.6
Oklahoma	26.55	15.03	41.8	36.7	15.2	19.5	4.6	1.5	12.1	19.3	73.7	77.0
Texas	27.47	15.88	44.8	38.5	14.8	20.1	5.1	1.5	11.3	18.2	76.0	78.3

Table S1B. All-cause age-standardized death rate at 40-84 and cause-of-death fractions for four selected categories by sex in 2010, All U.S. states

Region/State	All-cause death rate (per 1,000)		Proportion of all-cause death rate (%) Heart diseases		Other diseases of the circulatory system		Smoking-related cancers		All other cancers		Total proportion of selected causes	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
East North Central												
Illinois	14.47	9.62	27.0	20.7	5.5	6.3	11.8	10.8	18.6	23.4	62.9	61.2
Indiana	16.42	11.04	25.1	20.0	5.6	7.0	13.0	10.5	16.9	20.4	60.5	57.8
Michigan	15.24	10.42	27.2	22.0	5.4	6.1	11.9	10.5	17.6	21.8	62.1	60.5
Ohio	16.04	10.87	25.6	20.3	5.5	6.3	12.4	10.0	17.4	21.2	60.9	57.9
Wisconsin	13.68	9.02	24.7	18.7	5.6	6.1	11.9	10.8	19.7	24.5	62.0	60.1
East South Central												
Alabama	19.30	12.49	27.1	23.6	5.7	6.9	12.1	8.4	15.1	18.1	60.0	57.0
Kentucky	18.71	12.49	24.9	20.8	5.0	5.9	14.0	11.9	15.9	18.4	59.7	56.9
Mississippi	20.05	13.07	29.0	24.9	5.4	6.9	12.5	8.0	14.9	19.0	61.8	58.7
Tennessee	18.10	11.96	26.5	22.3	5.5	6.7	12.9	9.8	16.3	18.8	61.2	57.6
Middle Atlantic												
New Jersey	13.37	8.80	26.8	21.1	5.4	6.1	10.8	9.8	19.7	25.1	62.6	62.1
New York	13.00	8.58	30.1	24.8	4.7	5.4	11.1	10.4	19.1	24.7	65.0	65.3
Pennsylvania	15.14	9.82	25.7	20.7	5.0	6.1	11.6	10.0	18.5	23.5	60.8	60.2
Mountain												
Arizona	13.48	8.78	23.7	17.8	4.7	5.8	9.9	9.0	18.2	22.1	56.4	54.6
Colorado	12.53	8.77	21.4	16.2	5.0	6.7	9.1	8.4	18.6	23.3	54.2	54.6

Idaho	13.72	9.40	23.3	16.8	5.2	8.1	10.5	8.4	19.1	21.1	58.1	54.4
Montana	13.81	9.52	23.8	16.2	5.8	6.2	9.5	9.6	18.6	20.9	57.6	52.8
Nevada	15.66	10.65	28.4	21.5	4.8	6.2	9.7	9.9	17.4	20.0	60.3	57.6
New Mexico	14.33	9.26	21.0	18.2	4.7	6.0	8.3	7.5	17.7	21.5	51.7	53.2
Utah	12.57	8.90	21.3	18.3	5.2	6.3	6.4	5.1	18.9	21.8	51.9	51.4
Wyoming	13.99	10.56	23.5	19.6	4.2	6.3	10.3	7.5	18.1	22.9	56.0	56.1
New England												
Connecticut	12.26	8.25	24.5	19.7	4.1	5.6	11.7	11.6	20.0	24.5	60.3	61.3
Maine	14.44	9.84	21.2	15.8	4.8	5.1	13.3	12.1	19.7	22.6	59.0	55.7
Massachusetts	13.10	8.42	23.1	17.3	4.7	5.5	12.3	12.5	19.8	24.5	60.0	59.8
New Hampshire	12.70	8.94	23.2	16.8	5.0	5.3	12.3	12.2	18.8	23.8	59.2	58.2
Rhode Island	14.32	8.98	23.6	18.8	4.5	5.8	11.7	11.6	19.6	24.0	59.5	60.2
Vermont	13.67	8.93	23.7	15.0	5.1	6.0	13.3	12.0	19.4	24.2	61.5	57.1
Pacific												
Alaska	14.23	10.00	21.5	16.0	5.6	6.7	10.4	11.4	20.0	20.4	57.4	54.4
California	12.44	8.38	26.5	20.8	6.0	6.9	9.7	9.0	20.1	25.2	62.3	61.9
Hawaii	12.09	7.06	26.5	19.1	6.4	7.4	10.1	8.8	19.1	26.7	62.1	61.9
Oregon	13.75	9.65	20.1	15.2	5.8	5.9	11.0	10.6	19.3	23.2	56.3	54.9
Washington	13.15	9.12	23.7	16.5	5.6	6.2	11.9	11.1	19.6	23.6	60.8	57.4
South Atlantic												
Delaware	15.34	9.77	23.5	19.6	5.9	6.0	13.0	12.0	18.9	20.7	61.3	58.3
Dist. of Columbia	16.86	11.61	31.0	28.6	4.2	5.4	9.1	6.8	16.8	22.8	61.1	63.5
Florida	13.98	8.77	24.7	19.1	5.1	6.1	12.0	10.9	18.1	22.8	59.8	58.9
Georgia	17.11	11.38	25.9	21.4	5.6	6.9	10.9	8.3	15.9	19.2	58.3	55.9
Maryland	14.32	9.69	26.9	22.8	5.3	6.4	11.2	9.7	18.6	22.7	62.1	61.5
North Carolina	16.41	10.63	24.3	19.7	5.6	6.6	12.5	9.6	16.7	20.0	59.0	55.9

South Carolina	17.61	11.34	25.5	20.9	5.9	6.8	11.2	9.2	16.7	19.5	59.3	56.4
Virginia	14.39	9.76	24.7	20.0	5.4	6.6	12.0	9.8	18.3	22.1	60.4	58.5
West Virginia	18.78	12.41	24.3	20.2	4.9	6.5	12.4	10.0	15.3	18.0	56.9	54.7
West North Central												
Iowa	14.15	9.18	25.4	20.5	5.7	6.5	12.8	10.0	17.8	23.2	61.7	60.2
Kansas	14.90	9.73	22.9	17.5	6.0	7.3	11.6	10.2	18.0	21.1	58.5	56.1
Minnesota	12.31	8.12	20.0	13.9	5.4	6.2	11.4	11.3	21.7	25.9	58.4	57.3
Missouri	16.04	11.02	26.5	21.2	5.1	6.3	12.2	10.6	17.3	20.5	61.0	58.5
Nebraska	13.96	9.21	22.2	17.5	6.3	6.6	12.3	10.1	17.7	22.7	58.5	56.8
North Dakota	13.70	8.24	25.9	16.0	6.4	7.8	10.5	8.6	18.5	23.6	61.3	56.0
South Dakota	13.75	8.82	22.6	18.3	5.7	6.8	11.9	9.8	19.6	24.0	59.9	58.8
West South Central												
Arkansas	18.23	11.83	27.0	22.2	5.8	7.3	12.6	9.9	15.7	19.0	61.1	58.5
Louisiana	18.56	12.15	27.7	23.8	5.4	6.4	11.7	9.2	16.9	19.8	61.8	59.2
Oklahoma	18.27	12.67	27.3	22.8	5.0	6.8	11.6	9.1	15.7	18.3	59.6	56.9
Texas	15.30	10.24	25.4	21.1	5.8	7.0	10.1	8.2	17.8	20.5	59.1	56.6