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America's Lagging Life Expectancy in International Context: An Eroding Older-Age Mortality Advantage and Rising Younger Adult Mortality from Preventable Causes

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Abstract [150 words]

Recent trends in American life expectancy have generated considerable cause for concern. This study compares mortality in the United States to 17 other high-income countries from 2006-2016 using data from the HMD, WHO, and individual countries’ vital statistics agencies. Improvements in American life expectancy have failed to keep pace with other countries. In 2016, U.S. life expectancy was lower than in the comparison countries by 3.40 (men) and 2.99 (women) years on average. Over the past decade, the U.S.’s deteriorating performance in international comparisons of life expectancy has been driven by two separate processes: an erosion of the U.S.’s old-age mortality advantage and a dramatic worsening of mortality at the prime adult ages (15-44). The key causes of death contributing to the U.S. life expectancy shortfall include: circulatory diseases, injuries (homicide, suicide, drug overdose, and motor vehicle accidents), firearm-related deaths, and among women, smoking.

Introduction

Trends in life expectancy in the United States have generated considerable cause for concern over the past decade. Increases in American life expectancy stagnated from 2010 onwards, and overall life expectancy at birth declined between 2014-2015 and 2015-2016 (Xu et al. 2016; Kochanek et al. 2017), a highly alarming trend that was not observed for any other high-income country except the United Kingdom (Ho and Hendi 2018).

To date, two panels have been convened by the National Academy of Sciences on the topic of international differences in mortality, with an emphasis on the U.S. life expectancy shortfall (Crimmins, Preston, and Cohen 2011; Woolf and Aron 2013). The most recent of these panels covered the period 2006-2008, roughly a decade ago. A comprehensive assessment of how mortality trends over the past decade have affected the U.S.'s life expectancy performance relative to other high-income countries is overdue.

Background

The United States is distinctive in many regards: it is the most populous high-income country and the third largest country worldwide, it has the highest GDP, it spends the largest proportion of its GDP on health care compared to other countries, and its life expectancy is lower than life expectancy in other high-income countries. Its poor performance in international comparisons of life expectancy is a relatively new phenomenon – until the mid-1980s, American life expectancy ranked near the median among high-income countries. In the following decades, however, American life expectancy has failed to keep pace with the progress made by other countries, and the U.S. ranking has fallen precipitously to last place for both men and women.

Several features of the U.S. life expectancy shortfall have been established. First, mortality differences at younger ages play a key role in this shortfall, with ages below 50 accounting for two-thirds and two-fifths of the average U.S. life expectancy shortfall in 2007 for men and women, respectively (Ho 2013). Consistent with this finding, comparisons of age-specific death rates demonstrate that the U.S. performs very poorly relative to other countries at younger ages but very well at the oldest ages, experiencing among the lowest death rates above age 75 (Ho and Preston 2010; Manton and Vaupel 1995). A substantial literature exists on international differences in infant mortality, which is considerably higher in the U.S. than in other countries even after accounting for cross-national variations in the reporting of births and infant deaths (MacDorman et al. 2014; Chen, Oster, and Williams 2016). The U.S.'s fairly high percentage of preterm births (at 24-31 weeks of gestation) is an important contributor to its elevated infant mortality rate (MacDorman et al. 2014). Second, prior explorations of cross-national differences in life expectancy at age 50 have determined that smoking accounts for some but not all of the U.S. disadvantage at older ages (Preston, Glei, and Wilmoth 2011, 2011) and that the performance of the U.S. health care actually performs very well at older ages in the detection and treatment of screenable and treatable cancers such as breast and prostate cancer (Preston and Ho 2011). Third, deaths from injuries make substantial contributions to the U.S. life expectancy shortfall (Ho 2013; Fenelon, Chen, and Baker 2016; Woolf and Aron 2013). Key injury-related causes of death that have been implicated in the U.S. life expectancy shortfall include homicide (for men), motor vehicle accidents, and drug overdose (Ho 2013). Drug overdose is a new arrival on the scene – in the late 1990s and early 2000s, drug overdose death rates were highest in the Nordic countries, but in the course of the contemporary American opioid epidemic, drug overdose death rates skyrocketed in the United States and now exceed those in any other high-income country (Ho 2018). Drug overdose mortality is starting to make an important contribution to the magnitude and particularly the widening of the U.S. life expectancy shortfall (Ho 2018). Fourth, there are several areas in which U.S. mortality performs favorably relative to other countries. The U.S. tends to experience lower mortality at the oldest ages, as mentioned above, and lower mortality from suicide and screenable and treatable cancers compared to other high-income countries.

The value of international comparisons of mortality lies in their ability to illuminate key differences and similarities among countries. The former illustrate particular challenges that are faced by particular countries and help shed light on the social factors and institutional structures that may be contributing to these elevated mortality risks. The latter capture the extent to which mortality risks are shared or propagated in an increasingly globalized world. For example, Ho and Hendi (2018) found that the majority of high-income countries experienced large and simultaneous life expectancy declines between 2014-2015. While a common factor – a particularly bad influenza season – accounted for declines in most of these countries, the United States and the United Kingdom emerged as outliers, indicating that different processes may be shaping mortality in these countries (Ibid.). Ho (2018) demonstrated that trends and age patterns in drug overdose mortality in the Anglophone countries (Australia, Canada, the United Kingdom, and the United States) bear key similarities to one another and may constitute early warning signs of developing drug overdose epidemics in the other three Anglophone countries.

In order to assess how life expectancy has evolved over the past decade, this study compares life expectancy in the United States to 17 other high-income countries. It seeks to answer the following questions:

(1) How do life expectancy levels in the U.S. compare to life expectancy levels in its high-income peer countries in 2016? How has this changed between 2006 and 2016?

(2) Which age groups are responsible for the bulk of the U.S. shortfall in life expectancy at birth? At which ages does the U.S. perform better than the comparison countries, and at which ages does it perform poorly?

(3) Which causes of death are key contributors to the U.S. life expectancy shortfall relative to the comparison countries? In particular, how much of this shortfall can be accounted for by deaths due to smoking and to firearms?

Data and Methods

Data

This study uses data from three main data sources: the Human Mortality Database (HMD), the World Health Organization Mortality Database (WHO), and the vital statistics agencies of select individual countries. The 18 high-income countries that are the focus of this analysis are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. These countries were chosen for reasons of best comparability to the United States, having undergone their mortality transitions during roughly the same time period; population size; and data availability.

All-cause mortality data: Abridged life tables were extracted from the Human Mortality Database for each of the 18 countries for each year between 2006 and the most recent year available, which ranges from 2011 to 2017. For 9 of the countries, additional data for more recent years than were available through the HMD were obtained from the countries' vital statistics agencies to gather full coverage of the period from 2006-2016.[2] For this subset of countries and years, I constructed life tables based on the life table death rates (if available) or deaths and population counts[3] and using graduation to obtain ${}_na_x$ values (Preston, Heuveline, and Guillot 2001).

Cause-specific mortality data: Data on mortality by cause was obtained from the WHO. The most recent year for which data are available for 17 of the 18 countries is 2014. Since the WHO only has data for Canada through 2013, cause-specific mortality data are drawn from Statistics Canada for 2014. For the analyses considering cause of death, 2014 was chosen as the focal year for two reasons: first, this is the most recent year for which all countries have cause-specific mortality data, and second, it avoids any idiosyncrasies related to the widespread mortality declines observed between 2014-2015 in these countries (Ho and Hendi 2018). For example, because influenza mortality was particularly high in other countries in that year, using data from 2015 might lead us to conclude that the United States performs very favorably in terms of influenza related to other countries, but this could be a finding restricted to that year only.

Methods

Arriaga's decomposition is used to apportion the difference in life expectancy at birth between the U.S. and each comparison country into age and cause of death contributions (Arriaga 1989; Preston et al. 2001). This method assumes that the distribution of deaths by cause is constant within each age group in the population, allowing differences in all-cause mortality in

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[2] The sources and years for these data were: Australian Bureau of Statistics (2014-2016), Statistics Belgium (2016), Statistics Canada (2012-2016), Statistics Finland (2016), the Federal Statistical Office of Germany (2016), Instituto Nazionale di Statistica/Italy (2015-2016), Statistics Norway (2015-2016), Statistics Portugal (2016), and Instituto Nacional de Estadistica/Spain (2015-2016). 2016 is used as the end year because only four countries have mortality data available for 2017.

[3] Midyear population estimates were used when available. When necessary, population estimates for other dates (e.g., as of January 1) were adjusted to the midyear assuming a constant annual growth rate (Preston et al. 2001).

a specific age group to be distributed proportionately to differences in cause-specific mortality in that age group. The age group contributions sum up to the total difference in life expectancy at birth between the U.S. and each country, and the cause-specific contributions summed across age groups also add up to the total difference in life expectancy at birth between the U.S. and each country. The decomposition is performed for 18 mutually exclusive and exhaustive cause of death categories (see **Appendix Table A1**). A 19^{th} category, firearm-related deaths, is also examined because of longstanding interest in the contribution of guns to the U.S. life expectancy shortfall. This category includes firearm-related homicides, suicides, accidents, and deaths of unknown intent, and thus overlaps with some of the 18 aforementioned categories.

Smoking is the leading cause of premature morbidity and mortality worldwide. The indirect estimation method developed by Preston, Glei, and Wilmoth (2010, 2011) is used to estimate smoking-attributable mortality at ages 50+ for each country. This method calculates smoking-attributable mortality at ages 50+ because the vast majority of mortality caused by smoking occurs at these ages. It uses excess lung cancer mortality as an indicator of the burden of smoking on mortality and derives this quantity based on the difference between observed lung cancer death rates and lung cancer death rates among non-smokers in the Cancer Prevention Study-II, which approximates the level of lung cancer mortality that we would expect to observe in a population in the absence of smoking. The method uses negative binomial regression to model mortality from all other causes of death as a function of lung cancer mortality. These model coefficients are age- and sex-specific and incorporate a time trend, and they are used to estimate one of two components of smoking-attributable mortality – the fraction of all non-lung cancer deaths attributable to smoking. The second component is the fraction of lung cancer deaths attributable to smoking. In the counterfactual scenario where all mortality attributable to smoking is eliminated, the age-specific death rates are computed as:

$$ {}_{n}m_{x}^{without\ smoking} = {}_{n}m_{x}^{observed}\left(1 - {}_{n}A_{x}^{smoking}\right), $$

where ${}_{n}m_{x}$ is the observed, all-cause age-specific death rate and ${}_{n}A_{x}^{smoking}$ is the fraction of deaths attributable to smoking in the age group x to $x + n$. These new age-specific death rates are used as the inputs in estimating a set of counterfactual life tables that specify what life expectancy at age 50 would be in the absence of smoking in each country. The contribution of smoking to the U.S. shortfall in life expectancy at age 50 is calculated as:

$$ \frac{(e_{50}^{observed,country\ i} - e_{50}^{observed,U.S.}) - (e_{50}^{counterfactual,country\ i} - e_{50}^{counterfactual,U.S.})}{e_{50}^{observed,country\ i} - e_{50}^{observed,U.S.}}. $$

Results

Life Expectancy Levels and Trends

Figure 1 shows life expectancy at birth for men (panel A) and women (panel B) in each country between 2006 and 2016. The U.S. had the lowest life expectancy in almost every year for both men and women[4], and it is clearly falling far behind all of the comparison countries, particularly among men. Over this 11-year period, life expectancy increased by only 1.11 and 1.00 years for American men and women, respectively. These gains were considerably lower than those observed in other high-income countries, which averaged 2.28 years for men and 1.43 years for women. They are also nowhere near the pace of improvement in best-practice life expectancy, 2.5 years per decade (Oeppen and Vaupel 2002).

[4] The one exception is 2007, when Danish women had a life expectancy at birth that was a tenth of a year lower than that of American women.

Another measure of the U.S.'s deteriorating performance is how much lower its life expectancy is than the world leaders in each year, which were typically Swiss men (but occasionally Australian men and Japanese men) and Japanese women. In 2006, life expectancy for American men was 3.76 years lower than that of Swiss men; by 2016, this gap had increased to 5.14 years. Among women, the corresponding comparison was 5.33 years and 5.78 years, respectively. A particularly informative marker is the life expectancy difference between the United States and the country with the next-lowest life expectancy, which was Denmark among women and Portugal (in 9 out of 11 years) or Finland (in 2 out of 11 years) for men. In 2006, life expectancy for Portuguese men exceeded that of life expectancy for American men by only 0.19 years; by 2016, this had reached 1.65 years, a more than 8-fold increase. For women, these figures were 0.12 and 1.40 years, a more than 11-fold increase.

If we examine trends in life expectancy at age 50 (**Figure 2**), we can see a precipitous decline in the U.S. life expectancy ranking over this period for men. American men have gone from being ranked 13 out of 18 countries to last or second-to-last in the most recent three years. During this entire period, American women have always performed very poorly, ranking last or second-to-last in every year. Two additional observations of interest arise from this figure: first, Japanese women are the clear leaders in both life expectancy at birth and at age 50, and there is a clear separation between them and women in all of the other 17 countries. This is in contrast to men, where no dominant leader has pulled away from all the other countries. While Swiss men were typically the leaders in life expectancy at birth, Australian men were the leaders in life expectancy at age 50.

Age Patterns of the U.S. Mortality Disadvantage

As discussed above, the United States does not perform uniformly poorly across the age range. **Figure 3** shows the ranking of the U.S.'s age-specific death rates in 2006 and in 2016, with a rank of 1 corresponding to having the lowest death rate among the 18 countries and a rank of 18 corresponding to having the highest death rate among the 18 countries. The J-shaped pattern observed in a prior study (Ho and Preston 2010) is preserved – the U.S. has among the highest death rates until the older ages, where it has fairly low death rates. Between 2006 and 2016, the age at which the U.S. rankings start to improve has moved progressively older, being pushed back by 10 years (from the 65-69 to the 75-79 age group) among men and by 5 years among women (from 75-79 to 8-84), continuing a trend of deteriorating rankings observed in prior studies (Ho and Preston 2010; Palloni and Yonker 2016).

Figure 4 shows the ratio of U.S. death rates to the average of the 17 comparison countries at each age. These ratios are well above 1.00 until ages 75+. In 2006, these ratios were highest in infancy and the young adult years (15-29), coinciding with the so-called "accident hump" in mortality. In 2016, however, we see a dramatic expansion of this hump to older ages, now spanning ages 15-39 among men and ages 20-44 among women. We also see that the ratios have increased substantially at nearly every age between 2006 and 2016 (the solid lines lie above the dotted lines for all age groups below 60-64).

Age Group Contributions to the U.S. Life Expectancy Shortfall

Figure 5 plots the difference between life expectancy in the U.S. and each of the 17 comparison countries (as well as the average of these 17 countries) against the percentage of that difference attributable to mortality differences below age 50. Younger ages account for a substantial proportion of the U.S. shortfall in life expectancy at birth – 56% for men and 38% for women. This is substantial variation in this percentage, which ranges from 38% (Australia) to 93% (Portugal) among men and from 22% (Japan) to 82% (Denmark) among women. In general, younger ages count for more of the U.S. life expectancy shortfall among men compared to women, and there is a tendency for there to be a negative correlation between the size of the U.S. life expectancy shortfall and the percent of that shortfall due to mortality differences at younger ages – in other words, the larger the gap, the less of it that tends to be due to ages below 50.

Figure 6 shows the contribution of five broad age groups to the average U.S. life expectancy shortfall. Among both men and women, ages 85+ are making a negative contribution – mortality in this age group is lower in the United States than in the comparison countries, so it tends to narrow the life expectancy difference. Among men, the working ages make the largest contributions, with the age group 45-64 making the largest contribution (40%) followed by the age group 20-44 (34%). Among women, age groups 45-64 and 65-84 make the largest and roughly equal contributions of 36% and 38%, respectively. In general, younger age groups make larger contributions to the U.S. life expectancy shortfall among men, while older age groups make larger contributions among women.

Cause of Death Contributions

Figure 7 shows the contributions of 18 mutually exclusive and exhaustive cause of death categories to the difference in life expectancy at birth between the United States and each of the comparison countries. For each bar, the sum of these contributions corresponds to the difference in life expectancy at birth between the U.S. and that particular country. Negative contributions indicate that the U.S. has a mortality advantage for a particular cause of death, while positive contributions indicate that the U.S. has a mortality disadvantage for a particular cause of death.

Beginning with men (panel A), we can see that circulatory diseases account for the largest part of the U.S. life expectancy shortfall for all countries except Germany, where mental and nervous system disorders, respiratory diseases, and injuries (homicide, suicide, drug overdose, and motor vehicle accidents) make the largest contributions. These four injury-related causes of death, colored in different shades of red, figure prominently and account for roughly a year of American men's life expectancy shortfall in all countries (ranging from 0.72 to 1.26 years). Motor vehicle accidents account for between a fifth and a third of a year of the shortfall, while homicide accounts for between a fifth and a quarter of a year. The contributions of drug overdose (0.14 to 0.49 years) and suicide (-0.13 to 0.29 years) are more variable. Causes of death for which American men appear to be performing relatively well are the screenable and treatable cancers (breast, prostate, cervical, and colorectal cancer) and other malignant neoplasms (besides lung cancer).

Among women (panel B), we observe a similar key role for circulatory diseases except in Finland, Sweden, and Austria. The life expectancy difference between American women and women in these three countries is instead driven primarily by respiratory diseases (excluding influenza and pneumonia) and by mental and nervous system disorders. We also see that lung cancer makes an important contribution in some cases, accounting for up to half a year of the life expectancy shortfall. Together, the contributions of lung cancer and respiratory diseases suggest that smoking may play an important role in American women's life expectancy shortfall. Injuries also make large contributions to the U.S. life expectancy shortfall for women, although the magnitudes of these contributions are somewhat smaller than they are among men. Homicide, suicide, drug overdose, and motor vehicle accidents account for between 0.33 and 0.58 years of American women's life expectancy shortfall. Among these, drug overdose and motor vehicle accidents make the largest contributions, while homicide and suicide make smaller contributions. Similar to the case for men, American women also perform relatively well in terms of mortality from screenable and treatable cancers and all other cancers except lung cancer.

Special Cases: Mortality Related to Firearms and Smoking

The U.S. is an outlier in the accessibility of firearms among high-income countries. **Figure 8** presents the percent of the U.S. life expectancy shortfall accounted for by firearm-related mortality. This ranges from 10% (Switzerland) to 34% (Portugal) among men and from 2% (Japan) to 7% (Denmark) among women. Clearly, the contribution of firearms is more salient for American men than for women. These figures show that while firearm-related mortality makes a nontrivial contribution to the U.S. life expectancy shortfall, particularly for men, it does not account for more than a third of this shortfall, leaving the remainder to be explained by other factors.

Finally, we turn our attention to smoking. **Figure 9** shows the percentage of deaths above age 50 that are attributable to smoking in each country. While smoking-attributable mortality remains higher for men than women, women are rapidly catching up to men. This percentage ranges from 9% (Sweden) to 24% (Belgium) among men and from 2% (Portugal) to 25% (Canada) among women. American men have below-average smoking-attributable mortality, but American women have the fourth highest percentage of deaths attributable to smoking above age 50. **Table 2** translates these percentages into implications for life expectancy levels and the U.S. life expectancy shortfall. As suggested by **Figure 9**, the conclusions are quite different for men and women. The historical differences in smoking and thus contemporary smoking-related mortality among high-income countries are now favoring American men in many cases. For about half of the comparison countries (8 out of 17), American men's life expectancy shortfall would actually be *larger* in the absence of smoking. In the remaining countries, this shortfall would be smaller in the absence of smoking – by 12% on average, and smoking makes particularly large contributions to the difference in life expectancy at age 50 between the U.S.

and Finland (100%), Germany (93%), Sweden (66%), and Austria (60%). Among women, smoking is a key contributor to the U.S. disadvantage in life expectancy at age 50. Smoking accounts for at least half of the U.S. life expectancy shortfall in all but four of the 17 countries: Canada, Denmark, Japan, and the United Kingdom. On average, smoking accounts for 72% of American women's life expectancy shortfall.

Discussion

Life expectancy in the United States lags behind other high-income countries, and rather than improving and maintaining its position, the situation has worsened over time. Life expectancy in the United States has not only stagnated but actually declined in recent years (Xu et al. 2016; Kochanek et al. 2017), and it has failed to keep pace with its peer countries. This study examines the implications of these trends for the country's performance in international comparisons of life expectancy. The U.S. consistently comes in last place in international rankings of life expectancy at birth, and we have witnessed over the past decade a marked deterioration in its ranking for life expectancy at age 50. A particularly dismal indicator of the U.S.'s poor performance is that where it once used to trail the next most poorly-performing country by between a tenth and a fifth of a year, over the past decade these differences have widened to 1.65 (men) and 1.40 (women) years. On average, life expectancy at birth is lower by 3.40 years for American men and 2.99 years for American women than in the U.S.'s high-income peer countries. A three-year life expectancy difference is substantial – even at the rate of improvement observed for best-practice life expectancy (a highly unlikely possibility for the United States), 2.5 years per decade, and assuming all other countries maintained their current life expectancy levels, it would take the U.S. over a decade to catch up to the average of the comparison countries. Based on the rate of life expectancy increase observed in the United States between 2006 and 2016, it would take over 30 years for the U.S. to catch up to the average of the other countries, again assuming that those countries made no gains in life expectancy during those decades.

This study has demonstrated the continued importance of younger age (below 50) mortality for the U.S. life expectancy shortfall. The U.S. experiences particularly elevated mortality rates at the prime adult ages (e.g., between the ages of 15 and 44), and its excess mortality in this age range relative to the comparison countries increased dramatically between 2006 and 2016. Not only has its younger-age mortality disadvantage deepened, but the United States is also losing ground in areas where it once displayed an advantage. While the U.S. still has among the lowest mortality rates at the oldest ages, the ages to which this advantage applies is shrinking rapidly.

The key causes of death contributing to the U.S.'s life expectancy shortfall include circulatory diseases, injuries (homicide, suicide, drug overdose, and motor vehicle accidents), firearm-related deaths, and among women, smoking. A high burden of mortality from circulatory diseases may be linked to deleterious health behaviors such as smoking, sedentary lifestyle, and poor diet. The U.S. also has the highest levels of adult obesity among this set of high-income countries (OECD 2017). The U.S.'s high rates of homicide and firearm-related deaths have long been noted and have been linked to access to and availability of guns, concentrated poverty, residential segregation, and income inequality (Lee 2000; Lynch et al. 2004; Massey 1995; Richardson and Hemenway 2011). Suicide rates have increased in the United States in recent years (Hedegaard, Curtin, and Warner 2018). In earlier periods, the U.S. experienced lower suicide mortality than other high-income countries on average (Ho 2013); this situation has now reversed. Explanations of this uptick in suicide within the United States have been related to the ongoing drug overdose epidemic and to poor socioeconomic and labor force conditions (Braden, Edlund, and Sullivan 2017). Since 1995, the United States has been experiencing a drug overdose epidemic of unprecedented proportions. This epidemic was initially driven by astronomically high levels of painkiller prescribing, driven in large part by pharmaceutical marketing, institutional arrangements including health care financing and provision, and changes in attitudes regarding the treatment of pain and use of strong opioids (Ho 2018). Drug overdose deaths have now reached an all-time high in the United States, with no signs of leveling off (Ahmad et al. 2018). The U.S. disadvantage in mortality from motor vehicle accidents appears to be more strongly related to the amount of driving Americans do, rather than more dangerous driving. Per 100 million vehicle kilometers traveled, fatality rates are fairly similar in the U.S. and other high-income countries (Transportation Research Board 2010). However, it is also the case that over the past decade, improvements in fatality rates in the U.S. have not kept pace with those in other countries (Evans 2014).

Limitations

Any cross-national comparative work depends on the comparability of data across countries. All of the countries included in this analysis are high-income countries with well-developed vital registrations, and their quality of death reporting overall is expected to be fairly high. We have confidence that a death will be recorded as such, with the notable exception of infant deaths (MacDorman et al. 2014), since the definition of infant deaths and live births may vary across countries. There is greater concern over the comparability of cause of death reporting. Using broad cause of death categories is one measure employed in this study to address this issue. Certain causes of death may be more susceptible to this concern than others – for example, injury-related deaths like homicides and motor vehicle accidents are likely to be very consistently reported across countries, but this may be less so for chronic diseases. One example is the cause of death decomposition for the life expectancy difference between German and American women – one possibility is that these differences are real, another possibility is that the same types of deaths are being recorded as deaths from circulatory disease in the United States but as deaths from respiratory diseases and mental and nervous system disorders in Germany. Finally, life expectancy is the most commonly-used summary measure of mortality conditions in a population and has many key advantages, but it captures only one dimension of health and well-being.

Conclusion

Earlier efforts to explain lagging U.S. life expectancy concentrated on older adults and chronic diseases, and attempted to attribute poor outcomes mainly to the health care system. The fact that so much of the American life expectancy disadvantage comes from strongly socially-patterned causes of death occurring at younger ages is striking. These findings suggest that to fully explain and address the U.S. life expectancy shortfall, we must pay attention to the ways life is structured differently in the United States compared to other high-income countries. The institutions currently in place heighten vulnerability among younger versus older individuals and include concentrated poverty, residential segregation, access to firearms, a work culture increasingly oriented around long commutes, and a health care system that incentivizes patient volume and profit over quality of care.

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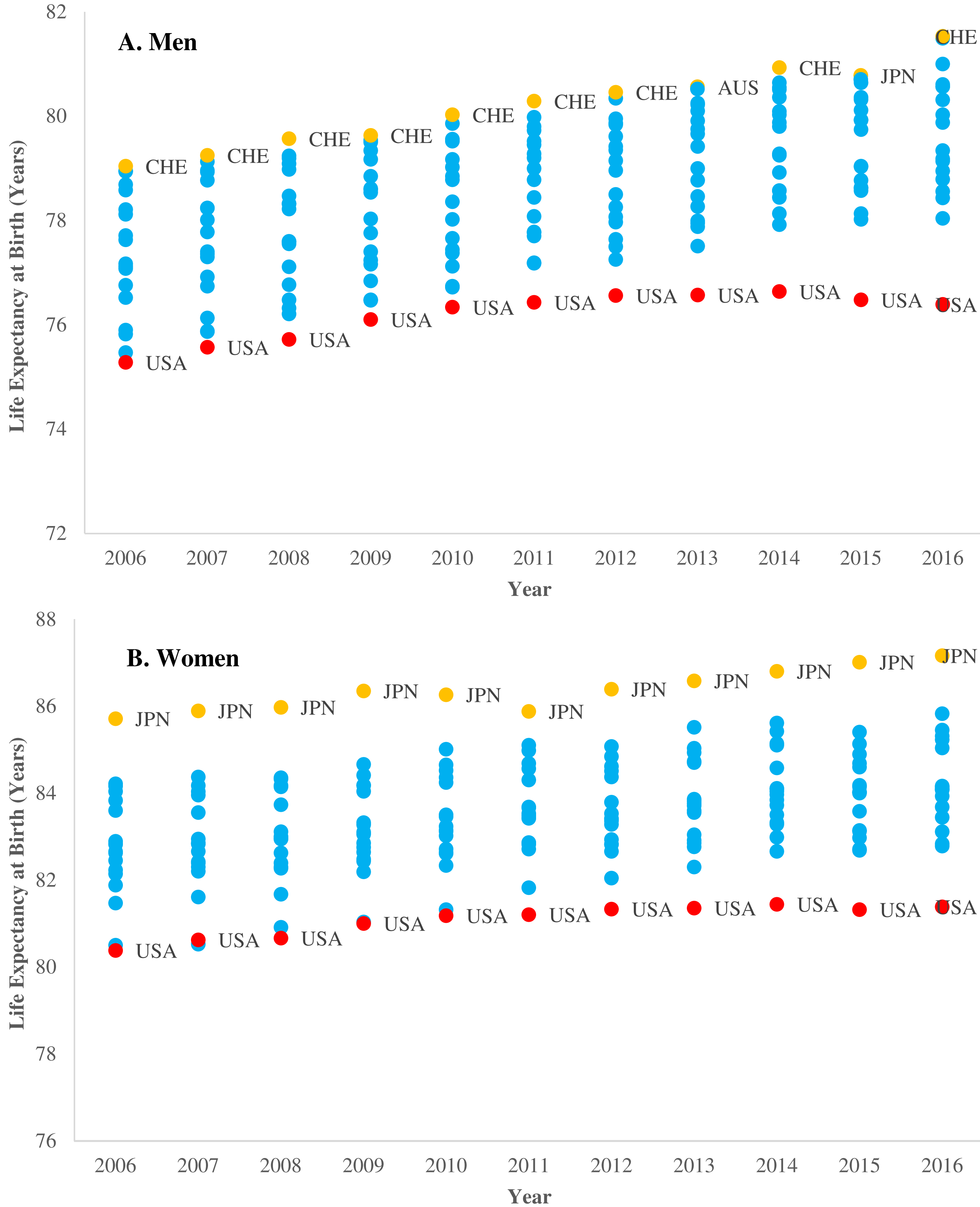
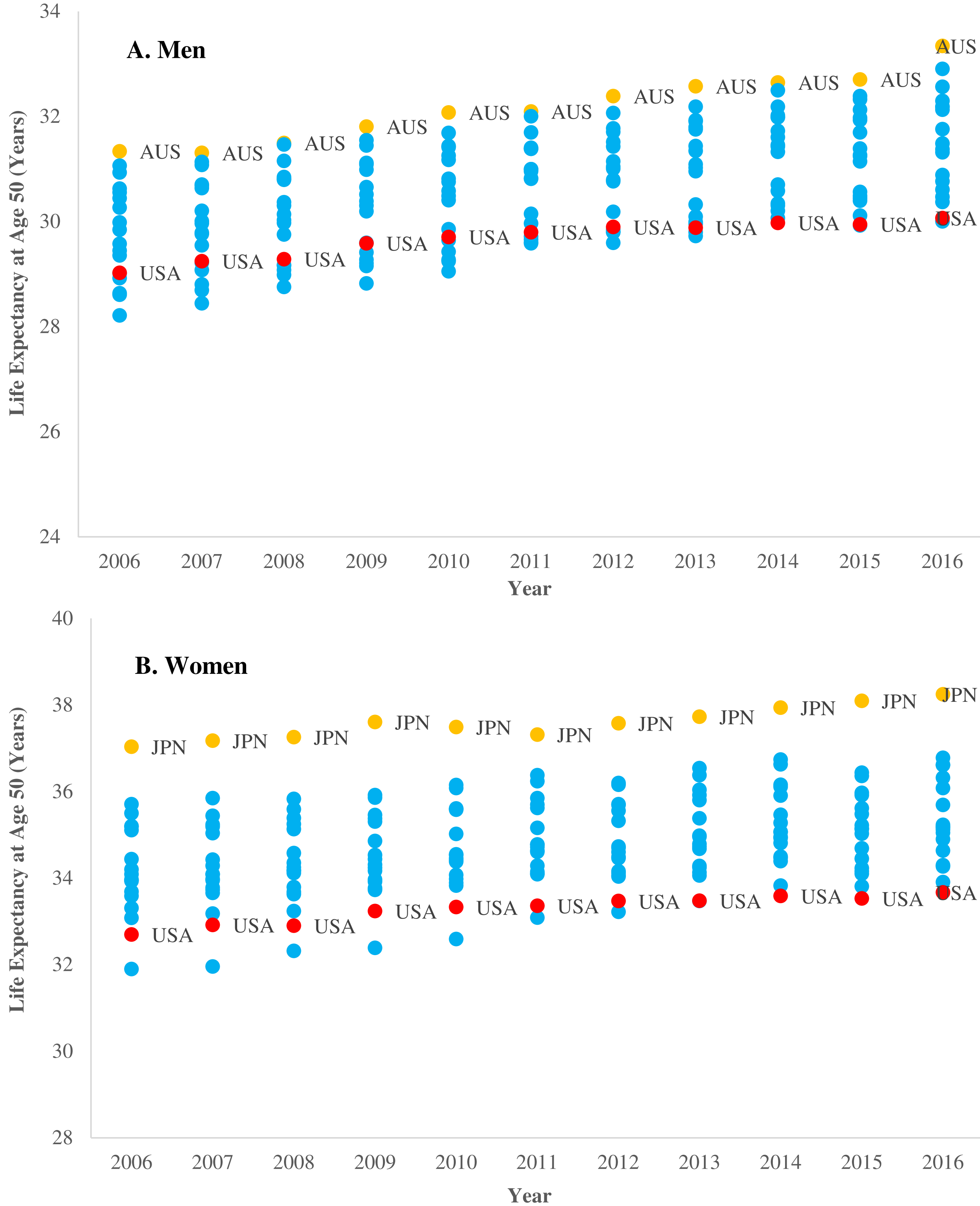
Figures

Figure 1. Life Expectancy at Birth in 18 High-Income Countries, 2006-2016



Notes: The United States (red) and the world leader in life expectancy (yellow) are indicated in each year. AUS=Australia, JPN=Japan, and SWI=Switzerland, and USA=United States.

Figure 2. Life Expectancy at Age 50 in 18 High-Income Countries, 2006-2016



Notes: The United States (red) and the world leader in life expectancy at age 50 (yellow) are indicated in each year. AUS=Australia, JPN=Japan, and USA=United States.

Figure 3. Ranking of U.S. Age-Specific Death Rates Among 18 High-Income Countries, by Sex, 2006 and 2016

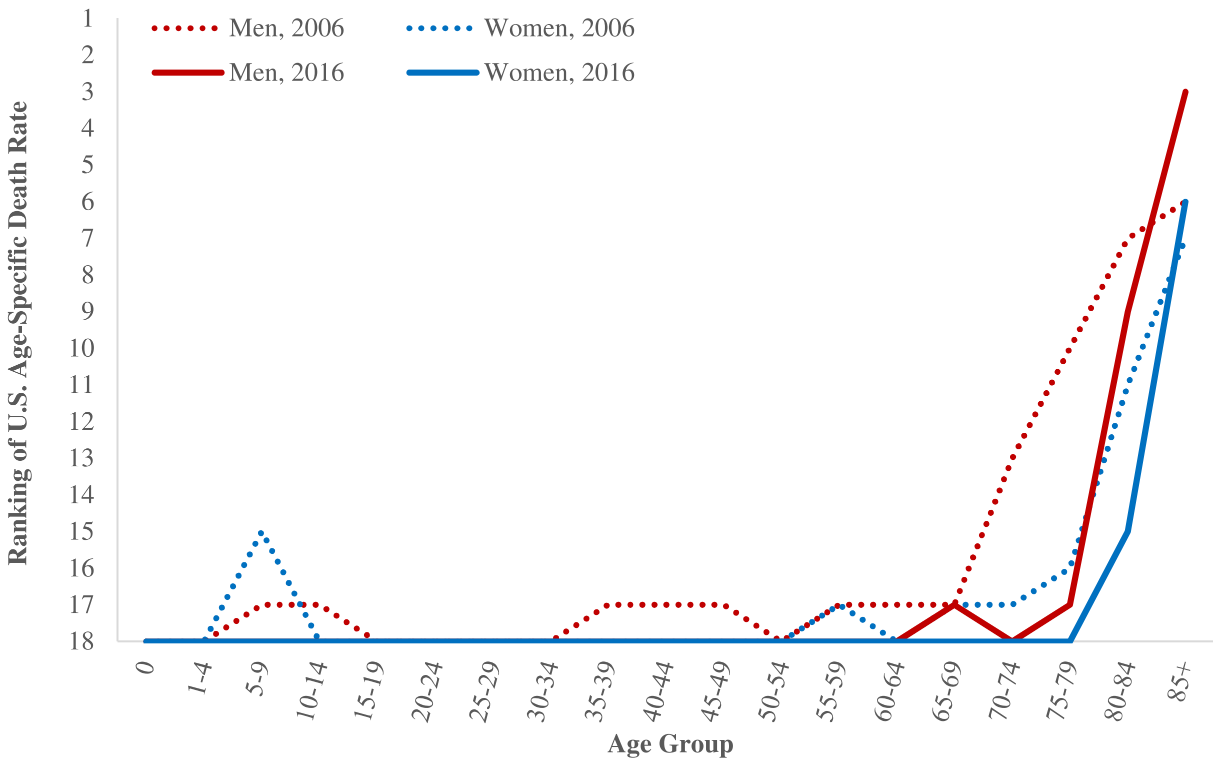


Figure 4. Ratio of U.S. Age-Specific Death Rates to Average of 17 Other High-Income Countries, by Sex, 2006 and 2016

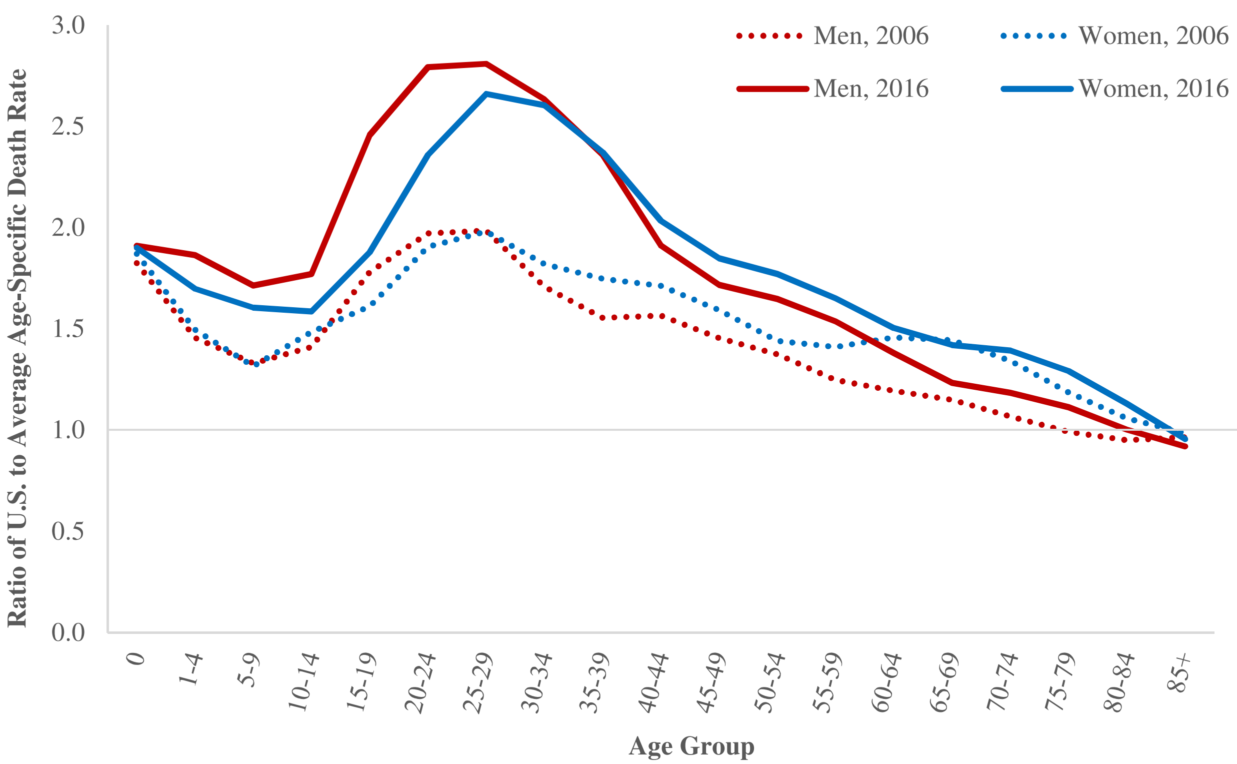
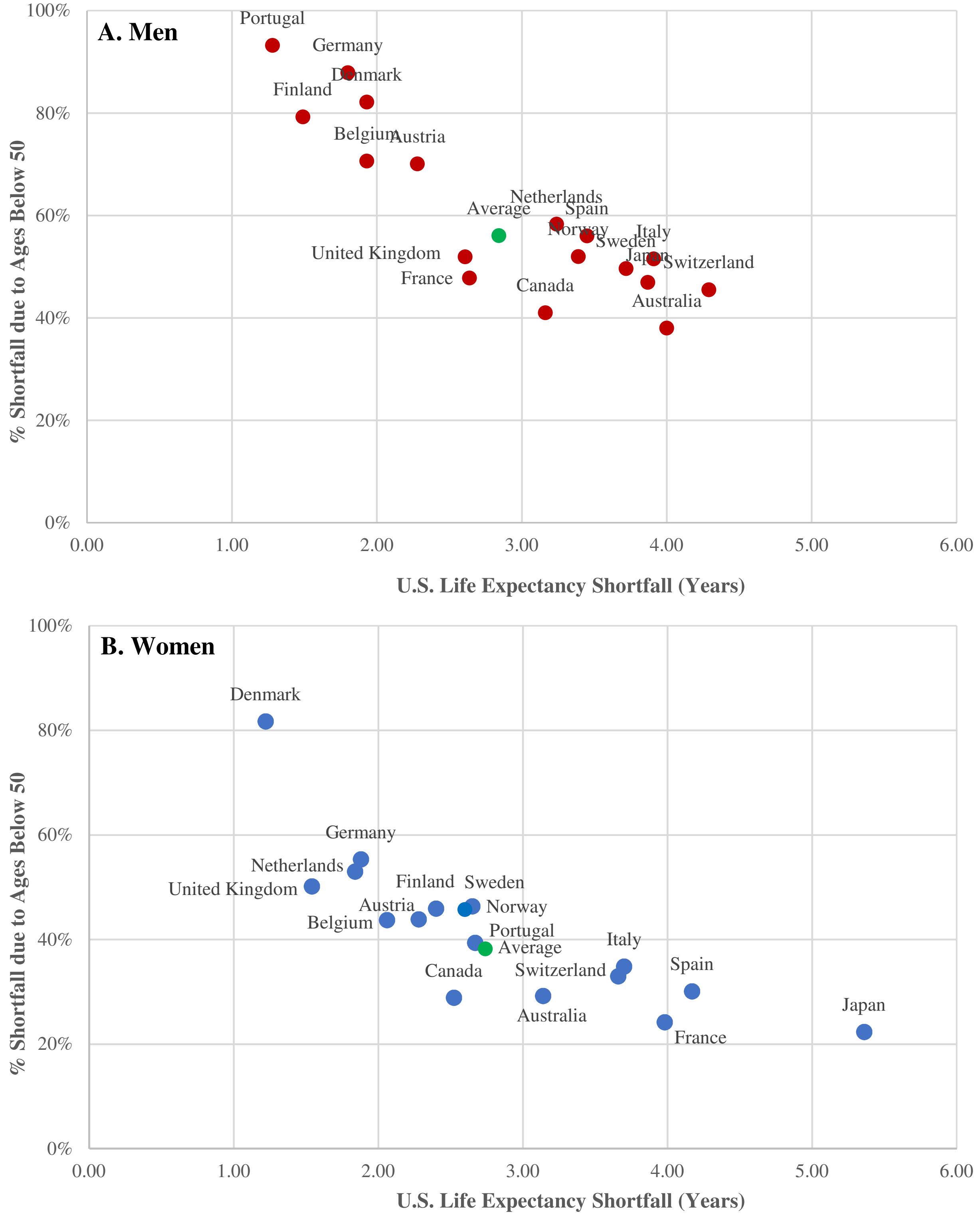
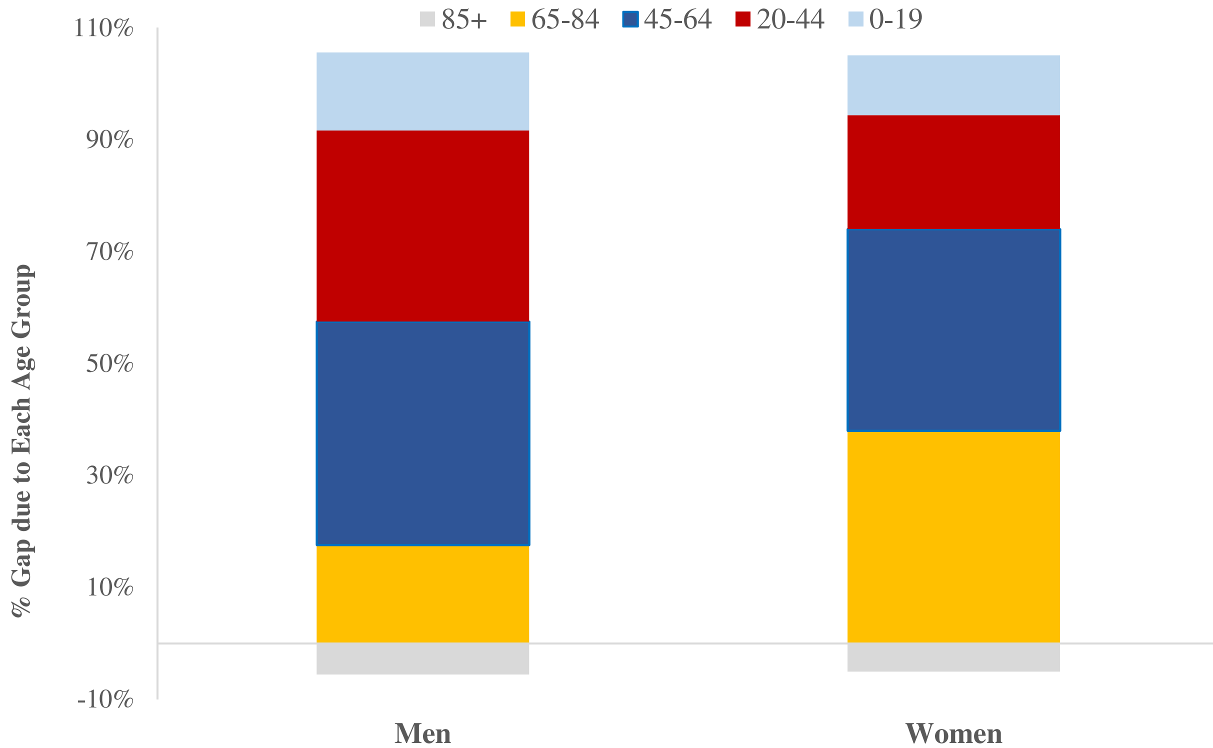


Figure 5. Percentage of U.S. Life Expectancy Shortfall due to Ages Below 50, 17 High-Income Countries, 2014



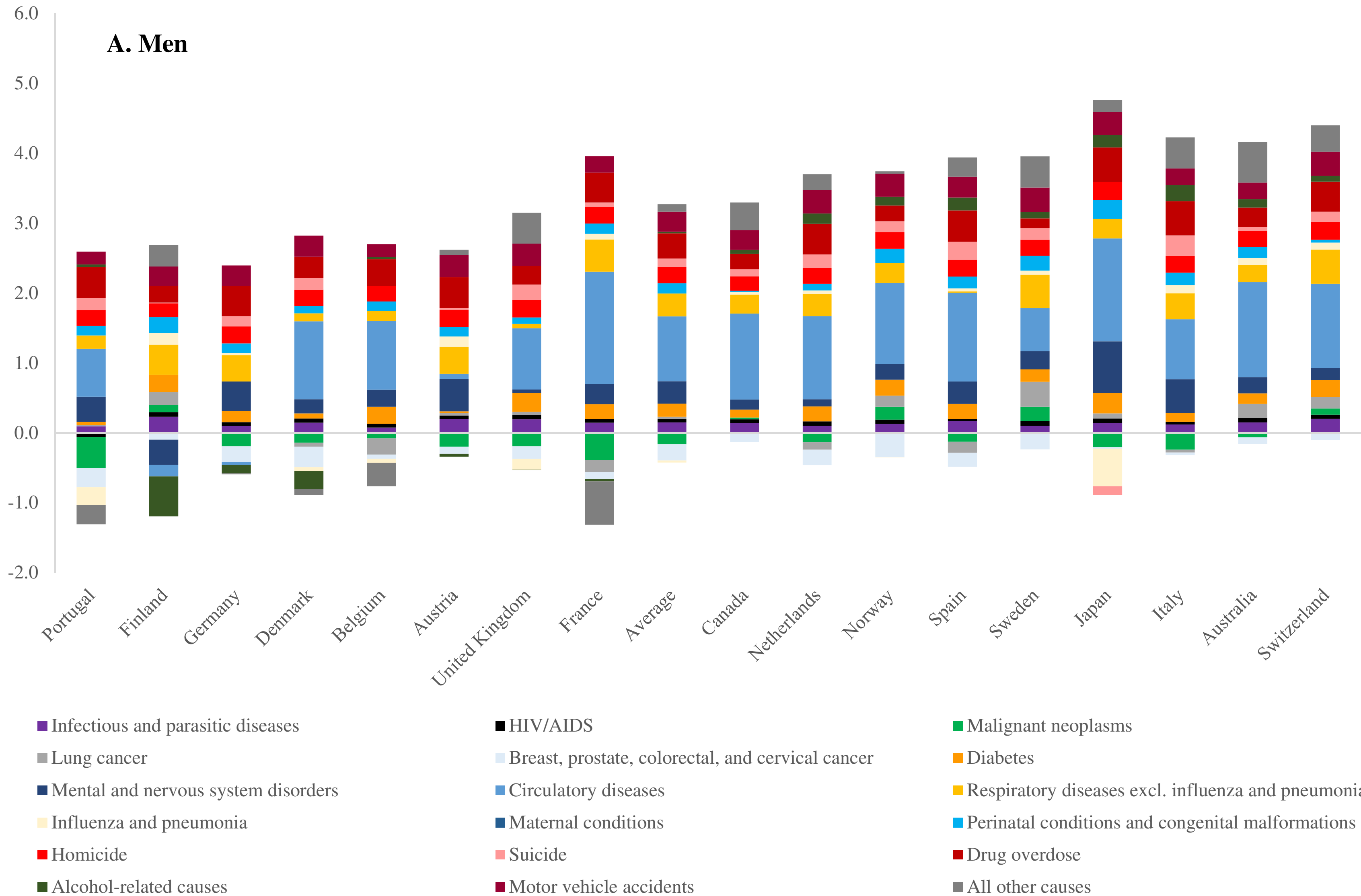
Notes: U.S. life expectancy shortfall is the difference in life expectancy at birth between each country and the United States.

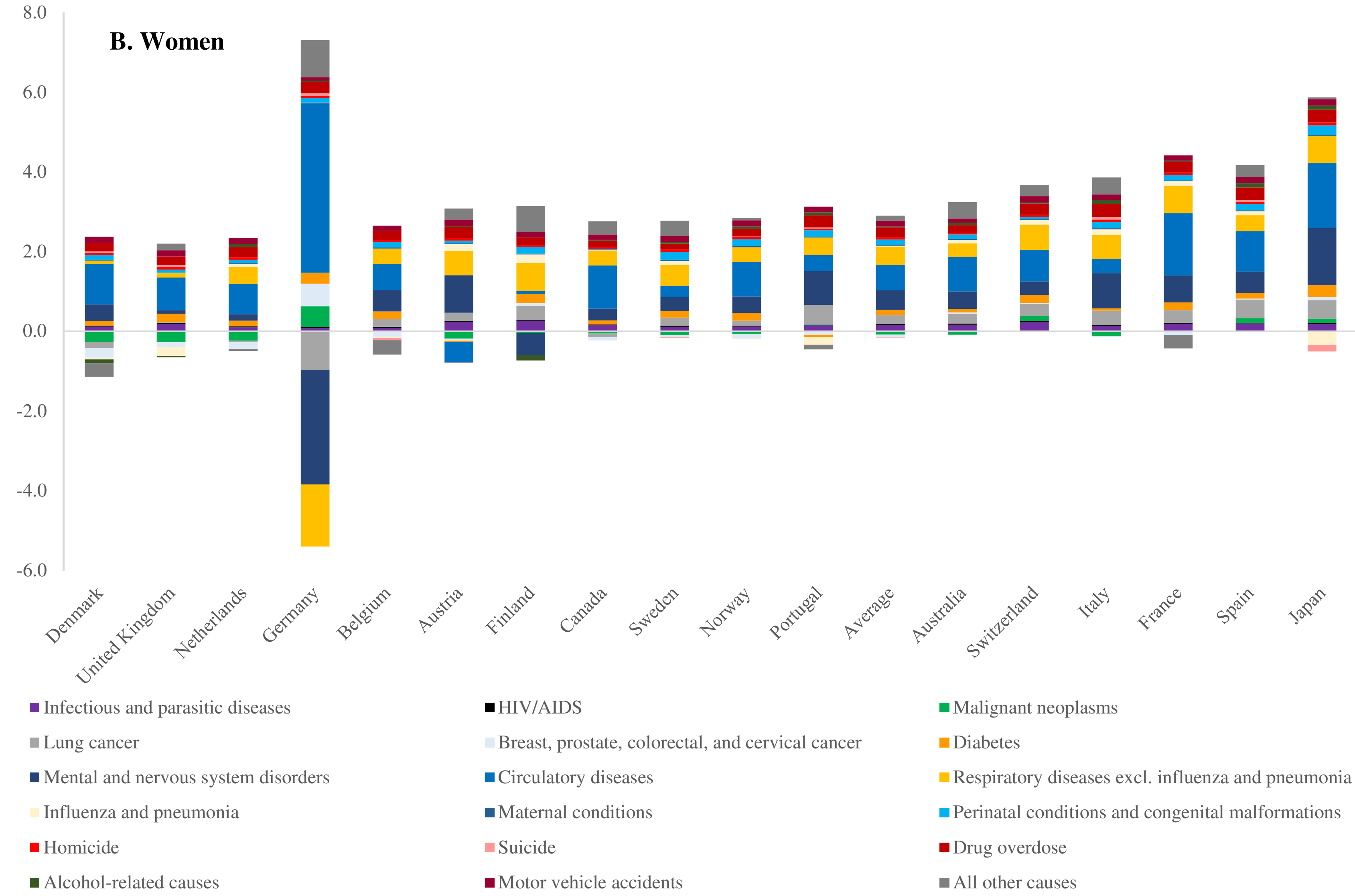
Figure 6. Percentage of U.S. Life Expectancy Gap due to Specific Age Groups, Average of 17 High-Income Countries, 2014



Notes: Percentages sum to 100%.

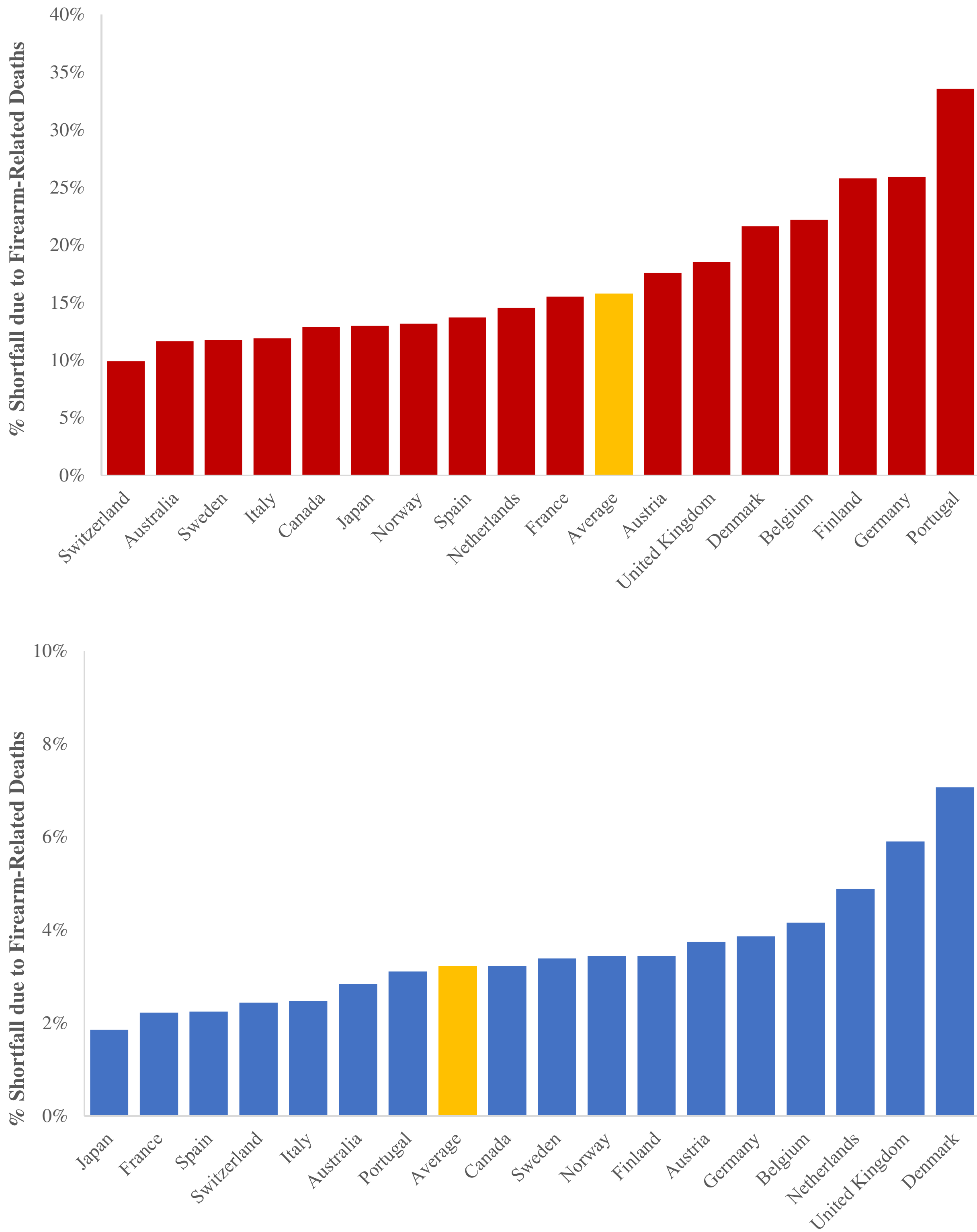
Figure 7. Contribution of 18 Causes of Death to U.S. Life Expectancy Gap, 2014





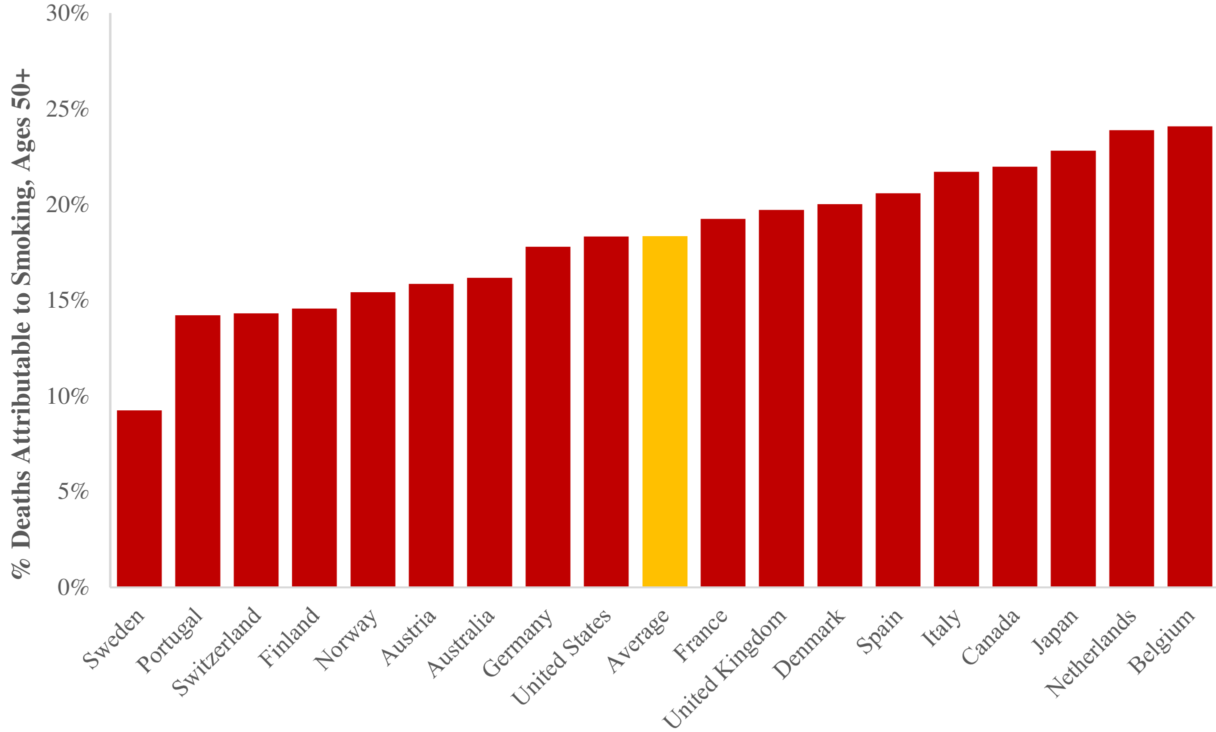
Notes: Bars sum to the total difference in life expectancy at birth between each country and the United States.

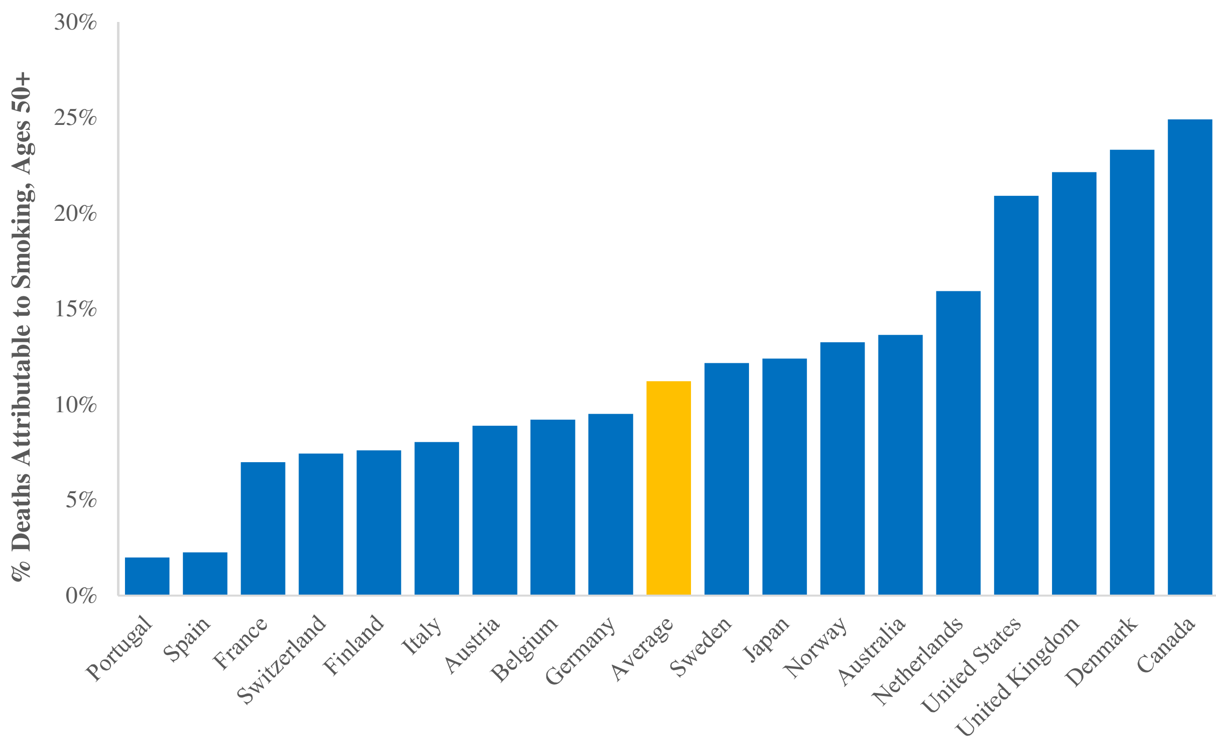
Figure 8. Percent Contribution of Firearm-Related Deaths to U.S. Life Expectancy Shortfall, 17 High-Income Countries, 2014



Notes: U.S. life expectancy shortfall is the difference in life expectancy at birth between each country and the United States.

Figure 9. Percentage of Deaths Attributable to Smoking at Ages 50+, 18 High-Income Countries, 2014





Tables

Table 1. Life Expectancy at Birth by Sex, 18 High-Income Countries, 2006 and 2016

	Men		*Women*	
	2006	**2016**	**2006**	**2016**
Australia	78.95	81.49	83.61	85.46
Austria	77.08	79.14	82.63	83.94
Belgium	76.52	78.79	82.15	83.69
Canada	78.21	80.03	82.85	84.15
Denmark	75.90	78.95	80.51	82.79
Finland	75.82	78.43	82.83	84.11
France	77.17	79.34	84.17	85.32
Germany	76.76	78.56	82.24	83.45
Italy	78.58	80.56	84.05	85.05
Japan	78.94	81.00	85.72	87.17
Netherlands	77.63	79.88	81.89	83.12
Norway	78.12	80.61	82.66	84.17
Portugal	75.47	78.04	82.46	84.08
Spain	77.71	80.31	84.22	85.84
Sweden	78.69	80.57	82.90	84.09
Switzerland	79.04	81.53	83.84	85.24
United Kingdom	77.12	79.18	81.48	82.84
United States	75.28	76.39	80.39	81.39
Life Expectancy Between United States and:				
World Leader	3.76	5.14	5.33	5.78
Next Lowest-Ranked Country	0.19	1.65	0.12	1.40

Table 2. Life Expectancy at Age 50 With and Without Smoking and Percentage of U.S. Life Expectancy Shortfall Due to Smoking, Men and Women, 18 High-Income Countries, 2014

	Men					*Women*				
	With Smoking		**Without Smoking**			**With Smoking**		**Without Smoking**		
Country	e50	Gap with U.S.	e50	Gap with U.S.	% Gap due to Smoking	e50	Gap with U.S.	e50	Gap with U.S.	% Gap due to Smoking
Australia	32.65	2.67	34.41	2.22	17%	35.91	2.32	37.40	1.17	49%
Austria	30.71	0.73	32.49	0.29	60%	34.93	1.34	36.02	-0.20	*
Average	31.33	1.35	33.38	1.18	12%	35.36	1.77	36.72	0.50	72%
Belgium	30.59	0.61	33.43	1.24	–	34.81	1.22	35.95	-0.27	*
Canada	31.99	2.01	34.61	2.41	–	35.47	1.88	38.62	2.39	–
Denmark	30.35	0.37	32.52	0.32	12%	33.83	0.24	36.67	0.45	–
Finland	30.31	0.33	31.85	-0.35	*	34.95	1.36	35.73	-0.49	*
France	31.46	1.48	33.81	1.62	–	36.74	3.15	37.62	1.40	56%
Germany	30.21	0.23	32.21	0.02	93%	34.47	0.88	35.61	-0.61	*
Italy	32.02	2.04	34.40	2.20	–	36.11	2.52	36.98	0.76	70%
Japan	32.19	2.21	34.99	2.79	–	37.94	4.35	39.37	3.14	28%
Netherlands	31.43	1.45	34.08	1.89	–	34.50	0.91	36.39	0.16	82%
Norway	31.73	1.75	33.30	1.11	37%	35.07	1.48	36.63	0.40	73%
Portugal	30.07	0.09	31.70	-0.49	*	35.28	1.69	35.50	-0.72	*
Spain	31.61	1.63	34.06	1.87	–	36.63	3.04	36.94	0.72	76%
Sweden	31.99	2.01	32.89	0.69	66%	35.07	1.48	36.43	0.21	86%
Switzerland	32.50	2.52	33.97	1.78	29%	36.16	2.57	37.00	0.78	70%
United Kingdom	31.33	1.35	33.53	1.33	1%	34.39	0.80	37.03	0.80	0%
United States	29.98		32.20			33.59		36.22		

Notes: – indicates that smoking does not contribute to the U.S. shortfall in life expectancy at age 50 (i.e., the U.S. life expectancy shortfall would be larger in the absence of smoking). * indicates that smoking accounts for the entirety of the U.S. shortfall in life expectancy at age 50 (i.e., the U.S. life expectancy would be higher than that of the comparison country in the absence of smoking). Average refers to the average of the non-U.S. countries.

Appendix

Table A1: Cause of Death Categories and Corresponding ICD-10 Codes

Cause of Death Categories	ICD-10 Codes
1. Infectious and parasitic diseases	A00-B99 (excluding B20-B24)
2. HIV/AIDS	B20–B24
3. Malignant neoplasms	C00-C97 (excluding C33, C34, C50, C53, C61, C18–C21)
4. Lung cancer	C33, C34
5. Breast, prostate, colorectal, and cervical cancer	C50, C53, C61, C18–C21
6. Diabetes	E10–E14
7. Mental and nervous system disorders	F01–F99, G00–G99 (excluding F10, G31.2, G62.1, G72.1)
8. Circulatory diseases	I00–I99 (excluding I42.6)
9. Respiratory diseases excl. influenza and pneumonia	J00–J99 (excluding J09–J18)
10. Influenza and pneumonia	J09–J18
11. Maternal conditions	O00–O99
12. Perinatal conditions and congenital malformations	P00–P96, Q00–Q99
13. Homicide	X85–Y09, Y87.1 (excluding X85)
14. Suicide	X60-X84, Y87.0 (excluding X60-X65)
15. Drug overdose	X40–X44, X60–X64, X85, Y10–Y14
16. Alcohol-related causes	E24.4, F10, G31.2, G62.1, G72.1, I42.6, K29.2, K70, K85.2, K86.0, R78.0, X45, X65, and Y15
17. Motor vehicle accidents	V02–V04, V09.0, V09.2, V12–V14, V19.0–V19.2, V19.4–V19.6, V20–V79, V80.3–V80.5, V81.0–V81.1, V82.0–V82.1, V83–V86, V87.0–V87.8, V88.0–V88.8, V89.0, V89.2
18. All other causes	D00–D48, D50–D89, E00–E90 (excluding E10–E14, E24.4), H00–H95, K00–K93 (excluding K29.2, K70, K85.2, K86.0), L00–L99, M00–M99, N00–N99, R00–R99 (excluding R78.0), V01–Y98 (excluding V02–V04, V09.0, V09.2, V12–V14, V19.0–V19.2, V19.4–V19.6, V20–V79, V80.3–V80.5, V81.0–V81.1, V82.0–V82.1, V83–V86, V87.0–V87.8, V88.0–V88.8, V89.0, V89.2, X40-X45, X60–Y15, Y87.0–Y87.1)
19. Firearm deaths	W32–W34, X72–74, X93–X95, Y22–Y24, Y35.0, Y36.4

Notes: Mental and nervous system disorders includes Alzheimer's disease. Homicide excludes assault by drugs, medicaments and biological substances (included in drug overdose) and suicide excludes suicide by drugs and alcohol (included in the drug overdose and alcohol-related categories, respectively). Categories 1-18 are mutually exclusive and exhaustive.