How Change in Age-Specific Mortality Has Affected US Life Expectancy Over the Past 120 Years?

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Abstract

This research provides a long-term overview of how age-specific mortality has affected US life expectancy trends since 1900. By comparing these findings with those of selected high-income countries, we examine whether the US trajectory has deviated from other countries from a long-term perspective. The results reveal relatively consistent trends across countries, with infant and child mortality losing its historically significant role and older-age mortality becoming more important in recent gains in life expectancy. Although mortality change in midlife and old age has exhibited diminishing importance for life expectancy gains in other countries over the recent decades, it is particularly so for the US, even turning negative contributions to change in life expectancy between 2010–2019. Historically, reducing mortality at ages 1–80 is more or less equally important for potential gains in life expectancy. Currently, the most potential gains in future life expectancy must be achieved by reducing mortality at ages 50–90, followed by ages immediately before 50 and after 90. We find that the most important source of life expectancy gains has shifted from cardiovascular disease mortality in 1960–2010 to neoplasms mortality in 2010–2019. On the other hand, cardiovascular disease is still the most common cause of death in 2019. Deaths from mental and nervous system diseases have increased quickly over the last four decades, becoming the second most common cause of death for US women, and the third most common cause for US men (followed by neoplasms).

Introduction

The recent discussion surrounding the plateau or decline in mortality improvement in the United States before the onset of the Covid-19 pandemic (Ho and Hendi 2018) has garnered significant attention across academia, mass media, policymaking circles, and among the general public. On the other hand, the United States is not an outlier in life expectancy gains over the twentieth century. Most of the contemporary high-income countries had a life expectancy below 50 years in 1900, and the same figure had been approaching 80 by the dawn of the twenty-first century. The remarkable increases in life expectancy at birth over the past century are among the most significant changes in human history. How does the recent stagnation in US mortality improvement look like in the backdrop of a century's increase in life expectancy? How has change in age-specific mortality affected US life expectancy from a long-run perspective? How similar or dissimilar has the United States' trajectory in life expectancy been compared to that of other high-income countries since 1900? Surprisingly, a long-term perspective is lacking in the current literature.

This study documents the long-term trends in US life expectancy from 1900 and traces out the role played by age-specific mortality. We contrast these findings to that of Italy and Sweden in order to examine if the US trajectory has been deviating from other high-income countries from a long-term perspective. The results of this study provide a comprehensive view on the history of evolution of mortality change and offer insights into the future of longevity in the United States. We show that a general pattern of age-specific mortality and life expectancy has been largely consistent from a century-long historical point of view. The relative importance of midlife and old-age mortality as compared to younger ages has been increasing in more recent decades, but the diminishing role and even negative contribution of mortality change in these ages in the most recent decade (2010–2019) is a US-unique case.

Data and Methods

We obtained sex-year-specific single-age life tables from the Human Mortality Database (USA: 1933–2020; Italy and Sweden: 1900–2020) and Human Life-Table Database (USA: 1900–1932). We used WHO mortality database 1950–

2020 for cause-specific death counts for the USA. The ICD 7–10 were harmonized following previous literature. We applied the Arriaga decomposition method (Arriaga 1989) to analyze the contributions of change in age- and cause-specific mortality to change in life expectancy at birth between every decade for the three countries. To assess the potential room for future life expectancy gains by reducing age-specific mortality, we calculated life expectancy under hypothetical scenarios in which there is no mortality at different ages, and contrasted hypothetical life expectancy with the observed life expectancy in the corresponding year. We conducted life table cause-of-death decomposition using the method suggested by Vaupel and Canudas-Romo (2003).

Preliminary Results

Figure 1 shows the trends in life expectancy at birth for USA and the selected HMD countries. Between 1900 and 2019, life expectancy increased steadily except for years with mortality shocks: the 1918 influenza, World War II, and the Covid-19 pandemic. US life expectancy was close to average of selected countries before 1990, and has fallen behind since then. The gap between the US and the average performance of selected high-income countries increased over the recent three decades, and exacerbated in 2020.

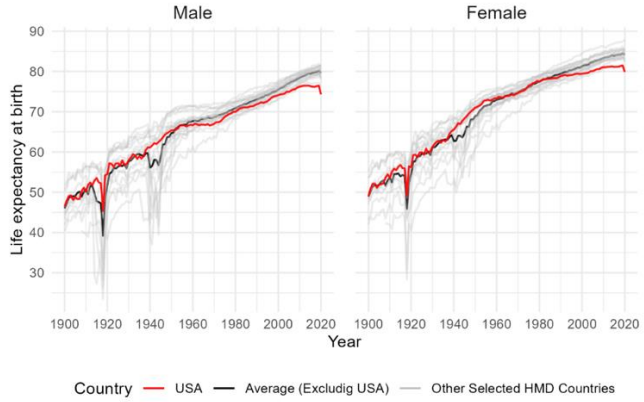

Figure 1: Trends in life expectancy at birth in USA and selected HMD countries by sex, 1900–2020

Figure 2 shows the changes in life expectancy in every adjacent 10 years between 1900 and 2019. Except for the periods when the 1918 influenza and the World War II had significant impacts on mortality, increases in life expectancy at birth were generally large (over 4 years for both sexes). Overall, increases in life expectancy at birth in the second part of the study period (i.e., after 1960) are less than in the first half (i.e., before 1960), especially the United States. We also see less variation in the increases in life expectancy among the selected countries after 1960.

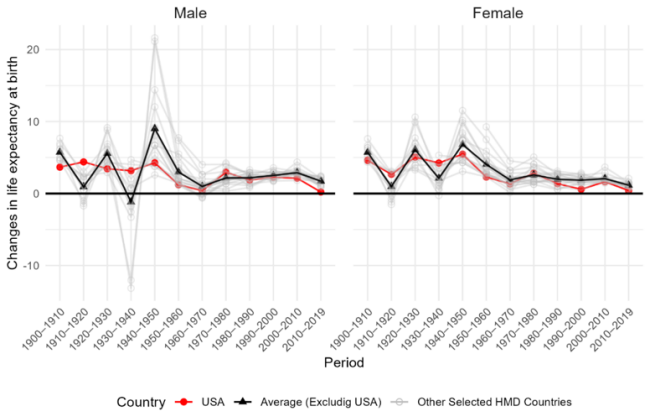

Figure 2: Changes in life expectancy at birth between every decade in USA, Italy, and Sweden, by sex, 1900–2020.

Figure 3 shows age contributions to life expectancy changes between every 10 years. Infant, child, and young and mid adult mortality (ages below 44) had the greatest contributions to life expectancy gains before 1950. The contributions of mortality at ages 80+ are negligible in the first half of the study period. The roles played by different ages changed importantly in the second half of the study period, with improvement in mortality above age 65 becoming increasingly important sources of life expectancy gains. The last period (2010–2019) in the US appears to be an outlier as compared to other countries. Life expectancy stalled (see Figure 2), and mortality at ages 15–44 contributed negatively to the overall life expectancy change. This phenomenon has been highlighted in prior studies. The contributions of ages above 45 are also smaller in the last decade as compared to previous decades.

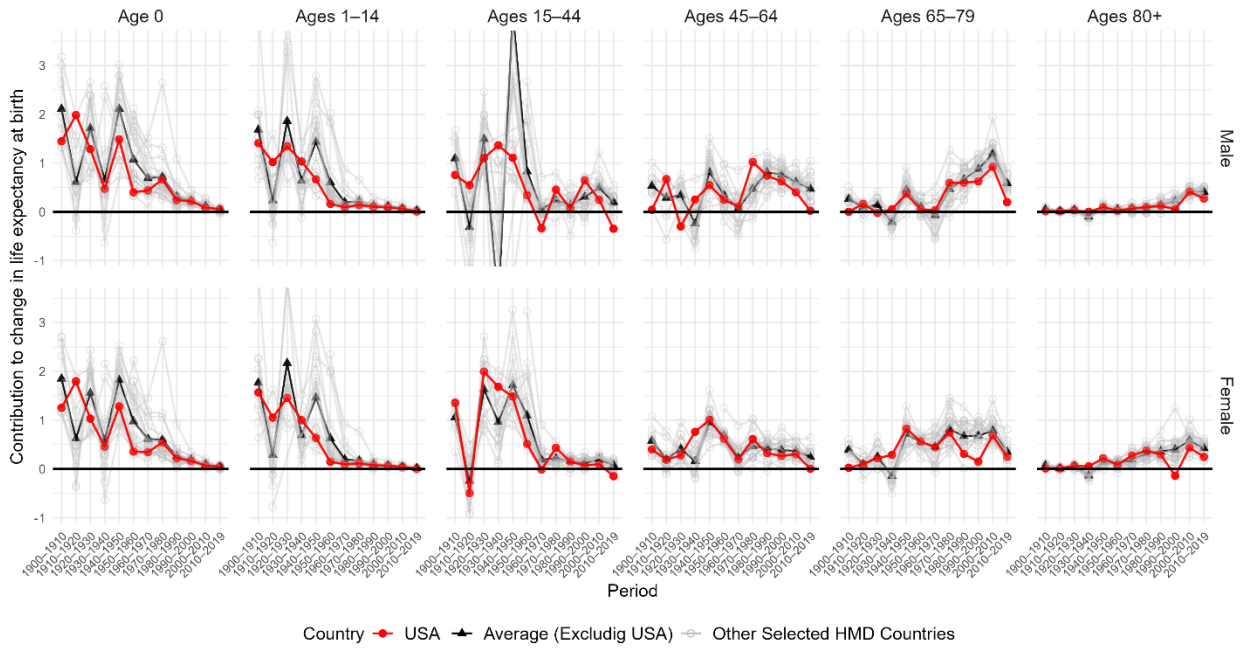

Figure 3: Contribution of age-specific mortality to change in life expectancy at birth every decade, USA and selected HMD countries, 1900~2019.

We then explore the importance of reducing mortality at different age groups for future gains in life expectancy by examining hypothetical scenarios in which age-specific mortality is set to be zero. Figure 4 shows the potential gains in life expectancy by eliminating mortality at different ages. Between 1900 and 1940, removing infant and child mortality can lead to the most increases in life expectancy; after 1940, child mortality becomes less important, but infant mortality remains relatively important. Reducing mortality at ages between 20 and 40 has a great potential for life expectancy gains, but the relative importance has decreased after 1920, and more so after 1940. We see a shifting age pattern in Figure 4, with older age becoming more important over time. At the end of the study period, removing mortality between age 60 and 90 has the greatest potential for life expectancy gains. Similar patterns can also be found in Figure 5, where we also show results for other countries. We find similar results for the United States (red line) and for the average of the selected countries. One difference is that the potential gains in life expectancy in removing mortality at ages 45–64 are more than that for other countries, indicating higher mortality in these ages in the United States than in peer countries, consistently over time.

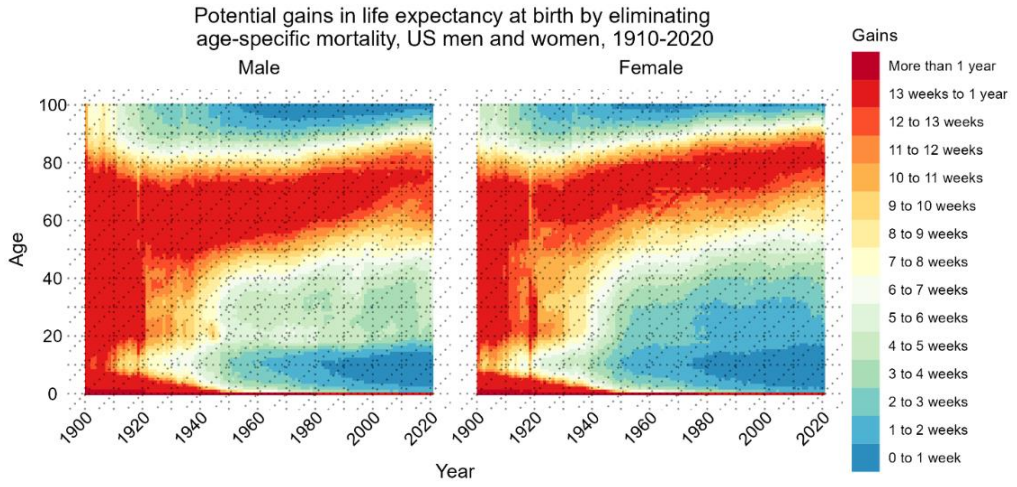

Figure 4: Potential gains in life expectancy at birth by removing age-specific mortality, USA,1900~2020.

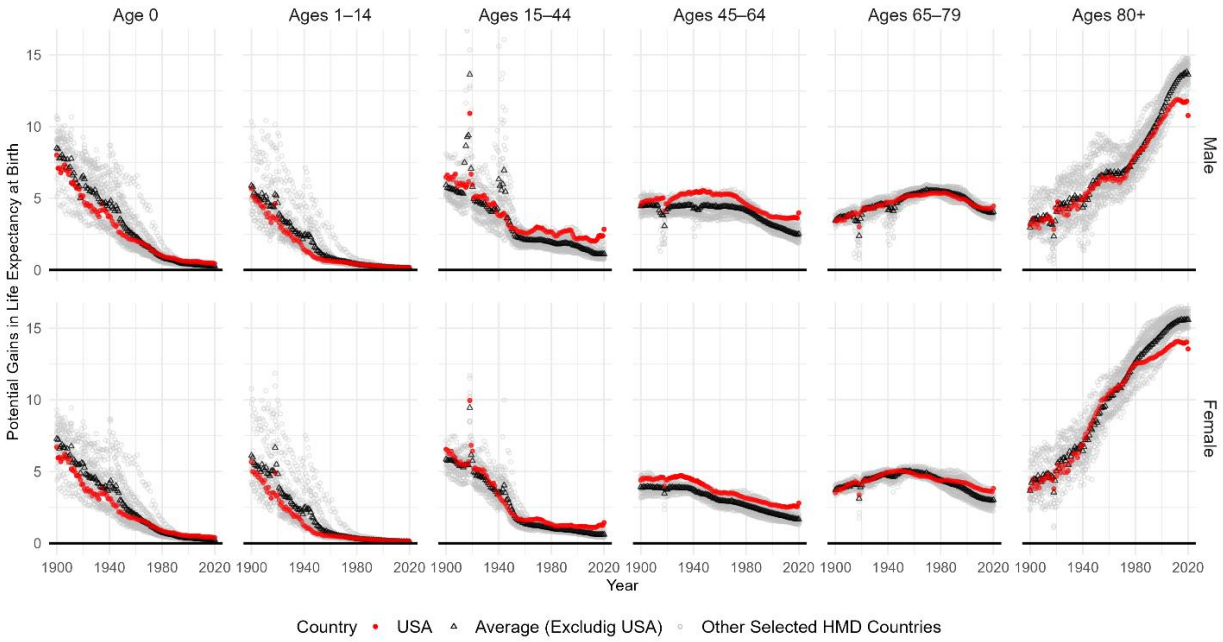

Figure 5: Potential gains in life expectancy at birth by removing age-specific mortality, USA and selected HMD countries, 1900~2020.

Next, we show how different causes of death have contributed to life expectancy changes in the United States from 1950. In Figure 6, we find that (improvement in) infectious diseases mortality is the most important source for life expectancy gains between 1950 and 1960 for US men. Between 1960 and 2010, cardiovascular is the most important source, and after 2010, neoplasms become the most important source. The results for women are largely similar except for the first period (1950–1960) when cardiovascular disease is the most important source. It is noteworthy that in the most recent decade, increases in mortality due to external causes are the most important reason for the stagnation in life expectancy.

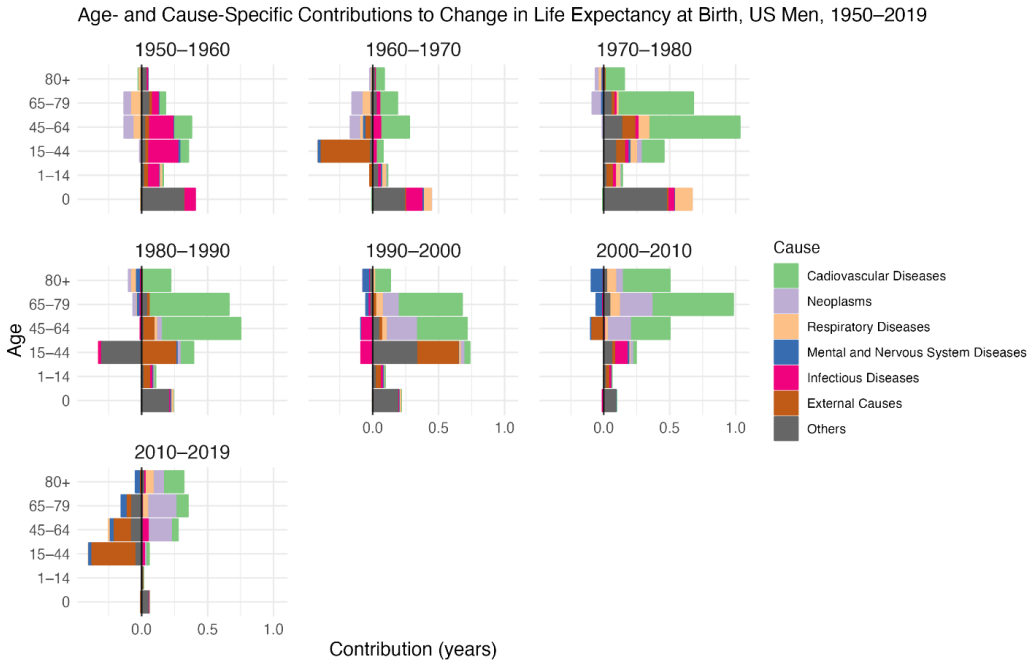

Figure 6: Decomposition of increases in life expectancy by age and cause of death, US men, 1950~2019.

Lastly, we show in Figure 7 how the distribution of life table deaths by causes has changed over time. In 1950, the most common cause of death is cardiovascular disease. Although the percentage of death from cardiovascular diseases has dropped over time, it still remains the highest in 2019. Deaths from neoplasms are the second most common (excluding "others") most of the time, except for females, as we see that mental and nervous system diseases has become the second most common cause of death for them in 2019. The increases in mental and nervous system diseases morality over the last three decades are an important trend in US mortality.

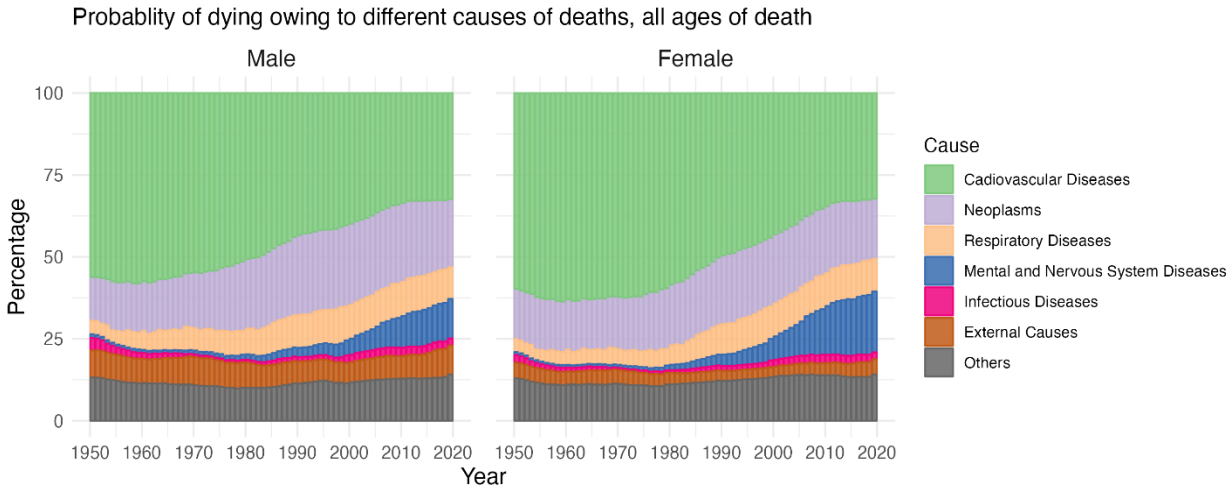

Figure 7: Life table distribution of causes of death, US men and women 1950~2019.

Discussion

In this extended abstract, we examined how age-specific mortality has contributed to changes in life expectancy at birth in the USA over the past twelve decades, and compared the US experience with that of other high-income countries The overall pattern of age-specific mortality and life expectancy gains from a long-run perspective is largely similar in the USA and in its peer countries, with infant mortality, child mortality and early adult mortality becoming less important over time and older age mortality becoming more important. However, the US experience has been distinct from other high-income countries in the most recent decades, especially the last decade, in which the total gains in life expectancy were much lower than in previous decades in the US.

Our hypothetical analysis based on zero mortality across ages shows that mortality at ages above 45 (especially 60–90) has become the most important for further gains in life expectancy. But the potential gains in life expectancy from eliminating mortality at ages 80+ are less in the USA than in other countries in recent years, mainly because of higher mortality at ages prior to age 80 in the USA.

We plan to conduct additional analyses for the EPC 2024 conference. First, we will include more high-income countries in our analysis on causes of death. Also, we will further look at more specific causes of death, especially in the category "external causes". Second, we will examine potential gains in life expectancy by reducing morality across age by 10%, 20%, 30%, etc., instead of eliminating mortality completely as we did in Figures 4 and 5. This is because eliminating mortality entirely is rather an unrealistic situation.

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