

Ages and causes of death contributing to widening educational inequalities in mortality in the US.

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Abstract

Educational inequalities in life expectancy in the US have increased, but less is known about why. Using data from US National Vital Statistics System, the American Community Survey, and the Human Mortality Database, we assessed the contributions of specific ages and causes of death to changes in educational inequalities in life expectancy at age 25 (e_{25}) from 2000 to 2023. After 2010, there was an increasing contribution of mortality under age 50 to widening inequalities, especially for those with less or equal than high-school education compared to those with Bachelor's (BA). For those with some college education compared to a BA, the contributions of mortality over age 50 from cardiovascular disease were more pronounced. Educational inequalities in life expectancy grew from 2020-2022 due to differential COVID-19 mortality, but narrowed again in 2023 as pandemic mortality subsided. We find suggestive evidence that younger cohorts contribute more to widening educational inequalities.

Keywords: Mortality inequalities, decomposition, life expectancy.

1. Introduction

How long will you live? The answer to this fundamental demographic question is heavily influenced by a person's socioeconomic status. In the US, life expectancy has stagnated since 2010 (Abrams et al., 2023), but this stagnation has only occurred among those without a bachelor's degree (BA) (Case & Deaton, 2021). Educational inequalities in life expectancy in the US are large, persistent, and in recent years have been growing (Ho, 2017; Sasson & Hayward, 2019). At the onset of the COVID-19 pandemic, excess death and life expectancy losses also disproportionately impacted people without a BA. (Paglino et al., 2025; Probst et al., 2025).

Previous studies have examined the causes of death driving changes in US life expectancy for different educational groups, finding that drug poisoning have contributed to declines in life expectancy among individuals without a BA in recent years (Ho, 2017; Sasson & Hayward, 2019). However, those studies did not assess the contribution of different causes of death to widening inequalities in life expectancy across educational groups, and most have examined only differences between binary BA/non-BA levels of education (Case & Deaton, 2021). In addition, less is known about whether increases in educational inequalities in life expectancy reflect period or cohort changes in mortality.

In this study, we estimate the contribution of different age groups and causes of death to increases in educational inequalities in life expectancy in the US from 2000 to 2023 and the evolution of educational inequalities in mortality from a cohort perspective. We analyze educational inequalities in life expectancy for three educational groups (\leq high school, some college, and BA or above) for a more nuanced picture of the dynamics of US educational inequalities. A better understanding of the causes of death and ages contributing most to widening educational inequalities in the US can help identify potential mechanisms linking less education to higher mortality and suggest possible areas for policy or public health interventions.

2. Data & Methods

We used data from three sources. For death counts and causes of death by level of education, we employed multiple cause-of-death files from the National Vital Statistics System (NVSS) for individual years from 2000 to 2023, covering 62,379,764 deaths. We focus on eleven mutually exclusive causes of death: i) alcohol-attributable mortality, ii) COVID-19, iii) cardiovascular and metabolic diseases, iv) drug poisoning, v) external causes of deaths, vi) infectious and respiratory diseases, vii) smoking-related cancers, viii) other cancers, ix) suicide, x) homicides, and xi) all other causes of death. These causes were selected based on their relevance in the literature on socioeconomic inequalities in mortality and recent mortality trends in the US (Dowd et al., 2024). Their corresponding ICD-10 codes are presented in the appendix in the extended version of the manuscript.

We derived exposures by educational attainment from two sources: the American Community Survey (ACS) (Steven Ruggles et al., 2025) and the Human Mortality Database (HMD) (HMD, 2021). For people 25 years and older, we defined three educational groups: less than or equal than high school; some college (up to 3 years of college education) and a bachelor's degree (BA) (4 or more

years of college education). To obtain the exposures by level of education, we first obtained the proportion of educational attainment by age and sex for each year from the ACS. We then applied those proportions to the corresponding age-sex-period of the exposures of the HMD, in that way, we ensure that our national mortality estimates are similar to the ones reported by HMD.

Both data sources report age in five-year age groups, so we next smoothed the data to obtain data by single year of age to obtain more accurate life expectancy estimates. We used a penalized composite-link model by using the *ungroup* packages in R, a widely used approach (Rizzi et al., 2015). We will also present results comparing smoothed and unsmoothed life expectancy estimates as a sensitivity analysis.

For our period analysis, we constructed life tables to obtain life expectancy at age 25, using standard methods (Preston et al., 2001). We defined educational inequalities in life expectancy at age 25 as the differences in life expectancy at age 25 between those with a BA and some college, and the differences in life expectancy at age 25 between those with BA and \leq HS. Next we decomposed the ages and causes of death contributing to changes over time in the educational inequalities in life expectancy at 25, using a model of continuous change we implemented with R using the package *Demodecomp* (Horiuchi et al., 2008; Riffe, 2014). For our cohort analysis, we estimated the percentage changes in mortality rates for each educational group, and trends in mortality rate ratios (MRR) from 2000 to 2023 by different age groups (25-29, 40-49, 50-59, 60-69, 70-79, and 80+).

3. Results

Widening educational inequalities in period life expectancy. Between 2000 and 2010, life expectancy at age 25 increased for all educational groups (see Figure 1A). After 2010, life expectancy decreased for those with some college or high school or less education, while it continued to increase modestly for those with a BA or higher. For those with some college, life expectancy declined by 0.22 years (females) and 0.5 years (males) between 2011 and 2019, and for those with less than or equal to HS, it declined by 0.4 years for females and 0.5 years for males. In contrast, for those with a BA, life expectancy increased by 1 year for females and 0.8 years for males. As a result, educational inequalities in life expectancy increased after 2010 (see Figure 1 B). In 2010, people with a BA had a life expectancy advantage of 4.4 years (females) and 7.3 years (males), compared to those with less than or equal to HS, and by 2019, this life expectancy advantage increased to 5.6 years (females) and 8.6 years (males). People with a BA or higher education also increased their life expectancy advantage compared to those with some college education. In 2010, the educational inequalities in life expectancy between those groups were 3.3 years for females and 4.3 years for males, and between 2010 and 2019 increased to 4.7 years and 5.8 years for females and males, respectively. During the COVID-19 pandemic, especially in 2020 and 2021, educational inequalities increased because of large life expectancy losses among those with less than a BA education.

[--- Figure 1 about here ---]

Age and cause of death contributions to changes in educational inequalities in life expectancy. Our decomposition analysis by age and causes of death shows that mortality above age 50 largely accounted for the increase in educational inequalities in life expectancy from 2000-2009 (Figures 2 and 3). The causes of death contributing to the increase were a mix of chronic diseases including cardiovascular disease, cancer, and infectious and respiratory disease. From 2010-2019 there was a shift to bigger contributions from mortality under age 50 to widening education inequalities, with significant contributions from deaths due to drug poisoning at younger ages, especially for men. For women, deaths above age 50 continued from a mix of chronic diseases, which continued to contribute the most to widening educational inequalities. The widening life expectancy gaps between those with a BA and those with some college came from mortality across the whole age range and a variety of causes, with notable contributions from cardiovascular diseases (CVD) and drug poisoning.

For the first year of the COVID-19 pandemic (2019-2020), deaths from COVID-19 at almost all ages drove increases in educational inequalities in life expectancy between those with BA and less than or equal to HS, especially at older ages. Life expectancy differences between those with BA and some college increased by 0.76 years, mostly due to COVID-19 deaths above age 70. There were also notable contributions from deaths due to drug poisoning at young ages for both men and women, especially for the BA category, compared to those with a high school or less education.

In the second year of the COVID-19 pandemic (2020-2021), COVID-19 deaths continued to account for most of the increase in educational inequalities in life expectancy, but with contributions shifting from older to younger ages. The contribution of drug poisoning to widening inequalities remained important for those with less than or equal to a HS education compared to those with a BA. From 2021-2022, educational inequalities in life expectancy narrowed primarily due to improvements in COVID-19 mortality at all ages.

[--- Figure 2 about here ---]

[--- Figure 3 about here ---]

Educational inequalities in mortality from a cohort perspective. Percentage changes in all-cause mortality among those with \leq HS or some college education have increased significantly more for younger age groups (<60), suggestive of cohort effects driving the widening educational inequalities. (Figure 4A). In contrast, the percentage declines in mortality for the BA category are much more consistent across age groups. (Figure 4B) shows that increases in the mortality ratio between educational groups has also increased in a non-parallel way across age groups, suggestive of cohort effects (National Academies of Sciences et al., 2021). This cohort perspective suggests that educational inequalities in mortality have increased most strongly in recent cohorts.

[--- Figure 4 about here ---]

4. Preliminary conclusions

We provide novel evidence of the ages and causes of death contributing to widening educational inequalities in the US. We find that mortality above age 50 contributed more to widening inequalities from 2000-2009, while this shifted to bigger contributions from mortality under age 50 after 2010, with significant contributions due to drug poisoning. While much previous research has compared only BA and non-BA levels of education, we provide new insights into the divergence of the “some college” group from those with a BA education. While the slower life expectancy improvements look more similar to those with \leq HS education, the divergence from those with a BA is driven more by mortality from cardiovascular disease at older ages and less from drug poisoning. In our full paper, we will discuss more thoroughly the contribution of additional causes and the important similarities and differences for the \leq HS vs some college categories to better identify key drivers of growing inequalities.

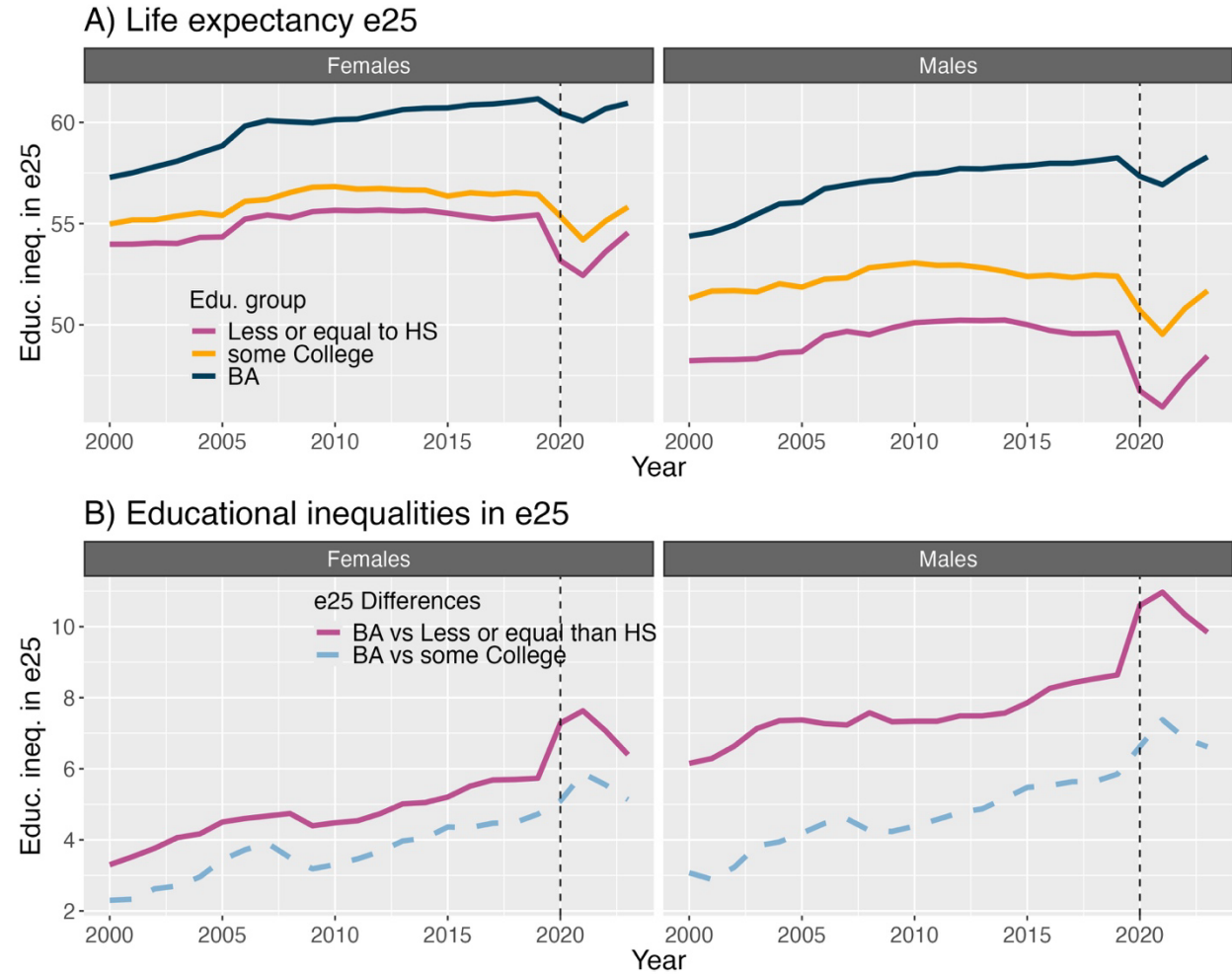
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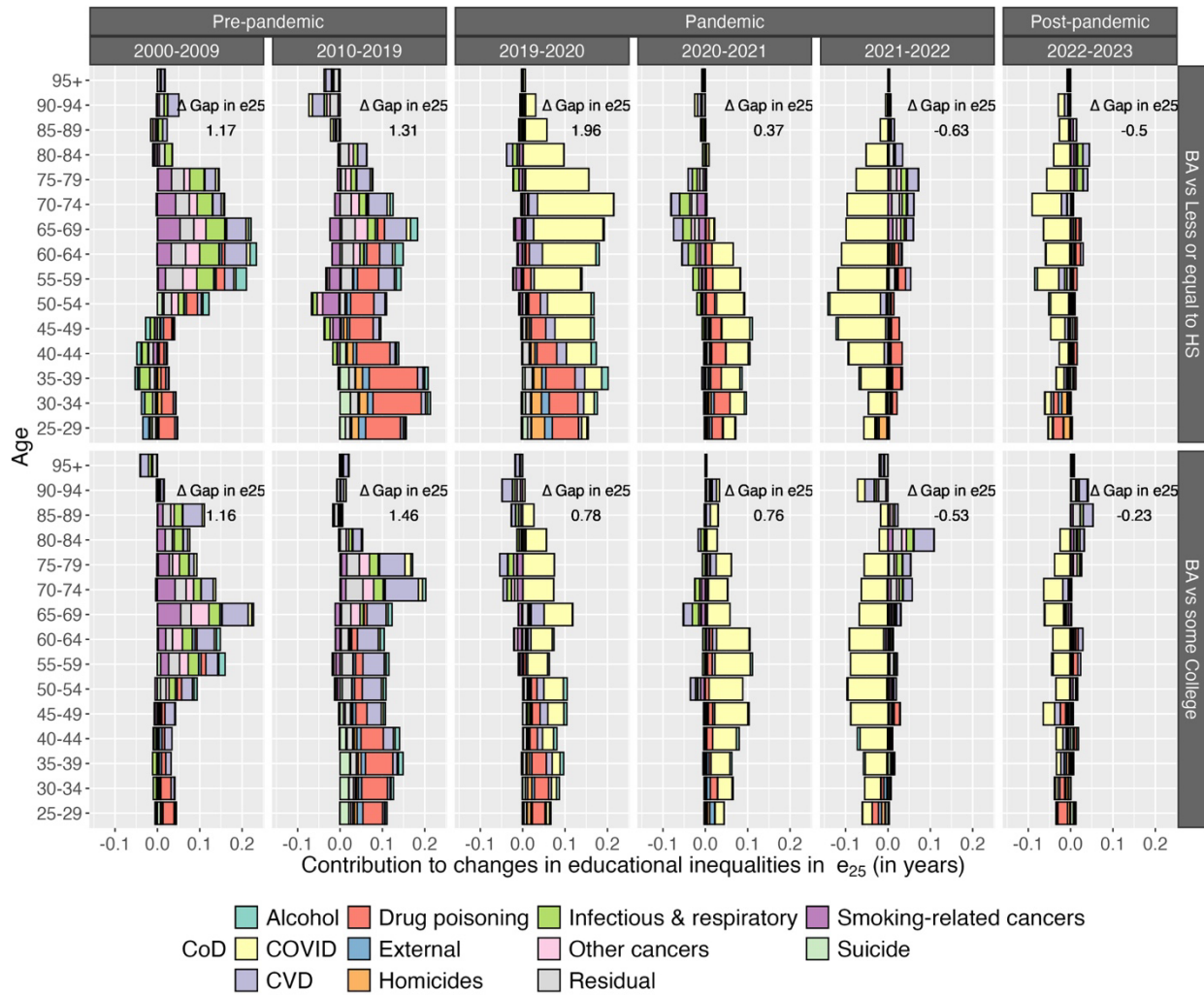
Main Figures

Figure 1. (A) Time trends in remaining life expectancy at age 25 (e25) by educational groups from 2000 to 2023 **(B)** Time trends in educational inequalities in remaining life expectancy at age 25 (e25) by sex and different comparison groups from 2000 to 2023.



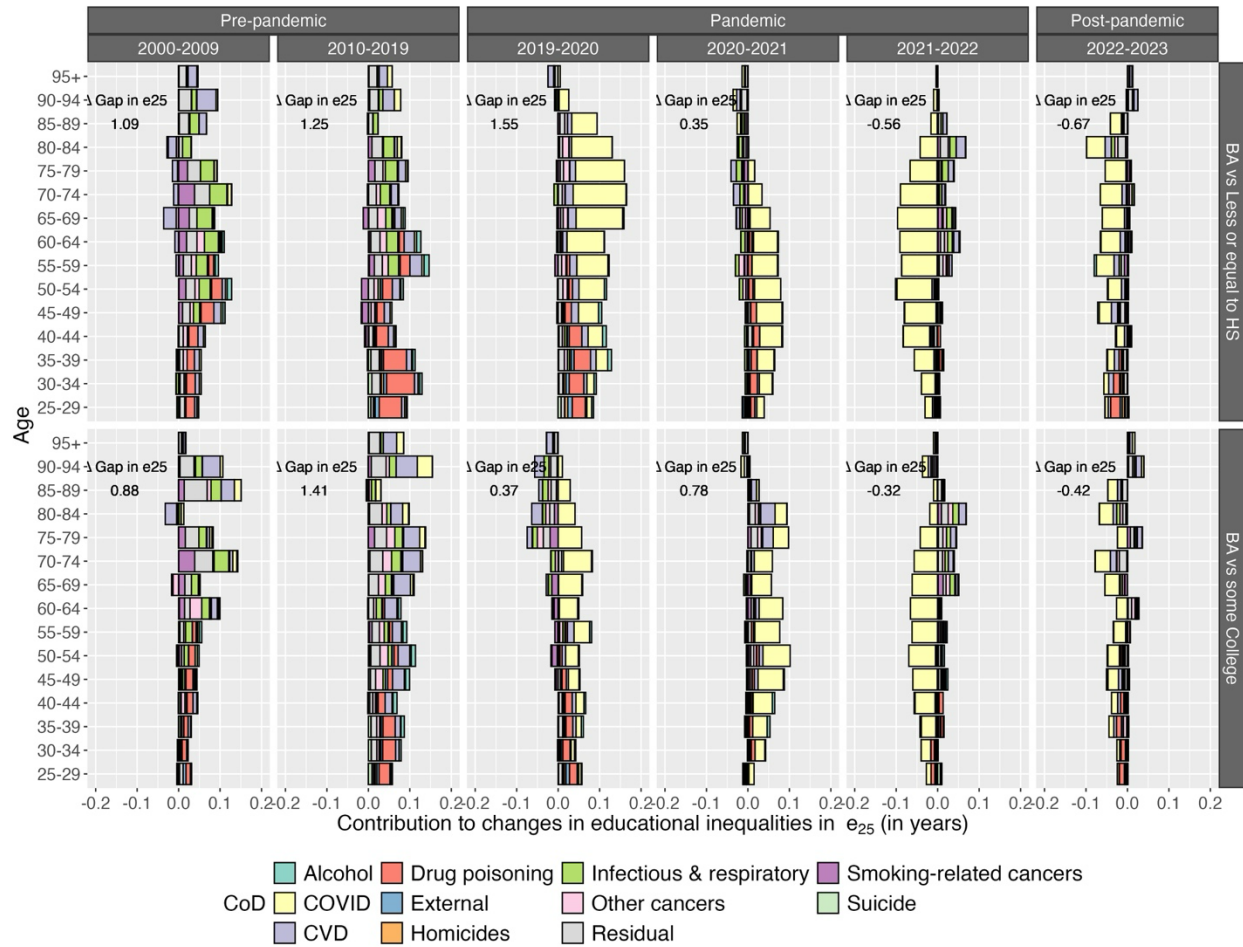
Source data: American Community Survey & Human Mortality Database.

Figure 2. Age and cause of death contributions to changes over time in educational inequalities in remaining life expectancy at age 25 (e25), before, during, and after the COVID-19 pandemic. Males.



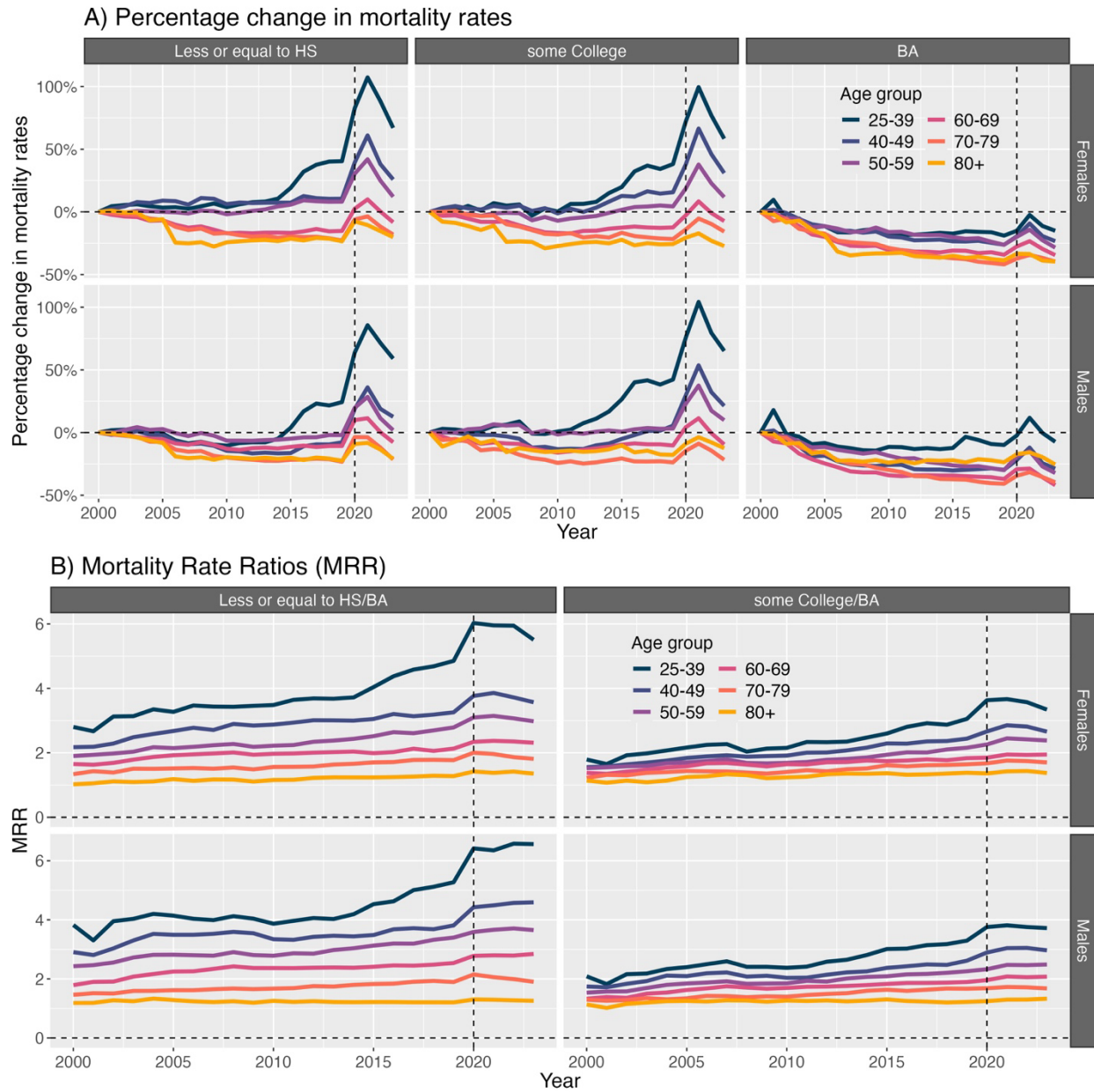
Source data: American Community Survey & Human Mortality Database.

Figure 3. Age and causes of death contribution to changes over time in educational inequalities in remaining life expectancy at age 25 (e_{25}), before, during, and after the COVID-19 pandemic. Females.



Source data: American Community Survey & Human Mortality Database.

Figure 4. (A) Percentage change in all-cause mortality rates by age groups compared to 2000 **(B)** Mortality rate ratios in all-cause mortality by sex and broader age groups compared to 2000.



Source data: American Community Survey & Human Mortality Database.