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Accounting for the Widening Mortality Gap between American Adults with and without a BA

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Accounting for the widening mortality gap between American adults with and without a BA

(Corrected conference draft)

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ABSTRACT We examine mortality differences between Americans adults with and without a four-year college degree over the period 1992 to 2021. Mortality patterns, in aggregate and across groups, can provide evidence on how well society is functioning, information that goes beyond aggregate measures of material wellbeing. From 1992 to 2010, both educational groups saw falling mortality, but with greater improvements for the more educated; from 2010 to 2019, mortality continued to fall for those with a BA while rising for those without; during the COVID pandemic, mortality rose for both groups, but markedly more rapidly for the less educated. In consequence, the mortality *gap* between the two groups expanded in all three periods, leading to an 8.5-year difference in adult life expectancy by the end of 2021. There have been dramatic changes in patterns of mortality since 1992, but gaps rose consistently in each of thirteen broad classifications of cause of death. We document rising gaps in other wellbeing-relevant measures, background factors to the rising gap in mortality, including morbidity, social isolation, marriage, family income, and wealth.

Outcome gaps between adult Americans with and without a four-year college degree have become increasingly salient in politics, economics, demographics and society more broadly. Voting patterns, wealth holdings, incarceration, wages and marriage are now sharply different between the approximately one third of the population aged 25 and older with a bachelor's degree and the two-thirds without. Documenting differences in mortality between groups provides evidence on how well society is functioning beyond aggregate measures of material wellbeing. Compared with money-based measures of wellbeing, which depend on often controversial assumptions about what to include and on how to convert money into real measures, mortality is an objective measure, less subject to measurement error—someone is dead or alive—and there is little debate around which is better. Death is particularly indicative of societal failure when it is not due to a widespread infectious disease—like COVID-19—or even to failures in the medical system, but to self-inflicted causes like suicide, alcoholism, or drug overdose.

An examination of the mortality gaps between more and less educated Americans can tell us how the U.S. economy is performing, not just on average, but for the majority of its population, those without a college degree. The division by education is in many ways an alternative to discussions of income distribution, for example by looking at outcomes at selected percentiles, and is a useful supplement to analysis by race and ethnicity. Educational differences are at least as salient as income differences. Similar considerations apply to international comparisons where there has been much recent commentary on the superior economic performance of the US relative to Europe, but where comparisons based on mortality are very different.

As we shall see in the next section, an examination of mortality for Americans with and without a college degree helps understand the much-researched issue of why, since the 1980s, American life expectancy has performed so much worse than the life expectancies of other rich countries. This has been the topic of two reports from the National Academy of Sciences on international comparisons, National Research Council (2011) and National Research Council and Institute of Medicine (2013), as well as another more recent report on high and rising mortality in midlife in the US, National Academy of Sciences, Engineering, and Medicine (2021). None of these reports focused on the mortality divide between those with and without a college degree.

We begin with an examination of life expectancy at age 25, often referred to as "adult life expectancy," which is defined as the number of years someone can expect to live beyond their 25th birthday if mortality rates were to remain at their current level. It is denoted by e_{25}. It is of course understood that mortality rates will change, and indeed the measure varies over time as mortality rates vary. It is *not* a forecast; like other period measures, is a convenient summary of age-specific mortality rates, a single number that conveniently aggregates the many age-specific rates. Age 25 is taken to be the age by which people either have a BA or will never have one, though see below. In the next section, we show data on e_{25} for the US and two dozen other rich countries, and show how the differentials between Americans with and without a college degree help interpret the international data.

For technical reasons, which we shall explain as we go, most of the paper works with two other measures, expected years of life between the 25th and 85th birthdays, denoted ${}_{60}e_{25}$ (where the 60 refers to the number of years after age 25) and age-adjusted mortality between the same two birthdays. These two other measures ignore mortality rates after age 85. When there is no risk of confusion, we shall refer to both e_{25} and ${}_{60}e_{25}$ as "adult" life expectancy.

For the college-educated group, both measures of life expectancy at age 25 grew continuously from 1992 up to 2019 while, for those without a four-year degree, progress stalled and reversed after 2010, Sasson (2016a, 2016b), Hayward and Farina (2023). The gap widened further in 2020 and 2021 during the pandemic. We provide a descriptive analysis of the factors contributing to the widening gap in ${}_{60}e_{25}$ and in age-adjusted mortality, focusing on causes of death, on age, and on gender, both prior to and during the pandemic. We identify the causes of death that make the largest contribution to these widening gaps, particularly "deaths of despair"—from drug overdose, alcoholic liver disease, and suicide—as well as deaths from cancer, cardiovascular disease, chronic lower respiratory diseases, and diabetes.

The differential mortality experiences of those with and without a college degree come not only from direct effects of education on individual health, for example through health behaviors or enhanced ability to deal with life, including the healthcare system, but also from broader social and economic forces in the communities where people work and live. Who does or does not complete a four-year degree is also likely to depend on health, a selection effect. A good analogy here is with the college wage premium, the percent by which the wage for college-educated workers exceeds the wage of those without a four-year college degree. This premium, which rose from 41 percent in 1979 to 83 percent in 2019,[1] depends not only on what a college education does to the skills and ability of each worker—the direct effect—but also on a range of indirect effects, including on how many people go to college, who they are and how they are selected, for example on ability, on how the labor market rewards skills, on available jobs and the technology they use, on how easy it is for workers to move to places where their skills are in demand, and on how the cost of employer health insurance affects the demand for more- and less-skilled workers, Finkelstein and others (2023).

Similar direct and indirect forces affect health. Among them are the increasingly difficult job situation for less-educated workers and the long-term negative impacts of a deteriorating labor market on their marriages and the communities in which they live. (The recent tight job market has improved matters but, as has happened in the past, the benefits may not last.) There is also an important recent literature on the negative effects on health of corporate-sponsored laws passed in Republican-controlled state legislatures—regarding minimum wages, right to work laws, pollution, guns, and tobacco taxes and controls—all of which are likely to differentially

[1] Authors' calculations using the Current Population Survey Outgoing Rotation Groups, for men and women ages 25-64, comparing median wages for those with less than a four-year college degree to those with a BA or more. The premium for some college, less than a four-year degree, relative to a high school degree did not change over this period (14 percent in 1979, 12 percent in 2019).

hurt working-class Americans, Jacob Grumbach (2022), Jennifer Karas Montez and others (2020) as well as Jonathan Skinner's comments on this paper.

European countries that have long been more open to trade and trade-related disturbances have built comprehensive welfare systems that help, not only with trade-related job losses but also with losses through automation, Rodrik (1998). While mortality rates and mortality trends for less- and more-educated people in other rich countries differ in both levels and trends, the US appears to be the only western country where life expectancies are trending in different directions, one up and one down, Mackenbach and others (2018), Case and Deaton, (2021, 2022).

We document how gaps in mortality and life expectancy increased from 1992 to 2021, especially rapidly from 2019 to 2021 during the COVID pandemic. We distinguish three periods: from 1992 to 2010 when both those with a BA and those without saw falling mortality, but with greater improvements for the more educated; from 2010 to 2019, when mortality was falling for those with a BA and rising for those without; and from 2019 to 2021, when mortality was rising for both groups, but much more rapidly for those without a BA. We document the contributions of different causes of death to the changing gaps—notably the contributions of deaths of despair and their components, drug overdose, alcoholic liver disease, and suicide, and those of cardiovascular disease, and of a range of cancers—and we offer a complete accounting over all the major classifications of causes of death using the International Statistical Classification of Diseases (ICD).

In the final section of the paper, we turn from death to life, and document the levels and trends in a range of outcomes for the more- and less-educated adult populations. Our underlying supposition is that the widening mortality gaps have their roots in differential life experiences between the two groups. Over a range of wellbeing-relevant outcomes, people with a college degree have fared better than those without. We do not attempt to link specific life outcomes to mortality rates, so we are "accounting" for the mortality outcomes only in the general sense of documenting the rising gaps in life outcomes among which, somewhere, lie the causal factors driving mortality differences.

We note that the fraction of the population with a four-year degree has risen over time. As is often discussed in the literature, rising educational attainment can change the kinds of people who do or do not have a four-year degree, a selection that can increase or decrease the educational gap in mortality and other outcomes, even when other effects of education are unchanging. We examine this for mortality and, to control for changing fractions with a BA, we examine how gaps change with age within birth cohorts. If education were constant within birth cohorts after age 25, the results would eliminate any effect of changes in the composition of groups with and without a BA on a cohort's mortality gap trend. However, we show that reported educational attainment increases *within* birth cohorts, even long after the normal age of educational completion. Some of the increase can be accounted for by differential mortality, but only for the earlier-born cohorts seen at older ages. The increase among the other groups remains a puzzle and we can do no more than suggest explanations such as adult education, immigration, or people as they age becoming more likely to claim having a degree when they do not.

There is a large literature examining the relationship between education and mortality, starting from Kitigawa and Hauser (1973). Many later studies focused, as we do, on changes in educational gaps over time, as well as on identifying the causes of death underlying the gaps, on the differences between men and women, and between racial and ethnic groups, see for example Preston and Taubman (1994) for an excellent early review, and the more recent updates by O'Rand and Lynch (2018). Most recently, the perspective by Hayward and Farina (2023) emphasizes the contingent and changing nature of the relationship between education and mortality. From the earliest studies, cardiovascular disease and lung cancer were identified as important in explaining educational gaps, leading back to smoking as a key behavioral determinant, which itself differed by men and women both in prevalence and timing.

Educational attainment began to be recorded on the standard U.S. death certificate in 1989, after which time, in principle, all decedents could be included in studies of education and mortality. Compared with mortality follow-ups using survey data, which have generated several important studies including Hummer and Lariscy (2011), Montez and others (2011), Montez and Zajacova (2013a, b), the complete data permit the analysis of relatively rare causes of death, as well as disaggregation over a range of correlates. We use the death certificate information in this paper, and our work most closely follows earlier studies of the gap by Olshansky and others (2012), Meara, Richards, and Cutler (2008) and, most recently and most closely, Geronimus and others (2019). Recent studies have documented that, particularly since 2010, drug overdoses, or more broadly deaths of despair, have become important in understanding the mortality gaps between those with and without a college degree, Case and Deaton (2017), Ho (2017), Sasson and Hayward (2019).

In the current paper, we update these studies in several ways and we add a section on differential life outcomes. We analyze annual data over the longer period now available, including the pandemic years 2020 and 2021. We choose a different, more limited, but sharper focus on the difference in outcomes between those with and without a four-year college degree. We are less concerned with the many possible mechanisms that account for the relation between education on health, and more with documenting differences in mortality associated with the college divide. This follows the analysis in our book, Case and Deaton (2020) where, among other things, we document the college divide in material wellbeing, morbidity, marriage and religiosity; in the last section of this paper, we update these estimates for marriage and for morbidity, including mental distress, as well as for family income and wealth.

We use data for the 30-year period from 1992 to 2021, though we go further back for some of the life measures whose deterioration traces back to the 1970s. The post-1992 period saw major changes in mortality patterns, including those for cardiovascular disease mortality—whose longstanding decline came to a halt—and those for several cancers, where there have been many improvements. Mortality from deaths of despair grew markedly over this period. We attempt to resolve some of the uncertainty about the relative contributions to declining life expectancy of, on the one hand, changes in mortality from cardiovascular disease and, on the other hand, rising mortality from deaths of despair, especially drug overdoses, Geronimus and others (2019), Mehta, Abrams and Myrskylä (2020). The COVID pandemic at the end of the period was characterized not only by COVID–19 deaths, but also by excess deaths from other causes, including an additional upsurge in deaths of despair, and we document what happened to the mortality gap as mortality changed in these unprecedented ways.

We also use the classification in ICD-10 to offer a complete accounting of the contribution of all causes of death to changes in the gap and examine whether any causes of death act to reduce the mortality gap between those with and without a college degree. We ask if it matters for the gap whether the cause of death is one associated with rising mortality, falling mortality, or a change from falling to rising mortality. We also raise new questions about the measurement of educational attainment, adding to an ongoing debate about self-reports versus post-mortem reports, a debate that has influenced the choice of data for studying the relationship between education and mortality.

I. Mortality: Data and Methods

In our analysis of mortality, we work with death certificates from 1992 through 2021, though in some cases we limit analysis to 1999 to 2021 so as to confine cause of death to the reporting structure of ICD-10, formally the International Statistical Classification of Diseases and Related Health Problems. Death certificates record age and sex, as well as highest education attained. We do not consider race or ethnicity in this paper, but see Case and Deaton (2021). There is undoubtedly some misreporting of education on death certificates but the divide between a four-year college degree and less than a four-year college degree appears to be minimally affected, Rostron, Arias and Boies (2010), and, as we shall document, there are also problems with self-reports of educational attainment. Education is missing for four states in 1992; Oklahoma began reporting education in 1997, South Dakota in 2004, Georgia in 2010, and Rhode Island in 2016. These states accounted for 4.55 percent of the US population in 1990, and 4.57 percent of adult deaths in 1992. For deaths without education information, we assign a BA or not in the same proportion as non-missings by year, age, and sex. Population totals for each year, age and sex from 25 to 84 are taken from the Census Bureau; the totals are split between those with and without a four-year college degree using ratios estimated from Current Population Surveys until 2000 and from the American Community Surveys thereafter. Our calculated statistics, age-adjusted mortality and adult life expectancy, are averages and as such reduce the influence of measurement errors.

We make extensive use of cause of death information as listed on the death certificates; we use the underlying cause of death, not proximate causes. The National Center for Health Statistics (2022) notes “the underlying cause of death is the disease or injury which initiated the train of morbid events leading directly or indirectly to death or to the circumstances of the accident or violence which produced the fatal injury.” There is clearly scope for discretion and for error here and causes of death are never as precise as the fact of death itself. There are particular difficulties during the pandemic, especially in the early days where testing was limited, and when people died of other conditions that might not have proved fatal in the absence of COVID-19.

We use standard life-table methods to calculate life expectancy at age 25, an age by which most people have completed their education; increasing attainment with age beyond 25 is an issue to which we return. The use of death certificates to compute mortality at the oldest ages is prone to error, and the official estimates from the National Center for Health Statistics (NCHS) use other sources, Arias and others (2022). We can avoid this by calculating the number of years of expected life of a 25-year-old between that person's 25th and 85th birthday, in standard demographic notation ${}_{60}e_{25}$, sometimes referred to as "temporary life expectancy," Arriaga (1984). The standard measure of adult life expectancy e_{25} replaces 60 by infinity or at least the maximum possible years. Our measure of life expectancy from 25 to 85 is also used by Geronimus and others (2019) who compute expected numbers of years lost as 60 (the maximum possible number of years of life between 25 and 85), minus expected life years, $60 -_{60} e_{25}$.[2]

In the next section, we also report calculations of e_{25}. Here, too, we use the death certificates, extrapolating beyond 85 using standard formulas that link mortality with age. We can provide some check on our calculations by using the same extrapolations to calculate e_{25}, not for those with and without a college degree, for which there are no official data, but for the whole population, and check against the official life tables, which we take in convenient form from the *US Mortality Database* (2023). Our calculations are close to the official estimates; our maximum absolute error is 0.44 percent for women in 1992, and errors are smaller than that in later years, with maxima after 2000 of 0.27 percent for men in 2010, and 0.26 percent for women in 2021.

In Section III and beyond, we make more complex calculations using individual causes of death, and we think it unwise to use interpolations to calculate those mortality rates at advanced ages. For these calculations we thus confine our attention to ${}_{60}e_{25}$ and to age-adjusted mortality between ages 25 and 84. We compute age-adjusted mortality rates from ages 25 to 84 for selected causes of death using the 2000 population and adjusting separately for men and women. We do not use separate reference populations by BA status; this is important because college graduates are on average younger than non-graduates, and we do not want these age differences to contribute to the gradient. We can use age-adjusted mortality rates, which are linear in both age-specific populations and causes of death, to exactly decompose the educational gaps by

[2] We are grateful to John Bound for confirming that our calculations and those in Geronimus et al (2019) use the same formulas, something that is not clear in their text.

cause of death and by age group. For adult life expectancy, we use a variant of the cause deletion method, Beltran-Sanchez et al (2008), in which we hold the age-sex-education specific mortality rates for selected causes at their 1992 levels, and then recompute adult life expectancy using the modified all-cause mortality rates. For example, deaths of despair rose rapidly after 1992, so to calculate the counterfactual excluding the increase we compute ${}_{60}e_{25}$ as if that increase had not taken place, with all other mortality rates at their actual values. This is an accounting exercise, not a prediction of what would have happened. As was the case during COVID-19, deaths from other causes would almost certainly have been different had the increase in deaths of despair not happened; this is the well-known problem of competing risks which precludes any straightforward, model-free calculation of counterfactuals. Even so, the calculations are useful in indicating orders of magnitude for the immediate consequences of modifying or eliminating different causes of death.

II. Adult Life Expectancy in the US and Other Wealthy Countries

Figure 1 shows adult life expectancy, e_{25}, for Americans with and without a college degree from 1992 to 2021; the figure combines men and women.

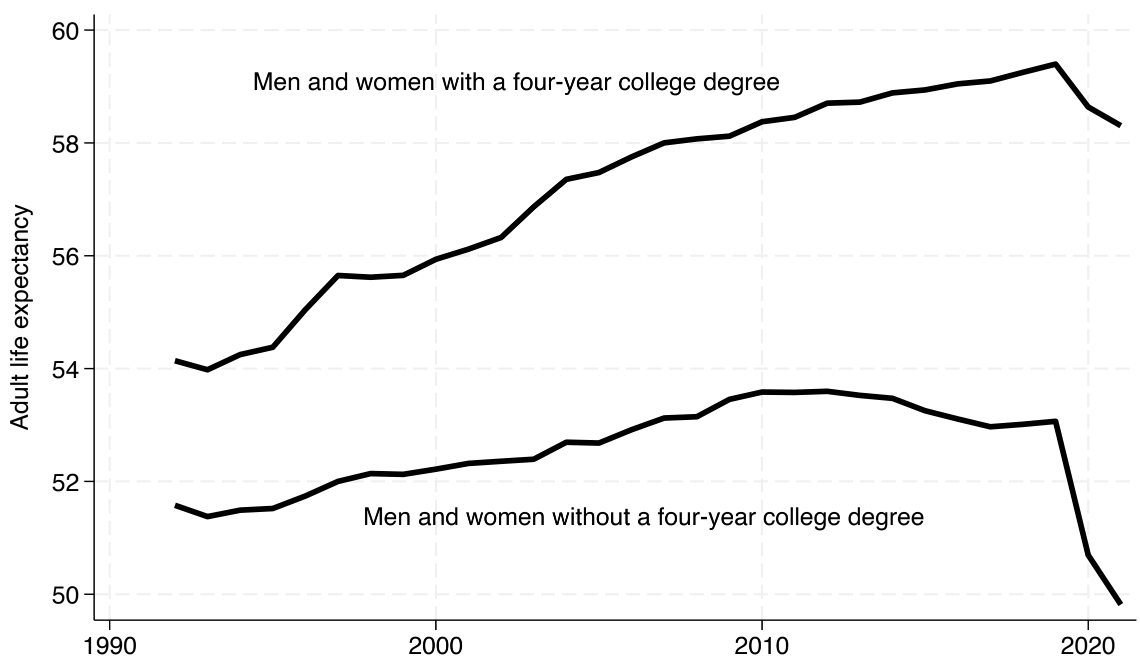

Figure 1: Adult life expectancy for Americans with and without a college degree

The college educated group experienced rising adult life expectancy until the onset of the pandemic in 2020. Those without a college degree saw their highest adult life expectancy in 2010 and have not regained it. Both groups lost years of life during the pandemic, 1.1 years for the college educated, and 3.3 years for those without the degree. The gap widened throughout, from 2.6 years in 1992 to 6.3 years in 2019, and to 8.5 years in 2021 during the pandemic. (Note that, at the time of writing, we cannot currently carry these calculations beyond 2021.)

We look at these results in more detail below, but we start by linking our findings to international comparisons between the US and other rich countries. Figure 2 shows a typical picture, here of life expectancy at birth, for the US and for 22 other rich countries, with data taken from the Human Mortality Database (2023). In the mid-1980s, US life expectancy

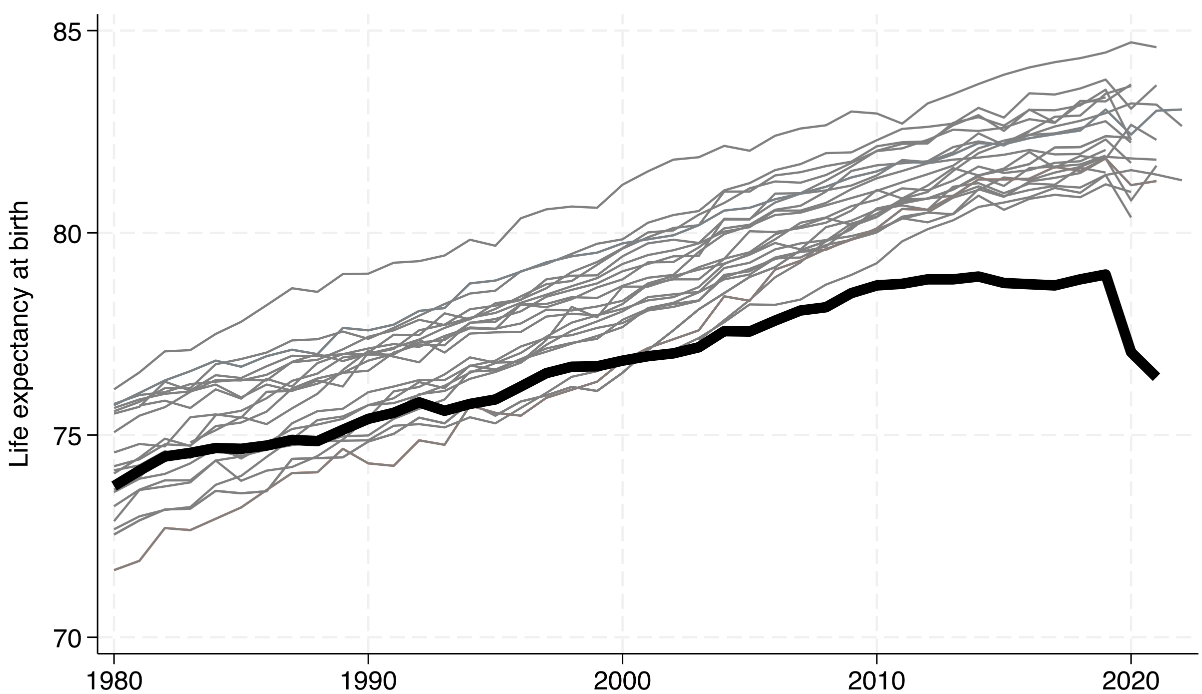

Figure 2: Life expectancy at birth for the US (in bold) and 22 rich countries

at birth was in the middle of the range, but it has not kept up over time, and by the early 2000s, was by far the lowest in the group. The pandemic added to an already large gap. The other countries shown in the graph, in order of their life expectancy in 2019, are Japan, Switzerland, Spain, Korea, Italy, Australia, Sweden, Norway, France, Ireland, Canada, Netherlands, Austria, Finland, Portugal, Belgium, New Zealand, Greece, Denmark, and the United Kingdom. (The Israeli data end in 2016 with a life expectancy of 82.5 years).

The literature lists many factors that can help explain the poor performance of the US, and it is not our purpose to add to those accounts. Instead, we point to Figure 3, which takes the Human Mortality Database (HMD) data for adult life expectancy, e_{25}, for the other countries and superimposes the data from Figure 1 on e_{25} for Americans with and without a college degree; this can only be done post 1992. One remarkable finding here is that Americans with a college degree, if they were a separate country, would be one of the best performers, just below Japan, though there was some decline in 2020 and 2021 during the pandemic.

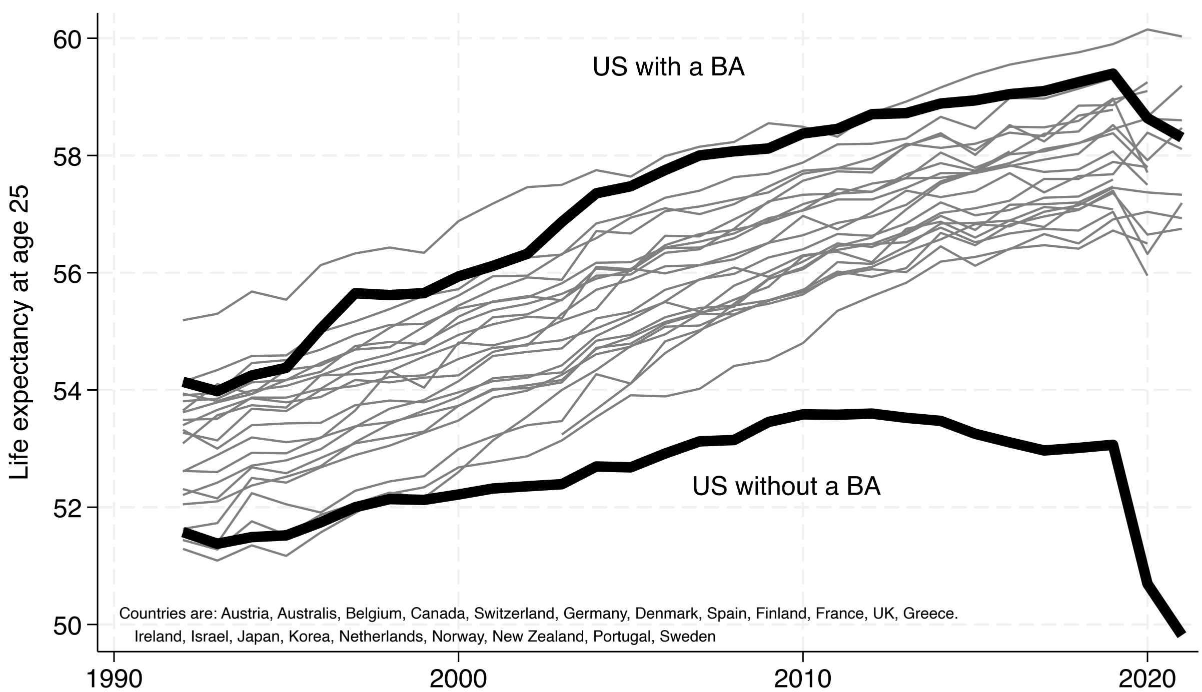

Figure 3: Adult life expectancy for Americans by college degree and for 22 rich countries

We do not have life expectancy estimates by educational attainment for the other countries, though we do know that higher educated people do better everywhere. But the picture shows that, without the widening gap in the US, which is the main topic of this paper, the US would not have done as relatively badly as it did.

III. Accounting for Education-Mortality Gaps in the US

Figure 4 plots adult life expectancy from 1992 through 2021 for men and women separately, split between those with and without a BA. As noted in the introduction, we now work, from here on, not with e_{25}, but with ${}_{60}e_{25}$, the expected years of life between the 25th and 85th birthdays. If everyone died on their 85th birthday the two measures would be identical. More generally, e_{25} exceeds ${}_{60}e_{25}$ by the product of life expectancy at 85, e_{85}, and the fraction of those alive at 25 who survive to 85, quantities that have both been increasing as mortality rates have fallen, but both of which decreased during COVID-19. Since 1992, the difference $e_{25} - {}_{60}e_{25}$ (for both genders taken together) has been between 2 and 3 years, rising from 2.13 in 1992 to 3.02 years in 2019, as mortality among the elderly fell and fewer adults died, and then falling to 2.34 years in 2020 and 2.39 in 2021.

The lower of each pair of solid black lines in each half of the figure is the actual outcome. For men with a BA degree, adult life expectancy rose by 3.6 years from 1992 until 2019, from 51.1 to 54.7 years, and then fell from 2019 to 2020 by 0.53 years and again from 2020 to 2021 by 0.19 years.

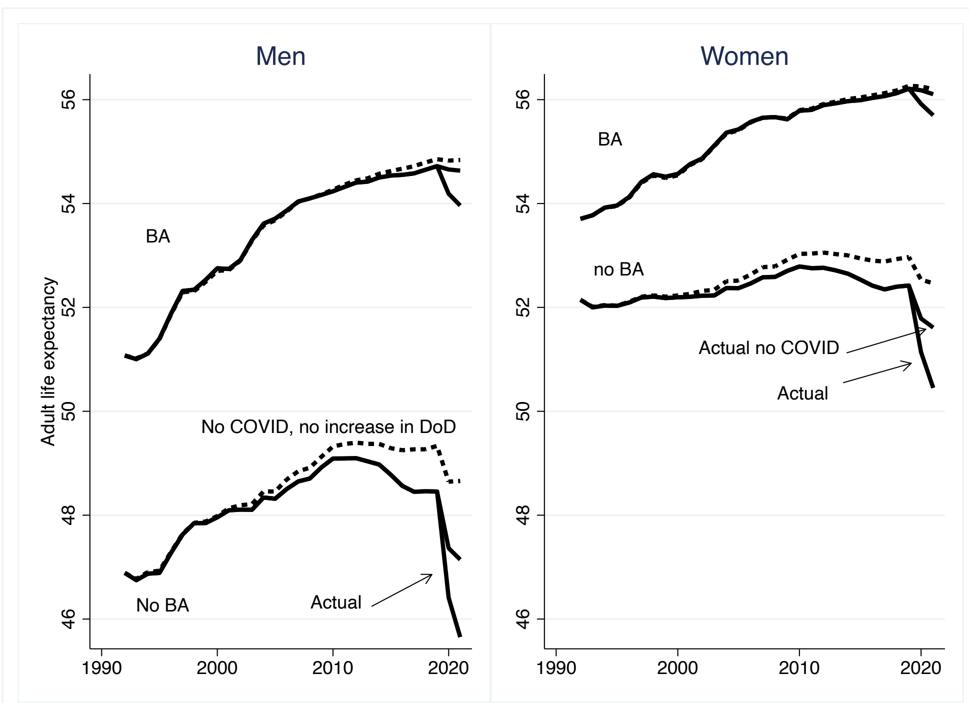

Figure 4: Adult life expectancy, with and without COVID-19 and deaths of despair

For women with a BA degree, our measure of adult life expectancy, ${}_{60}e_{25}$, rose by more than 2.5 years from 1992 until 2019, from 53.7 to 56.2 years, and then fell from 2019 to 2020 by 0.29 years and again from 2020 to 2021 by 0.22 years. Educated women gained less than educated men up to 2019 but lost less in the first two years of the pandemic. For men without a BA, adult life expectancy grew from 1992 to 2010, by 2.2 years, more slowly than for the more-educated men over the same period, and then fell by 0.6 years from 2010 to 2017, held steady for two years, and then fell dramatically during the pandemic, by 2.0 years from 2019 to 2020, and by another 0.7 years from 2020 to 2021. For women without a BA, adult life expectancy grew from 1992 to 2010, by only 0.7 years, fell by 0.4 years from 2010 to 2017, held steady for two years, and then fell during the pandemic, by 1.1 years from 2019 to 2020, and by a further 0.6 years from 2020 to 2021. Once again, women gained less before the pandemic, but lost less during it.

For both education groups, increases in life expectancy have been slower for women than for men. This is particularly dramatic for women without a college degree, for whom adult life expectancy in Figure 4 in 2019, before the pandemic, was only 0.4 of a year more than in 1992. Until the pandemic, men without a college degree had done better, gaining 1.5 years from 1992 to 2019. The slower gains for women are found in all rich countries, not just the United States. The main driver of mortality declines since the 1970s has been falling mortality from cardiovascular disease, primarily driven by reductions in smoking, and the use of antihypertensives and statins. But CVD is less prevalent among women, who therefore had less to gain by the reduction. This effect is magnified by the fact that, in the US as in most other countries, women were slower to start smoking, and slower to stop and smoking affects mortality, not only through lung cancer, but CVD.

The gap in adult life expectancy between the two education groups, which was 2.6 years (4.2 men, 1.6 women) in 1992, almost doubled to 5.0 years (6.3 men 3.8 women) in 2019, and then exploded during the pandemic, to 6.4 years (7.8 men, 4.8 women) in 2020, and 6.9 years (8.3 men, 5.2 women) in 2021. Accounting for these rising gaps is our main interest here.

The higher of the pair of two solid black lines, which differ from one another only in 2020 and 2021, shows the effects of eliminating reported mortality from COVID-19; this deletion removes almost all of the drop for those with a BA, but only half the drop for those without. That excess deaths were greater than those reported as COVID-19 is well-known; the figure shows that the non-COVID changes in mortality from 2019 to 2021, as well as the

COVID "excess" deaths in the pandemic years, were much larger for those without a BA. The higher dashed lines in both panels show estimates of adult life expectancy for each of the four groups when COVID mortality is removed and the mortality rate from deaths of despair is held at its 1992 value. For those with a BA, the adjustment makes little difference beyond eliminating COVID alone. For those without a BA, the actual and adjusted lines increasingly diverge as the epidemic of deaths of despair gathers momentum; indeed, the elimination of the increase in deaths of despair almost removes the post-2010 pre-pandemic decline in adult life expectancy for the less-educated group. It also moderates the declines during the pandemic; although the suicide rate fell in 2020, it rose again in 2021, and both drug overdose and alcohol-related liver disease mortality rates rose in both years.

Figure 4 also shows the three periods: up to 2010 when both groups were improving, but at different rates; from 2010 to the pandemic, when the groups were moving in different directions; and from 2019 when both groups were losing out, but at different rates.

Figure 5, for men and women combined, shows the evolution of the college gap from 1992 to 2021. The solid line marked "actual" is the gap; also shown are several counterfactuals. These include (1) eliminating COVID-19 deaths in 2020 and 2021; (2), as in (1) plus holding deaths of despair mortality rates at their 1992 levels; (3) as in (2) plus holding cardiovascular disease mortality rates constant at their 1992 values; then (4), all the above plus holding cancer mortality rates at their 1992 values. Each step reduces the temporal increase in the educational gradient. Note that both cardiovascular disease mortality and cancer mortality rates were *falling* over the period while the mortality rates from deaths of despair were *rising*. The figure does not show the effect on the *level* of life expectancy of, say, holding cancer mortality rates at their 1992 levels, something that would raise the mortality counterfactual in all subsequent years and lower life expectancy. Rather, the figure shows the effect of holding cancer mortality rates at their 1992 levels on *the educational gap* in life expectancy, and this, like the other counterfactuals, reduces the gap. In other words, the reduction in cancer mortality since 1992 has favored people with a college degree and has thus widened the gap.

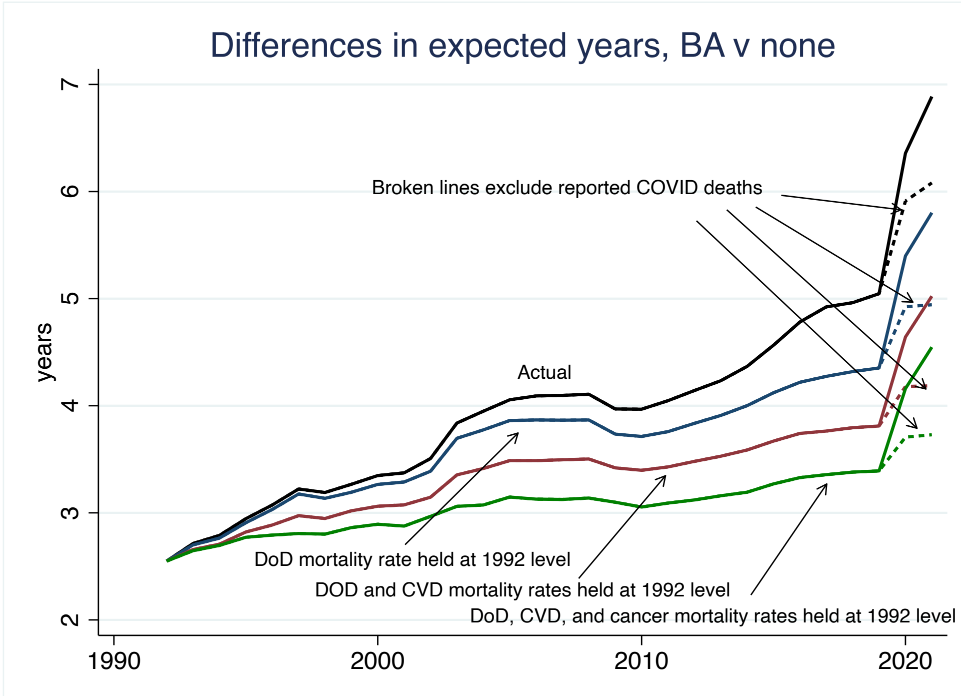

Figure 4 Differences in adult life expectancy with and without a BA

Age-adjusted mortality data reproduce the qualitative patterns in Figures 4 and 5 (Supplemental Figures 1 and 2). But because age-adjusted mortality rates are linear in both age-specific mortality rates and in population shares, they permit exact and straightforward decompositions by causes of death and by age groups. Table 1 presents pre- and post-pandemic age-adjusted mortality rates and covers eleven selected causes of death: deaths of despair, deaths from cancer, cardiovascular disease, chronic lower respiratory diseases, diabetes, transport accidents, Alzheimer disease and related dementias, nephritis, septicemia, assault and COVID-19. Collectively, these categories accounted for 80 percent of all deaths in 2019 for adults aged 25 to 84. The ICD9 and ICD10 codes associated with these causes of death are listed in the notes to the table.

The first three columns of Table 1 show age-adjusted mortality rates per 100,000 in 1992 for people aged 25 to 84 with and without a BA, as well as the difference between them. The next three columns do the same for 2019, the last year before the pandemic. The next three columns show the changes from 1992 to 2019, so that the last column of this set, bolded, shows the "differences in differences," the changes from 1992 to 2019 in the gradient between those with and without a BA. The causes of death in the table are ordered by their size in this column.

Finally, the last three columns present what happened during the pandemic, showing the contribution of each of the listed causes of death to the widening of the gap from 2019 to 2021. In 1992, age-adjusted all-cause mortality rates for those with and without a BA were 845 and 1056, respectively, a difference of 211. The corresponding figures for 2019 were 462 and 908, a difference of 445, an increase from the 1992 gradient of 234 age-adjusted deaths per 100,000. All-cause mortality fell between 1992 and 2019 for people with a BA, and more slowly from 1992 to 2010 for those without, rising thereafter. As a result, the gap in mortality between the two education groups increased from 1992 to 2019.

The eleven causes of death in Table 1 account for 184 of these 234 deaths per 100,000, or 79 percent; a complete accounting for the period from 2000 to 2021 is provided below. The largest contribution comes from deaths of despair, which added 49 deaths to the change in the gradient, followed by cancer, 43, cardiovascular disease, 35, and chronic lower respiratory diseases, 22. The contributions of diabetes, transport accidents, Alzheimer, nephritis, septicemia, and assault are smaller at 10, 7, 7, 6, 4, and 0. All estimates are rounded to whole numbers, which accounts for any discrepancies within the table. Apart from deaths of despair, where the increase in the gradient comes from a much larger increase in deaths among those without a college degree, the next largest increases in the gradient come from causes of death that have been falling over time.

The final three columns of Table 1 track the changes in age-adjusted mortality rates and educational mortality gaps from 2019 to 2021. Three numbers are particularly notable. First, note the increase (from zero) of the number of deaths from COVID-19, and the very much larger age-adjusted mortality for those without a BA. COVID-19 alone added 107 age-adjusted deaths per 100,000 to the educational gap between 2019 and 2021. Second, there was a large increase in deaths of despair from 2019 to 2021, almost exclusively among those without a BA, 37 versus 3. Third, age-adjusted deaths from CVD also rose rapidly, again largely among those without a BA, 27 versus 4. Those three causes of death widened the gradient by 162, out of 184 for the causes of death shown in the table, and out of a total of 198 age-adjusted deaths from 2019 to 2021.

The last rows of Table 1 decompose deaths of despair into its three components: deaths from drugs, from suicide and from alcohol. All three have seen consistent increases in their contributions to the education mortality gradient since the early 1990s. (See Supplemental Figure 3.) Of the three, drug overdose is the largest contributor to the increase in the gradient and has

Table 1. Age adjusted mortality per 100,000 people, ages 25–84

	1992			2019			Change 1992 to 2019			Change 2019 to 2021		
Cause of Death:	BA	No BA	Diff	BA	No BA	Diff	BA	No BA	**Diff**	BA	No BA	**Diff**
D of Despair*[a]	26	43	17	29	95	66	3	52	**49**	3	37	**33**
Cancer	263	297	34	136	212	77	–127	–85	**43**	–5	–1	**4**
CVD[b]	331	418	87	125	247	122	–206	–171	**35**	4	27	**22**
Respiratory[c]	33	50	17	16	55	39	–17	5	**22**	–2	–4	**–2**
Diabetes	18	28	10	13	33	20	–4	5	**10**	3	9	**7**
Transport	13	20	6	6	20	13	–7	0	**7**	0	5	**5**
Alzheimer[d]	11	8	–3	23	28	5	12	19	**7**	1	4	**2**
Nephritis[e]	7	10	4	7	17	10	0	6	**6**	0	1	**1**
Septicemia	6	9	3	6	13	8	0	4	**4**	0	2	**1**
Assault	3	11	8	1	10	8	–2	–2	**0**	0	4	**4**
COVID-19	0	0	0	0	0	0	0	0	**0**	57	164	**107**
Total above[f]	710	895	184	362	730	368	–348	–165	**184**	63	247	**184**
Total mortality	845	1056	211	462	908	445	–382	–149	**234**	66	265	**198**
*Decomposition of D of Despair:												
Drugs	2	6	4	7	45	38	5	39	**34**	2	26	**24**
Suicide	13	16	3	11	22	11	–2	6	**7**	–1	1	**1**
Alcohol	11	21	10	11	28	17	0	7	**8**	2	10	**8**

Notes.
[a] Deaths of despair are from drugs (ICD-9 292, 304, 305.2-305.9, 850-858, 980, ICD-10 F11-F16, F18-19, X40-X44, Y10-Y14); alcohol (ICD-9 291, 303, 305.0, 571.0-571.3, 571.5, ICD-10 F10, K70, K74.6, G31.2, X45, Y15); or suicide (ICD-9 950-959, ICD-10 X60-X84, Y87.0).
[b]Cardiovascular diseases (ICD-9 390-459, ICD-10 I00-I99).
[c]Chronic lower respiratory diseases (ICD-9 490-496, ICD-10 J40-J47).
[d]Alzheimer disease and related dementias (ICD-9 331.0, 290.0-290.4, ICD-10 F01, G30, G31.0, G31.1, G31.8, G31.9).
[e]Nephritis, nephrotic syndrome or nephrosis (ICD-9 580-589, ICD-10 N00-07, N17-19, N25-27).
[f]Differences in partial sums are due to rounding.

received the most attention. But suicide and alcohol deaths have increased among those without a BA; particularly notable is the contribution of alcohol deaths to the increase in the gradient during the COVID pandemic.

Table 2 shows a more complete characterization of causes of death from 2000 to 2021 using ICD-10 classifications; the shorter span of years obviates the need to match the

Table 2. Age adjusted mortality per 100,000 people, ages 25–84, by ICD10 category

	2000			2019			Change 2019-2000			Change 2021-2019		
Cause of Death:	BA	No BA	Diff	BA	No BA	Diff	BA	No BA	**Diff**	BA	No BA	**Diff**
COVID-19	--	--	--	--	--	--	--	--	**--**	57	164	**107**
X-codes	16	34	18	21	77	56	5	43	**38**	1	31	**29**
Cancer	223	278	55	136	212	77	–88	–66	**22**	–5	–1	**4**
J-codes	58	95	37	33	88	56	–25	–6	**19**	–3	–4	**–1**
CVD	247	358	111	125	247	122	–122	–111	**12**	4	27	**22**
G-codes	31	30	-2	44	49	8	10	19	**10**	2	5	**3**
K-codes	23	40	17	19	44	25	–4	4	**8**	2	11	**9**
E-codes	25	44	19	22	50	28	–2	6	**8**	3	12	**9**
F-codes	9	13	5	15	26	12	6	13	**7**	1	4	**3**
V-codes	11	20	9	6	19	13	–5	–1	**4**	0	5	**5**
N-codes	12	21	9	10	23	13	–2	2	**4**	1	3	**2**
A-codes	9	15	6	8	17	9	–1	2	**3**	1	2	**1**
W-codes	7	10	2	9	14	5	2	4	**3**	1	2	**1**
Total above	672	957	285	444	867	423	–228	–90	**137**	65	260	**195**
Total mortality	702	1008	307	462	908	445	–239	–101	**139**	66	265	**198**

Notes on ICD-10 codes.
X: Certain external causes, including accidental drug overdose, suicide, and assault with firearms
J: Diseases of the respiratory system, including chronic lower respiratory diseases, and influenza
G: Diseases of the nervous system, including Alzheimer and Parkinson diseases
K: Diseases of the digestive system, including alcoholic liver disease and cirrhosis
E: Endocrine, nutritional and metabolic diseases, including diabetes
F: Mental and behavioral disorders, including those due to psychoactive substance use
V: Transport accidents
N: Diseases of genitourinary system
A: Certain infectious and parasitic diseases
W: Certain external causes, including falls
Certain causes of death are not shown in the table. These include ICD10 codes B: Certain viral infections; D: Diseases of the blood and blood forming organs; H: Diseases of the eye and adnexa, and diseases of the ear and mastoid process; L: Diseases of the skin and subcutaneous tissue; M: Diseases of the musculoskeletal system; O: Pregnancy, childbirth and puerperium; P: Certain conditions from perinatal period; Q: Congenital malformations, deformations and chromosomal abnormalities; R: symptoms, signs and abnormal clinical and laboratory findings, NEC; and Y: Certain assaults, events of undetermined intent, sequelae of external causes.

classifications for ICD-9 and ICD-10. The table shows age-adjusted mortality rates for 2000, 2019, as well as changes from 2000 to 2019 and from 2019 to 2021. Table 2 is constructed in parallel to Table 1, but with different disease classifications. The text below the table explains the letter codes from ICD-10, and allows comparison of the two tables, despite the change in groupings. For example, deaths of despair in Table 1 are now primarily captured in X and K codes. We have excluded causes that account for a small number of adult deaths, so that columns 9 and 12 are now close to adding up to the totals in the last row, 137 out of 139 per 100,000 age-adjusted deaths for the change from 2000 to 2019, and 195 out of 198 per 100,000 for the pandemic years 2019 to 2021. Comparison of Tables 1 and 2 shows that the former did not miss any diseases that made large contributions to the widening gradient, though Table 2 identifies F-codes (mental and behavioral disorders), N-code (diseases of genitourinary system), A-codes (certain infectious and parasitical diseases), and W-codes (certain external causes, including falls) as making minor contributions to the widening gradients both before and during the pandemic.

An important result in Table 2 is that, between 2000 and 2019, *all* causes of death, grouped by ICD-10 classification, contributed positively to the increase in the gap, and between 2019 and 2021, all except one did so, the exception being J-codes which cover deaths from respiratory diseases. This it true whether the mortality rate for the cause is falling for both groups (cancer, cardiovascular disease), rising for both groups (deaths of despair, respiratory diseases, Alzheimer), or falling for the better educated group and rising for the less educated group (alcoholic liver disease, diabetes). With the one exception noted, the widening gap characterizes all time periods and all causes of death.

Figure 6 shows time series of age-adjusted mortality for the three diseases that contribute most to the increase of the gradient, deaths of despair, cancer, and CVD, by gender and by college degree status. The top panel shows CVD mortality and deaths of despair, while the bottom panel shows cancer mortality. The top panel shows that the rise in deaths of despair is more important for men than for women, and in both cases is almost entirely confined to those without a college degree. CVD mortality also contributes to the widening gap for both men and women. The long-term decline that began in the 1970s lost momentum among those with a BA and stopped falling altogether after 2010 for those without the degree. After 2010, it rose slowly up to the pandemic, and then more rapidly during it. These changes in the pattern of declining CVD mortality are recent, not well understood, and are of major importance, not only for understanding the gaps, but for understanding prospects for mortality more generally. Cancer mortality rates fell much more rapidly for women with a college degree than for women without; there is a more modest widening, with substantial decline for both those with and without a BA. Indeed, in 1992, mortality rates from cancer were *higher* for more educated women. For men, there is a more modest widening, with substantial decline for both those with and without a degree.

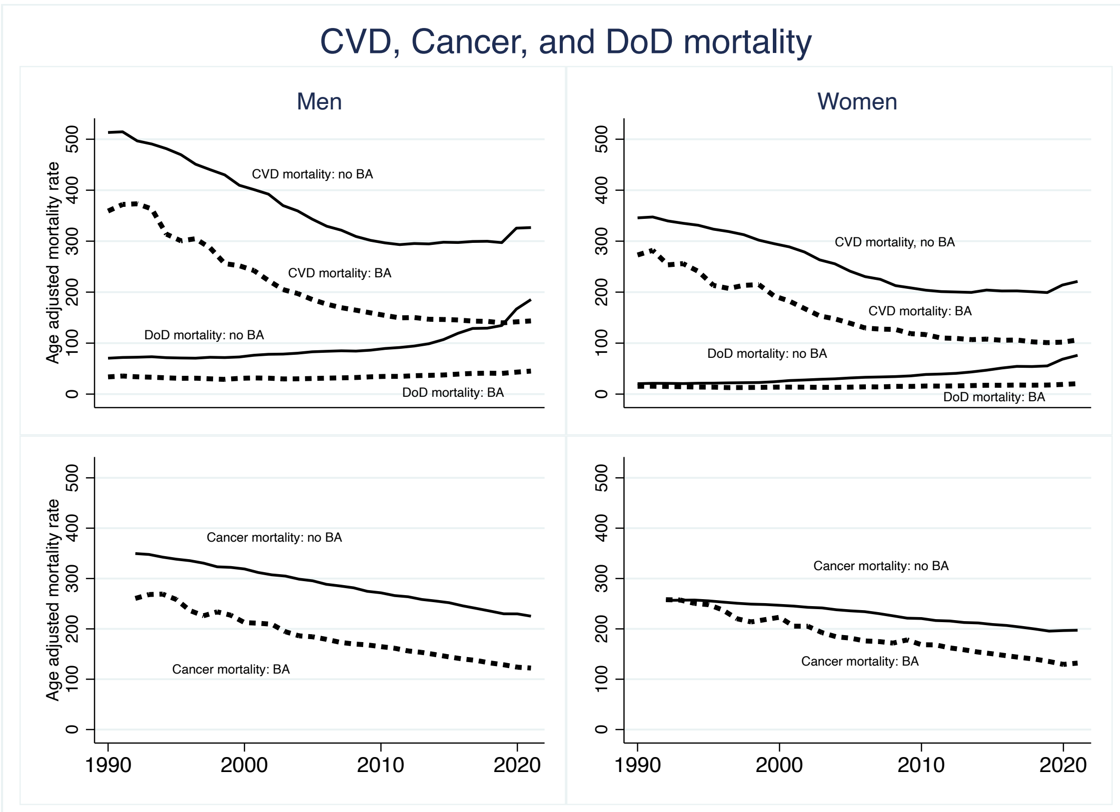

Figure 6. Age-adjusted mortality rates, by educational attainment

Figures 7 and 8, for women and men respectively, document patterns of mortality by education for the major cancers, for women, lung, breast, colon, ovarian, liver, and pancreatic cancer, and for men, lung, prostate, colon, liver, and pancreatic cancer. In the years immediately after 1992, lung cancer mortality was still rising for women without a BA but falling for those with a BA. After 2006, lung cancer mortality fell for both groups in parallel and, after 2014, the mortality gap in lung cancer fell modestly for women. The contribution to widening the gradient comes before 2006. For men, who stopped smoking earlier than women, lung cancer mortality

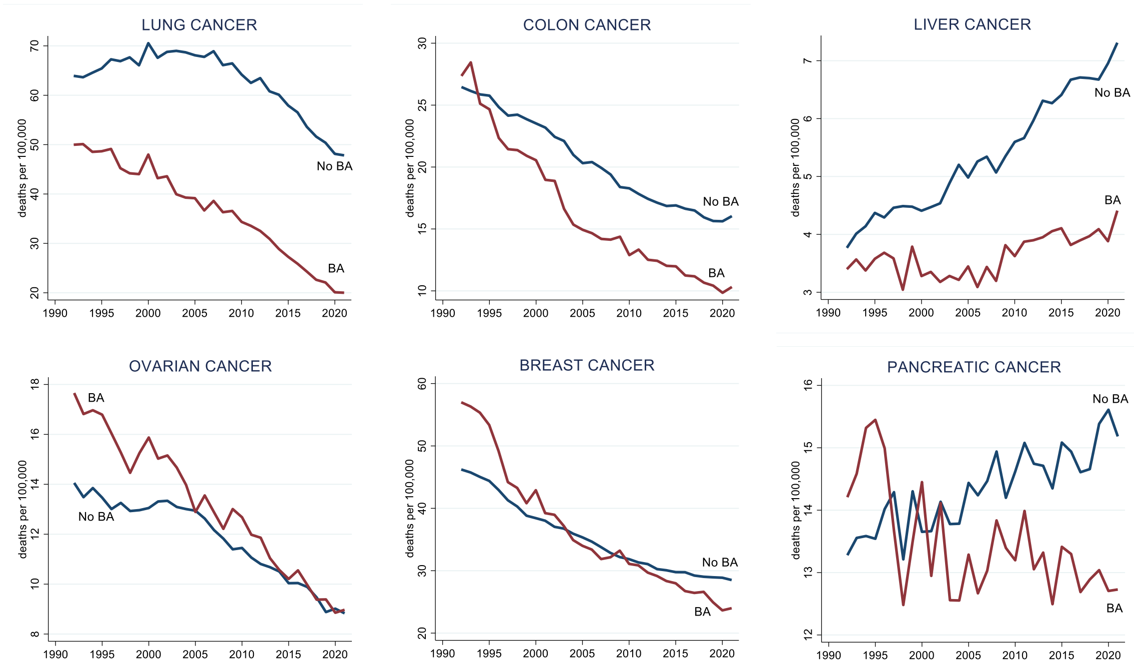

Figure 7. Age-adjusted cancer mortality rates, WOMEN, by BA status

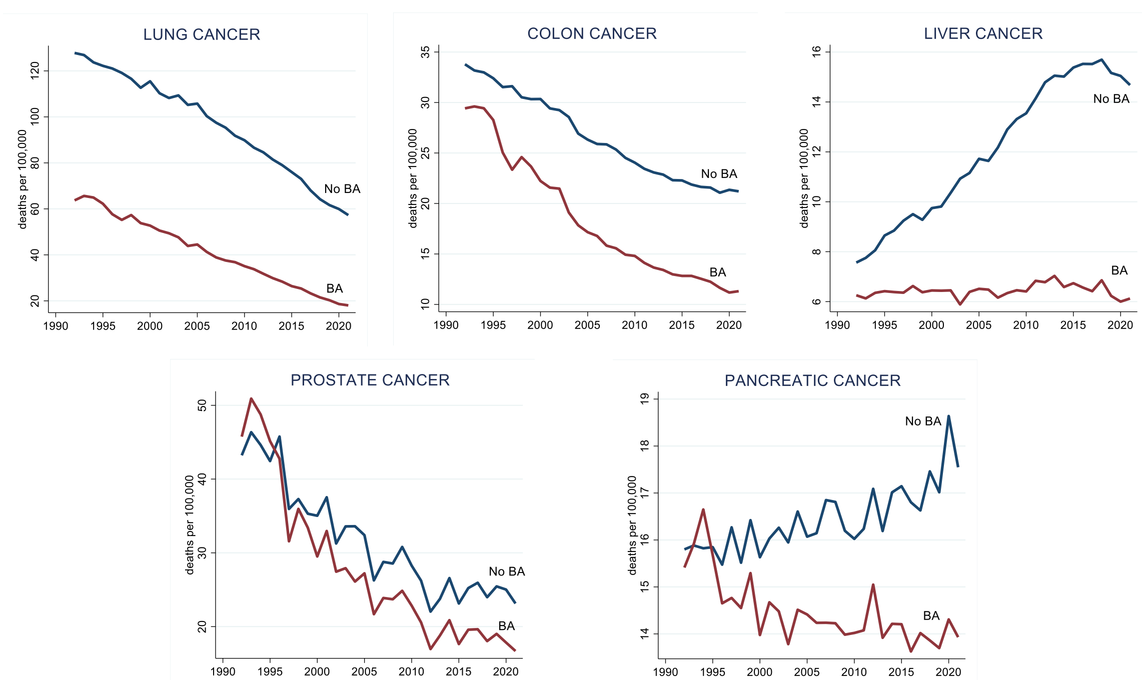

Figure 8. Age-adjusted cancer mortality rates, MEN, by BA status

fell for both groups from 1992 to 2021, though more rapidly for those *without* a college degree, so that changes in lung cancer mortality for men worked to narrow the mortality gap. In 1992, breast cancer mortality was higher for women with a college degree, a longstanding finding that is often attributed to the protective effects of early childbearing. But, as predicted by Link and others (1998), as scanning and effective treatment became available, breast cancer mortality fell more rapidly for the more-educated group, contributing to a widening of the gradient. Prostate cancer mortality has fallen for men with and without a college degree, but more rapidly for those with, adding a relatively small amount to the widening of the mortality gap.

Among women, mortality from both colon and ovarian cancer were higher among those with a college degree in 1992, but as was the case for breast cancer, mortality fell more rapidly among women with a BA, crossing over in colon cancer, and converging for ovarian cancer. As with breast cancer, screening and treatment were almost certainly both important. Mortality from liver cancer, for which risk factors include excessive alcohol use and cirrhosis, has been rising over time for both men and women, primarily among men and women without a college degree. Pancreatic cancer mortality has risen for both men and women without a college degree, while holding relatively steady after 2000 among those with a degree.

A key takeaway from Figures 7 and 8 is that while different cancer mortality rates have behaved differently, with some falling and some rising, and while, for some cancers, mortality is or was higher for those with a college degree, for all the cancers examined here, with the exception of lung cancer for men, the educational gaps in mortality widened over time. Advances in medical treatments for many cancers, and protective behavioral changes, have had larger effects for those with a BA.

Table 3 calculates the college mortality gap by age-group for 1992, 2019 and 2021. Column (1) gives the shares of each group in the population in 2000; these are the weights that can be applied to columns (2) through (6) to give the population totals in the bottom row. Column (2) gives the age adjusted mortality rates in 2000 irrespective of educational status, while columns (3), (4) and (5) give the gaps, the differences in age-adjusted mortality rates between those with and without a four-year college degree. Column (6) shows the change in the gaps from 1992 to 2021; these changes are, unsurprisingly, larger in groups with higher baseline mortality, and the final column shows the changes as a percentage of the baseline (2000) mortality rates. The baseline of 2000 was chosen to align with its use in age-standardization.

Table 3. College gaps in age adjusted mortality by age groups.

Age group:	(1) Population shares in 2000 (%)	(2) Age-Adjusted mortality rate[a] in 2000	(3) Mortality gap[b] 1992	(4) Mortality gap[b] 2019	(5) Mortality gap[b] 2021	(6)=(5)-(3) Change 1992 to 2021	(7)=(6)/(2) Change as a percent of 2000 rate
25-34	22.3	102	96	149	231	135	132
35-44	25.3	199	126	203	324	198	99
45-54	21.3	422	213	334	502	289	68
55-64	13.7	986	409	649	882	472	48
65-84	17.3	3,706	327	1,157	1,629	1,301	35
All 25-84	100	939	211	445	643	432	46

[a]Deaths per 100,000 persons.
[b]Difference in mortality rate for people without and with a four-year college degree.

The overall increase in the gradient from 1992 to 2021 is 432 deaths per 100,000, to which the largest contribution comes from those aged 65 and over, (0.173*1301)/432=52 percent. The largest share of this is due to education differences in COVID-19 mortality, though there are also substantial contributions from cancer and CVD. As a percentage of baseline mortality, younger age groups saw larger increases in education gradients over this period; for the age group 25 to 34, the increase in the gap exceeded baseline mortality. Two-thirds of the increase among the youngest group was from deaths of despair. As we move from young to old, COVID mortality becomes more important in contributing to the gradient, as do, to a lesser extent, mortality from CVD and cancer; deaths of despair become progressively less important with age. We already know that elderly people were at greater risk for dying from COVID, so the distressing result here is the large percentage increases in the youngest groups. This is an increasingly understood, but still underappreciated fact about deaths of despair, that the young are the worst affected. We accept some responsibility here because, in our first paper, Case and Deaton (2015), we first noticed and focused on increases in all-cause mortality in midlife, increases that were driven not only by deaths of despair but by faltering progress against mortality from cardiovascular disease. Yet, once we focus on deaths of despair alone, and as the birth cohort plots in our book show, it is the young who are at greatest risk.

IV. The Effects of Rising Educational Attainment

Our main interest is in documenting the changing differences in mortality between those with and without a four-year college degree, breaking up the patterns by cause of death, by gender, and by age. Beyond our scope here is a delineation of the *reasons* for the better health of college-degree holders, whether more schooling in and of itself brings better health and better health behaviors, or whether social and economic treatment of the college-degree credential has created an increasingly difficult environment for those without it. One account, however, needs to be discussed here, which is that the rising fraction of Americans with a four-year college degree may be contributing to the rising gap and can perhaps even account for it. If the new college attendees are healthier than those who remain in the non-college group, then a rising proportion of the population going to college will leave a non-college group that is increasingly negatively selected on health. In 2021, 35 percent of the population aged 25−84 had a four-year college degree compared with 22 percent in 1992; the increase for women, 18 percentage points, was larger than that for men, 10 percentage points.

The effects on the educational health *gap* are not clear a priori because health selection as described above can increase mortality rates for both groups, as the healthier non-graduates leave the pool of non-graduates, making the non-graduate group less healthy, and join an initially healthier graduate group, also reducing health in that group. It is straightforward to construct examples in which the gap does not change as more or fewer people go to college. For example, if health h is uniformly distributed between 0 and 1, and those with $h > \theta$ go to college, a fraction $(1 - \theta)$, the average health in the two groups is $\frac{\theta}{2}$ and $\frac{1+\theta}{2}$, and the gap is always $\frac{1}{2}$, which does not depend on θ. This example illustrates only one possibility. Another comes from giving h a standard normal distribution, where those with $h > \theta$ go to college, so the fraction going to college is $[1 - \Phi(\theta)]$ where $\Phi(\theta)$ is the cumulative distribution function of the standard normal. Note that this fraction is falling in θ. Average health among the non-college group is $-\frac{\phi(\theta)}{\Phi(\theta)}$ and among the college group is $\frac{\phi(\theta)}{[1-\Phi(\theta)]}$ where $\phi(.)$ is the probability density function of the normal distribution. Both these expressions are increasing in θ, i.e., decreasing as more people go to college, but the gap between average health of the college and the non-college groups, which is $\frac{\phi(\theta)}{\Phi(\theta)(1-\Phi(\theta))}$, rises as the fraction going to college increases until half the population is in college and decreases thereafter.

Our primary focus here is the mortality gap between those with and without a college degree, no matter who is in the two groups—again note the parallel with the earnings of those without a college degree. The fraction going to college, although it may affect the mortality gap, just as it may affect the wage premium, is not a source of bias in our estimates—we are not estimating a parameter of interest that would be biased by the selection—though it may certainly be a *cause* of what we find. Our view is that selection is one cause of health gaps among others, including the opportunities for and life circumstances of those with and without college degrees.

A number of papers in the literature have made corrections for possible selection effects. Meara, Richards and Cutler (2008) randomly reallocate some of their observations to keep constant the proportions in each of their groups. Others have worked with percentiles of the distribution of years of schooling, including Novosad, Rafkin and Asher (2022), and Geronimus and others (2019), whose focus, similar to ours, is on mortality gaps between more and less educated Americans. While we look at people with and without a college degree, Geronimus and others (2019) compare outcomes for people in the bottom quartile of the education distribution with those in the top three quartiles. Even if educational qualifications were measured continuously, it is unclear why what happens at a particular percentile is of interest, given that jobs and social standing depend more on qualifications than on percentiles, nor how, in the presence of health selection, looking at percentiles identifies a specific parameter of interest. Geronimus and others (2019) assign quartiles within (birth year, sex, race) cells for Black and White non-Hispanics. For White non-Hispanics, examination of the data shows that the bottom quartile has been defined by a high school degree since the birth cohorts born in the early 1920s, and for Blacks, since the early 1940s. As a result, a comparison of the bottom quartile to the rest of the distribution is quite similar to a comparison between those with no more than a high school degree to those with at least some college education. Their categorization differs from ours, in practice, in allocating the group with some college, but less than a BA, to their "high" education category. In previous work, we have shown that socioeconomic outcomes and mortality patterns for those with some college, but no BA, are more similar to those with a high school degree or less than to those with a college degree. (We update and explore this in Supplemental Figure 4.) Despite this difference, their estimates are qualitatively similar to ours. That this is so could also be taken as evidence that the selection effects on the gap are not very important, a finding that is echoed by Novosad and others (2022), as well as by Hayward and Farina (2023) based on a review of other relevant studies.

One useful procedure is to examine changes in education-mortality gaps within each birth cohort. On the assumption that education levels are fixed once education is completed, here taken to have happened by age 25, changes of health within each cohort cannot come from selection effects. Changes over time in the effects of a four-year degree on health will show up within cohorts; we have in mind changes in working or living conditions that differ between those with and without a college degree.

We define a relative gap measure for each age and year. For each age and year, we calculate the mortality gap ratio $(m_1 - m_3)/m_0$, the mortality difference between group 1—those without a BA—and group 3—those with a BA or more, scaled by the mortality rate for the population of the whole cohort. Note that this measure is at least crudely corrected for age effects, which are in both numerator and denominator. Figure 9 plots the mortality gap ratio by age for birth cohorts born at ten-year intervals for men and for women; the plots for all cohorts for all birth years are too crowded to read. (Figure 9 echoes the cohort graphs in Case and Deaton (2020, Chapter 4) which show similar patterns of upward movement and rotation, but only for those without a college degree, consistent with the pattern for the gap ratios in Figure 9.)

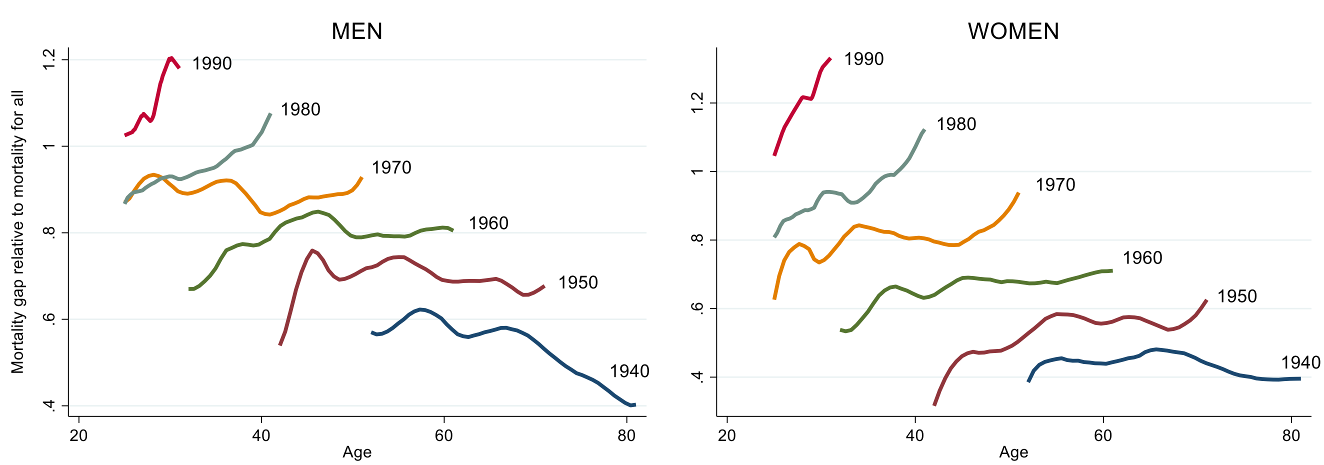

Figure 9. Mortality Gap as a fraction of mortality by age and birth year

Figure 9 shows that most of the increase in the relative mortality gap is *between* cohorts, and that there is no consistent increase in the gap within cohorts. For the birth cohorts of 1970 and after, the plots slope upward at higher ages. For those born in 1960 they are approximately flat, while, for men born in 1940, the plot declines with age. These increases cannot be due to selection nor to age-invariant health behaviors associated with education if educational attainment within each birth cohort does not increase with age after age 25.

However, examination of educational attainment within each birth cohort shows that the fraction of those reporting a college degree does indeed increase as the cohort ages. For example, for those born in 1940, a regression of degree attainment on age attracts a coefficient of 0.0011, so that between when we first see them at age 52 and last see them at age 81, the fraction with a college degree has increased by more than three percentage points. For younger cohorts, the numbers are larger; for example, for the cohort born in 1970, the fraction reporting a degree increases by 14 percentage points from age 25 to 51. Differential mortality rates—which we have in our data—will differentially select out the less educated as each cohort ages, but this effect is negligible for the younger cohorts. For the cohort born in 1940, differential mortality should increase the fraction with a degree by 4 percentage points, but for the 1970 cohort, the increase is less than 1 percentage point. According to the National Center for Education Statistics (2023), about a quarter of college graduates in 2012 obtained their degree between ages 25 and 39, presumably mostly at the lower end of that range. Even so, there is upward drift within cohorts beyond age 30 (and even beyond age 40) in the reported fraction of degree holders.

The upward drift in reported possession of a bachelor's degree for later-born cohorts cannot be explained by differential mortality, and is unlikely to be fully explicable by people going back to college. Immigrants are about as likely as native-born Americans to have a college degree, Krogstad and Radford (2018), and results are similar if we restrict the sample used in Figure 9 to the native-born population, so we are left with the supposition that people are granting themselves degrees as they age. There are certainly great incentives to do so, and perhaps few risks to people checking a box on a website for jobs in the hope that prospective employers will not check.

What does this imply for the analysis in this paper, or indeed for other papers in the literature that assume that education is complete by age 25? Effects ascribed to having a college degree are, at least in part, confounded with the effects of compositional change, even within birth cohorts. Several papers have questioned the use of education as reported on death certificates on the grounds that it is *not* self-reported and take that as a reason to work with the (much smaller) mortality follow-up of the National Health Interview Survey, Hendi (2017), Masters, Hummer, and Powers (2012). Yet our results show that self-reports may also be problematic. If the main concern is adults going back to college, the analysis can be confined to those ages 35 (or 45) and above; but the years before 35 (or 45) make little contribution to the widening gap, and Figures 4 and 5 show the same patterns of widening gradients if we work with ${}_{50}e_{35}$ or ${}_{40}e_{45}$ in place of ${}_{60}e_{25}$. Note that our parallel with calculations of the college wage premium is unaffected in the sense that the health and wage premia are both based on potentially exaggerated degree attainment. Each should be interpreted as the difference in earnings or mortality outcomes between those who have or claim to have a college degree and those who do not. Many people who falsely claim to have a degree may still receive the social and economic benefits of having one.

V. Mortality: Discussion

In 2008, Meara, Richards and Cutler examined mortality by education up to 2000 and entitled their paper "the gap gets bigger." Their title works just as well for the mortality gap between Americans with and without a bachelor's degree in the subsequent years, from 2000 to 2021. Indeed, the rate of widening accelerated after 2010 and exploded during the pandemic.

The years between 1992 and 2021 were years in which patterns of mortality changed dramatically, and those changes were different for men and for women. What is remarkable is that the widening of the gap transcended these changes in the mortality patterns. This would have been remarkable enough for the gap in all-cause mortality as the underlying causes of death changed. What is more surprising is that the widening gap is seen in virtually all the major groupings of causes of death. We see it in deaths whose rates have risen in the last thirty years, like deaths of despair and COVID-19, we see it in deaths whose rates have fallen in the last thirty years, like cancer, we see it in deaths whose rates have fallen and then risen, like deaths from cardiovascular disease, and we see it in deaths whose rates were originally higher for those without a BA, most diseases, and those that were originally lower for those without a BA, colon, liver, ovarian and breast cancer for women, and prostate and pancreatic cancer for men. Even though the mechanisms and stories are different for each disease, and sometimes different for men and women, the widening gap is almost always there.

The "virtual" and "almost" are there to note the only exception that we have found, which is the category in ICD-10 labeled "diseases of the respiratory system, including chronic lower respiratory diseases, and influenza," but excluding deaths from COVID-19, and then only during the two-year period from 2019 to 2021, the pandemic years. For the 2000 to 2019, the gap in this category widened, as in other causes of death. During 2020 and 2021, some respiratory diseases may have been misclassified as COVID-19 and, given that COVID-19 deaths were much more common among those without a BA, the narrowing of the gap in respiratory diseases could plausibly be due to this misattribution. Note again our earlier comments on the difficulties of assigning cause of death in such complex cases.

We note too that while the increasing gap is seen in cancer as a group, the gap is shrinking for one specific cancer, lung cancer mortality for men. Men with a BA gave up smoking much earlier than men without, but in recent years, the latter have been quitting too, which has narrowed the gap. For women, the mortality gap in lung cancer has continued to increase, as it has for mortality from other cancers, as well as for all cancers together for both men and women.

Fundamental cause theory says that, whenever there exists the means to prevent death, those means will be more effectively seized by those with power and resources, Link and Phelan (1995). What we are seeing here is fundamental cause mechanisms on steroids; the gap is not just present, but expanding, and expanding at an accelerating rate. Either the gap in power and resources is expanding or the means of preventing disease has been growing; we suspect both are true. However, we do not have a well-documented account of how and why this is happening, but point instead to the fact that these gaps, between those with and without a BA, are widening across a range of life outcomes that we have reason to care about, not just mortality, but also morbidity—including many kinds of pain—as well as in marriage rates, out-of-wedlock childbearing, religious observance, institutional attachments, and in wages and participation in employment, see Case and Deaton (2020) and the final section below.

Figure 10 sets the stage for Section VI and illustrates with one such comparison, between wage rates and deaths of despair. The blue line, labeled on the left-hand axis, shows the college wage premium, defined as the ratio of median wages for those with a BA or more to median wages for those without a BA, while the red line, labeled on the right-hand axis, shows the ratio of the age-adjusted mortality rate from deaths of despair for those without a BA to the age-adjusted mortality rate from deaths of despair for those with a BA or more. In both cases, we look at ages 25 to 64. Note that we are not arguing for a direct causal connection here; instead

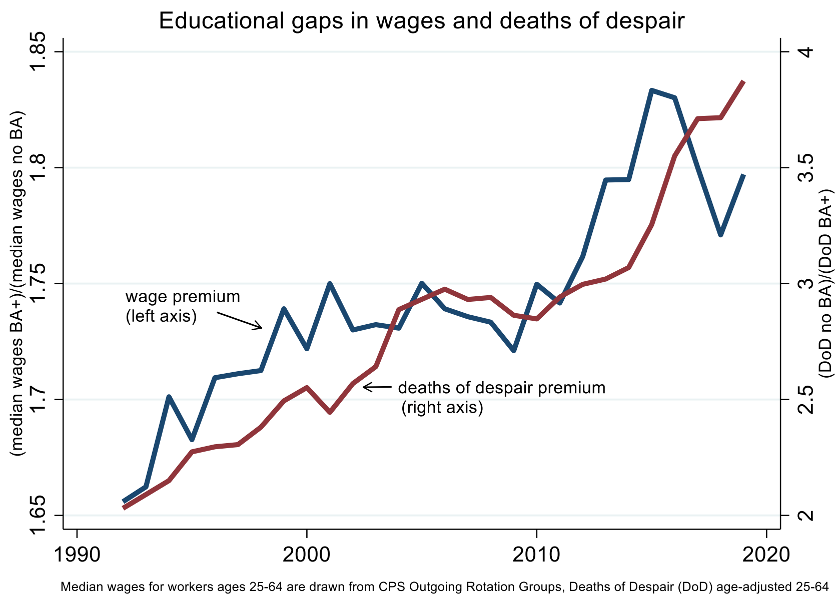

Figure 10: Educational gaps in wages and deaths of despair

we think of these series as two of many ways of documenting the deterioration in the situation of less-educated people in today's United States. Note that both comparisons show rising gaps up to 2000, then a period of relative pause, followed by an acceleration after 2010. A closing of mortality gaps may be an elusive goal while gaps in other domains continue to increase.

VI. Gaps Among the Living

The decades-long increase in mortality gaps we have documented are matched by widening gaps in many measurable outcomes among the living, of which Figure 10 is one example. We do not try to pin causality on any of the measures we document, though differences in adult mortality, especially differences in mortality that are essentially self-inflicted, are certainly rooted in differences in the lives that preceded them. In such accounts, causality would certainly operate slowly and cumulatively; to borrow a phrase, with long and variable lags. We do not attempt to disentangle the potential roles of the factors we consider, in affecting either deaths of despair or overall mortality. That said, we note the excellent work on the precursors of deaths of despair by Olfson and others (2021). Merging individual data from the American Community Survey with death records, Olfson and others (2021) report the risk of dying from drugs, or alcohol or suicide (each analyzed separately) is higher for those who are single, who have less than a four-year degree, and who report lower income; they show that the difference between those with and without a BA remains after controlling for a number of other factors.

We examine gaps and changes in gaps by BA status, in marriage, social isolation, pain, mental health, income and wealth. Our findings parallel the earlier documentation of gaps in mortality in that the gaps between those with and without a BA have been widening since at least the mid-1990s.

Figure 11 plots marriage rates, as well as rates of physical pain and mental distress. All are age-adjusted to the 2000 US population and combine men and women aged 25 to 79. The pain measure relates to sciatic pain—a type of pain that is specific and likely reliably reported. It and the fraction of people who report that they have difficulty socializing ("visiting friends, attending clubs") come from the National Health Interview Survey (NHIS), and run from 1997 to 2018; the NHIS was redesigned after 2018, and later data are not comparable. The "difficulty socializing" measure captures one aspect of loneliness, which the US Surgeon General (2023) has recently described as an epidemic; the standard surveys on which we rely do not have the more sophisticated questions that would be preferable.

The measure of extreme mental distress comes from the Behavioral Risk Factor Surveillance System (BRFSS) and was first suggested and used by Blanchflower and Oswald (2020) to analyze educational differences in mental health. The question asks, "now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?" The graph plots the fraction of the population who replied 30 days, that is, whose mental health was not good on every day of the past 30. Finally, marriage rates are taken from the Current Population Survey.

The fraction of adults currently married has been declining for those without and without a BA. From 1980 to 1990, the two lines fell in parallel, but since then, the fall has been markedly more rapid among those without a college degree. (See Supplemental Figure 5.) The decline persisted and perhaps slightly accelerated during and immediately after the COVID-19 pandemic. The long-established decline has been explored in the sociological literature on "fragile families," which describes the still-increasing phenomenon of serial cohabitation, often with children, who then live separated from one or other of their parents, McLanahan (2004),

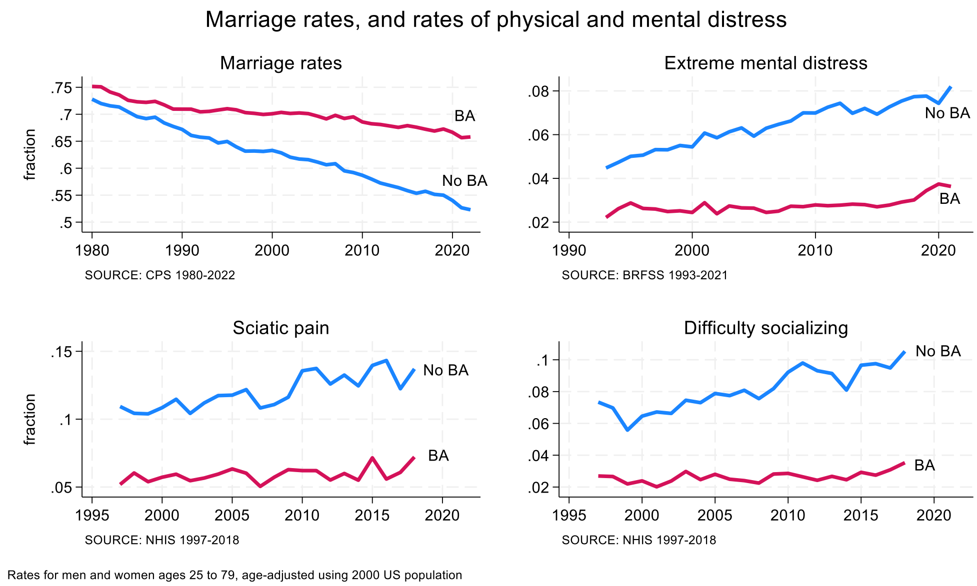

Figure 11: Marriage rates and rates of physical and mental distress

Cherlin (2014); the decreased attachment to the institution of marriage is part of a wider detachment from social institutions, including religion, by working-class Americans, Edin and others (2019).

The other three measures in Figure 11 are all rising over time, getting worse for both educational groups, but the increase is much more pronounced for those without a four-year college degree. Extreme mental distress has risen steadily since the early 1990s for those without a college degree, and by little for those with a degree before 2015. In 2019 to 2020, and 2020 to 2021, the two groups moved in opposite directions, down and then up for the less educated, and up then down for those with a BA. These contrary movements during the COVID pandemic are worth further analysis. The measures of sciatic pain and of difficulty socializing come from the NHIS, whose sample size is smaller, and are relatively noisy; even so the greater prevalence of both among the less educated is clear. As reported in Lamba and Moffitt (2023), the largest increase in reported pain occurred for those without a BA during the financial crisis, and the increase in this gap persisted through 2018.

Figure 12 summarizes the gaps in single picture in which the gaps for all four measures are rising over time. This graph shows a parallel with our findings on mortality, in that the gaps between the two groups have grown and are growing over time. Of course, we should not push the analogy too far; all four of the measures here are worsening over time, while several of the mortality rates, particularly for cancers, were improving.

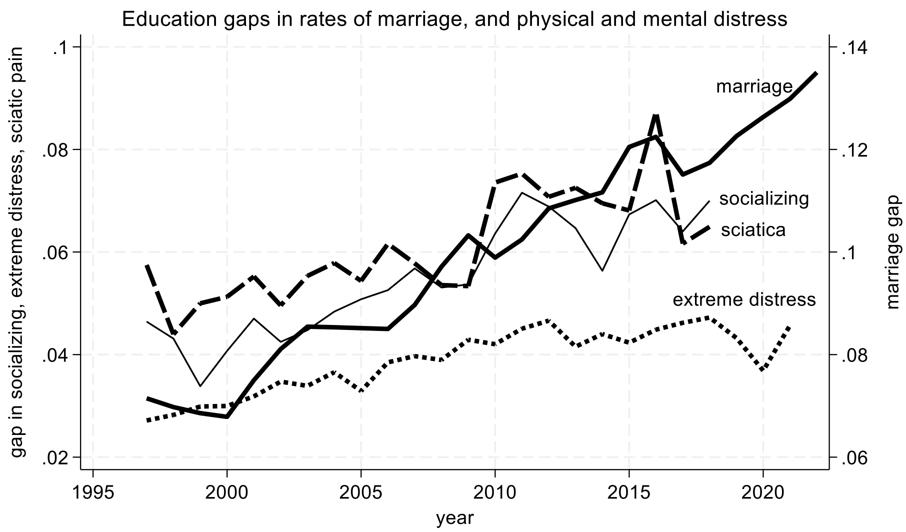

Figure 12: Education gaps in rates of marriage, and physical and mental distress

When we turn to income and wealth, the general trends are of improvement, albeit at different rates for the two groups. Figure 13 shows real family incomes from 1970 to 2021; 1970 is often identified as the year after which broadly shared general prosperity broke down. The data come from the census in 1970, 1980, 1990 and 2000, shown as blue dots, from the CPS for the non-census years from 1980 to 1999, shown as red dots, and from the American Community Survey annually since 2001. We have deflated by the CPI(U) to real 2012 dollars, and calculated family equivalents in which each child under 18 counts as 0.7 of as an adult, and where the sum of adults plus 0.7 children is raised to the power of 0.7 to capture economies of scale, see NRC (1995) for this and other measures. If we were to use the price deflator of per capita expenditure in place of the CPI(U), both income measures would rise somewhat more rapidly, though the change in the gap does not change qualitatively. There is scope for much argument about the choice of price indexes, but the main difference between the two is different weights, with the PCE deflator including many items that families do not directly purchase.

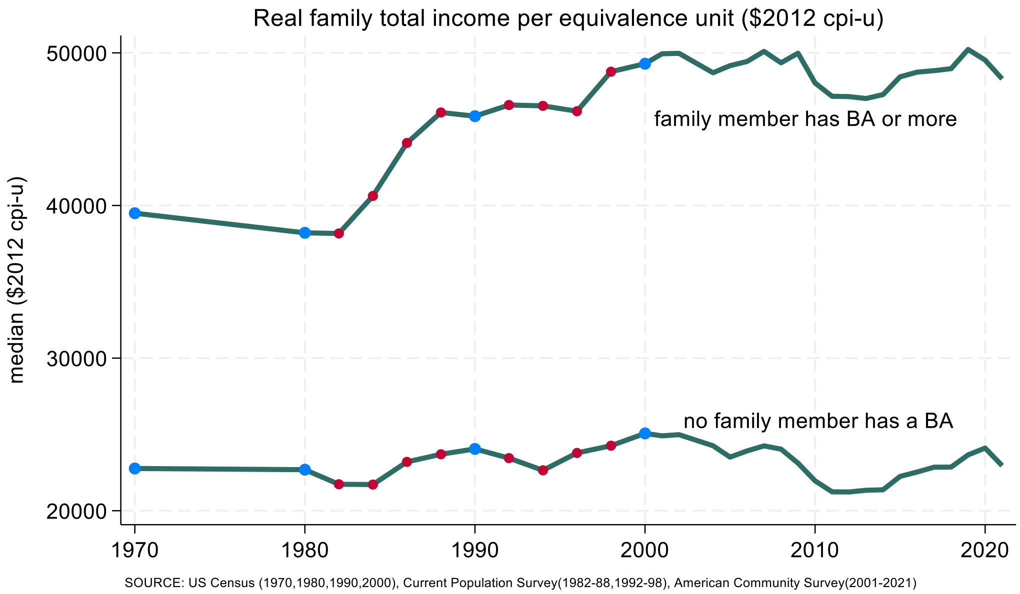

Figure 13: Real family total income per equivalent, 1970 to 2021

The headline from this graph is that the gap in real equivalized family income increased, from $16,500 in 1970 to more than $25,000 in 2022. The increase was not steady over the half-century shown. It fell slightly from 1970 to 1980, rose rapidly in the 1980s, rose more slowly from 1990 to 2010, and has been trendless since. We know the underlying anatomy of these changes. Part is the increase in the college wage premium, from 41 percent in 1979 to 83 percent in 2019. The 1980s and, to a lesser extent, the 1990s, were also periods of rising family income inequality, of which the gap between the education groups contributed. The changes also reflect labor force participation that differ by educational status, as well as by men and women. For those without a BA, the employment to population ratio for men has been falling, albeit with cyclical interruptions, since 1980, while for women, the ratio rose until 2000, and fell thereafter. For men and women with a BA, the patterns are similar, but the increases and decreases are much smaller. As a result, differential participation rates contribute to widening the gap until around 2010. In the recovery from the pandemic, these patterns have changed, with better outcomes for low-skilled workers, but it is too early to tell whether the long-term pattern has changed.

We have not attempted to adjust the gaps for taxes paid—these are pre-tax incomes, though they include benefits such as unemployment compensation, workers compensation, supplemental security income, and public assistance or welfare payments. Nor do we adjust for any increase in quality that is missed in the CPI, let alone for possible differentials in the rates of quality improvement between groups. We do not include employer contributions to health insurance as income, though we note that those are not very different for less- and more-educated workers, though there are presumably differences by employment. Given that those with a BA are more likely to have such coverage, incorporating such contributions would increase the gap. We do not attempt to put a value on coverage, nor to subtract out the part of costs that is due to healthcare industry rents. Nor, finally, do we add in the value of Medicaid and Medicare as some have argued for, Burkhauser and others (2023). Corrections of this kind, if indeed they can be justified as corrections, would have uncertain effects on the gap, although they would undo some of the stagnation of real incomes among families without a BA.

Wealth data from the Survey of Consumer Finances can be used to study differences by education. In particular, the infographic on their website shows that, taking all components of household wealth together, the total in 1990, Q1 was $20.91 trillion, rising to $140.56 trillion by 2023, Q2. In 1990, the fraction owned by those without a college degree was 49 percent, a fraction that had fallen to 27 percent by 2023, so that those with a college degree had moved from owning half of wealth to nearly three-quarters over this period. A good deal of this change is accounted for by the rising share of households with at least one member with a college degree. There were 26 million households where a member had a college degree in 1990, but 59 million in 2022. By contrast, the number of households with no BA was almost unchanged, rising from 68 million to 69 million.

Figure 14 shows the evolution of real wealth per household in 2012 prices with and without a college-educated member, as well as the gap between them, which has risen from $481k in 1990 to $852k in 2022. The ratio of per household wealth for households with and without a BA has no secular trend but has varied between 2.4 and 3.4 between 1990 and 2022.

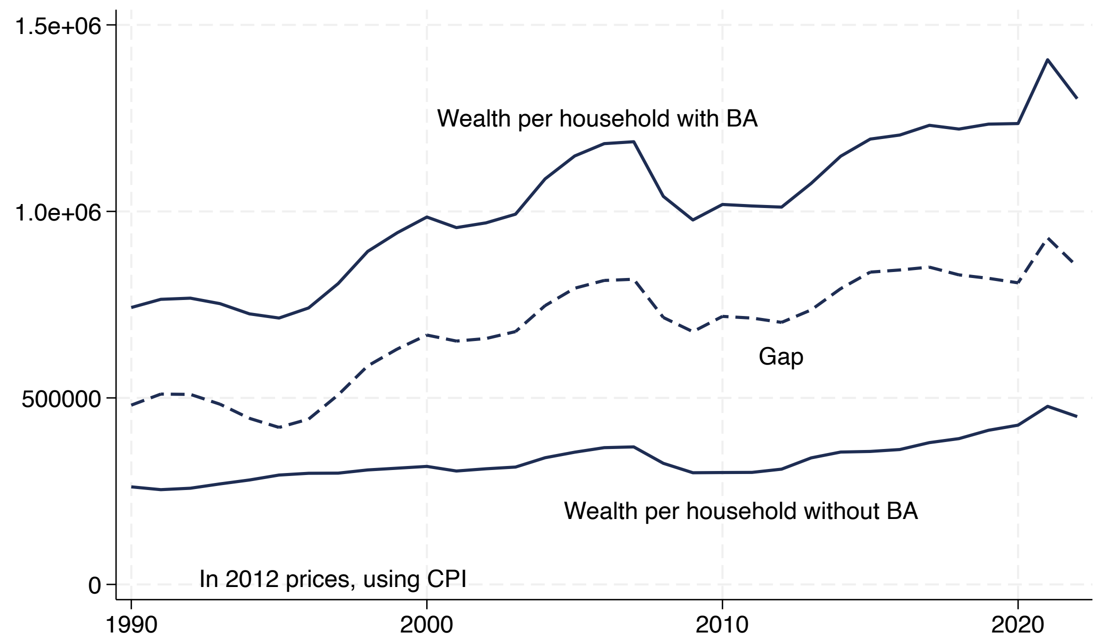

Figure 14: Real wealth per household, 1990 to 2022

If we calculate the ratio on a per person basis, using persons aged 25 and above, the ratio is higher because households with a BA member are smaller. This ratio also does not trend from 1990 to 2022, varying between 3.5 and 4.5. It is of interest to contrast this with the ratio for white to black per capita wealth, which has varied around 6 since 1860, Derenoncourt and others (2021).

VII. Mortality and Wellbeing: Discussion

The results in this paper, on how people live and on how they die should be seen in two different ways. The first is the documentation that the gaps between those with and without a college degree are not confined to one dimension of wellbeing such as the mortality rates with which we began but are pervasive across aspect of life that are important to people. Wherever we look, one group is doing better than the other; sometimes the college educated are doing well, and the non-college educated are losing ground and sometimes, both are seeing progress, but the better educated are seeing more.

The other way to look at the results is to use them to think about accounts of what is happening, about the why as well as the what. In our book on deaths of despair, we suggest several mechanisms—the effects of globalization and automation without a European-style safety net, and with an employer-based health insurance system that destroys good jobs, widens inequality, and lowers wages for less-skilled workers. Other rich countries do not finance healthcare in this way. We and others have documented an increase in corporate power relative to workers, the decline of unions, the spread of monopsony, and the decreased mobility of workers from less to more successful places. We also note again the evidence on some state legislatures passing business-written laws that harm workers.

Finally, we hazard our own guess on the role of the four-year college degree. We have increasingly come to believe that it works through often arbitrary assignation of status, so that jobs are allocated, not by matching necessary or useful skills, but by the use of the BA as screen. We are encouraged by efforts by both public and private employers to remedy this; it is a low-cost policy that could have large benefits.

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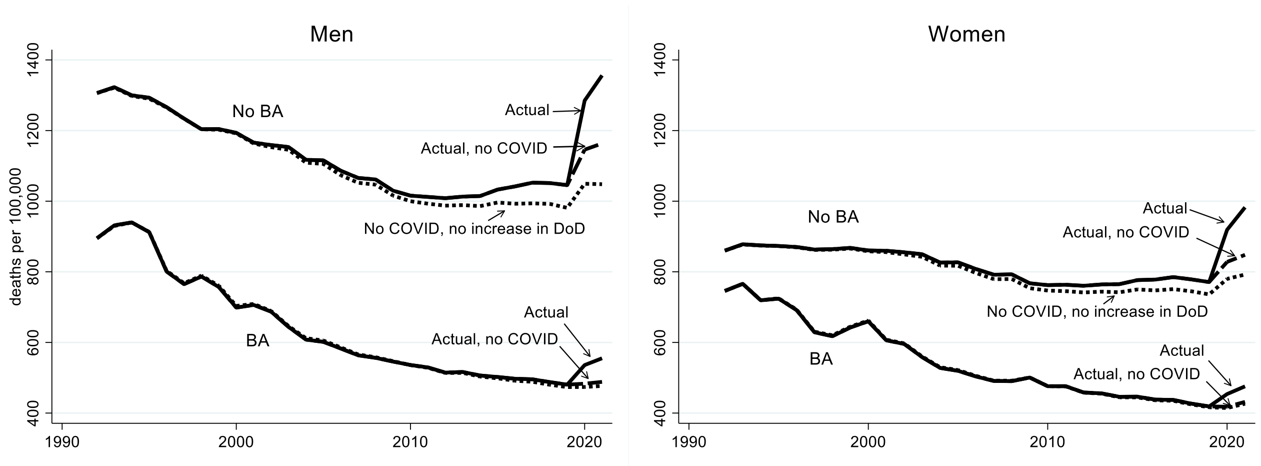
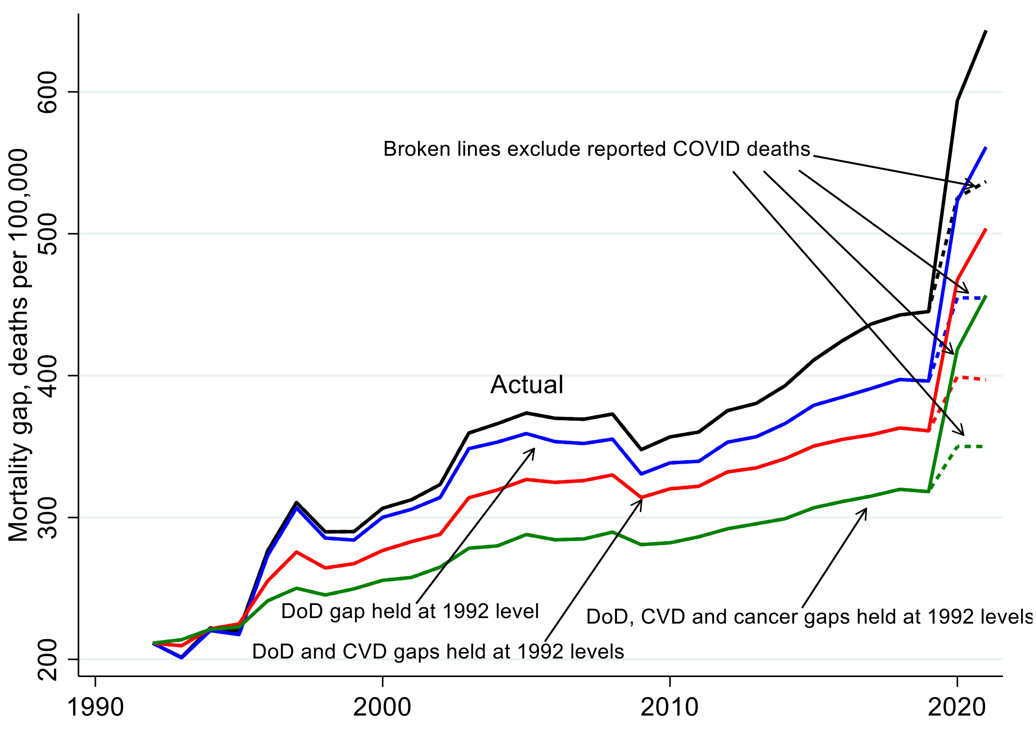
Supplementary appendix

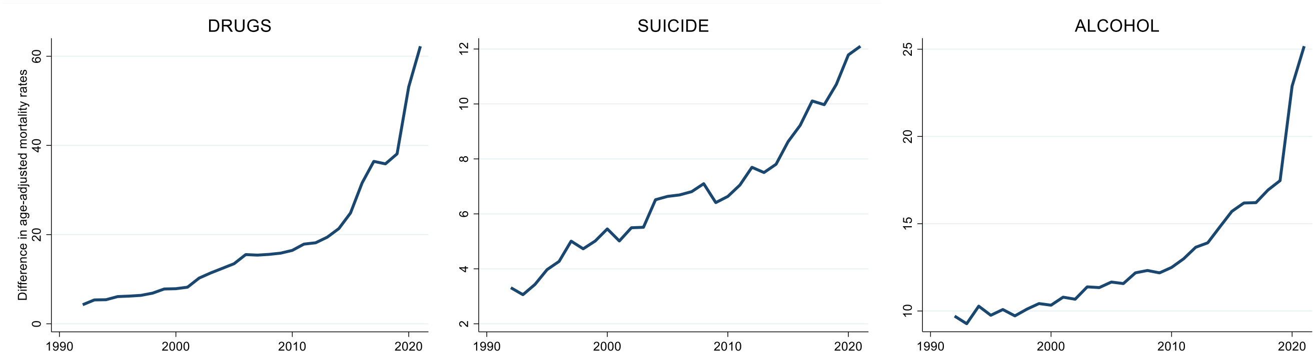
Supplementary Figure 1.
Age-adjusted 25-84 mortality rates, with and without COVID-19 and deaths of despair



Supplementary Figure 2.
Age-adjusted 25-84 mortality gaps between those without and with a BA

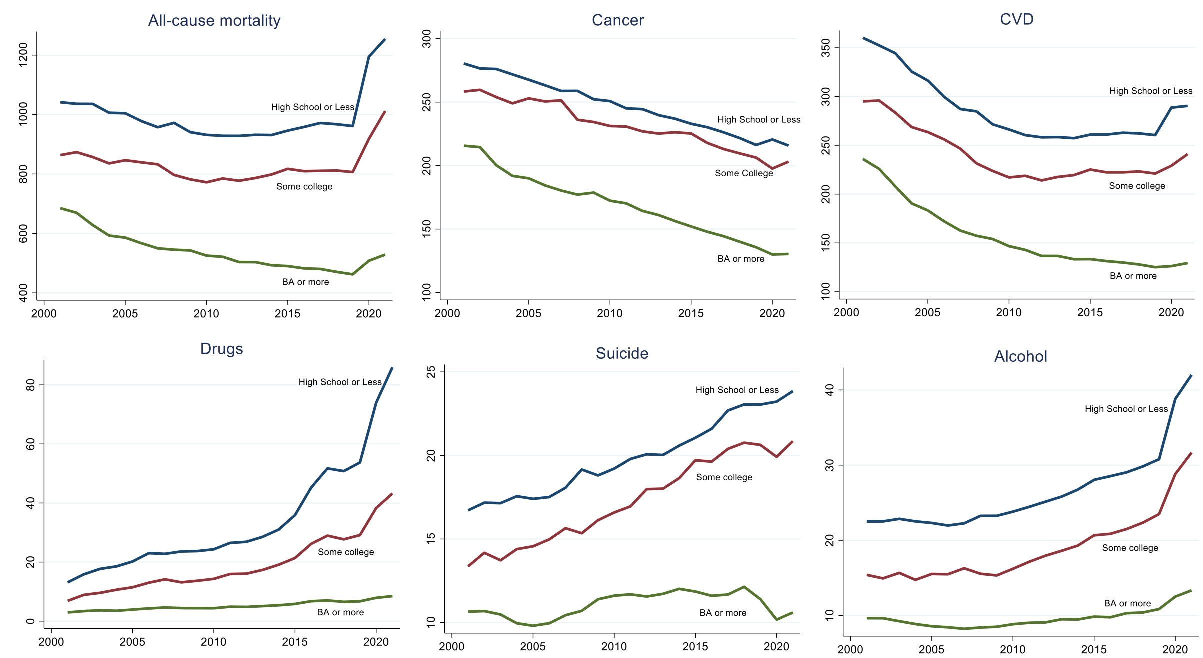


Supplementary Figure 3.
Age-adjusted 25-84 mortality gaps between those without and with a BA



Supplementary Figure 4.

Mortality by cause for three education groups: High School or Less, Some College, and BA



Supplemental Figure 5.
Marriage rates by education and year