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MORTALITY RATES BY COLLEGE DEGREE BEFORE AND DURING COVID-19

Anne Case
Angus Deaton

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ABSTRACT

It is now established that mortality and excess mortality from COVID-19 differed across racial and ethnic groups in 2020. Less is known about educational differences in mortality during the pandemic. We examine mortality rates by BA status within sex, age, and race/ethnic groups comparing 2020 with 2019. Mortality rates have increasingly differed by BA status in the US in recent years and there are good reasons to expect the gap to have widened further during the pandemic. Using publicly available provisional data from the National Center for Health Statistics we find that mortality rates increased in 2020 over 2019 for those with and without a BA, irrespective of age, sex, or race/ethnicity. Although mortality rates increased by more for those without a BA, the ratio of mortality rates for those with and without a BA changed surprisingly little from 2019 to 2020. The BA was protective against mortality prior to the pandemic, and it was equally protective during the pandemic. Among 60 groups (sex by race/ ethnicity by age) that are available in the data, the ratio of mortality rates of those without a BA to those with a BA fell for more than half of the groups. Our results suggest that differences in the risk of infection were less important in structuring mortality by education than differences in the risk of death conditional on infection.

Anne Case
School of Public and International Affairs
129 Julis Romo Rabinowitz Building
Princeton University
Princeton, NJ 08544
and NBER
accase@princeton.edu

Angus Deaton
School of Public and International Affairs
127 Julis Romo Rabinowitz Building
Princeton University
Princeton, NJ 08544-1013
and NBER
deaton@princeton.edu

1. Introduction

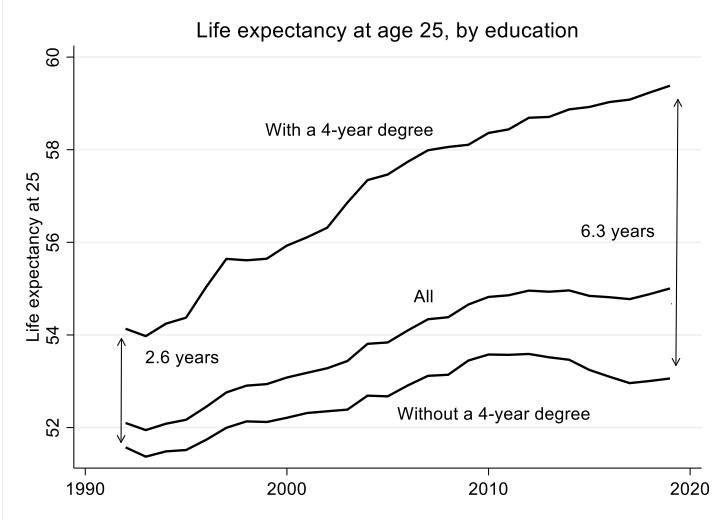

Figure 1: Adult life expectancy by BA status, 1992 to 2019

The mortality experience of Americans has increasingly differed according to whether they have a four-year college degree. By 2019, the gap in life expectancy at age 25 between those with and without a BA had risen to a high of 6.3 years, as shown in Figure 1.[1] Although adult life expectancy ticked up for those without a BA between 2018 and 2019, after having fallen for most of a decade, the education gap in adult life expectancy between those with and without a BA continued to widen, by a further 0.12 years. Similar widening gaps are seen for men and women separately, and for white and Black non-Hispanics separately, Case and Deaton (2021a), Montez, Hayward, and Zajacova (2021).

It would be surprising if the COVID pandemic did not further widen the gap in Figure 1. The virus was far from an equal opportunity killer, and in 2020 there were sharply different mortality rates by age and by race/ethnicity, CDC (2021a), Andrasfay and Goldman (2021a, b) Woolf et al (2021), Alsan, Chandra and Kosali (2021), Chan, Cheng, and Martin (2021). These mortality differences are plausibly linked to occupation, and to living and transportation patterns that also divide those with more and less education.

In this paper we focus on the comparisons of mortality rates for those with and without a BA degree during 2020 compared with 2019 and earlier years. We examine both differences in

[1]Figure 1 is updated to 2019 from Case and Deaton (2021a) who followed earlier calculations using death certificate data by Meara, Richards, and Cutler (2008), Olshansky et al (2012), Sasson (2016a, b) and Sasson and Hayward (2019). Similar patterns are found using follow-up mortality supplements to the National Health Interview Survey by Montez, Hummer, Hayward, Woo, and Rogers (2011).

mortality rates and ratios of mortality rates; these are both measures of the growing divide in a range of health, economic and social outcomes between those with and without a college degree, Case and Deaton (2021). For adults ages 25 to 64, the age-adjusted mortality rate for those without a BA was half-again as large as that for Americans with a BA in the early 1990s, but had grown to three times as large by 2019.

A fatal infectious disease could, in principle, narrow educational differences in mortality if everyone were to have an equal chance of being infected and of dying. But both infection risk for COVID-19 and the risk of dying conditional on infection differ by education. Many highly educated people were and are able to work safely from home, while those who worked as frontline workers, in retail, services, transportation, warehousing, or meatpacking ran the risk of infection. Blau et al (2020) find that "frontline workers are disproportionately comprised of less educated and disadvantaged minority workers, especially Hispanics, and immigrants, and earn below average wages, with a substantial share of workers in the bottom wage quartile. These workers, even healthcare workers, now face much higher risks than traditionally incurred in these occupations." Daly et al (2020) note "education is a common thread contributing to large differences in the severity of the virus's impact across individuals." That excess mortality was indeed higher in frontline occupations is documented for California by Chen YH et al (2021). Less-educated Americans are also more likely to have low incomes and to live in more crowded or inferior housing and are less likely to be able to avoid contact with others. The probability of death, conditional on infection, is influenced by a range of pre-existing conditions as well as by the quality and availability of healthcare, factors that are themselves structured by education.

We find that the BA was strongly protective against mortality during 2020. In all the race/ethnicity and age groups we examine, mortality rates rose from 2019 to 2020, and rose by more for those without a BA. That said, the ratio of mortality rates for those without to those with a

degree was little changed relative to pre-pandemic years; an exception to this pattern is for Hispanic women, for whom we find a small increase in the ratio. Even so, among the 60 groups (race/ethnicity by sex by age) that are available in the data, the ratio of mortality rates of those without a BA to those with a BA *fell* for more than half of the groups between 2019 and 2020. In relative terms, the protective effect of the BA against all-cause mortality was little different in 2020 than in 2019 and earlier, despite changes in the pattern of risk by education, occupation and income. These proportional to pre-existing mortality ratios patterns were also true for age,[2] but sharply different from the patterns by race/ethnicity and by sex, where pre-pandemic relative mortality rates changed dramatically.

Our paper adds to a small literature on deaths by education during the pandemic. Evidence on California between March and October 2020 is given by Chen YH et al (2020), and by Chen JT et al (2021) for the US for 2020, focusing on interactions between education and race/ethnicity, but using early data without information on age and sex.

2. Data and methods

We use publicly available data provided by the Centers for Disease Control and Prevention (2021b) on deaths from COVID-19 in 2020 and deaths from all causes in 2019 and 2020 aggregated by race/ethnicity, by broad age-groups, by sex, by educational level and by year. We combine the categories below BA (High School or less and some college) into a non-BA category, and attribute education to deaths with unknown education (2%) so as to maintain the fractions with a BA in each age, sex, and race/ethnicity category. We work with six ethnic/racial groups, Hispanics, non-Hispanic Whites (NHW), non-Hispanic Blacks (NHB), non-Hispanic Asians (NHAsian, including non-Hispanic Hawaiian Natives and other Pacific Islanders), non-Hispanic American Indians and

[2] See Goldstein and Lee, 2020, and Sasson, 2021.

Alaskan Natives (NHAIAN) and those who report two or more races (NHMany); we drop the unknown (other) category. We exclude those aged 24 or younger—for whom the BA distinction is not meaningful—leaving age groups 25–39, 40–54, 55–64, 65–74, and 75 plus. There are 60 race/ethnicity by sex by age (6x2x5) groups in all. For most presentations, we work with two aggregated age groups, 25–64, and 65 plus. For deaths from 2010-2018, we use NVSS Mortality Multiple Cause of Death Files from the Vital Statistics Online Data Portal (2021).

Population counts for 2005 to 2019 by BA/non-BA are taken from the American Community Survey via IPUMS USA database, Ruggles et al (2021). Population counts by ethnicity, race, sex, and age for 2020 are taken from the Census monthly population counts, United States Census Bureau (2021). The US population is aging rapidly, and for some groups aged 65 and older, including NHAsians and Hispanics, there were substantial population increases, around 6 percent, between 2019 and 2020, see also Shiels et al (2020) for the effects on early estimates of excess mortality. The fractions with and without a BA were taken to be the same in 2020 as in 2019.[3]

We analyze the difference in mortality rates by BA status between 2020 and 2019. This difference is of interest in and of itself, and corresponds to calculations of the change in life expectancy from 2019-2020 by Andrasfay and Goldman (2021a,b), Woolf et al (2021) and Chan, Cheng, and Martin (2021). Many earlier studies have analyzed *excess* mortality during the epidemic, comparing actual deaths with those expected, the latter estimated from models using data from earlier years or months. There is no uncontroversial way of forecasting mortality; for example, accidental drug overdoses were rising before the pandemic, and rose more rapidly during it, which may or may not have been caused by the pandemic. Moreover, we would need forecasts for all population groups, including small but important groups, such as NHAIAN; examination of the

[3] An earlier version of this paper used 2019 population estimates unchanged for 2020. Mortality rates for elderly groups are higher without the adjustment, but the effects of education are qualitatively unchanged.

data show that such forecasts are difficult with small population sizes. Comparisons of mortality in 2020 and 2019 are straightforward and transparent. The Centers for Disease Control and Prevention (CDC) estimate that over the period from late January 2020 to late February 2021, approximately 75%-88% of excess deaths were directly related to COVID-19, Rossen et al (2021), though the fraction is different for different racial and ethnic groups and for different age groups, Luck, Preston, Elo, and Stokes (2021). If we were to interpret the increase from 2019 to 2020 as a measure of excess mortality, we would have a ratio of excess to reported COVID-19 mortality of 1.28 from March to December 2020, consistent with the CDC range and with previous estimates for the year, Woolf et al (2021), Chan, Chen, and Martin (2021).

3. Education and mortality rates before COVID

The fractions of the adult population with a BA vary greatly by age, sex, and race/ethnicity. Figure 2 shows the percent of each sub-population with a BA degree in 2019 for two broad age groups (25-64, and 65 and above). Black bars denote men; gray bars, women. Overall, a third of adults in the US

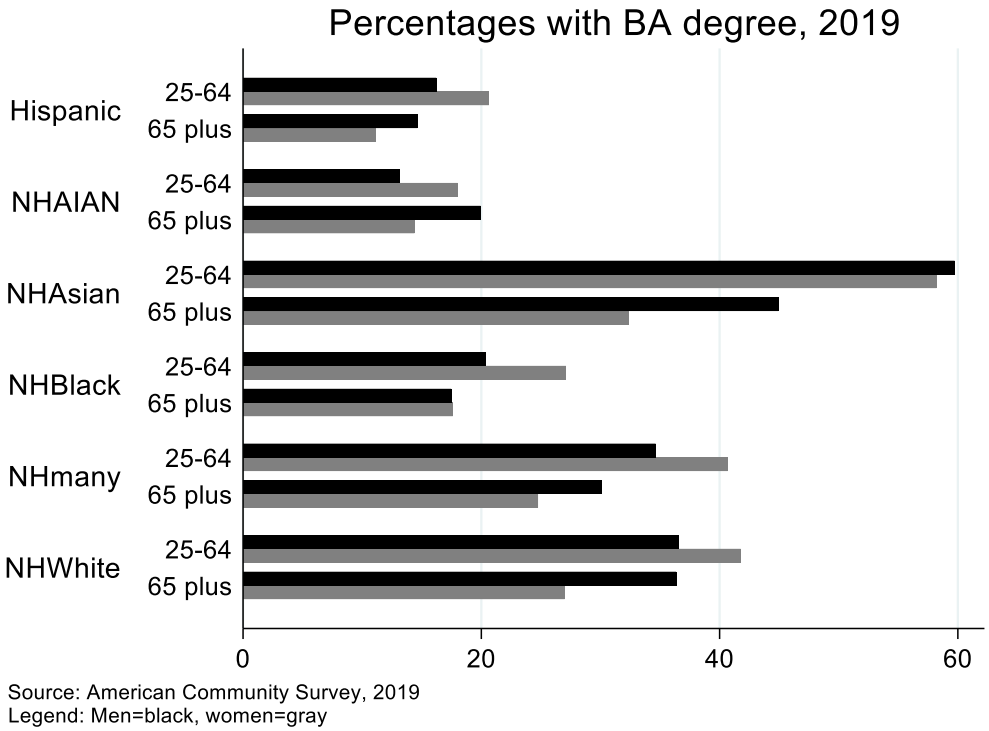

Figure 2: Percentages with a BA degree in 2019, by race/ethnicity, age, and sex

have a four-year degree. Educational attainment has increased over time, so that, except for NHAIAN men, rates are higher for the young. Rates are highest (60 percent) for younger NHAsians, followed by NHW and NHMany and are lowest among NHB, Hispanics, and NHAIAN. It is important to bear in mind that populations in some of these groups are much smaller than others, and some are absolutely small. For example, in the 65 and over group, there are only 45,478 NHAIANs with a BA, and only 123,427 who declare themselves non-Hispanic many race.

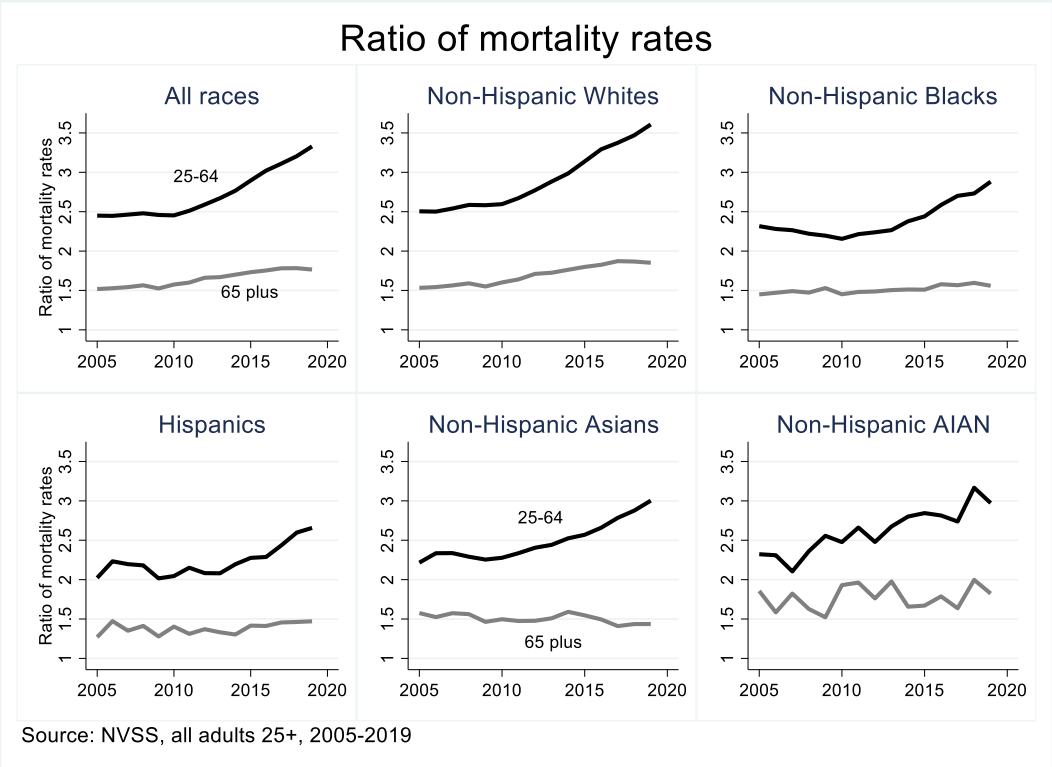

Figure 3: Ratio of mortality rates of those without a BA relative to those with a BA, by race/ethnicity and age group, 2005 to 2019

Figure 3 shows how mortality rates varied with the BA degree by race/ethnicity and age in the years before the pandemic. For each race/ethnicity, with men and women pooled, we show the ratio of the mortality rates of those without to those with a BA from 2005 to 2019; we use the two broad age groups, ages 25-64 and 65 and above, but do not adjust for age within the two age categories. The top (black) lines are for ages 25–64, and the bottom (gray) lines for ages 65 and above.

The mortality ratios are all bigger than one, and for the younger age group are everywhere larger than two; since at least the early 1990s the all-cause mortality rate in midlife for those without a BA has been more than twice that of those with a degree. That they are higher for young than old is to be expected; the association with education is largely for preventable deaths, which become relatively less important with age while, at older ages, selection acts to diminish the effect of a

covariate on the hazard of death. The upsurge in deaths of despair, which began in the mid-1990s, and which largely affected those without a BA, has had little effect on the elderly. For ages 25–64, the mortality ratio has risen over time, particularly since 2010; for most groups the ratio has also risen among those 65 and over. A ratio of 3 would imply that the BA provides 67% protection against death, where *protection*—as for a vaccine—is measured by one minus the ratio of the mortality rates of the "treated" relative to the "untreated" group where here the "treatment" is not a vaccine but a four-year college degree. (The variability in the bottom right panel reflects the small population of NHAIANs.) A version of Figure 3 (not shown) with five age groups shows similar patterns.

4. Mortality changes from 2019 to 2020

Figure 4 shows patterns of mortality rate *increase* (deaths per 100,000) between 2019 and 2020; these are the *absolute* changes in mortality rates between the two years. We separate by broad age groups, by sex, BA status, and the six races/ethnicities. The figure replicates the now-standard finding that Hispanic, NHBlack and, especially, NHAIAN Americans have suffered disproportionate mortality increases during 2020, with NHWhite, NHMany, and NHAsian Americans affected the least, though every group experienced an increase in mortality.

For each of the 24 groups by age, sex and race/ethnicity, the increase in mortality was larger for those without a BA than for those with a BA. The degree of protection afforded by the BA varies across the groups, but was particularly strong for NHAIAN, NHBlacks, and Hispanics. Comparing the difference in mortality increases in Figure 4 between those without and with a BA as a percentage of the baseline mortality of those without a BA, what we have called "protection" above, we find that for those aged 25 to 64 the BA is 70 percent effective against the increase in mortality. For those aged 65 and older, the protection is more limited, 26 percent. We have also calculated the protection against only those deaths in 2020 recorded as COVID-19 deaths. For these

deaths, the BA was 65 percent protective for adults aged 25 to 64, and 41 percent for those aged 65 and above. Of course, there is no experiment here, but thinking of a BA as a "treatment" and the lack of one as a "control" provides a convenient way to describe education differences in all-cause and COVID mortality.

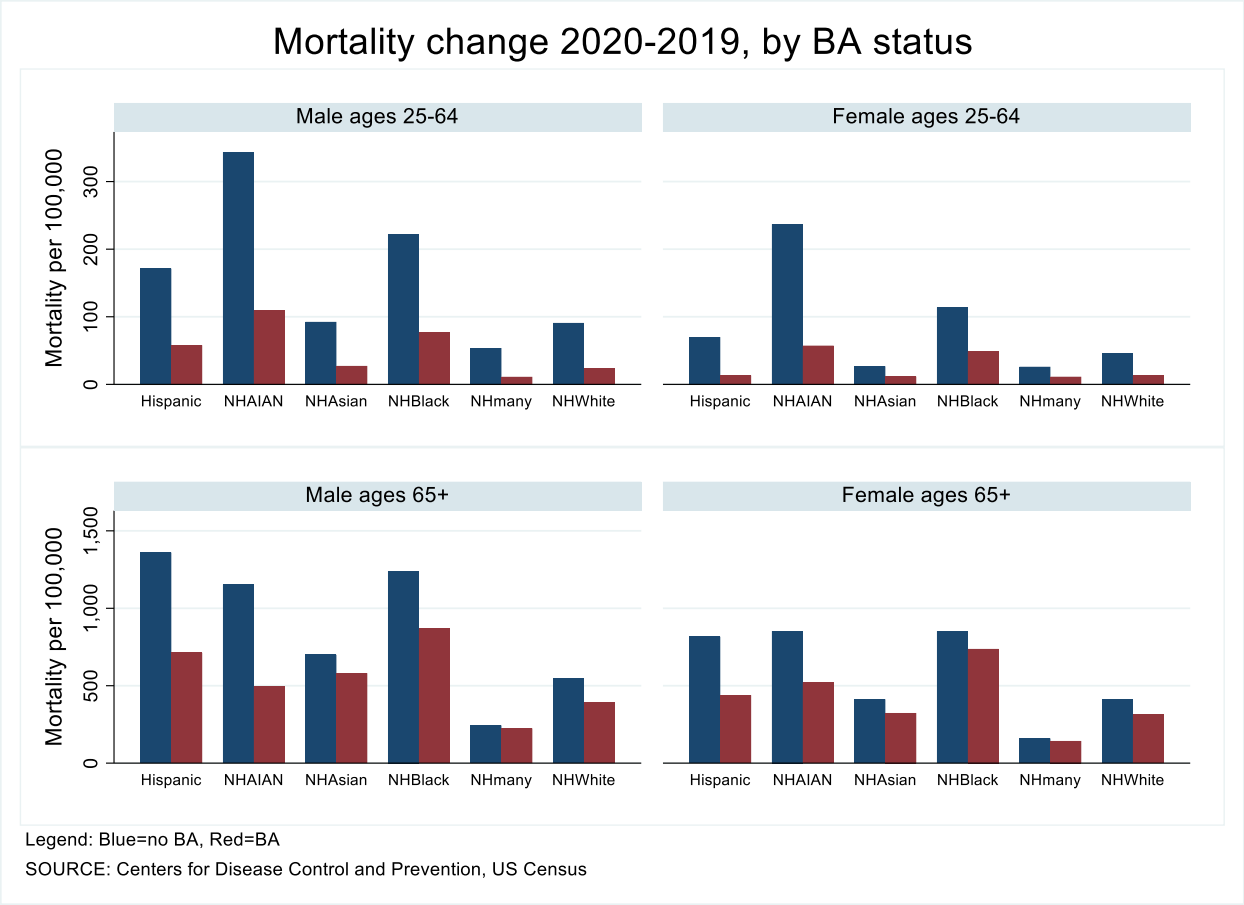

Figure 4: Changes in mortality rates per 100,000 from 2019 to 2020, by sex, age, and race/ethnicity

Figure 5 moves from increases in absolute risk to increases in *relative* risk, and the patterns are now quite different. For each of the 48 groups shown, we show the *ratio* of the increase in the mortality rate from 2019 to 2020 to their mortality rate in 2019. For the whole population, the ratio was 0.17; within the groups, it ranges from a high of 0.52 for younger Hispanic men without a BA to a low of 0.09 for younger adult NHW women irrespective of BA status. The racial/ethnic patterns

single out Hispanics as having seen the largest increase in relative risk, not NHAIAN, whose large increase in mortality is now compared to their long-standing high mortality rate. The low relative risk of the WNH community is notable.

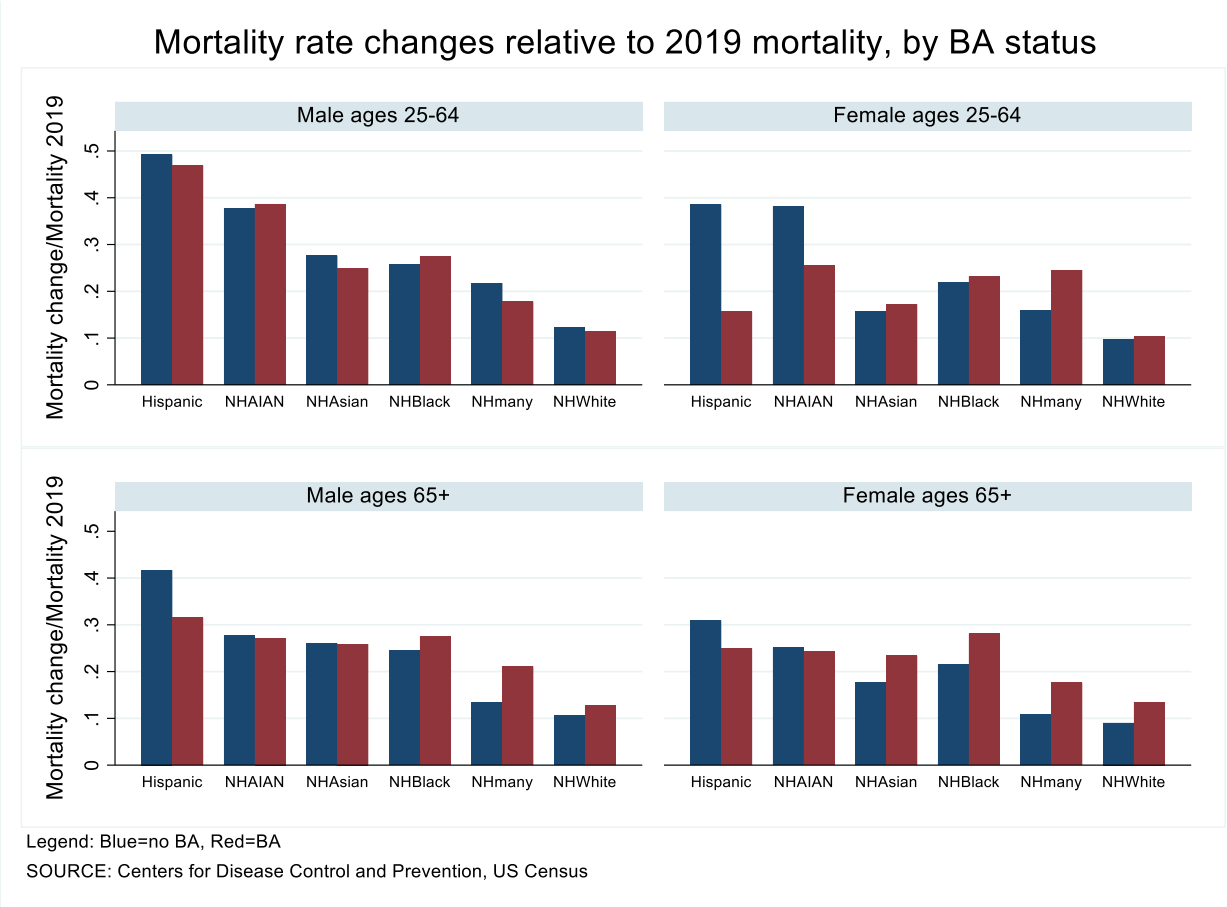

Figure 5: Changes in mortality rates from 2019 to 2020 relative to 2019 mortality rates

The most startling result in Figure 5 is the muted effects of having a BA on *relative* risk compared with the effects on *absolute* risk in Figure 4. For Hispanic and NHAIAN adult women, the relative risk is lower for those with a BA, as is true among older Hispanic men. But, for the large majority of groups, the relative risk was little different between those with and without a BA. Luck et al (2021) find that Hispanics had a higher fraction of excess deaths attributable to COVID-19 than did either WNH or BNH. These findings might help explain why the expected pattern appears among Hispanics, though it does not fully explain its absence among the other groups.

Figure 6 shows results for all five age groups in the underlying data, offering a check that the results are not contaminated by over-aggregation by age. The scatterplot shows the ratio of mortality rates for non-BA to BA in 2020 on the vertical axis versus the same ratio in 2019. The solid line is the 45-degree line. In both years, the ratio is larger for younger age groups and diminishes with age. Beyond that, we see once again that, with the exceptions—younger Hispanic women—discussed in the context of Figure 5, the mortality ratios associated with a BA were very little changed by the pandemic that, in other respects, did not treat other groups equally. There are 60 points in the figure; 32 are *below* the 45-degree line—so that the mortality rate for those without a BA was lower relative to the mortality rate for those with the BA during the pandemic than before it.

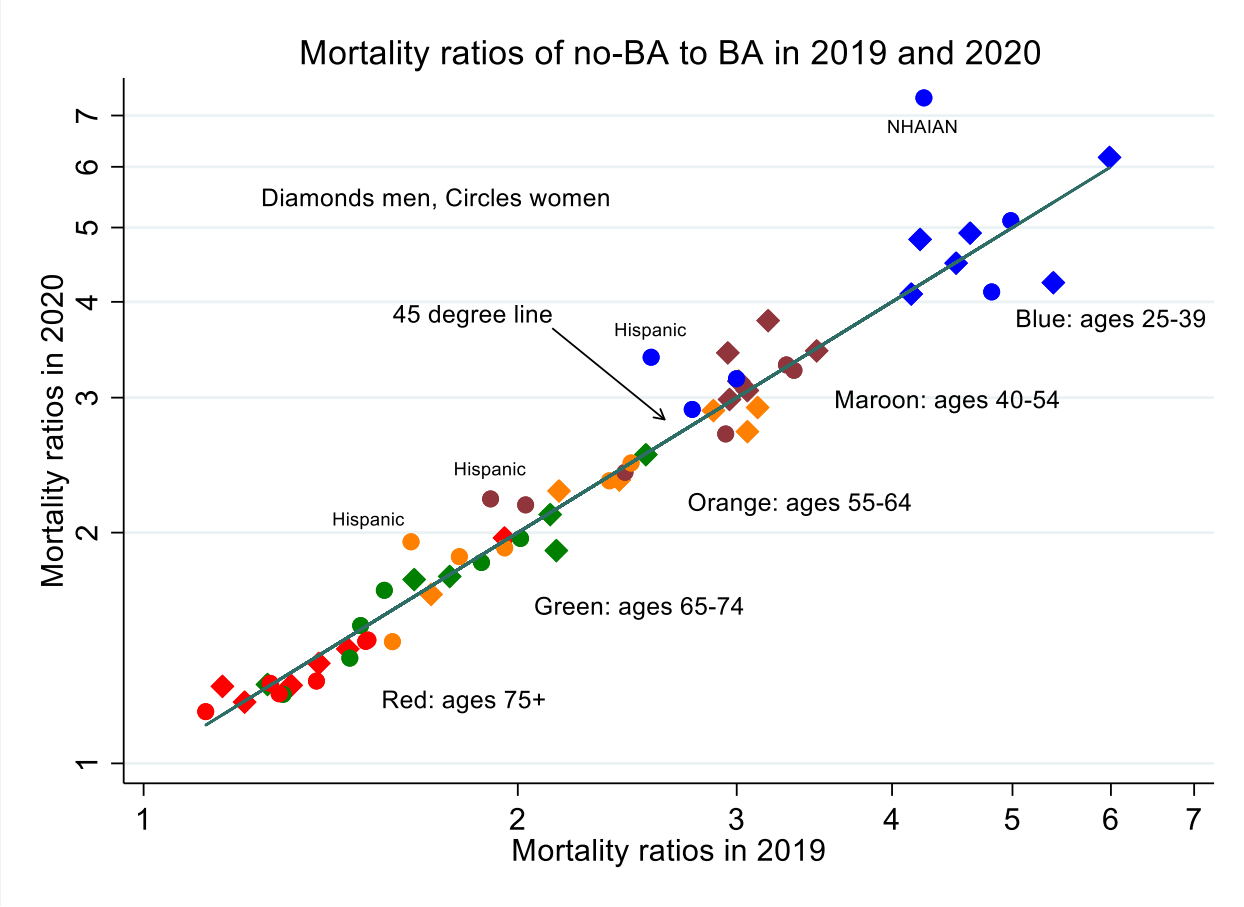

Figure 6: Mortality ratios of those without to those with a BA in 2020 compared with 2019

The largest increases in the mortality rate ratio is among the small population group of female NHAIANs aged 25-39 (population 187,000 of which 42,000 have a BA), and for female Hispanics aged 55-64 and aged 25-39.

5. Discussion and conclusions

It is easy to understand why those with a BA degree saw a smaller rise in mortality during the pandemic, and why the BA advantage should be smaller for those aged 65 and above who are largely not in the labor force—though many live with people who are. People with and without the degree work in different occupations with different risks of infection. Those with a BA were more than twice as likely to be able to telework (65 versus 30 percent) and were twice as likely to be in a low-contact occupation (40 versus 20 percent) compared to those without, Daly et al (2020). Few frontline workers have a BA, and frontline workers were more likely to die, Chen YH et al (2021). Sixteen percent of workers in grocery, convenience, and drug stores had a BA, 15 percent in public transit, 10 percent in trucking, warehouse, and postal service, and 9 percent in building cleaning services, occupations that are also structured by race/ethnicity and gender, Rho et al (2020). One "protective" factor for those without a BA was that many of those in high contact occupations, like entertainment, hospitality, and food services, lost their jobs during the pandemic, and were involuntarily protected.

An exception to frontline workers being disproportionately drawn from the ranks of the less educated is health care, where more than 40 percent of workers have a BA or more. Healthcare workers were three times more likely to die than all workers. Even so, in the first year of the pandemic, more than two-thirds of healthcare workers who died were people of color, and "(l)ow paid workers who handled everyday patient care, including nurses, support staff and nursing home employees, were far more likely to die in the pandemic than physicians were," Kaiser Health

Network (2021). These COVID risks for frontline workers were new in 2020, and were not simply increases in pre-existing risks.

Irrespective of occupation, less-educated Americans have lower incomes, which increases the risk of infection, for example through crowded lower-quality housing where social distancing is more difficult. Intrahousehold infection was important, Lee et al (2020). Our own calculations from the American Community Survey show that NHW and NHB household sizes do not vary by BA status, but for Hispanics and other NH groups, adults with a BA live in smaller households on average. Long-standing patterns of racial and ethnic segregation affect who lives where, the quality of local medical care, Bach et al (2004), and who rides on public transit, which likely caused many infections, particularly early in the pandemic in New York, Harris (2020), Kissler et al (2020), Sy et al (2021). Education was also related to compliance with public health recommendations in 2020, Weiss and Paasche-Orlow (2020).

The mystery is not why the BA was protective during the pandemic, but why the effect was proportionately as large *before* the pandemic. Despite a large literature, we do not fully understand the links between education and health prior to the pandemic, nor why the protective effect of a BA has been rising in the US in recent years, which makes it hard to know what to expect from the pandemic. That education is associated with better health has been documented in many countries at many times. There are plausible mechanisms with causality running from education to health behaviors and health, from health—especially childhood health—to education, and mechanisms in which third factors influence both, Cutler and Lleras-Muney (2006). The college wage premium—the percent by which wages of those with a four-year degree exceed those with a high school diploma—has doubled since 1980, from 40 percent to 80 percent, James (2012), paralleling the rise in the mortality premium in Figure 3. As documented elsewhere, Case and Deaton (2020, 2021b), the epidemic of deaths of despair is having ever larger effects on later-born birth cohorts and is

much less serious among those with a four-year degree. Case and Deaton (2020) argue that the fifty-year long dysfunction of the American labor market for less-educated Americans has undercut the pillars of a successful life, weakening or destroying the institutions of community, marriage, and religion on which working people depend, as well as reducing their wages and their attachment to employment. Our results here suggest that the COVID-19 pandemic in 2020, far from being a break with these previous trends, is a continuation of them in a new disease environment with the fundamental inequalities persisting.

A useful procedure is to decompose the change in relative risks for those with and without a BA into the sum of the change in relative risk of dying conditional on infection and the change in relative risk of infection. The discussion above focuses on the latter. But the former depends on comorbidities—such as obesity, diabetes, alcohol use disorder, or COPD—which, prior to the pandemic, were also patterned by age, race/ethnicity and education, Pampel et al (2010).

For any given subpopulation, we can write the mortality rate *m* as the product of the probability of dying, conditional on infection, i.e. the infection fatality rate (IFR), multiplied by the probability of infection p. In logarithmic terms

$$\log m = \log(IFR) + \log(p) \tag{1}$$

For two groups, 1 and 0, say those with and without the BA degree, we then have

$$log\frac{m_0}{m_1} = log\frac{IFR_0}{IFR_1} + log\frac{p_0}{p_1} \tag{2}$$

The discussion above supports the expectation that the second term on the right-hand side of (2) should have risen from 2019 to 2020 while our results show that, for most groups, the left-hand side of (2) did not change. We note again that many less-educated Americans lost their high-contact jobs during the pandemic, which would have moderated, although not eliminated, the expected increase in the probability of infection. It is possible that risk factors—age, comorbidities, or lack of

education—generated the same relative risk prior to and after COVID, which would be the case if COVID simply scaled up pre-existing risks. Given that the relative mortality rates changed little between the two years, equation (2) implies that the second term on the right-hand side is small or is less important than expected. Luck et al (2021) argue that the opposite is true for changes in mortality by race and ethnicity, and that differences in infection risk—the second term on the right-hand side of (2)—are likely to bear the largest share of blame for the changes in racial patterns of mortality. We again note their finding (confirmed in our data) that among non-Hispanic whites and Blacks under 65, the fraction of the increase in mortality accounted for by COVID-19 was substantially lower than was the case for Hispanics. For non-COVID deaths only the first term in (2) is relevant.

We conclude by noting a number of weaknesses in this study. The data are provisional and depend on correct identification of race/ethnicity on death certificates. Racial/ethnic classification at death may differ from self-reported classifications in the American Community Survey. This is particularly problematic for AIAN, Arias et al (2016). Education may be incorrectly recorded, although the BA/non-BA distinction on death certificates is likely more accurate than that for high-school completion, Rostron et al (2010). Our results compare 2020 with 2019 and may not apply in other settings. We are not estimating parameters but documenting a puzzle using notionally (if provisional) complete counts of deaths, so that, apart from the population estimates that are used as denominators in calculating mortality rates, they are not subject to standard errors or, more precisely, have standard errors of zero in the appropriate finite population calculation.

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