US racial inequality may be as deadly as COVID-19

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The COVID-19 pandemic is causing a catastrophic increase in US mortality. How does the scale of this pandemic compare to another US catastrophe: racial inequality? Using demographic models, I estimate how many excess White deaths would raise US White mortality to the best-ever (lowest) US Black level under alternative, plausible assumptions about the age patterning of excess mortality in 2020. I find that 400,000 excess White deaths would be needed to equal the best mortality ever recorded among Blacks. For White mortality in 2020 to reach levels that Blacks experience outside of pandemics, current COVID-19 mortality levels would need to increase by a factor of nearly 6. Moreover, White life expectancy in 2020 will remain higher than Black life expectancy has ever been unless nearly 700,000 excess White deaths occur. Even amid COVID-19, US White mortality is likely to be less than what US Blacks have experienced every year. I argue that, if Black disadvantage operates every year on the scale of Whites' experience of COVID-19, then so too should the tools we deploy to fight it. Our imagination should not be limited by how accustomed the United States is to profound racial inequality.

racial inequality | mortality | COVID-19

The COVID-19 pandemic is likely to kill people in the United States on a scale not seen in a century, since the 1918 flu. That catastrophic flu killed tens of millions worldwide and over half a million in the United States. Yet mortality levels that, for White Americans, were unprecedented nevertheless were lower than mortality for US Blacks in any given (nonpandemic) year. Past research has shown that the infectious mortality experienced by urban Whites in 1918 was lower than the infectious mortality of urban nonwhites in every documented year through 1920 (1). Fig. 1 shows that a similar pattern pertains to Whites' and Blacks' age-adjusted total mortality and life expectancy. Whites' life expectancy in 1918 was far lower than in other twentieth century years—yet higher than Black life expectancy in all years but one between 1900 and 1918. Similarly, Whites' age-adjusted mortality in 1918 was lower than Black mortality in all years but one from 1900 to 1931. By all major mortality measures—infectious mortality, total mortality, and life expectancy—in the early decades of the twentieth century, Blacks in the United States experienced a scale of death comparable to Whites' experience of the 1918 flu every year.

A century later, stark inequalities in survival persist. Will graphs of the early twenty-first century look like graphs of the early twentieth century, with a deadly pandemic causing a spike in mortality for Whites that nevertheless remains lower than the mortality Blacks experience routinely, outside of any pandemic? This question cannot be answered definitively until the final toll of COVID-19 is known. As a framework for answering it, I estimate how many White deaths from COVID-19 would be required for White mortality in 2020 to reach the levels of Black mortality in its best recorded year.

The results provide context for understanding the scale of racial inequality in mortality in the United States. Despite recent scholarly focus on rising White mortality (2), that racial inequality remains extreme. As Fig. 1 underscores, best-ever Black age-adjusted mortality and life expectancy are equivalent to White rates from, respectively, nearly 20 or 30 y earlier. For COVID-19 to raise mortality as much as racial inequality does, it would need to erase two to three decades of mortality progress for Whites.

Results

I used official US life tables (3) and demographic models to estimate how many additional deaths due to COVID-19 would be required for age-adjusted, non-Hispanic White mortality in 2020 to rise to the minimum recorded age-adjusted, non-Hispanic Black mortality, and, similarly, how many additional deaths would be required for non-Hispanic White mortality to fall to the highest recorded Black life expectancy. Mortality comparisons between Blacks and Whites require age standardization (4) because Whites are older than Blacks (median age 43 y vs. 33 y). The estimates also require an assumed age pattern of the excess deaths, which presumably reflect both COVID-19 directly and other pathways associated with, for example, hospital avoidance (5). I make two alternative assumptions: first, that White excess mortality is proportional over age to White all-cause mortality and, second, that White excess mortality throughout 2020 matches empirical estimates of the age patterning of COVID-19 mortality (6). This results in two alternative models for each outcome, one drawing on White COVID-19 data, and the other drawing only on pre-COVID White mortality.

These models estimate how many deaths in 2020 would raise White mortality, or lower White lifespan, to the year of the best recorded Black rates. Fig. 2 illustrates the gap between the best mortality year for Black Americans, 2014, and the most recent year with life table estimates for White Americans, 2017, which the models translate into hypothetical death counts for the White 2020 population. The lower estimates reflect the scenario in which white excess mortality in 2020 is proportional over age to White all-cause mortality in 2017; the higher numbers reflect the scenario in which White excess mortality is proportional to White COVID-19 mortality. For hypothetical White age-adjusted mortality to equal the lowest recorded Black age-adjusted mortality, about 400,000 to 420,000 excess White deaths are needed. For White life expectancy in 2020 to fall to the level of the best-recorded Black life expectancy would require an estimated 700,000 to 1 million excess White deaths.

The low-end estimate of about 400,000 excess White deaths is about 5.7 times the current confirmed COVID-19 deaths among Whites, representing an 18% increase in White mortality from prepandemic levels. For comparison, this estimate implies that, to reach the best-ever prepandemic Black mortality rates, the full US White population would need to experience a level of excess mortality comparable to 90% of the official COVID-19 death rate (for all racial groups) in New York City to date (7).

Discussion

These estimates make it plausible that, even in the COVID-19 pandemic, White mortality will remain lower than the lowest recorded Black mortality in the United States. If fewer than 400,000 excess White deaths occur in 2020, the COVID-19

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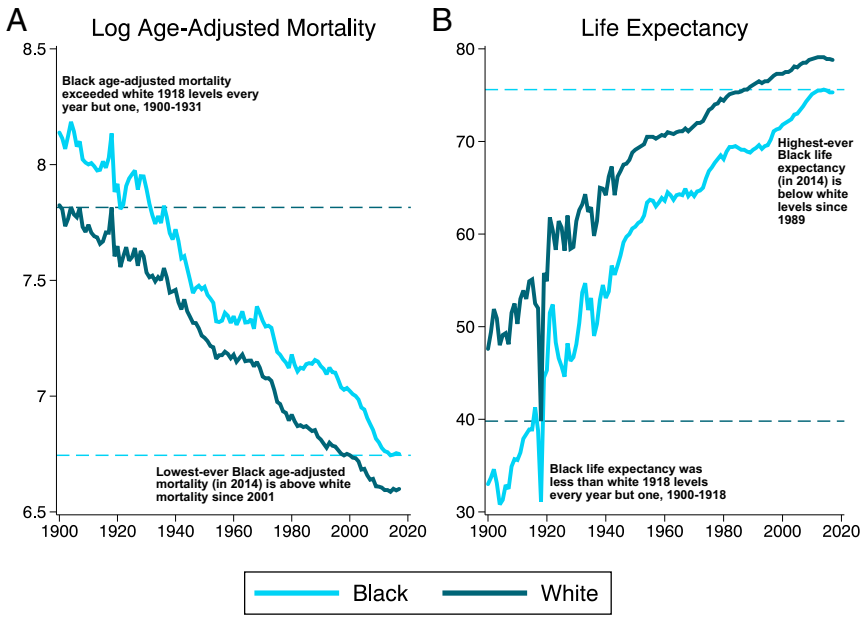

Fig. 1. US Black and White (*A*) logged deaths per 100,000 and (*B*) life expectancy, 1900–2017.

pandemic for Whites will be less consequential to overall White mortality than racial inequality is for Black mortality every year. And unless 2020 sees 700,000 to 1 million excess White deaths—a 31 to 46% mortality increase from recent years—life expectancy for Whites, even amid COVID-19, will remain higher than it has ever been for Blacks.

The legal and structural contexts that produce racial inequality have shifted dramatically since the early twentieth century, creating a more economically heterogeneous Black population (8). Yet, a century after the 1918 flu, the basic fact endures that Black disadvantage is on the scale of the worst pandemics in modern US history.

In reality, COVID-19 deaths themselves are highly disproportionately experienced by Black Americans and will almost certainly further widen the racial mortality gap (9). To date, age-adjusted confirmed COVID deaths are more than 2.5 times higher for Blacks than Whites. These deaths alone would increase the disparity between the most recent White and the best-ever Black age-adjusted mortality, shown in Fig. 2, by 27%. The results portrayed in Fig. 2 underscore that this extreme inequality

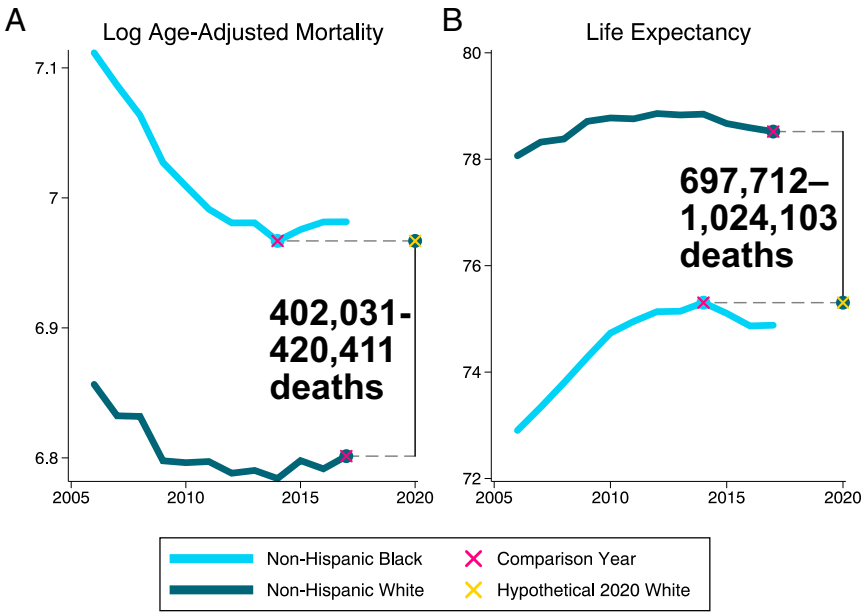

Fig. 2. Hypothetical excess White mortality that would raise White mortality, or lower White life expectancy, to best-ever Black levels. (*A*) Logged deaths per 100,000 and (*B*) life expectancy for non-Hispanic Blacks and Whites, 2006 to 2017, representing all years with official US life tables for these populations. The bolded numbers represent the number of excess White deaths in 2020 needed to raise the most recent documented White mortality to the lowest-ever Black mortality, or lower the most recent documented White life expectancy to the highest-ever Black life expectancy, respectively.

in COVID deaths is layered on top of stark disparities that have existed every year.

These estimates also pose a deeper challenge. Although specific policies are highly contested, we have radically reorganized how we live to minimize the risks associated with COVID-19, with relatively high social consensus (10) and lifesaving effects (11). Yet calls to radically reorganize social institutions in order to minimize racial disparities (12–17)—such as by providing various forms of reparations, greatly expanding and universalizing social programs, defunding the police, altering school assignment mechanisms and zoning laws to combat educational and residential segregation, and increasing wages and workplace democracy—remain highly contentious (18). These results should reframe these debates away from which transformations are politically tenable to, simply, which transformations will be effective in preventing harms associated with racism. If Black disadvantage operates every year on the scale of Whites' experience of COVID-19, then so too should the tools we deploy to fight it. Our imagination and social ambition should not be limited by how accustomed the United States is to profound racial inequality.

Materials and Methods

Historical data are from the National Center for Health Statistics (3, 19). Population denominators are from the American Community Survey, via IPUMS-USA (20), and the Census Bureau (21), and employ algorithms to allocate multiracial individuals (22). COVID-19 mortality data are from the Centers for Disease Control (6). Equations for equalizing age-adjusted mortality and life expectancy were developed by the author. Equations and their derivations, software code, and other detailed methods are available at https://osf.io/bzkcw/ (23).

Data Availability. Software code, equations, and data have been deposited in Open Science Framework, https://osf.io/bzkcw/.

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"U.S. Racial Inequality May Be as Deadly as COVID-19"—Detailed Methods Appendix

All results from the main analysis, and additional analyses described in this appendix, are summarized in Table S1. The results from the main analysis alone are also summarized more briefly in Table S2.

Data Sources

The analysis draws on four main types of data.

First, age-specific death rates for non-Hispanic whites and Blacks are recovered from U.S. life tables for 2006-2017,[4] reflecting all years in which official life tables are available for these populations. For years with multiple official life tables reflecting alternative assumptions (about intercensal population estimates or racial classifications), all life tables are used. (The estimates presented in Figure 2 are average estimates for those years.) The decision to use life tables that reflects the NCHS's final death data for each year, rather than less-processed death rates available through CDC Wonder, prevents the data from extending to 2018. As reflected in the non-final data for 2018, white age-standardized death rates in 2018 were lower than in 2017, which means that, had the analysis used 2018 as the most recent white mortality data, the estimated white deaths that would raise white mortality to Black levels would be larger than the estimates reported here.

Second, population denominators are taken from the American Community Survey (ACS) via IPUMS-USA.[24] The IPUMS estimates are preferable, for these purposes, to NCHS age-specific population estimates because the latter are top-coded at age 85, which is relatively young for describing the age distribution of the white population and its relationship to Covid-19 mortality, with its sharp age gradient. A race-bridging algorithm is implemented to allocate multi-racial individuals to their most likely single-race choice. For 2006-2014, a variable is available via IPUMS-USA that implements this algorithm using restricted data to match the algorithm used by the NCHS to estimate the life tables.[27] For 2015-2017 and for 2018 (used for other purposes, below), I used a modified algorithm that approximates the NCHS algorithm with public-use data.[26] Ages are top-coded at 94 to ensure stable population estimates.

Third, in order to convert estimates of excess mortality rates to estimates of excess deaths, the current size of the U.S. white population is estimated using the most recent (July 1, 2019)

Census Bureau estimate.[25] This estimate is for "non-Hispanic whites alone," which underestimates the non-Hispanic white population in that that some multi-racial individuals identify as white when forced into a single-race metric. To the extent that the larger NCHS race-bridged estimate is more accurate, the excess deaths reported here are a conservative estimate by about 2%. The age distribution of the current white population is estimated from the most recent (2018) ACS.[24]

Fourth, age-specific, race-specific estimates of Covid-19 mortality in the U.S. are taken from the CDC (July 29, 2020 data release).[7] These are used to estimate hypothetical deaths using an empirically-based age distribution of Covid-19 mortality.

Additional supplemental data are taken from the NCHS and the New York City Department of Health, as described below.

Age Composition and Age-Specific Mortality

The main analytical choices are motivated by the need to adjust for the different age composition of Black and white non-Hispanic U.S. populations. The respective age distributions of these populations are shown in Fig. S1. Blacks are overrepresented at young ages, and whites at older ages. Because of these differences in age composition, unadjusted aggregate death rates are higher for whites than for Blacks, even though, at specific ages, Black mortality is higher until age 85 (the so-called "black-white mortality crossover"), as shown in Fig. S2.

Unadjusted aggregate death rates, known as Crude Death Rates (CDR),[5] are given in Eq. S1 for racial group r and year y, as a function of the population proportion in each age group a, $f(a,r,y)$, and age-, race-, year-specific mortality $m(a,r,y)$:

$$CDR(r,y) = \frac{D(r,y)}{N(r,y)} = \sum_a f(a,r,y) \cdot m(a,r,y) . \quad (1)$$

In 2017, the white CDR was 1126 deaths per 100,000 and the Black CDR was 811 per 100,000, reflecting the substantially older age of the white population. (These rates are slightly higher—4% higher for whites and 3% for Blacks—than those estimated by the NCHS because the NCHS population estimate is larger than that derived from the ACS.[4]) The two age standardization measures described below—direct and indirect age standardization—are transformations of this CDR designed to make the Black and white populations comparable despite their different age

distributions.

Direct age standardization

The main age adjustment strategy is direct age standardization, which re-weights each population's age-specific mortality using a standard, shared set of weights.[5:pp.24-25] The weights used here reflect the age distribution of the total U.S. population in 2018 (the most recent available year) derived from the one-year ACS,[24] smoothed using a loess smoother with a tri-cube weighting function and bandwidth of 0.15. Thus, the directly age-standardized death rate (SDR) for race *r* in year *y* is:

$$SDR(r,y) = \sum_a f_{\text{st}}(a) m(a,r,y), \tag{2}$$

where $f_{st}(a)$ refers to the proportion of the standard age distribution at age *a* and $m(a,r,y)$ is the mortality rate at age *a* for racial group *r* in year *y*.

To equalize the hypothetical white 2020 SDR to the Black 2014 SDR, and then translate this hypothetical white SDR to the number of "excess" deaths beyond those implied by white 2017 death rates, an age pattern of excess mortality must be assumed. The analysis makes two alternative assumptions about this age pattern.

The first assumption is that excess 2020 deaths (deaths directly or indirectly associated with Covid-19) occur in proportion to all-cause mortality, so that the white death rate at each age is raised by a constant proportion, $c^{\text{h}}_{\text{prop,SDR}}$. (Throughout the equations, all terms referring to hypothetical 2020 outcomes built around the assumption that age-adjusted white death rates rise to minimum Black levels—rather than empirically estimated terms—are denoted with a superscripted *h*.) This assumption yields a simple formula for relating hypothetical white 2020 age-specific mortality rates to white 2017 and Black 2014 mortality rates:

$$\begin{aligned} SDR(b,2014) &= SDR^h(w,2020) \\ &= \sum_a m^h(a,w,2020) f_{\text{st}}(a) \\ &= c^h_{prop,SDR} \sum_a m(a,w,2017) f_{\text{st}}(a) \\ &= c^h_{prop,SDR} SDR(w,2017) \end{aligned} \tag{3}$$

Eq. 3 can be rearranged to

$$c^{h}_{prop} = \frac{SDR(b,2014)}{SDR(w,2017)}.$$

(4)

This proportional change is estimated to be $c^{h}_{prop} = 1.1800391$, indicating that white 2020 age-adjusted mortality would need to rise 18 percent from white 2017 age-adjusted mortality to reach minimum Black levels. Since by assumption, c^{h}_{prop} applies in constant proportion to each age group, whites' unstandardized CDR would rise by the same amount, to 1329 per 100,000. Excess deaths are derived by applying this rate to the estimated size of the white population.

The second, alternative assumption is that Covid-19-associated deaths adhere to the age pattern of Covid-19 mortality among U.S. whites, as estimated from CDC data.[7] (Details on this estimation are given below.) That empirical age pattern, denoted $m_{\text{covid}}(a,w,2020)$, can be scaled up and down by a constant factor $c^{h}_{\text{covid,SDR}}$ to relate hypothetical white 2020 mortality to white 2017 and Black 2014 mortality:

$$\begin{aligned} SDR(b,2014) &= SDR^{h}(w,2020) \\ &= \sum_{a} f_{st}(a)\left[m(a,w,2017) + m^{h}_{2020excess}(a) \right] \\ &= SDR(w,2017) + \sum_{a} f_{st}(a) m^{h}_{2020excess}(a) \\ &= SDR(w,2017) + c^{h}_{\text{covid,SDR}} \sum_{a} f_{st}(a) m_{\text{covid}}(a,w,2020) \end{aligned} .$$

(5)

Eq. 5 can be rearranged to:

$$c^{h}_{\text{covid,SDR}} = \frac{SDR(b,2014) - SDR(w,2017)}{\sum_{a} f_{st}(a) m_{\text{covid}}(a,w,2020)},$$

(6)

which yields an estimate of $c^{h}_{\text{covid,SDR}} = 5.5068932$, which represents the factor by which white Covid-19 mortality would need to increase from its current levels. To translate this to an estimate of hypothetical excess deaths, the estimated hypothetical age-specific Covid-19 white mortality is multiplied by the estimated white population at each age. (This estimate of $c^{h}_{\text{covid,SDR}}$ differs

slightly from the empirical ratio between the hypothetical excess deaths and confirmed white Covid-19 deaths, which is 5.6766372, because of discrepancies between this one-year-old denominator and the true population size.)

Indirect Age Standardization

As a supplement to the main analysis, I additionally used an alternative standardization method, indirect age standardization.[5:pp.26-28] Results using this method are shown in Table S1 and Fig. S3. Indirect age standardization compares the mortality in each racial group to mortality predicted from its age distribution, based on a standard schedule of mortality at each age. The standard mortality schedule was the population-weighted aggregate mortality for all non-Hispanic Blacks and whites, pooling across years. In years with two different life table mortality estimates, I used both estimates, each weighted by one half, to construct the aggregate standard.

Indirect age standardization generates a Comparative Mortality Ratio (CMR), as the ratio between the population's CDR and the CDR that would be expected based on its age distribution and the standard mortality schedule:

$$CMR(r,y) = \frac{CDR(r,y)}{CDR_{\text{expected}}(r,y)} = \frac{\sum_a f(a,r,y)m(a,r,y)}{\sum_a f(a,r,y)m_{\text{st}}(a,r,y)}, \tag{7}$$

where $m_{st}(a,r,y)$ is the "standard" mortality at age a for racial group r in year y. The CMR is multiplied by 100 to convert it into a percentage of expected mortality. Thus, for example, black mortality is 17-37% above what would be expected based on its age distribution, given aggregate age-specific mortality, while white mortality has been 3-5 percentage points below what would be expected since 2009.

To estimate the additional white deaths needed to raise the 2017 white CMR to the 2014 Black CMR, I use the equation:

$$CMR^h(w,2020) = CMR(b,2014)$$
$$\frac{CDR^h(w,2020)}{CDR^h_{\text{exp}}(w,2020)} = \frac{CDR(b,2014)}{CDR_{\text{exp}}(b,2014)}$$
$$CDR^h(w,2020) = \frac{CDR_{\text{exp}}(w,2017)}{CDR_{\text{exp}}(b,2017)} CDR(b,2017)$$

(8)

where $CDR_{\text{exp}}(r,y)$ is the CDR expected for racial group *r* in year *y* based on its age distribution. The last step in Eq. 8 assumes that the age distribution of the white population does not change appreciably from 2017 to 2020, hence $CDR^{h}_{\text{exp}}(w,2020)=CDR_{\text{exp}}(w,2017)$. Because indirect standardization weights all deaths equally, it requires no assumption about the age pattern of hypothetical excess mortality.

Life Expectancy

Life expectancy, for each racial group *r* and year *y*, is the average lifespan of a synthetic cohort that successively experienced racial group *r*'s age-specific mortality rates in *y*.[5:pp.51-53] This per-capita lifespan is defined as

$$e(0,r,y)=\frac{\sum_{a} L(a,r,y)}{l(0,r,y)}$$

(9)

where $L(a,r,y)$ is the total person-years lived by members of racial group *r* in year *y* at age *a* and $l(a,r,y)$ represents the number of cohort members reaching age *a*, such that $l(0,r,y)$ is the initial cohort size (an arbitrary scaling factor).

Hypothetical white life expectancy in the presence of Covid-19 mortality is estimated from new life tables in which white 2020 mortality is raised from white 2017 mortality using two alternative assumptions that parallel the alternative assumptions in the direct age standardization. First, assuming that Covid-19 raises white mortality in constant proportion over age, hypothetical white mortality is given by

$$m^{h}(a,w,2020)=c^{h}_{\text{prop},e(0)}\cdot m(a,w,2017).$$

(10)

Alternatively, assuming that Covid-19 raises white mortality in proportion to the age pattern estimated from CDC data (described below), hypothetical white mortality is given by

$$m^{h}(a,w,2020)=m(a,w,2017)+c^{h}_{\text{covid},e(0)}\cdot m_{\text{covid}}(a,w,2020).$$

(11)

The values of the two constants $c^h_{prop,e(0)}$ and $c^h_{\text{covid,e(0)}}$ are estimated using a trial-and-error algorithm to find the values that result in the equality $e^h(0,w,2020)=e(0,b,2014)$ to six decimal places. To translate these two alternative estimates of sets of $m^h(a,w,2020)$ values into a death count, each is multiplied by the estimated white age-specific population. The values estimated from Covid-19 mortality data for the respective life expectancy models are $c^h_{prop,e(0)}=1.3069449$, indicating a 31% increase in all-cause mortality, and $c^h_{\text{covid,e(0)}}=13.4145589$, indicating excess mortality equal to a 13-fold increase in Covid-19 mortality rates. (As reported in Tables S1 and S2, the estimate of $c^h_{prop,e(0)}=1.3069449$ yields a final estimate of 31.2%, rather than 30.7%, increased white deaths because the white population is aging. If 2020 excess deaths are estimated using the 2017 age distributions, rather than 2018, in order to remove changing age distributions as a factor, then the final death estimate is 30.69% higher than whites' 2017 mortality, matching this multiplier. To the extent that the white population has continued to age since 2018, the age distributions used here result in a conservative estimate of excess mortality needed to equalize life expectancy.)

In constructing the new life tables, to estimate the life table "$_na_x$ values" (the mean portion of each year lived by those who die during the year), I recovered the values from the official U.S. life tables. Extending those estimates into the 2020 hypothetical simplifies reality since, as mortality rises due to Covid-19, the portion of the interval lived by those who die during it will typically be expected to shrink. However, retaining the original estimates of the per-death person-years in each interval is standard when age intervals are a single year, since in that case they make very little difference.[5:pp.81-84]

Deaths at younger ages have a greater impact on life expectancy than deaths at older ages, since the lifespan that might follow an averted death at a young age is much longer. An implication for this analysis is that, because white deaths generally occur at old ages (see Fig S1), excess deaths that follow the pre-pandemic age pattern of white mortality—and, even more so, deaths that follow the Covid-19 age pattern that concentrates deaths at very old ages—have relatively little impact on life expectancy. This accounts for why many more excess white deaths would be needed to equalize white and Black life expectancy than to equalize white and Black aggregate mortality.

Age Pattern of Covid-19 Mortality for White Americans

CDC data give estimated Covid-19 mortality rates by race, ethnicity, and age.[7] The data used are the July 29, 2020 (most recent) data release, reflecting deaths through July 25, 2020. The rates used are for non-Hispanic whites. The rates themselves amount to a scaling factor in the main analysis, and are not directly important to the final estimation of deaths; the shape of the rates over age, however, is important. Reporting errors in the official Covid-19 data matter to this analysis to the extent that they do not affect estimated Covid-19 counts equally at all ages.

The CDC data are reported in 10-year age intervals. For the analyses in the main text, these were interpolated and extrapolated on log scale to single-year estimates, attributing the CDC rate to the mean age of the white population within each age interval. The CDC rates and extrapolated rates are shown in Fig. S4. The age pattern of white Covid-19 mortality in 2020, compared to white all-cause mortality in 2017, is shown in Fig. S5.

As an alternative strategy and a sensitivity analysis, the analyses using the empirical age distribution of Covid deaths were repeated using the 10-year age units reported by the CDC, without interpolation and extrapolation. The results are reported in Table S1. Results obtained using this alternative approach are extremely similar to those estimated using the main models.

Additional Analyses

Fig. 1, which places the main analyses into historical context, uses mortality and life expectancy estimates generated by the NCHS for 1900-2017.[23] The estimates shown in Fig. 1 differ from those in the main analyses in the article in two respects. Most importantly, while the main analysis considers non-Hispanic whites and Blacks, the NCHS data represent all whites and all Blacks, including Hispanics, due to inconsistency in data collection on Hispanic identity during most of the twentieth century. Of secondary importance, the age-adjusted mortality shown in Fig. 1 is a direct age standardization based on the 2000 U.S. population as an age standard, while the age standard used in the main analysis is based on the 2018 U.S. population.

The estimation of age-adjusted Covid-19 mortality is based on CDC estimates for Black and white Covid deaths as the numerator.[7] Current CDC race-specific estimates (updated July 29, 2020) give 70,822 non-Hispanic white, 30,413 non-Hispanic Black, and 136,577 total Covid-19 deaths. Age-specific population sizes for the denominator, for whites, are as described above.

The overall size of the Black population is estimated by applying the 2018 proportion of the population that is non-Hispanic Black to the 2019 population size. For both racial groups, the age composition is based on the 2018 (most recent) ACS via IPUMS-USA.[24] The age adjustment is the "direct age standardization" method described above, using the same age standard, in the CDC's 10-year age units. Without age adjustment, the confirmed-Covid-19 rates estimated here (32.7 per 100,000 for whites and 52.3 per 100,000 for Blacks) are very similar to estimates compiled by the APM Research Lab for whites, but smaller than the APM estimates for Blacks.[28] Accordingly, the estimate of the factor by which age-adjusted Black Covid-19 mortality exceeds white (estimated here to be 2.5) should be considered a conservative estimate. Possible reasons for the discrepancy include the use of race-bridging algorithms to estimate the denominators used here, which may generate larger race-specific population estimates than the racial categorizations used by state departments of health, and, especially, the APM Research Lab's inclusion of additional sources of Covid-19 deaths beyond those confirmed by the CDC.

The contextual information comparing hypothetical excess white deaths to Covid-19 death rates in New York City draws on data from the New York City Department of Health, which puts the New York City Covid-19 death rate at 224.88 per 100,000 as of July 30, 2020.[8]

To create the final column of Table S1 and Table S2, I estimate baseline mortality from the 2017 mortality estimates and the July 1, 2019 populations so that the baseline mortality and 2020 hypothetical excess mortality are estimated using the same population size.

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Models					Results	
Mortality measure	**Black 2014 (best) value**	**White 2017 (most recent) value**	**Assumption about age distribution of white excess mortality**	**Age Units**	**Estimated white Covid-19-associated deaths for white 2020 mortality to equal minimum Black mortality**	**Hypothetical white excess mortality as a percentage of 2017 mortality**
Age-adjusted (directly age-standardized) mortality	1061 deaths per 100,000 people	899 deaths per 100,000 people	White excess mortality proportional to white all-cause mortality	Single year	402,031	18.0%
			Age distribution estimated from CDC race-specific estimates	Single year (extrapolated)	420,411	18.8%
				10 years (directly estimated)	419,262	18.8%
Indirectly age-standardized mortality	117 percent of "expected" death rate (based on age structure)	97 percent of "expected" death rate (based on age structure)	None	Single year	468,795	21.0%
Life expectancy	75.3 years of lifespan	78.5 years of lifespan	White excess mortality proportional to white all-cause mortality	Single year	697,712	31.2%
			Age distribution estimated from CDC race-specific estimates	Single year (extrapolated)	1,024,103	45.9%
				10 years (directly estimated)	1,006,608	45.1%

Table S1. Models of excess white deaths that would raise white mortality, or lower white life expectancy, to best-ever Black levels (detailed version). Table S1 summarizes all models used in the main analysis, plus three additional models: indirectly age-standardized mortality; and, for age-adjusted (directly age-standardized) mortality and life expectancy, values using empirical estimates of the age pattern of white Covid-19 mortality from the CDC in their original 10-year age units.[7]

Models				Results	
Mortality measure	**Black 2014 (best) value**	**White 2017 (most recent) value**	**Assumption about age distribution of white excess mortality**	**Estimated white Covid-19-associated deaths for white 2020 mortality to equal minimum Black mortality**	**Hypothetical white excess mortality as a percentage of 2017 mortality**
Directly age-standardized mortality	1061 deaths per 100,000 people	899 deaths per 100,000 people	White excess mortality proportional to white all-cause mortality	402,031	18.0%
			Age distribution interpolated and extrapolated from CDC race-specific estimates	420,411	18.8%
Life expectancy	75.3 years of lifespan	78.5 years of lifespan	White excess mortality proportional to white all-cause mortality	697,712	31.2%
			Age distribution interpolated and extrapolated from CDC race-specific estimates	1,024,103	45.9%

Table S2. Models of excess white deaths that would raise white mortality, or lower white life expectancy, to best-ever Black levels (abridged version). This abridged version of Table S1 reports only the models included in the main results.

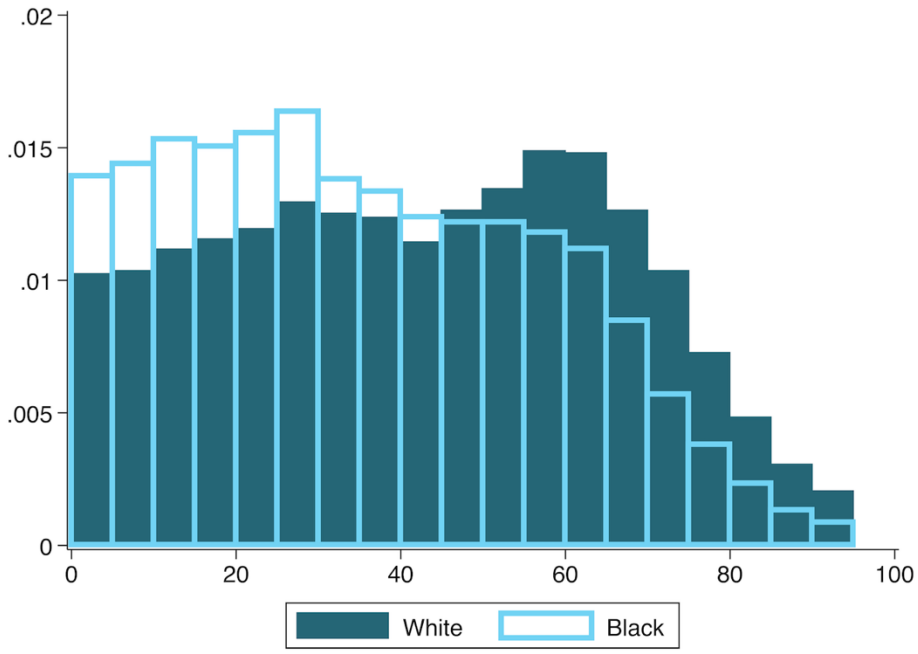

Fig. S1. Non-Hispanic Black and white age distributions in 2018. Units are densities. Data are from the 2018 single-year American Community Survey via IPUMS-USA.[19] 2018 is the most recent available population estimate.

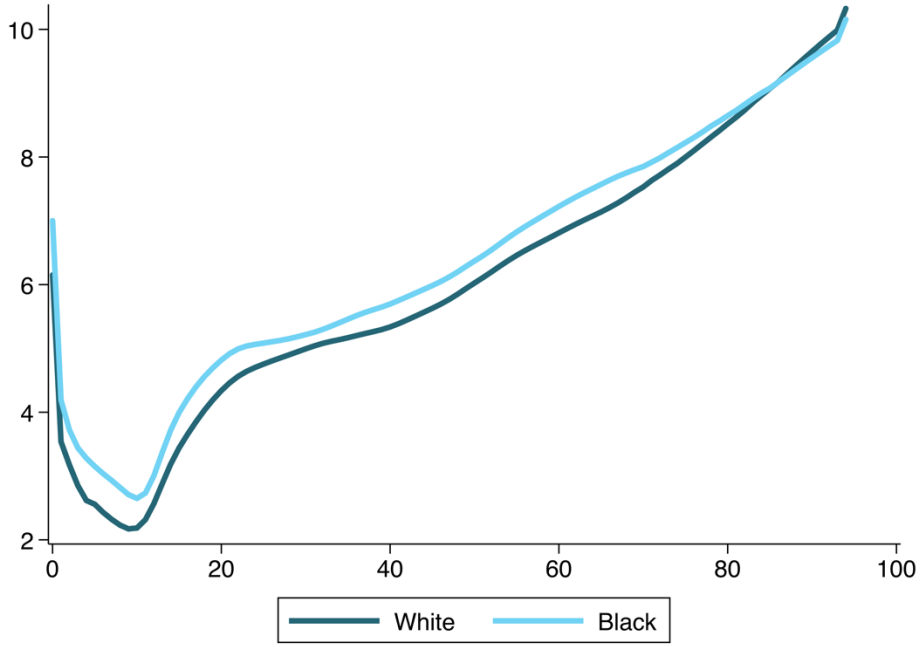

Fig. S2. Non-Hispanic Black and white age-specific mortality in 2017. Units are logged deaths per 100,000. Estimates are derived from data provided by the National Center for Health Statistics.[3] 2017 is the most recent available mortality estimate.

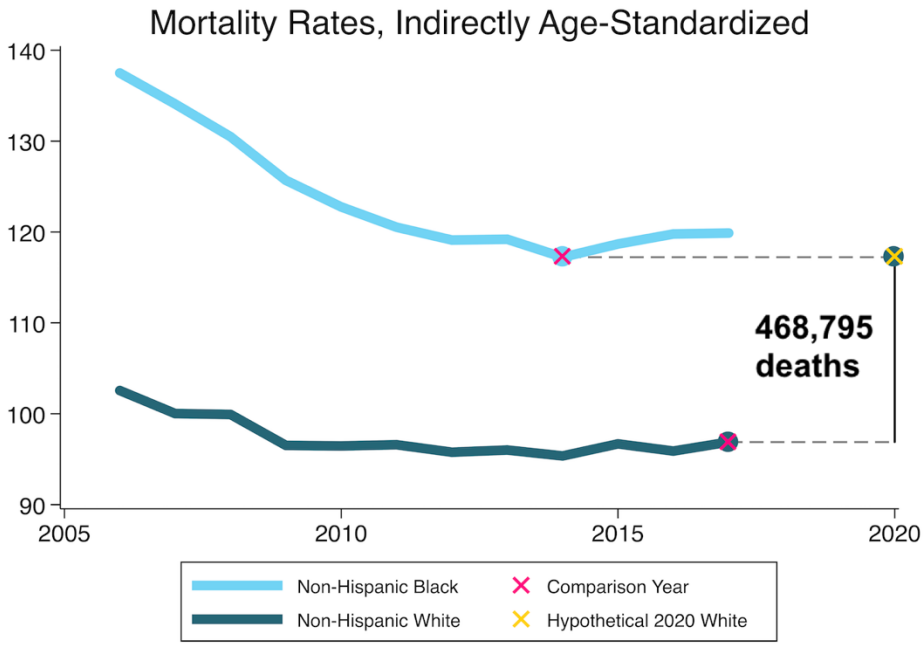

Fig. S3. Indirect age standardization model of hypothetical excess white mortality to reach best-ever Black levels. Units are the percent of "expected" death rates based on the population's age distribution and a standard mortality schedule. Non-Hispanic Black and white rates are shown from 2006-2017, representing all years with U.S. life tables for these populations. The bolded numbers represent the number of excess white deaths in 2020 needed to raise most recent (2017) documented white mortality to lowest-ever (2014) Black mortality, using indirect age adjustment.

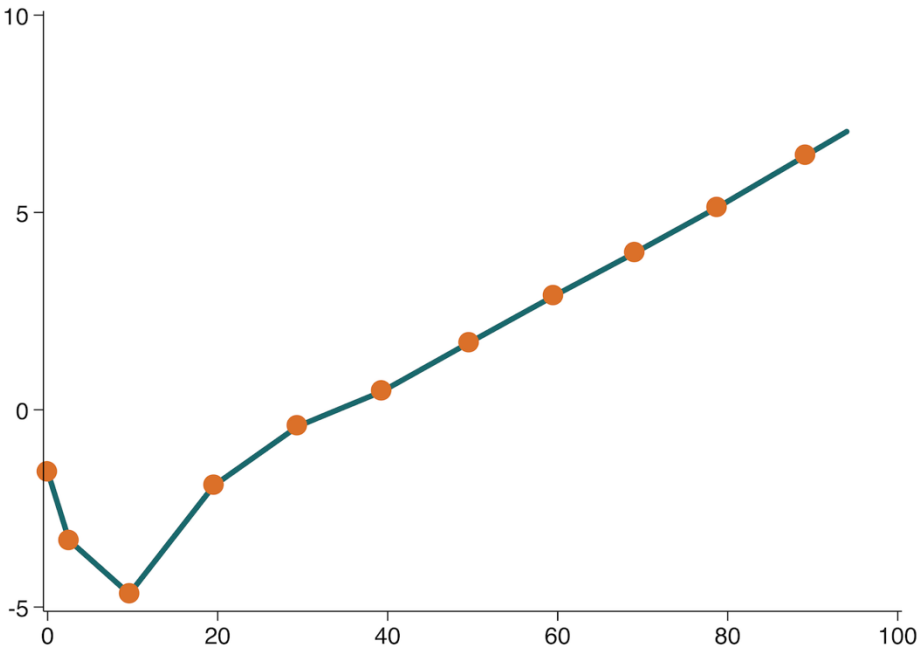

Fig. S4. Covid-19 mortality for U.S. non-Hispanic whites. Units are logged deaths per 100,000. Points represent data reported by the CDC[7] for 10-year age intervals, attributed to the mean age of the interval for non-Hispanic whites. The line represents interpolated and extrapolated values used in the main analysis. The original CDC data are used in the additional analyses reported in Table S1.

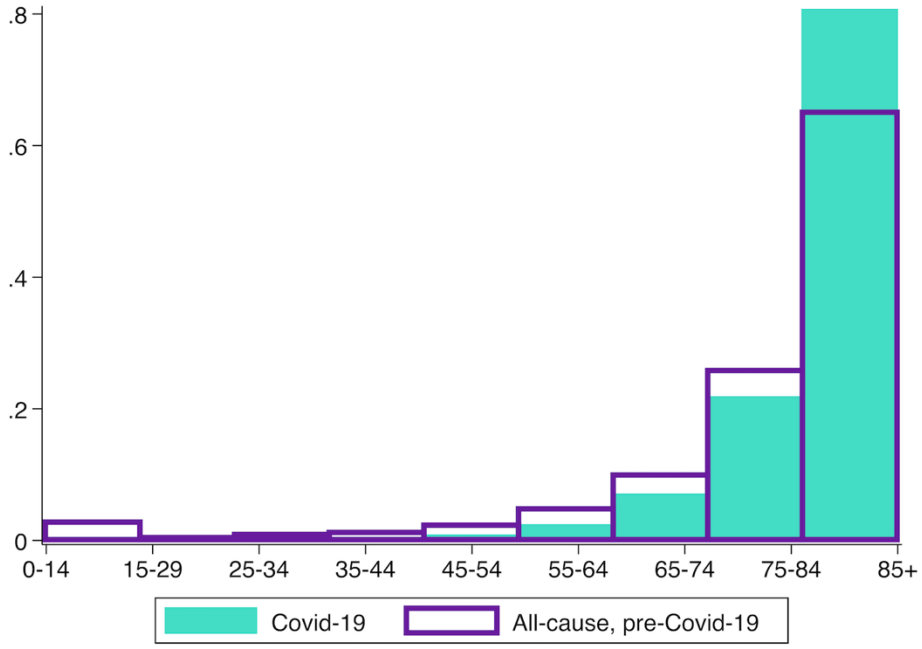

Fig. S5. Age pattern of Covid-19 mortality and all-cause mortality for U.S. non-Hispanic whites. Bars represent the density of death rates for each age group. Covid-19 death rates are estimated from the CDC[7] and the ACS.[24] All-cause mortality rates are estimated by the NCHS; the estimates here are from 2017 (the most recent available year).[4]