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Actual Racial/Ethnic Disparities in COVID-19 Mortality for the Non-Hispanic Black Compared to Non-Hispanic White Population in 353 US Counties and Their Association with Structural Racism

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Abstract

Introduction Although disparities in COVID-19 mortality have been documented at the national and state levels, no previous study has quantified such disparities at the county level by explicitly measuring race-specific COVID-19 death rates. In this paper, we quantify the racial/ethnic disparities in COVID-19 mortality between the non-Hispanic Black and non-Hispanic White populations at the county level by estimating age-adjusted, race-specific death rates.

Methods Using COVID-19 case data from the Centers for Disease Control and Prevention, we calculated crude and indirect age-adjusted COVID-19 mortality rates for the non-Hispanic White and non-Hispanic Black populations in each of 353 counties for the period February 2, 2020, through January 30, 2021. Using linear regression analysis, we examined the relationship between several county-level measures of structural racism and the observed differences in racial disparities in COVID-19 mortality across counties.

Results Ninety-three percent of the counties in our study experienced higher death rates among the Black compared to the White population, with an average ratio of Black to White death rates of 1.9 and a 17.5-fold difference between the disparity in the lowest and highest counties. Three traditional measures of structural racism were significantly related to the magnitude of the Black-White racial disparity in COVID-19 mortality rates across counties.

Conclusions There are large disparities in COVID-19 mortality rates between the Black and White populations at the county level, there are profound differences in the level of these disparities, and those differences are directly related to the level of structural racism in a given county.

Keywords COVID-19 (coronavirus disease 2019) · Health disparities · Structural racism · Black Americans · Age-adjusted mortality rates

Abbreviations

ACS	American Community Survey
CDC	Centers for Disease Control and Prevention
CI	confidence interval
COVID-19	coronavirus disease 2019
ICE	Index of Concentration at the Extremes
NCHS	National Center for Health Statistics
SMR	standardized mortality ratio
SRR	standardized rate ratio

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Introduction

More than one full year into the COVID-19 pandemic, we are still seeing marked racial/ethnic disparities in COVID-19 morbidity and mortality rates across the USA [1]. Although these disparities have been well documented at the national [2] and state [3] levels, there is a great need to better characterize these disparities at more localized levels of geography, such as at the county level. Many studies have demonstrated a relationship between the percentage of Black or Latinx people living in a county and that county's overall COVID-19 mortality rate;

however, none of these studies explicitly measured race-specific COVID-19 death rates, so they could not quantify the disparity. In this paper, we aim to quantify the racial/ethnic disparities in COVID-19 mortality between the non-Hispanic Black and non-Hispanic White populations at the county level throughout the USA by explicitly measuring race-specific death rates. In addition, we explore the potential role of structural racism as an explanation for these disparities, focusing on the manifestations of structural racism in the areas of racial segregation, racial economic segregation, disparities in mass incarceration, disparities in accumulated wealth, and disparities in economic mobility from one generation to the next.

The overwhelming majority of studies that have explored racial disparities in COVID-19 mortality at the county level have done so by examining the relationship between the percentage of Black or Latinx residents in a county and that county's overall COVID-19 death rate [4–22]. However, finding such a relationship does not necessarily demonstrate that a racial disparity exists. It is possible that the percentage of Black residents is an indicator of other factors, such as the overall socioeconomic status of the county, that may lead to both Black and White residents experiencing higher levels of COVID-19-related death. As Cheng et al. explain: "It is possible that Whites also have higher COVID-19 mortality rates in counties with larger shares of Blacks and Hispanics if the conditions in these counties increase the risk of underlying health conditions that increase the risk of transmission and death (e.g., insufficient testing, poor health care access, and social determinants" [12 , p. 607].

Most of the surveillance for racial disparity in COVID-19 outcomes at the county level has also relied on comparing total infection or death rates across counties with differing proportions of racial groups. For example, the COVID-19 Racial Data Tracker [23], perhaps the most widely used tool to understand racial disparities in COVID-19 mortality, tracks counties with the highest overall COVID-19 infection and death rates with respect to the largest racial/ethnic group in each county. While this is extremely useful as a tool, it is limited because it does not present race-specific rates, making it impossible to quantify and compare the magnitude of racial disparities across counties. Ideally, one would directly measure racial disparities in COVID-19 mortality at the county level by explicitly calculating and comparing race-specific death rates. This has not been done previously because of limited available data on the race/ethnicity of COVID-19 decedents at the county level.

Fortunately, the Centers for Disease Control and Prevention (CDC) has recently released COVID-19 death counts at the county level by race/ethnicity for the most populous counties in the USA. This paper extends the previous research by using these new data to calculate race-specific COVID-19 death rates for the non-Hispanic Black and non-Hispanic White populations and by quantifying these disparities through the calculation of the ratio of these race-specific death rates.

To the best of our knowledge, no previous study has explicitly identified and quantified racial disparities in COVID-19 mortality at the county level by comparing race-specific death rates. One previous paper that investigated the relationship between green space and racial disparities in COVID-19 infection at the county level calculated race-specific infection rates among Black and White populations in 135 US counties [24]. However, this study did not account for differences in the age distribution of the Black and White populations by deriving age-adjusted infection rates. We have previously shown that relying on crude rates substantially underestimates the magnitude of the Black-White disparity in COVID-19 [25]. This study was also limited because it used green space as the only measure of structural racism [24].

In this paper, we quantify the Black-White racial disparity in COVID-19 mortality rates in 353 US counties by calculating race-specific death rates. We use indirect age adjustment to account for differences in the age distribution of the non-Hispanic Black and non-Hispanic White populations. We then explore the relationship between five different measures of structural racism and the magnitude of the observed racial disparities in COVID-19 mortality rates across counties. This research advances the existing literature by (1) quantifying racial disparities in COVID-19 mortality at the county level; (2) presenting age-adjusted estimates of race-specific, COVID-19 death rates at the county level; and (3) exploring the potential role of a variety of measures of structural racism in explaining differences in the magnitude of the observed racial disparities in COVID-19 mortality across counties.

Methods

Design Overview

We collected data on 353 counties for which data were available on both the number of COVID-19 deaths reported by race/ethnicity and 2019 population counts by age group and race/ethnicity. Using data from the Centers for Disease Control and Prevention's (CDC) National Center for Health Statistics (NCHS), we calculated both crude and indirectly age-adjusted COVID-19 mortality rates for the non-Hispanic White and non-Hispanic Black populations in each of the 353 counties based on age group-specific, race/ethnicity-specific population data from the 2019 American Community Survey. For descriptive purposes, we defined the Black-White disparity in COVID-19 mortality as the ratio of the death rate among the Black population to the death rate among the White population. For analytic purposes, the racial disparity was treated by modeling the Black death rate while controlling for the White death rate. In both cases, we generated and compared

results using both crude and age-adjusted death rates. There were three parts to our analysis. First, we examined the estimated racial disparities across counties and compared the magnitude of the racial disparities that resulted from crude and age-adjusted mortality estimates. Second, using linear regression analysis, we examined the relationship between several county-level measures of structural racism and the observed differences in racial disparities in COVID-19 mortality across counties. Finally, we explored whether any observed relationship between structural racism and racial disparities in COVID-19 mortality could be explained by the following: disparities in exposure based on occupation; disparities in exposure based on the use of public transportation; disparities in exposure based on household size; disparities in the severity of disease based on the prevalence of comorbidities; and disparities in health care access based on differences in health insurance coverage.

Measures and Data Sources

COVID-19 Mortality Data

We obtained data on confirmed COVID-19 deaths by race/ethnicity and county from the National Center for Health Statistics' COVID-19 Death Data and Resources [26]. We used the county-level data set entitled "Provisional COVID-19 Deaths by Race and Hispanic Origin" [27]. Updated weekly, this data set contains county- and race/ethnicity-specific counts of COVID-19 deaths from the NCHS' National Vital Statistics System. The NCHS prepares the data set by processing, coding, and tabulating data from death certificate information reported directly to it by state health departments. At the time we downloaded the data sets, they included a cumulative count of confirmed COVID-19 deaths from February 2, 2020, through January 30, 2021. There were missing data for deaths in some age strata because the CDC suppresses any cell counts less than 10. There was a total of 353 counties with complete data (see Figure 1 to see the location of these counties).

Calculation of Crude Mortality Rates

We calculated crude COVID-19 death rates for the non-Hispanic White and non-Hispanic Black population in each county by dividing the total number of deaths among that racial group by the population of the racial group.

Calculation of Age-Adjusted Mortality Rates

We calculated age-adjusted death rates using indirect age standardization, a standard procedure to generate rates that account for the age distribution of the population, explained in detail by Naing [28] and demonstrated by Preston et al. [29]. Indirect age standardization is especially useful when

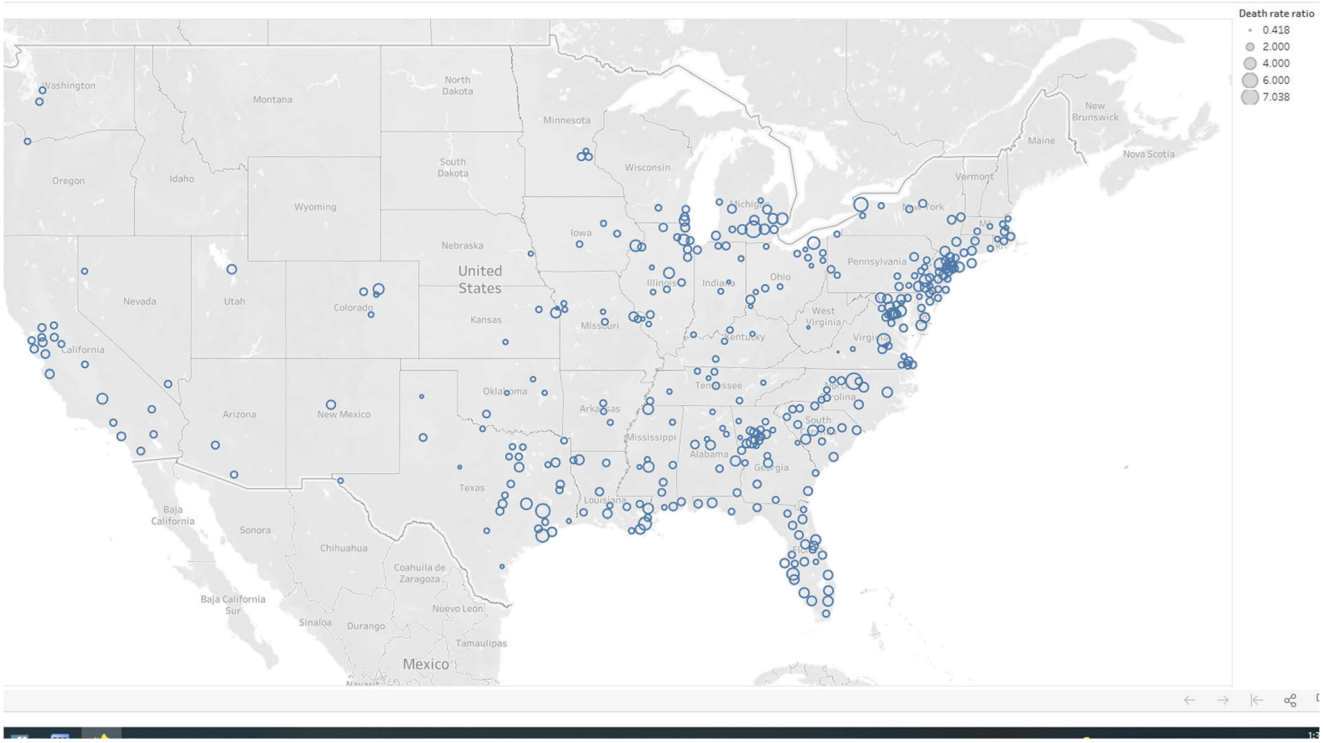

Fig. 1 Location of 353 counties in sample. The size of the circle indicates the magnitude of the Black-White racial disparity in age-adjusted COVID-19 mortality rates

observed deaths by age strata in the populations of interest are not available. As a useful alternative, age-specific death rates from a reference population are applied to the populations of interest to estimate the expected number of deaths [28, 29]. The ratio of observed to expected deaths in each population unit https://97-percent.org/ is then multiplied by the crude rate in the reference population to generate the indirectly age-adjusted mortality rate for the population of interest.

Death rates were indirectly age adjusted using the entire US population as the standard population. Death rates were standardized using seven age groups: 0–34, 35–44, 45–54, 55–64, 65–74, 75–84, and 85+. We chose these age categories to optimize the balance between having so many strata that we had missing data requiring us to omit counties and having enough age strata to generate stable age-adjusted estimates.

We first calculated national age-specific COVID-19 mortality rates for each age group for the USA as a whole. These would be the expected age-specific death rates for each racial group in each county if there were no mortality differences between racial groups or between counties. We then applied these age-specific national COVID-19 death rates to the race-specific county-level population information, multiplying the age-specific national COVID-19 death rates by the number of people in the age groups in each racial group at the county level to get the expected number of deaths for each racial group. This represents the number of deaths that would be expected among either the non-Hispanic Black or non-Hispanic White population in each county if the actual age-specific mortality rates in that county for both racial groups were identical to the national age-specific mortality rates. Next, we calculated the standardized mortality ratio (SMR) for each racial group in each county by dividing the observed number of deaths by the expected number. From there, we calculated the country-level race-specific COVID-19 age-adjusted death rate as the product of the SMR for the county (race-specific) and the national crude death rate. Essentially, what this procedure is doing is estimating the degree to which the observed number of deaths in a county differs from that expected based on national age-specific mortality data as an estimate of the degree to which that county's race-specific mortality rate differs from the overall national rate. By multiplying the SMR by the overall national rate, one obtains a race- and county-specific death rate that accounts for differences in the age distribution of each subpopulation. As a result, we were able to generate age-adjusted COVID-19 death rates for both the non-Hispanic White and non-Hispanic Black populations in all 353 counties.

The racial disparity in COVID-19 mortality rates was then generated by dividing the Black age-adjusted death rate by the White age-adjusted death rate. We also generated estimates of the racial disparity based on crude death rates for comparison purposes by dividing the Black crude death rate by the White crude death rate.

A complete example of the calculating of race-specific, indirectly age-adjusted COVID-19 mortality rates for the case of Cook County, Illinois, is displayed in Appendix Table 6.

Analysis of Relationship Between Racial Disparities and Structural Racism

Outcome Variable

The main outcome variable was the natural logarithm of the age-adjusted COVID-19 death rate among the non-Hispanic Black population in each county. We modeled the log of the Black mortality rate because the distribution of the death rates was skewed, but a log transformation produced a histogram that approximated the normal distribution. To explore the potential relationship of the structural racism measures to racial disparities in COVID-19, we conducted a linear regression in which we estimated the influence of the structural racism measure of interest on the Black COVID-19 mortality rate, while controlling for the White COVID-19 mortality rate. Given a certain rate of COVID-19 death among the White population in a county, this regression estimates the impact of other independent variables in the model on the magnitude of the Black COVID-19 death rate. Thus, an independent variable with a positive and significant coefficient in the model is associated with a higher racial disparity in mortality rates, since it increases the Black death rate at a fixed level of the White death rate.

Main Predictor Variables

The main predictor variables were five measures of county-level structural racism, each of which has been used in previous studies. First, we used three of the individual indices that comprise the state racism index which we developed and validated in previous research exploring the relationship between structural racism and racial disparities in fatal police shootings [30]. These measures address three critical dimensions of structural racism: residential segregation, mass incarceration, and accumulation of wealth, which is largely determined by historical, racist housing policies [31]. The measures were (1) residential racial segregation, operationalized in several ways described below; (2) Black-White disparities in incarceration rates, operationalized as the ratio of the proportion of incarcerated Black people to the proportion of incarcerated White people; and (3) Black-White disparities in accumulated wealth, defined as the ratio of the proportion of the Black population living in rental housing to the proportion of the White population living in rental housing. In their study of structural racism and COVID-19 mortality at the county level, Tan et al. [18] used similar measures. For each of these measures, higher values indicate a greater degree of structural racism. We derived these measures using data from the 2019

American Community Survey 5-year estimates (for rental housing disparities), 2010 incarceration data from the Prison Policy Initiative [32], and the 2010 Decennial Census and 2019 American Community Survey (for the measures of racial residential segregation).

Second, we used the Index of Concentration at the Extremes (ICE), a measure developed by Douglas Massey [33] and extended by Krieger et al. to measure racialized economic segregation [34, 35]. This measure jointly assesses racial segregation and economic deprivation by analyzing the spatial distribution of the concentration of people at the extremes of race-based economic privilege or economic deprivation [34, 35]. These extremes result from historically inequitable race relations that constitute a central aspect of structural racism. We calculated the ICE as the number of White people in a county with high income minus the number of Black people in a county with low income divided by the total county population, where high and low incomes were defined as the 80th and 20th percentiles for US household income. The scale goes from − 1 to 1, with − 1 indicating a county consisting only of low-income Black people and 1 indicating a county consisting only of high-income White people. Thus, the ICE increases with a high degree of White economic advantage and decreases with a high degree of Black economic disadvantage. We calculated the ICE for racialized economic segregation using data from the 2019 American Community Survey, 5-year estimates.

Third, we used the racial opportunity gap developed by O'Brien et al. in their recent article on structural racism and health disparities at the county level [24]. They introduced the racial opportunity gap "as a novel place-based measure of structural racism" [24 , p. 2]. This measure assesses the racial gap in economic mobility over time. The racial opportunity gap is defined as the difference between the expected income percentiles of Black compared to White children born in families with identical income levels in the same county. Data on the expected economic mobility by race across counties were made publicly available by Chetty et al., who used Internal Revenue Service earnings records to compare the income of young adults to that of their parents decades earlier [36]. These data were kindly provided to us by O'Brien. Higher values of the racial opportunity gap indicate higher levels of structural racism.

Measures of Racial Segregation We used the index of dissimilarity, calculated at the block level, as the primary indicator of racial residential segregation because it is "the most commonly used and accepted method of measuring segregation" [37] and thus provides a useful, easily understood point of reference. Nevertheless, it has been noted that the use of the index of dissimilarity as a measure of residential racial segregation may be problematic because this measure can be biased, especially under conditions of low systemic segregation and low population units [38]. In addition, calculating the index of dissimilarity at the block level, as we did in our state racism index, cannot be done using recent data, since block-level population figures are only measured every 10 years in the decennial Census and the last such census for which data are available occurred in 2010. To address these potential limitations, we took two additional steps. First, as an alternative measure of racial segregation, we used the index of dissimilarity calculated at the Census tract level (i.e., the Census tract was the lower geographic unit instead of the Census block). This has the added advantage of allowing more recent data to be used because the Census tract population is assessed every year in the American Community Survey. We thus included the index of dissimilarity calculated at the Census tract level using the 2019 American Community Survey 5-year estimates.

Second, we assessed an additional measure of racial residential segregation proposed by Reardon and O'Sullivan [39] that was used by Tan et al. [18] in their analysis of county-level COVID-19 rates: the Spatial Theory Information Index [18]. This is a measure of spatial clustering of Black people and White people in a county [18]. Thus, we used a total of three different measures of racial residential segregation.

Details of each structural racism measure are shown in Appendix Table 7.

Potential Mediating Variables

A secondary aim of our analysis was to investigate whether or not racial disparities in several factors directly related to COVID-19 risk completely explained any observed association between structural racism and racial disparities in COVID-19 mortality. Therefore, we collected data on racial disparities in the following factors.

Differential Exposure Due to Occupation We used race- and county-specific occupational data from the 2019 American Community Survey [40] to calculate the proportion of workers for each racial/ethnic group in "essential" jobs. The categories included were protective service occupations, food preparation and serving, cleaning and maintenance, personal care and services, construction, repair, production, and transportation and material moving. We operationalized the racial disparity as the ratio of the proportion of Black workers in essential occupations to the proportion of White workers in those occupations.

Differential Exposure Due to Use of Public Transportation We used race- and county-specific data from the 2019 American Community Survey [41] to calculate the proportion of people in each racial/ethnic group who use public transportation to get to work. The disparity was defined as the proportion of Black people who rely on public transportation to the

proportion of White people who rely on public transportation in each county.

Differential Exposure Due to Household Size We used race- and county-specific data from the 2010 Decennial Census to calculate the average household size for each racial/ethnic group. The disparity was defined as the difference between the average household size for the Black population to the average household size for the White population in each county.

Differential Severity of Disease Due to Comorbidities Using county estimates of race-specific mortality from CDC WONDER's multiple cause of death database [42], we derived the ratio of Black to White death rates for each county for the following conditions: obesity, diabetes, circulatory system disorders, and respiratory system disorders.

Differences in Health Care Access Due to Insurance Coverage Disparities Using the 2019 American Community Survey, 5-year estimates [43], we calculated the ratio of the proportion of Black people in each county without health insurance to the proportion of White people in that county without health insurance.

Details regarding these potential mediating variables are shown in Appendix Table 8.

Control Variables

In each regression, we controlled for the total county population and the percentage of Black residents.

Data Analysis

We first examined the relationship between each of the measures of county-level structural racism and the degree of the racial disparity in COVID-19 mortality in each county. Then, we modeled the relationship between those structural racism measures that were associated with the racial disparity in COVID-19 death rates in the presence of each of the potential mediating variables to determine whether the regression coefficient for the structural racism measures remained significant in the presence of these variables. Because there was multicollinearity between many of these predictor variables (see Appendix Table 9 for a correlation matrix), we examined variance inflation factors for these multiple linear regressions and did not draw any inferences from analyses unless all variance inflation factors were below four, a level typically used to detect multicollinearity.

To ease interpretation of the regression coefficients, we standardized the independent variables so that they had a mean of 0 and a standard deviation of 1. Thus, the regression coefficients, once exponentiated, represent the percentage change in the Black COVID-19 death rate for each one standard deviation increase in the predictor variable.

The relationship between structural racism and age-adjusted differentials in COVID-19 mortality is of greatest interest because structural racism itself affects the underlying age distribution of the population; thus, examining crude death rates only may directly mask one of the impacts of structural racism. Nevertheless, because many other papers have employed crude death rates, we also present the relationship between our structural racism measures and the crude death rates for comparison purposes.

Adequacy of County Sample

The 353 counties included in the analysis accounted for 63.7% of the US population and 84.4% of the US Black population (Appendix Table 10). These counties accounted for 95.4% of US COVID-19 deaths and 96.9% of US COVID-19 deaths among Black people (Appendix Table 10). Thus, the sample includes the overwhelming majority of COVID-19 deaths in the nation and provides an adequate representation of counties in which COVID-19 cases occurred in order to draw conclusions regarding racial disparities in COVID-19 death rates and the relationship between these disparities and measures of structural racism. The average population of the 353 included counties is approximately 600,000, while that of the excluded counties is only about 40,000 (Appendix Table 10). The average Black population of the included counties is approximately 100,000, while that of the excluded counties is only about 2000. The results of our analyses should not be generalized to these much smaller and less racially representative counties.

Results

Descriptive Results

Across the 353 counties, the ratio of the age-adjusted Black COVID-19 death rate to the age-adjusted White COVID-19 death rate ranged from a low of 0.4 in Roanoke City, Virginia, to a high of 7.0 in Orange County, North Carolina, with an average of 1.9 (Table 1, Table 2, Appendix Table 11, Fig. 1). Of the 353 counties, 329 (93%) had death rate ratios greater than one, indicating a Black-White disparity in COVID-19 mortality.

In 347 (98.3%) of the 353 counties, the age-adjusted death rate ratio was greater than the crude death rate ratio. Relying on the crude death rate ratio would have identified only 145 counties (41%) with a Black-White disparity in mortality, while relying on the age-adjusted death rate ratio identifies 329 (93%) with such a disparity.

Table 1 Crude and age-adjusted racial/ethnic disparities in COVID-19 mortality rates between the non-Hispanic Black and non-Hispanic White populations—top 25 counties in terms of the death rate ratio

County	Crude			Age-adjusted		
	Black death rate	White death rate	Death rate ratio	Black death rate	White death rate	Death rate ratio
Orange County, North Carolina	247.9	39.7	6.2	285.2	40.5	7.0
Jackson County, Michigan	421.6	149.5	2.8	823.4	118.8	6.9
Montgomery County, Texas	266.0	96.8	2.7	520.0	93.9	5.5
Niagara County, New York	206.4	103.6	2.0	425.9	79.1	5.4
Hanover County, Virginia	697.7	118.7	5.9	493.2	103.1	4.8
Brazoria County, Texas	129.6	59.0	2.2	250.1	54.1	4.6
Jefferson Parish, Louisiana	395.3	200.0	2.0	636.4	144.1	4.4
Lake County, Ohio	119.7	95.8	1.2	297.4	71.0	4.2
Manatee County, Florida	168.5	118.9	1.4	241.7	58.9	4.1
Morris County, New Jersey	441.1	271.6	1.6	819.3	201.4	4.1
Montgomery County, Pennsylvania	509.6	199.7	2.6	588.4	146.5	4.0
Brazos County, Texas	249.5	148.8	1.7	636.9	171.9	3.7
Macomb County, Michigan	204.5	130.7	1.6	389.6	105.6	3.7
Scott County, Iowa	164.7	138.9	1.2	424.6	116.1	3.7
Fayette County, Georgia	302.5	125.6	2.4	323.9	92.1	3.5
DuPage County, Illinois	168.8	124.2	1.4	354.0	102.2	3.5
Arlington County, Virginia	239.3	90.6	2.6	408.5	119.3	3.4
Rankin County, Mississippi	115.6	63.6	1.8	183.7	55.5	3.3
Adams County, Colorado	218.9	112.2	2.0	385.8	116.8	3.3
Anne Arundel County, Maryland	162.9	93.7	1.7	277.3	84.1	3.3
McLean County, Illinois	149.5	125.1	1.2	435.4	132.0	3.3
Lexington County, South Carolina	155.8	91.8	1.7	265.7	81.4	3.3
Kern County, California	101.2	89.8	1.1	248.7	76.5	3.3
DeSoto County, Mississippi	209.0	155.6	1.3	466.7	146.6	3.2
Wicomico County, Maryland	287.9	192.9	1.5	513.4	162.9	3.2

The age-adjusted mortality rates were calculated using indirect standardization to the US population

Similar to many previous papers, we found a significant positive relationship between the percentage of Black residents in a county and that county's overall age-adjusted COVID-19 death rate, with each one standard deviation increase in the percentage Black population associated with a 10.9% increase in the overall COVID-19 death rate (Appendix Table 12). However, as we had hypothesized, a higher percentage of Black residents was associated with both higher White and Black death rates: for each one standard deviation increase in the percent Black population, the Black death rate increased by 2.0% and the White death rate increased by 9.1% (Appendix Table 12).

Table 2 Crude and age-adjusted racial/ethnic disparities in COVID-19 mortality rates between the non-Hispanic Black and non-Hispanic White populations—bottom 25 counties in terms of the death rate ratio

County	Crude			Age-adjusted		
	Black death rate	White death rate	Death rate ratio	Black death rate	White death rate	Death rate ratio
Muskogee County, Oklahoma	153.2	241.3	0.6	179.3	178.4	1.0
Douglas County, Nebraska	98.4	167.3	0.6	166.1	168.2	1.0
Fayette County, Kentucky	94.0	145.0	0.6	145.4	151.1	1.0
Baltimore city, Maryland	186.4	204.9	0.9	203.3	215.6	0.9
Suffolk County, Massachusetts	204.1	264.1	0.8	246.7	263.0	0.9
Richmond County, Georgia	266.2	496.1	0.5	370.8	397.0	0.9
Lynchburg city, Virginia	248.9	395.1	0.6	349.0	374.6	0.9
Oklahoma County, Oklahoma	129.2	231.0	0.6	185.2	199.0	0.9
Peoria County, Illinois	121.2	352.6	0.3	248.2	266.8	0.9
Davidson County, Tennessee	152.3	252.5	0.6	251.3	271.9	0.9
Hinds County, Mississippi	265.1	653.3	0.4	402.8	441.3	0.9
Jefferson County, Texas	134.0	282.8	0.5	179.4	196.6	0.9
Cuyahoga County, Ohio	132.9	216.5	0.6	135.1	152.5	0.9
Stark County, Ohio	140.3	225.4	0.6	156.4	178.5	0.9
Carroll County, Georgia	121.6	220.7	0.6	201.0	229.9	0.9
Richmond city, Virginia	97.8	127.3	0.8	109.8	134.3	0.8
Hamilton County, Ohio	104.8	179.6	0.6	127.0	155.4	0.8
St. Louis city, Missouri	146.4	182.5	0.8	159.0	198.9	0.8
Nueces County, Texas	90.5	190.5	0.5	115.9	148.9	0.8
Madison County, Indiana	92.0	176.4	0.5	108.1	141.6	0.8
Potter County, Texas	320.1	841.3	0.4	498.0	662.9	0.8
Wyandotte County, Kansas	240.6	344.2	0.7	250.8	336.3	0.7
Taylor County, Texas	104.7	359.7	0.3	226.7	307.8	0.7
Kanawha County, West Virginia	116.0	200.1	0.6	96.0	147.3	0.7
Roanoke city, Virginia	88.4	390.8	0.2	116.7	279.4	0.4

The age-adjusted mortality rates were calculated using indirect standardization to the US population

Overall, the percentage of Black residents in a county was negatively related to the magnitude of the Black-White disparity: each one standard deviation increase in the percentage of Black residents in a county was associated with a 6.5% decrease in the Black-White adjusted death rate ratio (Appendix Table 12). This relationship is also demonstrated by examining the counties with the greatest and lowest racial disparities in COVID-19 mortality rates: the 10 counties with the greatest disparities had an average of 9.9% Black residents, while the 10 counties with the lowest disparities had an average of 20.8% Black residents (Appendix Table 13).

Table 3 Results of linear regression showing percentage change in the age-adjusted Black COVID-19 mortality rate for each one standard deviation increase in the county structural racism measures shown, 95% confidence intervals (CI), and *P* values (*N* = 353 counties)

Structural racism measure	Percent change in racial disparity in COVID-19 death rates	95% CI	*P* value
Incarceration ratio	+ 9.4%	+ 5.0 to + 14.-0%	< 0.-0-01
Rental housing ratio	+ 7.1%	+ 2.9 to + 11.-5%	0.001
Index of Concentration at the Extremes (racialized economic segregation)	+ 11.1%	+ 4.8 to + 17.-8%	< 0.-0-01
Racial opportunity gap	+ 8.6%	+ 4.5 to + 12.-9%	< 0.-0-01
Racial segregation measures			
Index of dissimilarity, block level	+ 2.0%	− 2.0 to + 6.2-%	0.332
Index of dissimilarity, tract level	− 1.4%	− 5.2 to + 2.7-%	0.500
Spatial clustering index	− 1.5%	− 5.5 to + 2.7-%	0.485

All models include the log of the White COVID-19 mortality rate, total county population, and percent Black

Table 4 Results of linear regression showing percentage change in the crude Black COVID-19 mortality rate for each one standard deviation increase in the county structural racism measures shown, 95% confidence intervals (CI), and *P* values (*N* = 353 counties)

Structural racism measure	Percent change in racial disparity in COVID-19 death rates	95% CI	*P* value
Incarceration ratio	+ 6.0%	+ 1.2 to 11.-0%	< 0.-0-01
Rental housing ratio	− 0.4%	− 4.8 to + 4.2-%	0.864
Index of concentration at the extremes (racialized economic segregation)	+ 13.3%	+ 6.1 to + 20.-9%	< 0.-0-01
Racial opportunity gap	+ 10.3%	+ 5.7 to + 15.-1%	< 0.-0-01
Racial segregation measures			
Index of dissimilarity, block level	+ 8.7%	+ 3.8 to + 13.-8%	< 0.-0-01
Index of dissimilarity, tract level	+ 4.0%	− 0.5 to + 8.8-%	0.085
Spatial clustering index	+ 2.2%	− 2.6 to + 7.2-%	0.375

All models include the log of the crude White COVID-19 mortality rate, total county population, and percent Black

Analytic Results

Of the five structural racism measures tested, four were significantly and positively related to the magnitude of the age-adjusted racial disparity in COVID-19 mortality across counties: the incarceration ratio, the rental housing ratio, the Index of Concentration at the Extremes for racialized economic segregation, and the racial opportunity gap (Table 3). The magnitude of this relationship was greatest for the Index of Concentration at the Extremes. For each one standard deviation increase in the Index of Concentration at the Extremes for racialized economic segregation, the Black adjusted death rate increased by 11.1% (95% CI, 4.8 to 17.8%). There was no significant relationship between the index of dissimilarity or the spatial clustering score and differences across counties in the magnitude of the racial disparity in COVID-19 mortality.

When we repeated the analysis using crude instead of age-adjusted death rates, the incarceration ratio, Index of Concentration at the Extremes, and racial opportunity gap were still strongly and positively related to the Black COVID-19 death rate, although the rental housing ratio was not (Table 4). Again, the Index of Concentration at the Extremes was related most strongly, with each one standard deviation increase in this index being associated with a 13.3% increase in the crude Black COVID-19 death rate (95% CI, 5.7 to 15.1%). The index of dissimilarity calculated at the block level was now strongly associated with higher Black COVID-19 death rates, with each one standard deviation increase in this index being associated with an 8.7% increase in the crude Black death rate (95% CI, 3.8 to 13.8%).

When we repeated the age-adjusted models while controlling for Black-White differences in risk factors for COVID-19 mortality, the relationships between each of the four structural

Table 5 Results of linear regression showing percentage change in the age-adjusted Black COVID-19 mortality rate for each one standard deviation increase in the county structural racism measures shown, 95% confidence intervals (CI), *P* values, and highest variance inflation factors (VIF) in multivariate models ($N = 353$ counties)

Structural racism measure	Percent change in age-adjusted Black COVID-19 death rate	95% CI	*P* value	Highest VIF
Model 1				
Incarceration ratio alone	+ 9.4%	+ 5.0 to +14-.0%	< 0.-0-01	1.28
With all five mediating variables	+ 10.9%	+ 6.1 to +15-.9%	< 0.-0-01	2.60
Model 2				
Rental housing ratio alone	+ 7.1%	+ 2.9 to + 11.5-%	0.001	1.15
With all five mediating variables	+ 7.9%	+ 3.4 to + 12.6-%	0.001	2.94
Model 3				
Index of Concentration at the Extremes (racialized economic segregation) alone	+ 11.1%	+ 4.8 to + 17.8-%	< 0.-0-01	2.48
With all five mediating variables	+ 13.7%	+ 6.0 to + 22.1-%	< 0.-0-01	3.71
Model 4				
Racial opportunity gap alone	+ 8.6%	+ 4.5 to + 12.9-%	< 0.-0-01	1.11
With all five mediating variables	+ 9.7%	+ 5.1 to + 14.6-%	< 0.-0-01	2.64

All models include the log of the age-adjusted White COVID-19 mortality rate, total county population, and percent Black. Multivariate models also include five mediating variables: racial differences in percent essential workers, percent taking public transportation to work, average household size, comorbidity death rates, and percent without health insurance

racism measures that were positively associated with the magnitude of the racial disparity across counties were all still present, and each of them actually increased slightly (Table 5). For example, after adjusting for Black-White differences in the percentage of essential workers, percent taking public transportation to work, average household size, comorbidity death rates, and percent without health insurance, for each one standard deviation increase in the Index of Concentration at the Extremes for racialized economic segregation, the age-adjusted Black COVID-19 death rate increased by 13.7% (95% CI, 6.0 to 22.1%).

Discussion

To the best of our knowledge, this is the first study to explicitly identify and quantify Black-White racial disparities in COVID-19 mortality at the county level by comparing age-adjusted, race-specific death rates. We found that there is, in fact, a substantial disparity in COVID-19 mortality rates at the county level between the non-Hispanic Black and non-Hispanic White populations. Of the 353 counties in our study, 93% experienced higher death rates among the Black compared to the White population. The average Black-White racial disparity was 1.9, but there was a 17.5-fold difference between the counties with the lowest and highest disparities in race-specific COVID-19 mortality. Second, we found that using crude race-specific death rates resulted in a substantial underestimation of the true racial disparity in COVID-19 mortality; in fact, only 41% of counties were found to have racial disparities prior to age adjustment (as opposed to 93% after age adjustment). Third, we found that three traditional measures of structural racism—the incarceration ratio, the Index of Concentration at the Extremes (racialized economic segregation), and the racial opportunity gap—were significantly related to the magnitude of the Black-White racial disparity in COVID-19 mortality rates across counties.

In an attempt to characterize racial disparities in COVID-19 cases or deaths in counties, numerous previous studies have reported that the proportion of Black residents in a county is positively associated with the overall COVID-19 death rate in that county [4–22]. Our concern was that the proportion of Black residents may be correlated with factors that increase not only the Black COVID-19 death rate, but the White COVID-19 death rate as well. In her recently released 2021 work "*The Sum of Us: What Racism Costs Everyone and How We Can Prosper Together*," attorney Heather McGhee has documented that many counties with large Black populations, in an effort to avoid having to provide equal resources on the basis of race, have instead chosen to reduce overall expenditures on factors that affect general social conditions in the county [31]. This is one mechanism that could explain why not only Black, but White COVID-19 rates could be higher in counties with larger Black populations. In fact, in this paper, we found that the proportion of Black residents in a county is

related to higher levels of COVID-19 mortality among both the Black and White populations. This is why our methods—which directly compare race-specific death rates—improve upon these existing studies. While these previous studies revealed an important correlation between Black population composition and overall COVID-19 mortality rates, they were unable to directly demonstrate the presence of racial disparities in COVID-19 mortality because they did not analyze race-specific mortality data. Here, we are able to directly measure the extent of the racial disparity in each county based on such data.

A second way in which this paper advances the literature is by demonstrating the critical importance of accounting for the age distribution of the population in assessing racial disparities in COVID-19 death. Failure to age adjust the race-specific death rates underestimates the true racial disparities because COVID-19 mortality is greatly influenced by age with older populations being more affected. It is important to take this into consideration because the average life expectancy of the Black population is lower than that of the White population, meaning that they have a younger age distribution, which should theoretically result in a smaller percentage of the Black population being at increased risk of COVID-19 mortality compared to the older White population, thus masking disparities in age-specific mortality rates [44].

We examined the possible role of five standard measures of structural racism at the county level in an effort to explain the observed differences in the magnitude of racial disparity in COVID-19 death rates across counties. We found that three of these measures—the racial opportunity gap, the Index of Concentration at the Extremes for racialized economic segregation, and the incarceration rate ratio—were significantly and robustly positively related to the magnitude of the Black-White disparity in COVID-19 death rates across counties. These relationships held whether we used crude or age-adjusted death rates and persisted even after we controlled for five potential mediating variables that could directly explain racial disparities in COVID-19 mortality. This robust finding may suggest that there are deep aspects of structural racism, going beyond its easily observable and measurable tangible consequences that must be addressed in order to ameliorate the observed racial disparities in COVID-19 mortality.

Our analyses provided mixed results regarding the relationship between residential segregation and Black-White disparities in COVID-19 mortality. For example, the index of dissimilarity was not associated with disparities in age-adjusted death rates but was positively related with disparities in crude death rates. The index of dissimilarity calculated at the Census tract level was not related to disparities in either analysis, nor was the spatial clustering measure. Many previous studies have shown residential segregation to be associated with racial disparities in a variety of health outcomes [45]. Perhaps one explanation for the nuanced results in this study is that although racial segregation was associated with higher Black COVID-19 death rates, it was even more strongly associated with White COVID-19 death rates. This in some cases actually led to a negative, although not statistically significant, relationship between residential segregation and racial disparities in COVID-19 mortality. We hypothesize that residential segregation may not have been associated with lower COVID-19 death rates among the White population because as an infectious disease, higher rates in one part of a county are likely to translate into higher rates in other parts of that same county. Torrats-Espinosa similarly hypothesized that higher levels of segregation could translate into higher rates of White COVID-19 deaths "if minorities and Whites overlap in public places (e.g., public transit and restaurants) so that the virus spills over from the minority clusters to the rest of the population through these encounters" [46 , p. 2]. Although residential segregation is discriminatory, infectious diseases are not, indicating that structural racism may harm the entirety of the communities that it affects, and not just the specific minority communities that are being oppressed. This finding is enlightening in view of McGhee's argument that structural racism is not a zero-sum game and that ending structural racism may benefit both the White and Black populations [31].

The results of this investigation have several implications for future research, data collection, and public health policy. Specifically, they have implications for each of the four dimensions that Bailey et al. articulated as being essential to dismantle structural racism and its consequences in their sentinel article in the *New England Journal of Medicine*: (1) better documenting racial health disparities; (2) improving the collection of race/ethnicity-specific health data; (3) shining the light on the medical and public health systems themselves and their potential role in enabling structural racism; and (4) creating systemic and structural change to dismantle structural racism at its roots [47]. First, we provide the strongest evidence to date that there is indeed a profound racial disparity in COVID-19 mortality at the county level and that the magnitude of this disparity across counties is equally profound. Second, this investigation demonstrates the importance of collecting race/ethnicity-specific data. The previous studies examining COVID-19 mortality at the county level were unable to quantify racial disparities because of the lack of race-specific mortality data. We were only able to conduct this analysis because the CDC eventually began releasing data on the race and ethnicity of COVID-19 victims in all of the most populous counties in the country. Third, these findings should force us to reflect on the

public health profession itself and its failure to have anticipated and prevented the racial disparities that resulted during the pandemic. Fourth, our findings point to the need for systemic, structural, and institutional policy changes that improve the health of underserved populations.

Limitations

The primary limitation of this analysis is that many counties failed to track COVID-19 deaths by race/ethnicity or used varying definitions that were inconsistent. In addition, the CDC does not report counts for any cell in which there are fewer than 20 deaths, nor does it report rates that are based on fewer than 20 deaths. As a result of these two limitations, our analysis was constrained to 353 counties. Nevertheless, these 353 counties account for 63.7% of the US population and 81.7% of the US Black population. Moreover, they account for 95.4% of US COVID-19 deaths during the study period. The results of this analysis should not be generalized to counties that have very low Black populations.

Because of the absence of age-specific and race-specific data for many counties, we relied upon indirect rather than direct age standardization. While it may not be as precise as direct age standardization, it still accounts for differing age distributions among various counties and between racial groups.

Third, there was collinearity between several of the predictor variables, limiting our ability to estimate independent effects of each predictor. We have identified several four measures of structural racism that correlate with higher racial disparities in COVID-19 mortality at the county level; however, the independent effects of these measures should be examined in future studies.

Fourth, the index of dissimilarity calculated at the block level was based on 2010 data because no more recent data were available at that level. We addressed this by also including the index of dissimilarity calculated at the Census tract level, for which 2019 data were available. Additionally, average household size by race was also available only as recently as the 2010 decennial Census. While inaccuracy in this variable would not affect our estimation of racial disparities in COVID-19 mortality or their relationship with structural racism measures, it could affect our conclusion that there is no change in the regression coefficients for the structural racism measures after controlling for the potential mediating effects of differences in household size. This particular analysis should be replicated once the data from the 2020 Decennial Census are available.

Finally, this analysis only examined racial disparities between non-Hispanic Black and non-Hispanic White populations. There is strong evidence of COVID-19-related racial disparities among other racial/ethnic groups, including Latinx, Indigenous, and Asian-American groups, to name a few, and each of these needs to be studied in its own right.

Conclusion

In spite of these limitations, this paper has demonstrated that there are large and previously underestimated disparities in COVID-19 mortality rates between the non-Hispanic Black and non-Hispanic White populations at the county level, that there are profound differences in the level of these disparities, and that those differences are directly related to the level of structural racism in a given county. Three measures of structural racism at the county level were significantly associated with the magnitude of the racial disparity in COVID-19 mortality: the Index of Concentration at the Extremes for racialized economic segregation, the racial opportunity index, and the incarceration ratio. These results suggest that in order to reduce racial disparities in this or future pandemics, it will be necessary to dismantle structural racism and its consequences, particularly the mass incarceration of Black people, the massive racial disparity in wealth and access to resources, and the profound disparities in upward mobility. Finally, our findings demonstrate that dismantling structural racism is not a zero-sum game, but will yield benefits for the entire population, especially in the context of infectious diseases and health outcomes.

Acknowledgements Tableau Public was used in the creation of the map shown in Fig. 1. The use of Tableau Public is governed by the terms of service outlined at https://www.tableau.com/tos.

Code Availability Not applicable.

Data Availability The database produced in this research project is available from the corresponding author.

Declarations

Research Involving Human Participants and/or Animals This is a secondary analysis of publicly available data obtained, analyzed, and reported at an aggregated state level. No human subject or identification data is collected or analyzed in this study.

Informed Consent No human subject was involved in this study.

Conflict of Interest The authors declare no competing interests.

Appendix

Table 6. Demonstration example of method for indirect age standardization of race- and county-specific COVID-19 mortality rates and calculation of racial disparity: Cook County, Illinois

Step 1: Calculate age-specific death rates for the entire U.S. population. These would be the expected age-specific death rates for each racial group in each county if there were no mortality differences between racial groups or between counties. Also calculate overall mortality rate for the U.S. population (bottom line).

United States			
Age group	Number of deaths	Population in age group	Age-specific mortality rate (per 100,000)
0-34	3,412	148,919,430	2.29
35-44	7,057	41,914,845	16.84
45-54	19,454	40,863,107	47.61
55-64	49,131	42,468,113	115.69
65-74	89,896	31,575,561	284.70
75-84	117,104	16,140,238	725.54
85+	135,324	6,358,229	2128.33
Entire population	**421,378**	**328,239,523**	**128.38**

Step 2: Apply national age-specific mortality rates to the number of people in each age group by race in the county of interest to estimate the expected number of deaths if there were no differences compared to national rates.

Cook County, Illinois							
Non-Hispanic Black				**Non-Hispanic White**			
Age group	Population	Expected death rate per 100,000 (from table above)	Expected number of deaths	Age group	Population	Expected death rate per 100,000 (from table above)	Expected number of deaths
0-34	558,253	2.29	12.78	0-34	849,414	2.29	19.45
35-44	143,210	16.84	24.12	35-44	285,032	16.84	48.00
45-54	149,739	47.61	71.29	45-54	267,794	47.61	127.50
55-64	158,563	115.69	183.44	55-64	316,732	115.69	366.43
65-74	104,142	284.70	296.49	65-74	241,444	284.70	687.39
75-84	56,387	725.54	409.11	75-84	128,896	725.54	935.19
85+	19,500	2128.33	415.02	85+	64,819	2128.33	1,379.56
Entire population	**1,189,794**		***1,412.25***	**Entire population**	**2,154,131**		***3,563.52***

Step 3: Calculate standardized mortality ratios (SMR) for each racial group by dividing the observed number of deaths by the expected number of deaths.

Cook County, Illinois					
Non-Hispanic Black			**Non-Hispanic White**		
Observed deaths	Expected deaths	SMR	Observed deaths	Expected deaths	SMR
2,440	1,412.25	1.728	3,467	3,563.52	0.973

Step 4: Estimate age-adjusted, race-specific death rate in each county by multiplying the SMR by the national crude death rate from step 1.

Cook County, Illinois					
Non-Hispanic Black			**Non-Hispanic White**		
SMR	National crude death rate	Estimated race-specific death rate	SMR	National crude death rate	Estimated race-specific death rate
1.728	128.38	221.84	0.973	128.38	124.91

Step 5: The racial disparity in age-adjusted COVID-19 death rates is estimated by dividing the Black age-adjusted death rate by the White age-adjusted death rate.

Racial disparity = 221.84/124.91 = 1.8

Step 6: The racial disparity in death rates based on crude mortality rates can be derived for comparison purposes by dividing the crude Black death rate by the crude White death rate.

Here, the crude Black death rate is 2,440 deaths/1,189,794 = 205.08 per 100,000.

The crude White death rate is 3467 deaths/2,154,131 = 160.95 per 100,000.

Thus, the racial disparity based on the crude mortality rates is 205.08/160.95 = 1.3, which is substantially lower than the racial disparity of 1.8 based on the age-adjusted rates.

Table 7 Definitions, data sources, and methods for calculation of the structural racism measures

Dimension	Measure	Description	Data source
Residential racial segregation	Index of dissimilarity, calculated at block level	D = 1/2 SUM [Blackpct − Whitepct] * 100, where Blackpct is the proportion of the county's Black population living in each block and Whitepct is the proportion of the county's White population living in that block. Values are on a scale from 0-100 with 100 being the most spacially segregated by race. It represents the percentage of Black people who would have to move in order to achieve an equal distribution of White and Black people across all blocks within a county.	US Decennial Census, 2010
	Index of dissimilarity, calculated at Census tract level	Same as above, except the Census tract is the lower level unit rather than the block.	2019 American Community Survey, 5-year estimates; measured calculated by and obtained from County Health Rankings (https://www.countyhealthrankings.org/explore-health-rankings/rankings-data-documentation)
	Spatial Information Theory Index	This is a measure of spatial clustering by race and is also called the H index. It measures the extent to which individuals' local environments differ in population group composition by race. A higher H indicates more spatial segregation, while the maximum value of 1 indicates maximal segregation.	Data were kindly provided by Dr. Shin Bin Tan of MIT based on 2018 American Community Survey, 5-year estimates; measure is described in detail by Tan, deSouza, and Raifman, 2021*
Mass incarceration	Incarceration ratio	Ratio of Black incarceration rate to White incarceration rate for each county.	2010 data from Prison Policy Initiative
Accumulation of wealth	Rental housing ratio	Ratio of proportion of Black people in rental housing to proportion of White people in rental housing for each county.	2019 American Community Survey, 5-year estimates
Racialized economic segregation	Index of Concentration at the Extremes for race and income combined	Number of White people with incomes in the highest quintile minus number of Black people with incomes in the lowest quartile, divided by the total county population with known incomes.	2019 American Community Survey, 5-year estimates
Racial disparity in economic mobility	Racial opportunity gap	Difference between expected income percentile of Black children and expected income percentile of White children born to families at the 20th percentile of income.	Chetty et al., 2020** (using earnings data from Internal Revenue Service)

* Tan SB, deSouza P, Raifman M. Structural racism and COVID-19 in the USA: a county-level empirical analysis. *J Racial Ethn Health Disparities*. (2021). https://dx.doi.org/10.1007%2Fs40615-020-00948-8

** Chetty R, Hendren N, Jones MR, Porter SR. Race and economic opportunity in the United States: an intergenerational perspective. *Q J Econ*. 2020;135(2):711-83

Table 8 Definitions, data sources, and methods for calculation of the potential mediating variables

Dimension	Measure	Description	Data source
Disparities in potential exposure based on differences in proportion of workers in "exposed" occupations	Ratio of proportion of Black workers in essential jobs to proportion of White workers in essential jobs	Proportion of workers in the following job categories: Protective service occupations (33-0000); Food preparation and serving related occupations (35-0000); Building and grounds cleaning and maintenance occupations (37-0000); Personal care and service occupations (39-0000); Construction and extraction occupations (47-0000); Installation, maintenance and repair (49-0000); Production occupations (51-0000); and Transportation and material moving (53-0000).	2019 American Community Survey, 5-year estimates
Disparities in potential exposure based on differences in proportion of people who rely on public transportation to get to work	Difference between proportion of Black workers who take public transportation to work and proportion of White workers who take public transportation to work	Proportion of workers who take public transportation to work	2019 American Community Survey, 5-year estimates
Differences in potential exposure based on household size	Ratio of average household size for Black population to average household size for White population	Average household size	2019 American Community Survey, 5-year estimates
Differences in severity of disease based on comorbidities	Ratio of the Black death rate due to comorbidities to White death rate due to comorbidities	Death rate for obesity, diabetes, cardiovascular diseases, and respiratory diseases	CDC WONDER, multiple cause of death files, 2019
Disparities in health care access	Ratio of the proportion of the Black population without health insurance to the proportion of the White population without health insurance	Proportion of the population without health insurance	2019 American Community Survey, 5-year estimates

Table 9 Correlation matrix for main predictor variables

	Index of Dissimilarity	Incarceration ratio	Rental housing ratio	ICE (racialized economic segregation)	Racial opportunity gap	Black-White disparity in essential jobs	Black-White disparity in use of public transportation to work	Black-White disparity in average household size	Black-White disparity in comorbidities	Black-White disparity in health insurance coverage	Percent Black
Index of dissimilarity	1.00										
Incarceration ratio	0.17	1.00									
Rental housing ratio	0.24	0.32	1.00								
ICE (racialized economic segregation)	− 0.17	0.46	0.17	1.00							
Racial opportunity gap	0.42	0.29	0.17	0.23	1.00						
Black-White disparity in essential jobs	0.26	0.19	− 0.22	0.18	0.28	1.00					
Black-White disparity in use of public transportation to work	0.35	0.22	− 0.05	0.08	0.26	0.24	1.00				
Black-White disparity in average household size	0.23	− 0.07	− 0.15	− 0.12	0.05	0.22	0.11	1.00			
Black-White disparity in comorbidities	0.27	0.27	− 0.03	0.09	0.42	0.65	0.19	0.01	1.00		
Black-White disparity in health insurance coverage	0.15	0.33	0.20	0.43	0.29	0.50	0.20	0.12	0.25	1.00	
Percent Black	0.10	− 0.43	− 0.27	− 0.73	− 0.11	0.13	− 0.05	0.17	− 0.03	− 0.15	1.00

Table 10 Comparison of 353 counties included in the sample with the 2790 counties not included in the sample

Characteristic	353 counties included	2790 counties excluded
Total population	209,000,000 (63.7%)	119,000,000 (36.3%)
Black population	34,300,000 (84.4%)	6,350,969 (15.6%)
Average population	592,068	42,652
Average Black population	97,167	2276
Population density	693.6	36.8
Black population density	113.8 per square mile	2.0 per square mile
COVID-19 deaths	304,778 (95.4%)	14,696 (4.6%)
Black COVID-19 deaths	55,467 (96.9%)	1774 (3.1%)
Average COVID-19 deaths	863	5
Average Black COVID-19 deaths	157	0.6
Crude overall COVID-19 death rate	145.8 per 100,000	12.3 per 100,000
Crude overall Black COVID-19 death rate	161.7 per 100,000	27.9 per 100,000

Table 11 Crude and indirectly age-adjusted COVID-19 mortality rates (per 100,000) and rate ratios for non-Hispanic White and non-Hispanic Black populations in 353 counties—by descending death rate ratio

County	Black crude death rate	White crude death rate	Crude death rate ratio	Black adjusted death rate	White adjusted death rate	Adjusted death rate ratio
Orange County, North Carolina	247.9	39.7	6.2	285.2	40.5	7.0
Jackson County, Michigan	421.6	149.5	2.8	823.4	118.8	6.9
Montgomery County, Texas	266.0	96.8	2.7	520.0	93.9	5.5
Niagara County, New York	206.4	103.6	2.0	425.9	79.1	5.4
Hanover County, Virginia	697.7	118.7	5.9	493.2	103.1	4.8
Brazoria County, Texas	129.6	59.0	2.2	250.1	54.1	4.6
Jefferson Parish, Louisiana	395.3	200.0	2.0	636.4	144.1	4.4
Lake County, Ohio	119.7	95.8	1.2	297.4	71.0	4.2
Manatee County, Florida	168.5	118.9	1.4	241.7	58.9	4.1
Morris County, New Jersey	441.1	271.6	1.6	819.3	201.4	4.1
Montgomery County, Pennsylvania	509.6	199.7	2.6	588.4	146.5	4.0
Brazos County, Texas	249.5	148.8	1.7	636.9	171.9	3.7
Macomb County, Michigan	204.5	130.7	1.6	389.6	105.6	3.7
Scott County, Iowa	164.7	138.9	1.2	424.6	116.1	3.7
Fayette County, Georgia	302.5	125.6	2.4	323.9	92.1	3.5
DuPage County, Illinois	168.8	124.2	1.4	354.0	102.2	3.5
Arlington County, Virginia	239.3	90.6	2.6	408.5	119.3	3.4
Rankin County, Mississippi	115.6	63.6	1.8	183.7	55.5	3.3
Adams County, Colorado	218.9	112.2	2.0	385.8	116.8	3.3
Anne Arundel County, Maryland	162.9	93.7	1.7	277.3	84.1	3.3
McLean County, Illinois	149.5	125.1	1.2	435.4	132.0	3.3
Lexington County, South Carolina	155.8	91.8	1.7	265.7	81.4	3.3
Kern County, California	101.2	89.8	1.1	248.7	76.5	3.3
DeSoto County, Mississippi	209.0	155.6	1.3	466.7	146.6	3.2
Wicomico County, Maryland	287.9	192.9	1.5	513.4	162.9	3.2
St. Tammany Parish, Louisiana	236.7	152.8	1.5	426.2	136.4	3.1
Chester County, Pennsylvania	263.2	148.2	1.8	377.5	123.2	3.1

Table 11 (continued)

County	Black crude death rate	White crude death rate	Crude death rate ratio	Black adjusted death rate	White adjusted death rate	Adjusted death rate ratio
Washtenaw County, Michigan	256.5	120.0	2.1	368.3	120.4	3.1
Pitt County, North Carolina	102.4	43.2	2.4	137.7	45.5	3.0
Johnson County, Kansas	134.7	114.5	1.2	312.8	103.7	3.0
Broward County, Florida	128.5	111.7	1.1	182.1	61.4	3.0
Lee County, Alabama	235.3	119.4	2.0	429.0	145.2	3.0
Washington County, Maryland	138.2	200.4	0.7	442.1	151.0	2.9
Kenosha County, Wisconsin	157.1	206.5	0.8	505.6	173.9	2.9
Lee County, Florida	96.3	103.0	0.9	137.2	47.4	2.9
Nassau County, New York	460.7	275.1	1.7	516.9	179.6	2.9
District of Columbia, District of Columbia	227.9	56.2	4.1	228.9	79.6	2.9
Aiken County, South Carolina	114.3	68.5	1.7	143.0	49.9	2.9
Volusia County, Florida	113.8	96.1	1.2	155.4	54.3	2.9
Bossier Parish, Louisiana	139.4	111.0	1.3	280.6	99.2	2.8
Oakland County, Michigan	374.0	165.7	2.3	384.7	136.1	2.8
Montgomery County, Maryland	218.9	166.1	1.3	319.3	113.3	2.8
Orange County, New York	218.3	174.2	1.3	448.3	159.2	2.8
Sussex County, Delaware	204.7	143.3	1.4	224.9	80.3	2.8
Lafourche Parish, Louisiana	309.1	152.0	2.0	355.7	127.4	2.8
Wake County, North Carolina	47.2	28.0	1.7	82.3	30.0	2.7
Collier County, Florida	111.1	128.3	0.9	123.9	45.7	2.7
Okaloosa County, Florida	130.4	124.9	1.0	291.4	108.3	2.7
Shelby County, Alabama	84.4	63.7	1.3	165.7	61.6	2.7
Palm Beach County, Florida	143.6	164.9	0.9	188.0	70.0	2.7
Sarasota County, Florida	157.4	155.6	1.0	166.0	61.9	2.7
Calhoun County, Michigan	168.6	107.7	1.6	231.0	86.8	2.7
Alexandria city, Virginia	123.2	84.1	1.5	219.6	83.5	2.6
St. Lucie County, Florida	110.9	94.3	1.2	131.2	50.2	2.6
Delaware County, Pennsylvania	228.2	192.5	1.2	361.9	139.7	2.6
Ellis County, Texas	114.8	92.8	1.2	239.6	92.9	2.6
Salt Lake County, Utah	47.2	68.7	0.7	212.8	82.5	2.6
Ingham County, Michigan	163.8	118.4	1.4	306.1	119.5	2.6
Frederick County, Maryland	99.8	103.9	1.0	239.2	93.9	2.5
Lafayette Parish, Louisiana	226.3	161.9	1.4	414.9	164.1	2.5
St. Charles County, Missouri	161.3	113.8	1.4	274.6	109.5	2.5
Galveston County, Texas	196.1	94.4	2.1	219.7	87.6	2.5
Middlesex County, New Jersey	306.1	278.7	1.1	446.8	180.1	2.5
Lake County, Florida	114.3	117.0	1.0	144.5	58.4	2.5
Pinellas County, Florida	133.6	131.3	1.0	170.9	69.3	2.5
Cumberland County, North Carolina	52.5	26.8	2.0	73.7	30.1	2.4
Bernalillo County, New Mexico	131.8	121.4	1.1	190.5	78.1	2.4
Baltimore County, Maryland	161.8	140.6	1.2	227.3	93.4	2.4
Houston County, Georgia	129.2	85.8	1.5	199.9	82.2	2.4
New York County, New York	415.1	183.7	2.3	381.6	157.6	2.4

Table 11 (continued)

County	Black crude death rate	White crude death rate	Crude death rate ratio	Black adjusted death rate	White adjusted death rate	Adjusted death rate ratio
Lake County, Illinois	139.5	115.7	1.2	221.9	92.0	2.4
Genesee County, Michigan	215.8	143.2	1.5	274.9	114.3	2.4
Suffolk County, New York	299.2	251.8	1.2	437.7	182.5	2.4
Butler County, Ohio	146.9	102.5	1.4	238.0	99.4	2.4
Dutchess County, New York	155.1	148.8	1.0	259.2	108.8	2.4
Seminole County, Florida	65.6	59.9	1.1	114.2	48.2	2.4
Gregg County, Texas	355.0	336.6	1.1	600.4	254.8	2.4
Monterey County, California	122.6	87.8	1.4	117.3	49.9	2.4
Charleston County, South Carolina	201.0	93.6	2.1	202.3	86.4	2.3
New Haven County, Connecticut	200.0	210.8	0.9	321.1	137.5	2.3
Glynn County, Georgia	194.9	199.5	1.0	295.2	126.9	2.3
Alameda County, California	93.1	55.6	1.7	100.1	43.6	2.3
Rockland County, New York	378.0	237.1	1.6	471.6	205.4	2.3
Berrien County, Michigan	139.3	134.3	1.0	200.4	87.7	2.3
Horry County, South Carolina	153.9	102.1	1.5	167.4	73.3	2.3
Kent County, Michigan	133.5	113.6	1.2	239.9	105.3	2.3
Coweta County, Georgia	122.9	68.0	1.8	172.7	75.8	2.3
Williamson County, Texas	61.9	80.1	0.8	176.1	77.4	2.3
Clay County, Florida	179.5	103.2	1.7	214.4	94.6	2.3
Walton County, Georgia	122.3	147.5	0.8	276.2	124.1	2.2
Orange County, California	102.7	102.3	1.0	158.8	71.6	2.2
Marion County, Florida	151.0	166.3	0.9	179.8	81.6	2.2
Chesterfield County, Virginia	71.4	63.2	1.1	122.3	55.7	2.2
Polk County, Florida	137.1	127.8	1.1	173.5	79.4	2.2
Santa Clara County, California	77.1	70.3	1.1	110.7	50.9	2.2
Albany County, New York	164.2	182.2	0.9	296.2	136.8	2.2
Tuscaloosa County, Alabama	278.2	202.3	1.4	467.1	216.1	2.2
Bergen County, New Jersey	362.0	312.0	1.2	452.2	209.6	2.2
Luzerne County, Pennsylvania	56.8	215.5	0.3	310.7	144.3	2.2
Mercer County, New Jersey	248.9	201.1	1.2	295.2	138.3	2.1
Rensselaer County, New York	96.2	67.3	1.4	115.5	54.2	2.1
Jackson County, Mississippi	177.9	149.0	1.2	268.6	126.3	2.1
Richmond County, New York	331.6	296.5	1.1	490.3	231.5	2.1
Escambia County, Florida	249.9	204.7	1.2	349.7	165.4	2.1
Winnebago County, Illinois	148.4	194.8	0.8	291.2	140.3	2.1
Alachua County, Florida	270.6	188.9	1.4	368.7	178.2	2.1
Norfolk city, Virginia	121.0	84.7	1.4	192.8	93.9	2.1
Florence County, South Carolina	439.7	324.8	1.4	562.4	274.0	2.1
Rapides Parish, Louisiana	322.9	297.2	1.1	519.7	253.8	2.0
Will County, Illinois	125.5	108.1	1.2	213.5	104.4	2.0
San Mateo County, California	96.5	54.3	1.8	76.8	37.7	2.0
Bucks County, Pennsylvania	158.3	165.8	1.0	254.3	125.1	2.0
Fulton County, Georgia	123.4	86.3	1.4	174.4	85.8	2.0
Passaic County, New Jersey	283.1	250.2	1.1	346.4	171.1	2.0
Hartford County, Connecticut	246.3	254.4	1.0	336.6	166.9	2.0

Table 11 (continued)

County	Black crude death rate	White crude death rate	Crude death rate ratio	Black adjusted death rate	White adjusted death rate	Adjusted death rate ratio
Wayne County, Michigan	235.3	159.7	1.5	270.2	134.0	2.0
Kankakee County, Illinois	157.2	155.1	1.0	239.0	118.7	2.0
Dougherty County, Georgia	299.2	402.9	0.7	451.6	225.3	2.0
Brevard County, Florida	152.7	102.7	1.5	123.7	61.8	2.0
York County, Pennsylvania	114.4	142.6	0.8	236.9	118.4	2.0
Nacogdoches County, Texas	293.8	305.5	1.0	501.0	250.7	2.0
Leon County, Florida	179.7	162.4	1.1	319.4	160.9	2.0
Plymouth County, Massachusetts	185.4	157.0	1.2	250.6	126.8	2.0
York County, South Carolina	78.1	58.2	1.3	117.3	59.6	2.0
Travis County, Texas	85.5	58.4	1.5	134.6	68.5	2.0
Lake County, Indiana	227.1	178.6	1.3	272.0	138.4	2.0
Racine County, Wisconsin	127.0	142.6	0.9	219.4	111.6	2.0
Union County, New Jersey	280.1	239.2	1.2	320.4	163.3	2.0
Mobile County, Alabama	193.1	150.6	1.3	254.2	129.6	2.0
Guilford County, North Carolina	53.3	53.9	1.0	78.1	40.0	2.0
Cobb County, Georgia	84.9	104.9	0.8	192.3	98.4	2.0
Somerset County, New Jersey	174.0	209.4	0.8	263.1	135.0	1.9
Elkhart County, Indiana	157.9	214.9	0.7	345.2	178.0	1.9
Clayton County, Georgia	38.3	71.5	0.5	82.5	42.6	1.9
Norfolk County, Massachusetts	132.7	151.3	0.9	224.5	116.1	1.9
Troup County, Georgia	212.1	262.8	0.8	430.9	223.2	1.9
Oneida County, New York	132.3	204.3	0.6	282.2	146.3	1.9
Hennepin County, Minnesota	114.7	161.6	0.7	270.7	140.7	1.9
Greenwood County, South Carolina	210.0	225.8	0.9	285.8	149.6	1.9
Prince William County, Virginia	56.8	50.4	1.1	106.6	56.0	1.9
Rock Island County, Illinois	159.5	211.6	0.8	275.7	144.9	1.9
Solano County, California	81.9	64.0	1.3	87.7	46.3	1.9
Houston County, Alabama	447.3	448.4	1.0	655.9	346.5	1.9
San Joaquin County, California	165.7	168.6	1.0	225.7	119.4	1.9
Madison County, Illinois	118.8	140.8	0.8	222.7	117.9	1.9
St. Mary's County, Maryland	187.0	94.0	2.0	177.6	94.4	1.9
Maricopa County, Arizona	109.7	154.5	0.7	216.1	115.0	1.9
Virginia Beach city, Virginia	47.0	43.5	1.1	74.2	40.1	1.9
Jones County, Mississippi	175.4	148.6	1.2	212.4	115.1	1.8
Fort Bend County, Texas	60.0	52.6	1.1	102.0	55.5	1.8
San Diego County, California	60.8	67.2	0.9	95.7	52.4	1.8
Fairfield County, Connecticut	194.5	207.3	0.9	270.9	148.7	1.8
Lubbock County, Texas	283.9	342.8	0.8	586.1	325.3	1.8
Forrest County, Mississippi	409.6	521.0	0.8	746.8	416.4	1.8
Gloucester County, New Jersey	210.1	141.7	1.5	237.5	132.8	1.8
Denver County, Colorado	125.7	74.1	1.7	144.8	81.0	1.8
Henry County, Georgia	85.5	103.4	0.8	163.8	91.6	1.8
Cumberland County, New Jersey	129.5	207.6	0.6	236.8	132.8	1.8

Table 11 (continued)

County	Black crude death rate	White crude death rate	Crude death rate ratio	Black adjusted death rate	White adjusted death rate	Adjusted death rate ratio
Rockdale County, Georgia	111.8	163.5	0.7	177.7	99.9	1.8
Cook County, Illinois	205.1	160.9	1.3	221.8	124.9	1.8
Comanche County, Oklahoma	78.2	133.8	0.6	223.5	126.0	1.8
Beaver County, Pennsylvania	248.0	167.8	1.5	215.3	121.9	1.8
East Baton Rouge Parish, Louisiana	247.7	272.7	0.9	392.9	222.6	1.8
Essex County, New Jersey	335.5	317.5	1.1	411.1	233.9	1.8
Contra Costa County, California	65.0	55.5	1.2	68.1	38.7	1.8
Bristol County, Massachusetts	123.7	185.2	0.7	251.7	144.8	1.7
Greenville County, South Carolina	143.7	130.7	1.1	203.1	117.1	1.7
Prince George's County, Maryland	113.8	120.1	0.9	132.2	76.4	1.7
Milwaukee County, Wisconsin	117.0	147.0	0.8	194.5	112.4	1.7
Ouachita Parish, Louisiana	273.0	321.8	0.8	482.3	278.8	1.7
McLennan County, Texas	184.7	205.7	0.9	275.9	159.8	1.7
Kent County, Delaware	121.7	114.8	1.1	155.3	90.2	1.7
Champaign County, Illinois	77.6	116.6	0.7	180.3	105.1	1.7
Queens County, New York	314.4	288.9	1.1	297.8	174.7	1.7
Harford County, Maryland	85.4	75.2	1.1	115.0	67.7	1.7
Montgomery County, Alabama	263.4	331.6	0.8	388.5	229.5	1.7
Calcasieu Parish, Louisiana	152.8	141.9	1.1	238.5	140.9	1.7
Spartanburg County, South Carolina	167.3	180.9	0.9	250.5	148.5	1.7
Durham County, North Carolina	62.9	61.5	1.0	90.0	53.4	1.7
Onondaga County, New York	132.7	184.3	0.7	232.8	138.1	1.7
Rutherford County, Tennessee	137.3	164.6	0.8	355.2	211.3	1.7
Lauderdale County, Mississippi	537.0	420.3	1.3	520.5	310.2	1.7
Clark County, Nevada	137.5	161.4	0.9	207.8	124.1	1.7
Pierce County, Washington	49.2	52.2	0.9	83.6	50.1	1.7
Shelby County, Tennessee	142.9	158.5	0.9	213.7	128.1	1.7
Riverside County, California	106.4	146.6	0.7	153.1	92.1	1.7
Chesapeake city, Virginia	68.0	54.2	1.3	93.5	56.3	1.7
Howard County, Maryland	60.9	54.2	1.1	74.3	44.8	1.7
Gwinnett County, Georgia	46.9	70.2	0.7	107.5	64.8	1.7
San Bernardino County, California	153.5	163.7	0.9	220.9	133.8	1.7
Angelina County, Texas	260.8	248.3	1.1	333.0	202.1	1.6
Westchester County, New York	259.0	274.8	0.9	287.1	174.4	1.6
Pasco County, Florida	61.8	99.2	0.6	106.7	64.9	1.6
Columbia County, Florida	129.5	221.0	0.6	263.9	161.3	1.6
Henrico County, Virginia	137.7	145.9	0.9	177.4	108.4	1.6
San Francisco County, California	51.8	29.1	1.8	51.3	31.4	1.6
Dallas County, Texas	94.0	120.8	0.8	150.5	92.1	1.6
Clark County, Ohio	191.3	160.9	1.2	208.9	128.2	1.6

Table 11 (continued)

County	Black crude death rate	White crude death rate	Crude death rate ratio	Black adjusted death rate	White adjusted death rate	Adjusted death rate ratio
Pima County, Arizona	112.1	182.3	0.6	173.9	107.0	1.6
Anderson County, South Carolina	167.5	154.3	1.1	213.8	131.8	1.6
Tangipahoa Parish, Louisiana	118.4	138.8	0.9	224.1	138.3	1.6
Ramsey County, Minnesota	107.9	228.2	0.5	276.5	171.3	1.6
DeKalb County, Georgia	65.7	66.7	1.0	96.1	59.6	1.6
Los Angeles County, California	144.1	126.6	1.1	148.8	92.6	1.6
Miami-Dade County, Florida	141.8	136.3	1.0	171.9	107.2	1.6
Orange County, Florida	84.1	89.8	0.9	144.5	90.4	1.6
Cabarrus County, North Carolina	71.6	66.9	1.1	98.1	61.5	1.6
Orangeburg County, South Carolina	179.3	177.6	1.0	171.8	107.8	1.6
St. Louis County, Missouri	192.9	222.2	0.9	252.5	158.9	1.6
Richland County, South Carolina	116.5	124.5	0.9	191.6	120.9	1.6
Kane County, Illinois	102.0	126.5	0.8	172.2	108.8	1.6
Sacramento County, California	80.6	89.0	0.9	113.0	71.5	1.6
Charles County, Maryland	66.6	90.9	0.7	117.8	74.8	1.6
Caddo Parish, Louisiana	356.1	395.8	0.9	433.8	276.8	1.6
Hillsborough County, Florida	80.4	100.0	0.8	132.0	84.9	1.6
Kings County, New York	326.2	227.1	1.4	346.9	223.8	1.5
Fairfax County, Virginia	62.6	72.5	0.9	99.3	64.2	1.5
Camden County, New Jersey	195.8	211.8	0.9	250.8	162.0	1.5
Atlantic County, New Jersey	169.4	171.6	1.0	179.4	116.5	1.5
Ocean County, New Jersey	201.9	221.4	0.9	225.8	146.8	1.5
Burlington County, New Jersey	146.6	153.2	1.0	180.6	117.6	1.5
Lowndes County, Georgia	192.9	210.8	0.9	323.4	210.7	1.5
Faulkner County, Arkansas	104.3	144.9	0.7	274.3	179.0	1.5
Orleans Parish, Louisiana	149.5	110.2	1.4	164.4	107.6	1.5
Sumter County, South Carolina	126.1	96.2	1.3	128.7	84.7	1.5
Summit County, Ohio	134.1	155.3	0.9	179.6	119.1	1.5
Mecklenburg County, North Carolina	39.8	45.4	0.9	67.6	45.0	1.5
Cole County, Missouri	115.0	326.7	0.4	406.2	272.0	1.5
Portsmouth city, Virginia	117.7	108.4	1.1	137.8	92.4	1.5
King County, Washington	50.7	58.9	0.9	79.7	53.5	1.5
Lehigh County, Pennsylvania	141.1	360.3	0.4	365.4	246.2	1.5
Stanislaus County, California	163.2	219.1	0.7	259.8	175.1	1.5
Harris County, Texas	84.9	102.3	0.8	138.9	94.0	1.5
Linn County, Iowa	77.7	174.8	0.4	220.6	149.7	1.5
Macon County, Illinois	112.0	185.4	0.6	181.8	123.8	1.5
Bibb County, Georgia	255.9	342.1	0.7	344.7	234.9	1.5
Monroe County, Pennsylvania	113.4	151.3	0.7	178.5	122.0	1.5
Fresno County, California	107.6	155.6	0.7	152.4	104.7	1.5
Hampden County, Massachusetts	175.4	262.8	0.7	260.8	179.5	1.5

Table 11 (continued)

County	Black crude death rate	White crude death rate	Crude death rate ratio	Black adjusted death rate	White adjusted death rate	Adjusted death rate ratio
Kalamazoo County, Michigan	122.0	168.0	0.7	225.5	156.4	1.4
Trumbull County, Ohio	121.5	144.9	0.8	149.6	103.9	1.4
Lorain County, Ohio	90.2	111.8	0.8	127.9	88.9	1.4
Chatham County, Georgia	136.8	170.0	0.8	191.8	133.5	1.4
Tarrant County, Texas	105.6	158.3	0.7	208.8	146.2	1.4
Sumner County, Tennessee	103.3	141.8	0.7	198.4	139.4	1.4
Loudoun County, Virginia	63.3	71.8	0.9	126.3	88.8	1.4
St. Joseph County, Indiana	146.0	169.8	0.9	199.8	140.6	1.4
Bowie County, Texas	316.6	363.9	0.9	400.9	282.3	1.4
Bell County, Texas	69.6	130.0	0.5	175.7	123.8	1.4
Bay County, Florida	173.4	162.9	1.1	188.6	133.9	1.4
Hall County, Georgia	250.6	333.0	0.8	378.9	269.4	1.4
Jefferson County, Kentucky	146.7	191.6	0.8	216.7	154.6	1.4
Collin County, Texas	67.4	107.0	0.6	165.9	118.6	1.4
Dauphin County, Pennsylvania	152.8	216.3	0.7	223.4	160.4	1.4
Dane County, Wisconsin	46.7	87.6	0.5	121.4	87.3	1.4
Hamilton County, Tennessee	177.9	173.4	1.0	191.2	137.5	1.4
Monmouth County, New Jersey	217.5	207.1	1.1	226.5	163.1	1.4
Suffolk city, Virginia	170.4	178.2	1.0	218.5	158.1	1.4
Rowan County, North Carolina	65.1	83.4	0.8	93.7	67.8	1.4
Warren County, Kentucky	154.6	237.1	0.7	389.7	282.3	1.4
Polk County, Iowa	97.0	173.3	0.6	242.6	176.1	1.4
Philadelphia County, Pennsylvania	183.9	187.4	1.0	218.8	159.2	1.4
Bronx County, New York	270.6	516.5	0.5	345.5	255.9	1.4
Multnomah County, Oregon	63.3	69.5	0.9	96.0	71.1	1.3
Muscogee County, Georgia	206.9	260.7	0.8	280.0	207.7	1.3
Shawnee County, Kansas	133.2	241.0	0.6	244.9	182.0	1.3
Duval County, Florida	111.0	149.0	0.7	178.8	135.2	1.3
Middlesex County, Massachusetts	135.0	187.5	0.7	200.6	152.1	1.3
Terrebonne Parish, Louisiana	173.1	117.1	1.5	158.7	120.6	1.3
Denton County, Texas	47.1	79.3	0.6	121.6	92.8	1.3
New London County, Connecticut	58.1	119.9	0.5	115.4	88.2	1.3
Pulaski County, Arkansas	165.3	278.5	0.6	250.9	192.0	1.3
Hudson County, New Jersey	190.2	150.2	1.3	206.4	159.0	1.3
Forsyth County, North Carolina	39.6	54.1	0.7	53.9	41.6	1.3
Berks County, Pennsylvania	98.0	195.6	0.5	181.1	139.8	1.3
Spalding County, Georgia	188.5	247.6	0.8	237.6	183.9	1.3
Muskegon County, Michigan	155.6	183.3	0.8	195.3	152.6	1.3
St. Landry Parish, Louisiana	173.2	228.4	0.8	233.6	182.8	1.3
Northampton County, Pennsylvania	87.5	169.6	0.5	147.9	115.9	1.3
Allegheny County, Pennsylvania	135.4	175.3	0.8	157.3	123.2	1.3
Hardin County, Kentucky	81.4	125.0	0.7	165.5	130.7	1.3

Table 11 (continued)

County	Black crude death rate	White crude death rate	Crude death rate ratio	Black adjusted death rate	White adjusted death rate	Adjusted death rate ratio
Monroe County, New York	108.5	181.2	0.6	165.4	131.7	1.3
Newport News city, Virginia	76.9	119.1	0.6	121.1	96.7	1.3
Washoe County, Nevada	104.2	133.0	0.8	141.9	113.8	1.2
Lee County, Mississippi	460.8	519.9	0.9	581.4	467.9	1.2
Jefferson County, Arkansas	181.6	278.1	0.7	219.6	178.3	1.2
Montgomery County, Tennessee	63.7	77.1	0.8	132.9	107.9	1.2
Erie County, Pennsylvania	110.4	156.5	0.7	150.4	122.5	1.2
Smith County, Texas	305.0	377.6	0.8	342.9	282.3	1.2
Black Hawk County, Iowa	177.6	257.5	0.7	272.5	225.7	1.2
Madison County, Mississippi	79.5	112.9	0.7	126.9	106.6	1.2
Essex County, Massachusetts	103.6	213.1	0.5	179.6	151.1	1.2
Providence County, Rhode Island	135.7	347.8	0.4	297.7	252.9	1.2
Erie County, New York	151.5	211.3	0.7	184.2	156.6	1.2
Lancaster County, Pennsylvania	72.8	173.2	0.4	147.7	126.9	1.2
Marion County, Indiana	149.4	217.9	0.7	229.0	197.4	1.2
Clarke County, Georgia	210.2	250.4	0.8	400.9	345.7	1.2
Jackson County, Missouri	92.6	116.3	0.8	119.1	102.8	1.2
Allen County, Indiana	147.5	225.9	0.7	250.8	216.6	1.2
El Paso County, Colorado	85.2	101.8	0.8	127.6	110.7	1.2
Calhoun County, Alabama	162.5	215.0	0.8	211.3	183.6	1.2
Mahoning County, Ohio	204.0	297.7	0.7	224.4	195.5	1.1
Vanderburgh County, Indiana	125.1	251.0	0.5	251.7	220.3	1.1
Clay County, Missouri	68.1	159.9	0.4	178.9	156.7	1.1
Lucas County, Ohio	169.7	231.6	0.7	217.0	190.4	1.1
Worcester County, Massachusetts	89.9	200.7	0.4	189.3	166.6	1.1
Etowah County, Alabama	255.6	313.7	0.8	291.5	257.0	1.1
Franklin County, Ohio	117.4	161.6	0.7	195.1	172.2	1.1
Wichita County, Texas	196.4	310.5	0.6	301.7	266.5	1.1
Bexar County, Texas	82.5	134.8	0.6	125.9	113.3	1.1
Harrison County, Mississippi	94.8	145.6	0.7	146.8	132.3	1.1
New Castle County, Delaware	73.7	113.7	0.6	102.2	92.2	1.1
Sangamon County, Illinois	94.5	211.8	0.4	193.4	175.6	1.1
Anoka County, Minnesota	46.8	135.2	0.3	146.1	133.2	1.1
St. Clair County, Illinois	139.4	176.8	0.8	164.4	150.2	1.1
Arapahoe County, Colorado	69.9	119.3	0.6	120.7	110.9	1.1
Osceola County, Florida	70.6	88.3	0.8	84.9	78.3	1.1
Madison County, Alabama	86.8	152.3	0.6	138.1	128.1	1.1
Floyd County, Georgia	247.0	374.6	0.7	317.4	294.6	1.1
El Paso County, Texas	96.2	193.4	0.5	178.3	165.9	1.1
Saginaw County, Michigan	198.6	304.5	0.7	228.2	217.1	1.1
Jefferson County, Alabama	181.4	280.5	0.6	235.2	224.2	1.0
Tulsa County, Oklahoma	114.3	224.3	0.5	189.9	182.6	1.0
Madison County, Tennessee	411.9	683.9	0.6	547.0	529.6	1.0
Boone County, Missouri	109.7	169.2	0.6	198.1	192.0	1.0
Montgomery County, Ohio	189.6	252.5	0.8	204.6	200.2	1.0

Table 11 (continued)

County	Black crude death rate	White crude death rate	Crude death rate ratio	Black adjusted death rate	White adjusted death rate	Adjusted death rate ratio
Sedgwick County, Kansas	124.5	174.3	0.7	157.9	155.9	1.0
Knox County, Tennessee	111.4	175.2	0.6	163.5	162.5	1.0
Muskogee County, Oklahoma	153.2	241.3	0.6	179.3	178.4	1.0
Douglas County, Nebraska	98.4	167.3	0.6	166.1	168.2	1.0
Fayette County, Kentucky	94.0	145.0	0.6	145.4	151.1	1.0
Baltimore city, Maryland	186.4	204.9	0.9	203.3	215.6	0.9
Suffolk County, Massachusetts	204.1	264.1	0.8	246.7	263.0	0.9
Richmond County, Georgia	266.2	496.1	0.5	370.8	397.0	0.9
Lynchburg city, Virginia	248.9	395.1	0.6	349.0	374.6	0.9
Oklahoma County, Oklahoma	129.2	231.0	0.6	185.2	199.0	0.9
Peoria County, Illinois	121.2	352.6	0.3	248.2	266.8	0.9
Davidson County, Tennessee	152.3	252.5	0.6	251.3	271.9	0.9
Hinds County, Mississippi	265.1	653.3	0.4	402.8	441.3	0.9
Jefferson County, Texas	134.0	282.8	0.5	179.4	196.6	0.9
Cuyahoga County, Ohio	132.9	216.5	0.6	135.1	152.5	0.9
Stark County, Ohio	140.3	225.4	0.6	156.4	178.5	0.9
Carroll County, Georgia	121.6	220.7	0.6	201.0	229.9	0.9
Richmond city, Virginia	97.8	127.3	0.8	109.8	134.3	0.8
Hamilton County, Ohio	104.8	179.6	0.6	127.0	155.4	0.8
St. Louis city, Missouri	146.4	182.5	0.8	159.0	198.9	0.8
Nueces County, Texas	90.5	190.5	0.5	115.9	148.9	0.8
Madison County, Indiana	92.0	176.4	0.5	108.1	141.6	0.8
Potter County, Texas	320.1	841.3	0.4	498.0	662.9	0.8
Wyandotte County, Kansas	240.6	344.2	0.7	250.8	336.3	0.7
Taylor County, Texas	104.7	359.7	0.3	226.7	307.8	0.7
Kanawha County, West Virginia	116.0	200.1	0.6	96.0	147.3	0.7
Roanoke city, Virginia	88.4	390.8	0.2	116.7	279.4	0.4

Table 12 Results of linear regression showing percentage change in the total death rate, Black death rate, White death rate, and ratio of Black to White age-adjusted COVID-19 death rates for each one standard deviation increase in the percentage Black population in a county, 95% confidence intervals (CI), and *P* values in bivariate models ($N = 353$ counties)

Outcome variable	Percent change in outcome variable for each one standard deviation increase in percent Black population	95% CI	*P* value
Overall COVID-19 death rate	+ 10.9%	+ 5.5 to 16.6%	< 0.001
Black COVID-19 death rate	+ 2.0%	− 3.3 to +7.5%	0.472
White COVID-19 death rate	+ 9.1%	+ 3.3 to +15.2%	0.002
Ratio of Black to White COVID-19 death rate	− 6.5%	− 2.5 to − 10.3%	0.002

Table 13 Percentage Black population for the top 10 and bottom 10 counties in terms of the Black-White death rate ratio

County	Age-adjusted Black/White death rate ratio	Percentage Black population (%)
Orange County, North Carolina	7.0	11.4
Jackson County, Michigan	6.9	6.9
Montgomery County, Texas	5.5	5.2
Niagara County, New York	5.4	6.5
Hanover County, Virginia	4.8	10.0
Brazoria County, Texas	4.6	14.8
Jefferson Parish, Louisiana	4.4	27.1
Lake County, Ohio	4.2	4.7
Manatee County, Florida	4.1	9.0
Morris County, New Jersey	4.1	3.8
Average for Top 10	**5.1**	**9.9**
Richmond city, Virginia	0.8	45.2
Hamilton County, Ohio	0.8	25.7
St. Louis city, Missouri	0.8	45.2
Nueces County, Texas	0.8	4.0
Madison County, Indiana	0.8	8.4
Potter County, Texas	0.8	10.6
Wyandotte County, Kansas	0.7	22.1
Taylor County, Texas	0.7	9.0
Kanawha County, West Virginia	0.7	6.8
Roanoke city, Virginia	0.4	30.8
Average for Bottom 10	**0.7**	**20.8**

The age-adjusted mortality rates were calculated using indirect standardization to the U.S. population

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