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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Received: 3 May 2021 / Revised: 6 July 2021 / Accepted: 7 July 2021 / Published online: 30 August 2021
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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

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. 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...
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.
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).
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).

| County                        | Crude Black death rate | Crude White death rate | Crude Death rate ratio | Age-adjusted Black death rate | Age-adjusted White death rate | Age-adjusted 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.
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 20.9%). 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 racism measures and the magnitude of the racial disparity in COVID-19 mortality remained significant.

### Table 3

| Structural racism measure | Percent change in racial disparity in COVID-19 death rates | 95% CI | P value |
|---------------------------|-----------------------------------------------------------|-------|--------|
| Incarceration ratio       | + 9.4% < 0.01                                            | + 5.0 to + 14.1   |
| Rental housing ratio      | + 7.1% < 0.001                                           | + 11.4 to + 0.0%  |
| Index of Concentration at the Extremes | + 11.1% < 0.01                                      | + 4.8 to + 17.0   |
| Racial opportunity gap    | + 8.6% < 0.01                                           | + 12.0 to + 0.0%  |

### Table 4

| Structural racism measure | Percent change in racial disparity in COVID-19 death rates | 95% CI | P value |
|---------------------------|-----------------------------------------------------------|-------|--------|
| Incarceration ratio       | + 6.0% < 0.01                                            | + 1.2 to + 11.1  |
| Rental housing ratio      | - 0.4% < 0.01                                           | - 4.8 to + 4.2   |
| Index of Concentration at the Extremes | + 13.3% < 0.01                                      | + 6.1 to + 20.9  |
| Racial opportunity gap    | + 10.3% < 0.01                                          | + 5.7 to + 15.1  |

All models include the log of the White COVID-19 mortality rate, total county population, and percent Black.
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                   | 9.4%                                                   | +5.0 to < 1.28 | 0.01  |
| With all five mediating variables | +10.9%                                             | +6.1 to < 2.60 | 0.01  |
| Model 2                   | 7.1%                                                   | +2.9 to 0.001 1.15 | 0.01  |
| With all five mediating variables | +7.9%                                             | +3.4 to 0.001 2.94 | 0.01  |
| Model 3                   | 11.1%                                                  | +4.8 to < 2.48 | 0.01  |
| With all five mediating variables | +13.7%                                             | +6.0 to < 3.71 | 0.01  |
| Model 4                   | 8.6%                                                   | +4.5 to < 1.11 | 0.01  |
| With all five mediating variables | +9.7%                                             | +5.1 to < 2.64 | 0.01  |

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.

Table 5 shows the results of linear regression models predicting the percentage change in the age-adjusted Black COVID-19 mortality rate for each one standard deviation increase in the county structural racism measures shown, along with 95% confidence intervals (CI), P values, and highest variance inflation factors (VIF). The 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.

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 death rates, not only Black, but White COVID-19 rates could be higher in counties with larger 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 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).*

| Age group (in years) | 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.*

| 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** | **Entire population** | **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 3,467 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                       | $D = \frac{1}{2} \text{SUM} [\text{Blackpct} - \text{Whitepct}] \times 100$, 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 spatially 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                       |
| 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                      |
| 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                       |
| Onedia 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                       |
| 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**

| 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                      |
| 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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