

Comparison of Rates of Firearm and Nonfirearm Homicide and Suicide in Black and White Non-Hispanic Men, by U.S. State

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Background: The extent to which differences in homicide and suicide rates in black versus white men vary by U.S. state is unknown.

Objective: To compare the rates of firearm and nonfirearm homicide and suicide in black and white non-Hispanic men by U.S. state and to examine whether these deaths are associated with state prevalence of gun ownership.

Design: Surveillance study.

Setting: 50 states and the District of Columbia, 2008 to 2016. Cause-of-death data were abstracted by using the Centers for Disease Control and Prevention's WONDER (Wide-ranging On-line Data for Epidemiologic Research) database.

Participants: Non-Hispanic black and non-Hispanic white males, all ages.

Measurements: Absolute rates of and rate differences in firearm and nonfirearm homicide and suicide in black and white men.

Results: During the 9-year study period, 84 113 homicides and 251 772 suicides occurred. Black-white differences in rates of firearm homicide and suicide varied widely across states. Rela-

tive to white men, black men had between 9 and 57 additional firearm homicides per 100 000 per year, with black men in Missouri, Michigan, Illinois, Indiana, and Pennsylvania having more than 40 additional firearm homicides per 100 000 per year. White men had between 2 fewer and 16 more firearm suicides per 100 000 per year, with the largest inequalities observed in southern and western states and the smallest in the District of Columbia and densely populated northeastern states.

Limitations: Some homicides and suicides may have been misclassified as deaths due to unintentional injury. Survey data on state household gun ownership were collected in 2004 and may have shifted during the past decade.

Conclusion: The large state-to-state variation in firearm homicide and suicide rates, as well as the racial inequalities in these numbers, highlights states where policies may be most beneficial in reducing homicide and suicide deaths and the racial disparities in their rates.

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In 2016, non-Hispanic black men were nearly 10.4 times more likely than non-Hispanic white men to die by homicide in the United States, whereas white men were 2.5 times more likely than black men to die by suicide (1). More than 80% of homicides and 60% of suicides involved firearms. The relative racial inequalities in violent deaths are especially marked for firearm homicide. Black men are 14 times more likely than white men to die by firearm homicide (1).

Racial disparities in violent deaths are well-established in the United States overall, but whether these inequalities vary by state—and if so, by how much—is unknown. Large variation in racial disparities would suggest the presence of explanatory factors that differ across states. These factors might reflect differences in race-specific levels of exposure to socioeconomic characteristics, neighborhood residential conditions, medical care, or policy environments that are known to affect violence (2). Measuring state-to-state variation in racial disparities in homicide and suicide rates, which are masked when looking only at the pop-

ulation average, may help identify areas where subpopulations may have an excess burden of injury and where efforts might be directed to reduce inequalities.

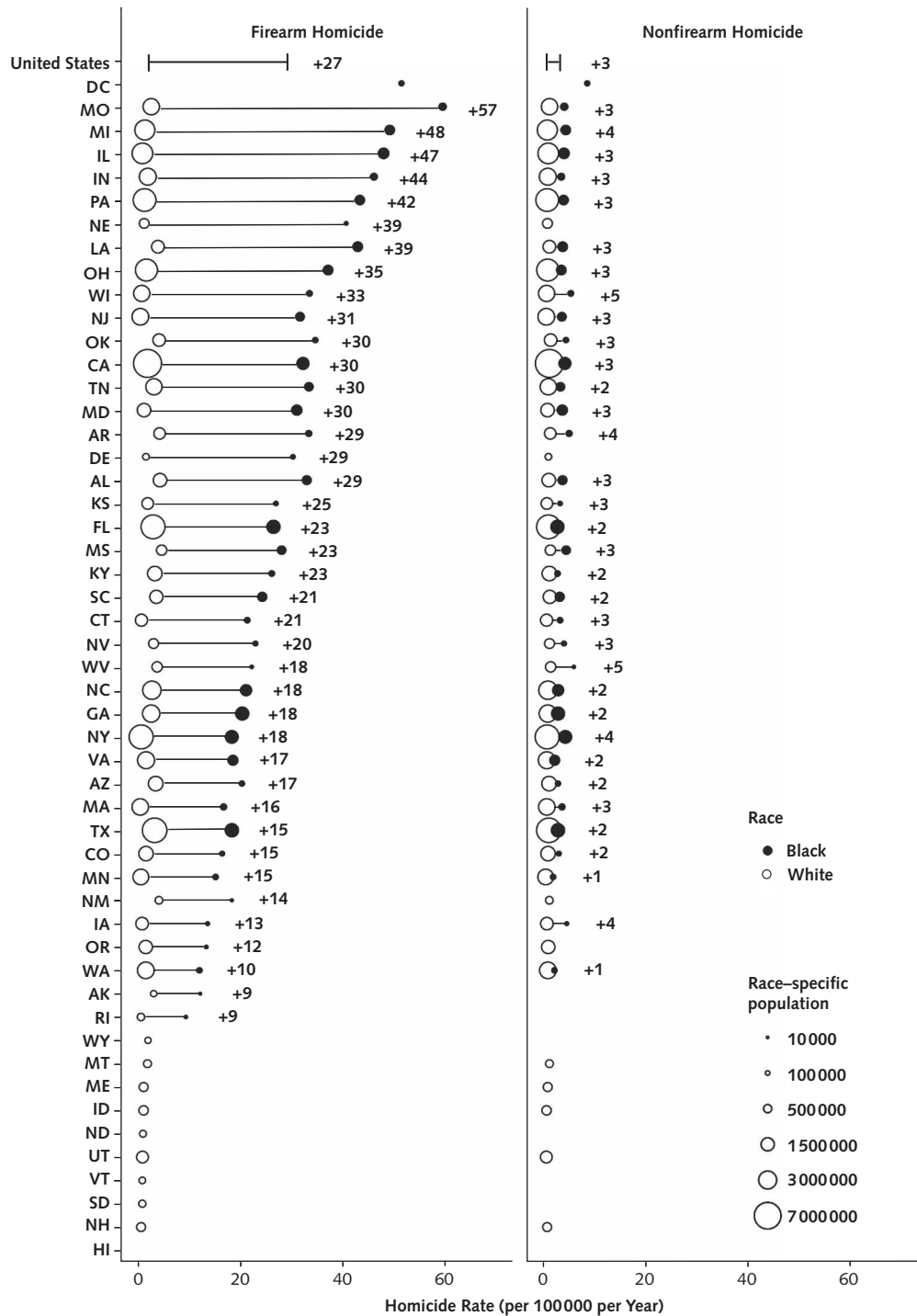
Across the United States, states with the highest levels of household gun ownership also have the highest rates of firearm suicide and homicide (3). Ecological studies comparing U.S. states have estimated that gun ownership rates are positively associated with rates of firearm homicide and suicide (4–8), and case-control studies have found positive associations between the presence of a gun in the home and a person's risk for homicide occurring at home (9), as well as his or her overall risk for suicide (10). Two components of the causal pathway to homicide or suicide are motivation and opportunity (11). Gun availability or ownership increases opportunity, and motivation conceivably might vary by racial group. For example, participation in illegal activity is linked to increased homicide risk (12), whereas social support and cultural cohesion are linked to decreased suicide risk (13). Thus, the relationship between gun availability and homicide or suicide may differ according to race. This information is currently unknown but could inform whether policies aimed at reducing gun prevalence might have different effects among blacks versus whites.

In this study, we aimed to compare the rates of firearm and nonfirearm homicide and suicide among black and white non-Hispanic men by U.S. state and to

See also:

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Supplement

Figure 1. Comparison of firearm and nonfirearm homicide rates between black and white non-Hispanic men by U.S. state, 2008 to 2016.



The homicide rate for non-Hispanic white men (*open circles*) is compared with the rate for non-Hispanic black men (*solid circles*) for each state. The area of the circle is proportional to its race-specific population size, as defined in the key. For each state, the difference between rates is shown to the right of the circles and quantifies the excess number of homicides in black men per 100 000 per year. The average firearm and nonfirearm homicide rates for the entire United States are shown at the top of each graph, followed by the states organized according to the size of the black-white difference. States that are missing circles for black or white men had 19 or fewer firearm or nonfirearm homicides within the affected racial group during the study period, and data were not available for analysis.

examine the association between state gun ownership prevalence and firearm homicide and suicide rates.

METHODS

We used the WONDER (Wide-ranging Online Data for Epidemiologic Research) database of the Centers for Disease Control and Prevention to abstract age-adjusted rates of homicide and suicide (1). Data were abstracted for all states and the District of Columbia between 2008 and 2016 for non-Hispanic white and black males of any age. Codes from the International Classification of Diseases, 10th Revision, were used to identify firearm homicides (X93, X94, and X95), nonfirearm homicides (X85 to X92, X96 to X99, and Y01 to Y05), firearm suicides (X72, X73, and X74), and nonfirearm suicides (X60 to X71 and X75 to X84). Rates were suppressed by the data provider for any state that had fewer than 20 deaths for the race group between 2008 and 2016. Suppressed data were set to missing in our statistical analysis. These data originated from death certificates provided by states to the National Vital Statistics System and overseen by the Centers for Disease Control and Prevention's National Center for Health Statistics. Race and Hispanic ethnicity were recorded by medical examiners. Throughout this article, we refer to the study population as men because the vast majority of deaths occurred after childhood.

We computed the average annual fatality rate according to race, intent, and firearm involvement by dividing the number of fatalities by the total population estimate (that is, the sum of population estimates from 2008 to 2016), and we calculated the absolute inequality (rate difference) in estimates between black and white men. For homicide, we subtracted the fatality rate of white men from that of black men. For suicide, these rates were reversed, such that the estimated rate differences are mostly positive and interpreted as the number of additional deaths of black (white) men due to homicide (suicide) associated with the heightened fatality rate of black (white) men. When either of the race-specific rates was suppressed, a rate difference was not calculated for the state. To reflect varying population sizes among states and by race, we represent the area of each data marker to be proportional to the race-specific average annualized population size.

To examine the relationships among household gun ownership, firearm homicide, and firearm suicide by race and state, we used the last available state-level estimates of household firearm ownership from the National Behavioral Risk Factor Surveillance System (BRFSS) from 2004. The BRFSS is an annual telephone survey of the noninstitutionalized adult population that asks respondents about their health-related risk behaviors, chronic health conditions, and use of preventive services. In 2001, 2002, and 2004, the BRFSS asked, "Are any firearms kept in or around your home?" More than 293 000 people responded to this question; estimates of household gun ownership prevalence (percentage) by state were computed previously and ranged from 10.2% in Hawaii to 65.5% in Wyoming

(14). Given that respondents may have underreported gun ownership and that state gun prevalence may have shifted since 2004, we grouped states into 4 broad categories of gun prevalence—10.2% to 19.9%, 20.0% to 34.9%, 35.0% to 44.9%, and 45.0% to 65.5%—to provide a reasonable approximation of current levels of ownership.

We then visually assessed the relationships among state gun prevalence, firearm homicide, and firearm suicide by plotting the rate of firearm homicide as a function of firearm suicide. We color-coded the points by category of gun prevalence, separately for black and white men. This descriptive exercise illustrates whether states with relatively high rates of firearm homicide also have relatively high rates of firearm suicide, and whether this pattern exists for both black and white men and is associated with state gun ownership. A strong association would suggest that firearm homicide and suicide share risk factors and may be amenable to similar prevention strategies. A weak association would indicate less overlap in risk factors and therefore a need for distinct preventive approaches.

Data management and visualization were performed in R, version 3.3.2 (The R Foundation) (15). Because this study used publicly accessible data, an institutional ethical review was not required (16). A replication data set including the raw data and statistical code to reproduce this work is publicly available on GitHub (<https://github.com/corinne-riddell/InjuryDisparity/>).

Role of the Funding Source

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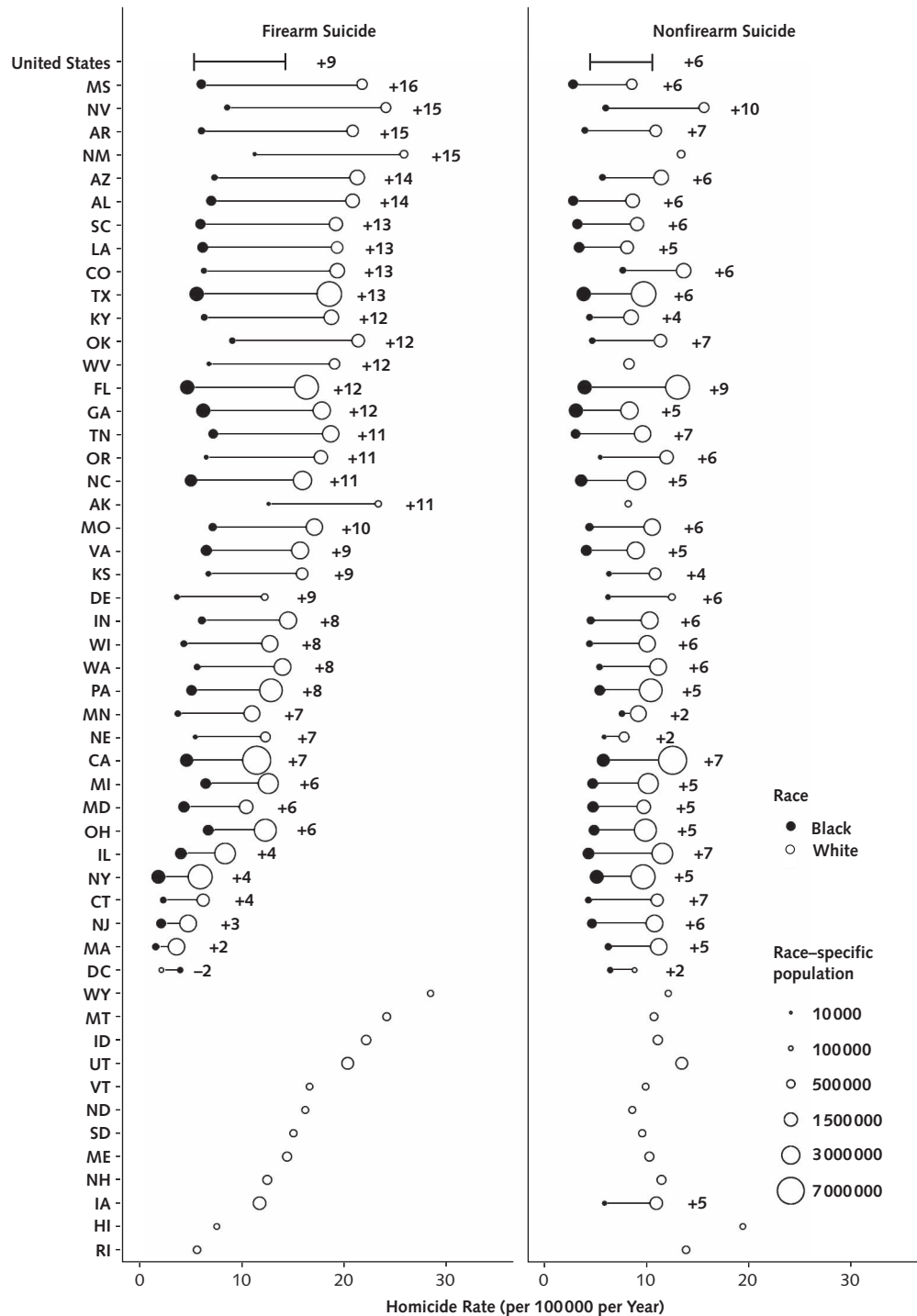
RESULTS

Our analysis included 84 113 homicides and 251 772 suicides from 2008 to 2016. Homicide deaths were suppressed by the National Center for Health Statistics for black men in 16 states and for white men in 8 states. Suicide deaths were suppressed in 14 states for black men; no suicides were suppressed for white men.

Comparison of Firearm Homicide Rates

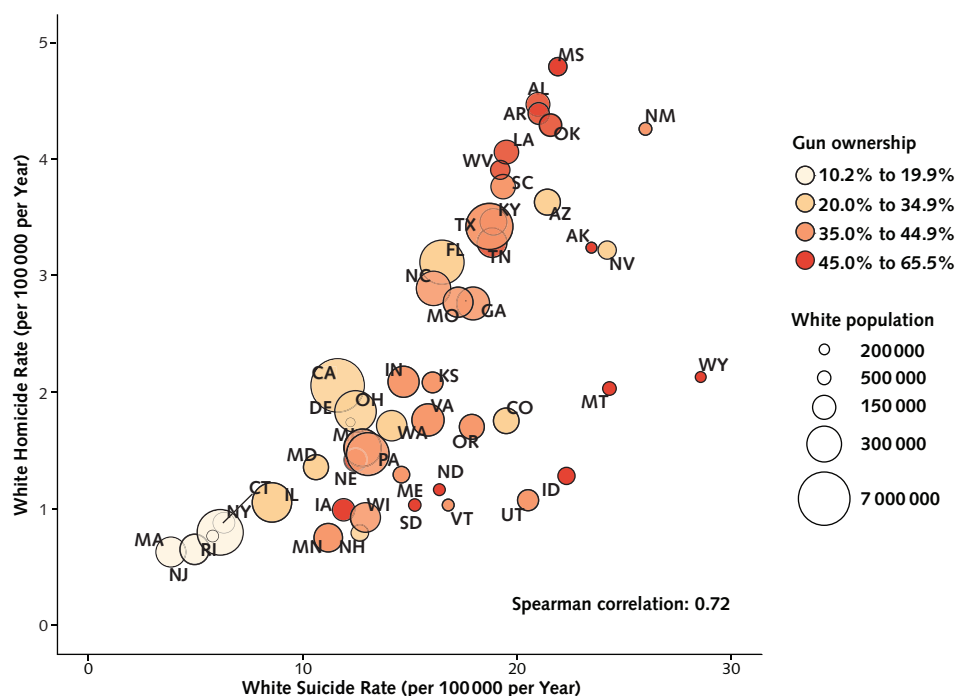
Figure 1 displays the homicide rates among black versus white men, according to state and firearm use. The Supplement (available at [Annals.org](https://annals.org)) contains tables providing the exact estimates of the rates shown in the figures. Across the entire United States, black men had 27 more homicides per 100 000 per year than white men. The black-white difference in firearm homicide rates varied strikingly by state, from 9 to 57 per 100 000 per year, and was driven by marked variation in firearm homicides of black men across states. States with the smallest firearm homicide rates among blacks had fewer than 15 deaths per 100 000 per year during the study period, compared with more than 40 deaths per 100 000 per year in states with the highest rates. Firearm homicide rates for white men showed relatively little variation across states: between 1 and 5 deaths

Figure 2. Comparison of firearm and nonfirearm suicide rates between black and white non-Hispanic men by U.S. state, 2008 to 2016.



The suicide rate for non-Hispanic white men (open circles) is compared with the rate for non-Hispanic black men (solid circles) for each state. The area of the circle is proportional to its race-specific population size, as defined in the key. For each state, the difference between rates is listed to the right of the circles and quantifies the excess number of suicides in white men per 100 000 per year. The average firearm and nonfirearm suicide rates for the entire United States are shown at the top of each graph, followed by the states organized according to the size of the white-black difference. States that are missing circles for black or white men had 19 or fewer firearm or nonfirearm suicides within the affected racial group during the study period, and data were not available for analysis.

Figure 3. Relationship between the annual rates of firearm homicide and suicide among white men, by state, and reported household firearm ownership, 2008 to 2016.



Each state's homicide and suicide mortality rates among non-Hispanic white men are plotted. The area of the circle is proportional to the white male population size, and the shading represents state gun ownership prevalence. The District of Columbia and Hawaii had suppressed estimates for firearm homicide or suicide in white men; therefore, the estimates are not plotted.

per 100 000 per year. The states with the highest rates of firearm homicide for black men (namely Missouri, Michigan, Illinois, and Indiana) also had the largest differences in rates between blacks and whites, signaling states that had the highest risk for blacks but a relatively low risk for whites. The District of Columbia also had a relatively high risk for black but not white men.

Comparison of Firearm Homicide Rates in Black Men Among States With the Largest Black Populations

Another way to make comparisons is to consider the states that are home to the most black residents to determine whether these states also varied in their rates of firearm homicide compared with spatially contiguous states. Nearly 40% of the U.S. black population lives in Georgia, New York, Florida, Texas, and California, and make up between 6% and 30% of each state's population. Among these states, Texas exhibited the smallest black-white difference in firearm homicide (15 additional deaths in black men per 100 000 per year), which also was substantially lower than the differences estimated for neighboring states, including Louisiana (+39), Oklahoma (+30), and Arkansas (+29). Georgia (+18) and Florida (+23) had differences similar to those of nearby South Carolina (+21) and North Carolina (+18) and had lower rates than Alabama (+29) and Tennessee (+30). New York's difference (+18) was similar to that of Massachusetts (+16) and Connecticut (+21)

but substantially lower than the rates of neighboring New Jersey (+31) and Pennsylvania (+42). California exhibited the largest black-white difference (+30) in firearm homicide among the 5 states with the largest black populations. California's black-white difference was larger than that estimated for contiguous states, including Nevada (+20) and Oregon (+12), although these states had relatively small black populations.

Comparison of Nonfirearm Homicide Rates

Nonfirearm homicides occur much less frequently among both black and white men. On average, 3 more nonfirearm homicides per 100 000 per year occurred among black than white men. Black men had rates that varied between 2 and 8 per 100 000 per year by state, whereas rates in white men were less than 1 per 100 000 per year. On average, firearm homicide rates were 9-fold higher than nonfirearm rates among black men. The states with the largest differences between firearm and nonfirearm homicide rates were Missouri, Indiana, Illinois, and Louisiana, each of which had firearm homicide rates more than 12 times higher than their nonfirearm homicide rates.

Comparison of Firearm Suicide Rates

In contrast to homicide, suicide rates were higher among white than black men, independent of firearms involvement, with the exception of firearm suicide in the District of Columbia (Figure 2). Across the United

States, white men had 9 more firearm suicides per 100 000 per year than black men. The white-black difference in firearm suicides varied from −2 per 100 000 per year in the District of Columbia to 16 per 100 000 per year in Missouri, although differences could not be estimated for 12 states with fewer than 20 firearm suicides among blacks. The annual rate of firearm suicide varied more markedly for white than black men: from 2 per 100 000 per year in the District of Columbia to 29 per 100 000 per year in Wyoming for white men, compared with a range of 2 per 100 000 per year in Massachusetts to 13 per 100 000 per year in Alaska among black men.

Six of the 10 states with the largest white-black differences in firearm suicide—Mississippi, Arkansas, Alabama, Texas, South Carolina, and Louisiana—are located in the South, whereas the other 4—Nevada, Arizona, New Mexico, and Colorado—are in the West (range, 12.9 to 15.7 per 100 000 per year). Along with the District of Columbia, the northeastern states of Massachusetts, New Jersey, Connecticut, and New York had the smallest white-black differences (≤ 4 per 100 000 per year) in firearm suicide rates.

Comparison of Nonfirearm Suicide Rates

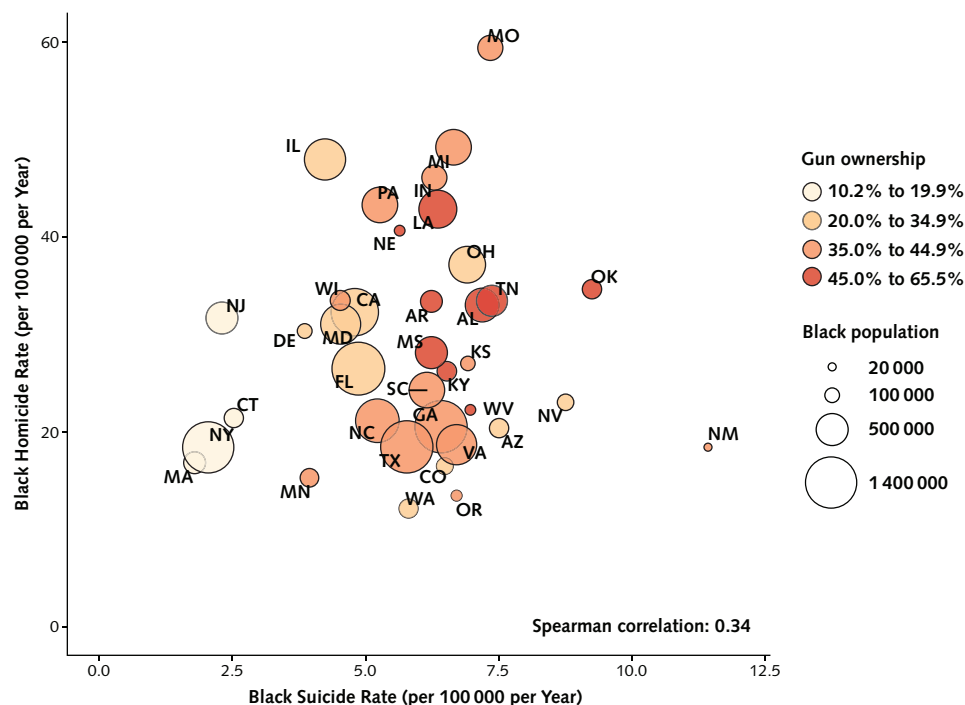
The rates of nonfirearm suicides among whites and blacks, as well as the difference between rates, varied substantially less than the rates of suicides involving

firearms. In the United States overall, the nonfirearm suicide mortality rate was 10.6 per 100 000 per year in white men compared with 4.4 per 100 000 per year among black men. Of all the states, Hawaii had the highest rate of nonfirearm suicides for white men—19 per 100 000 per year—whereas Nebraska had the lowest rate—8 per 100 000 per year. For black men, the highest estimated rate was 8 per 100 000 per year in Colorado; the lowest was 3 per 100 000 per year in Mississippi.

Relationship of Firearm Homicide and Suicide to State Household Gun Ownership Among White Men

Firearm homicide and suicide were strongly associated for white men (Figure 3). In terms of the relationship among firearm homicide, suicide, and state gun prevalence, the 5 states with lower rates of both firearm homicide and suicide in white men (namely Massachusetts, New Jersey, Rhode Island, New York, and Connecticut) also were in the lowest category of reported state gun prevalence. Furthermore, many states with the highest firearm homicide and suicide rates belonged to the highest category of gun prevalence, whereas most states located in the middle of the graph were in the middle categories of gun prevalence. Of note, several states in the highest gun prevalence cat-

Figure 4. Relationship between the annual rates of firearm homicide and suicide among black men, by state, and reported household firearm ownership, 2008 to 2016.



Each state's homicide and suicide mortality rates among non-Hispanic black men are plotted. The area of the circle is proportional to the black male population size, and the shading represents state gun ownership prevalence. Hawaii, Idaho, Iowa, Maine, Montana, North Dakota, New Hampshire, South Dakota, Rhode Island, Utah, Vermont, and Wyoming had suppressed estimates for firearm homicide or suicide in black men; therefore, the estimates are not plotted.

egory had relatively low rates of firearm homicide, including Iowa, Nebraska, the Dakotas, Idaho, Montana, and Wyoming.

Relationship of Firearm Homicide and Suicide to State Household Gun Ownership Among Black Men

Among black men, firearm homicide and suicide were modestly associated (Figure 4). States with the lowest reported prevalence of guns had the lowest rates of firearm suicide and below-average rates of firearm homicide. Missouri and several rust belt states (Illinois, Indiana, Michigan, and Pennsylvania) reported the most firearm homicides among black men but medium levels of gun ownership. Among the southern states, those with high levels of gun ownership, such as Louisiana, reported higher homicide rates among black men than states with medium levels, such as Texas.

DISCUSSION

Firearm homicide rates among black men varied substantially across states. For white men, rates were consistently lower and less variable, leading to large racial inequalities in firearm homicide, especially in Missouri, Michigan, Illinois, Indiana, and Pennsylvania. Nonfirearm homicides occurred much less frequently than firearm homicides and exhibited little variation across states. However, these homicides still occurred more frequently among black than white men. White men were at higher risk than black men for firearm suicide, most notably in Mississippi, Nevada, Arkansas, New Mexico, and Alabama. Northeastern states with reliable data (New York, Connecticut, New Jersey, and Massachusetts) and the District of Columbia showed the smallest differences in firearm suicide rates. These states also had the lowest suicide risk for both black and white men, implying that they offer the lowest race-specific risks and are the closest to achieving racial equality in firearm suicide. In terms of nonfirearm suicide, white men had higher rates than black men, although these rates varied less than those of firearm suicide.

For white men, firearm homicide and suicide shared a strong positive association. This suggests that the characteristics that generate variation across states in firearm homicide and suicide are similar for white men. States with the lowest gun ownership rates had the lowest rates of firearm homicide and suicide among white men, and several states with the highest gun ownership rates had the highest rates of firearm homicide and relatively high rates of firearm suicide.

The relationship between firearm homicide and suicide was modest for black men. In contrast to white men, this moderate relationship suggests that the risk factors for firearm homicide and suicide for black men are more dissimilar, and the substantial variation in firearm homicide among black men suggests the presence of additional explanatory factors for firearm homicide compared with firearm suicide. Although state gun ownership was positively associated with both out-

comes for white men, some states with medium levels of gun ownership had the highest homicide rates among black men, whereas others had relatively low rates, implying the presence of important unexamined factors in determining homicide risk for black men.

The spatial distribution of homicides is known to vary, with suicides occurring at the highest rates in the most rural settings and homicides occurring at the highest rates in the most urban settings (17). Particularly with respect to homicide, this urban-rural divide probably reflects predictors present in metropolitan environments, such as higher levels of income inequality, female-headed households, and crowding (18). Higher suicide rates in rural areas have been attributed to social and geographic isolation, access to lethal mechanisms, and stresses associated with agricultural work (19).

Although ample research has been done on homicide and suicide risk factors, the mechanisms that have led to varying racial inequalities across states are less clear. Structural disadvantage (namely concentrated poverty, joblessness, and family disruption) (20), racial residential segregation (21–24), and participation in drug markets (25, 26) have all been implicated in the higher risk for homicide among black men relative to white men. Thus, these risk factors may occur more frequently among black men residing in states with the largest disparities in firearm homicide.

Firearm policy also has been implicated in differences in the overall rates of homicide and suicide across the United States. A cross-sectional ecological study found that states with more restrictive firearm laws had 6.6 fewer firearm deaths per 100 000 per year than states with the least restrictive environments (27). Analyses comparing states that revised their firearm policies with a synthetic control estimated that changes to permit-to-purchase laws are linked to decreases in firearm (but not nonfirearm) homicide and suicide rates (28, 29). Thus, differences in state policy environments probably have contributed to the levels of homicide and suicide estimated in this study, although whether policies are linked to racial inequalities is less clear.

State gun prevalence was strongly tied to firearm suicide for both black and white men, and firearms are the most lethal means of attempted suicide (30, 31). In addition, states with the lowest risk for firearm suicide also had the most restrictive gun laws (32).

Alcohol is another important risk factor for suicide, in terms of both history of alcoholism and overuse at the time of suicide (33, 34). Alcohol was found in the system of 25% of white and 15% of black men who died by suicide in 2005 to 2006, with 16% of the white men being described as alcohol dependent at the time of suicide, compared with 7% of the black men (35). Given that white men have higher rates of alcohol abuse than black men (35), alcohol use might be implicated in both the direction of the white-black inequality and its variation across states.

Although we could not estimate state-level disparities in age-specific mortality rates, national figures indicate very different trends for black and white men

(36). Suicidal risk increases for white men as they age and exceeds 30 firearm suicides per 100 000 per year for men aged 75 years or older. For black men, the peak rate of 10 firearm suicides per 100 000 per year occurs at ages 25 to 29 years (36). The estimated white-black differences in suicide mortality and their variation by state therefore may reflect differences across states in the risks for younger black and older white men to commit suicide by firearm.

We searched MEDLINE for literature on racial disparities in homicide or suicide using the search strategy

"Homicide"[MeSH] OR "Suicide"[MeSH]) AND (health disparit [Text Word] OR health inequal [Text Word] OR health inequit [Text Word] OR social disparit [Text Word] OR social inequit [Text Word] OR social inequal [Text Word])

from database conception to 19 January 2018 with no language restriction. We identified 102 articles, none of which estimated inequalities in homicide or suicide mortality by U.S. state. One report did classify states according to their rates of overall homicide mortality (37). This report estimated that overall rates of homicide mortality ranged from 1.1 to 12.8 deaths per 100 000 in 2009, with southern states generally having the highest rates (37). Given the large differences in homicide mortality by race, our analysis adds to these findings by emphasizing racial disparities and demonstrating their considerable variation across states.

This study was subject to several limitations. Some homicide and suicide deaths are difficult to classify. Homicides may be classified as suicides, or vice versa, and either may be misclassified as an unintentional injury. Misclassification of drug poisoning deaths is particularly important during the current opioid epidemic, which has led to a sharp increase in fatal overdoses (38). The most recent data on state gun ownership was collected in 2004, 4 to 12 years before the mortality data used in this study. Given that more than 80% of firearm suicide attempts are fatal (30, 31) and approximately 20% of firearm homicide attempts result in death (39), studying only fatal outcomes misses the morbidity of nonfatal assaults and suicide attempts. We were limited to contrasting age-standardized mortality rates but would rather have contrasted age-specific rates, had there been more deaths. We did not examine homicide or suicide in women, because their risks are much lower than men's, and data for black women were suppressed for more than half the states. We did not examine homicide or suicide in Hispanic persons, because they are subject to higher rates of misclassification on death certificates than blacks and whites (40), and extracting Hispanic persons from the black-white grouping would have cut the data too sparsely. Finally, these results are purely descriptive and make no claims regarding causal mechanisms.

This work elicits questions for future investigation. In particular, we would like to better understand the wide variation in black homicide rates, especially across

southern and rust belt states with similar levels of gun ownership. Multilevel models that account for state-, county-, and individual-level characteristics also might shed light on the reasons for the variation in homicide and suicide rates across states.

Firearms feature differently in the deaths of black and white men in the United States. The large variation in homicide and suicide rates and their racial differences across states highlight areas where policies may help reduce the rates of homicide and suicide, as well as their racial disparities.

From McGill University, Montreal, Quebec, Canada (C.A.R., S.H., J.S.K.); and University of California, Davis, Davis, California (M.C.).

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Reproducible Research Statement: *Study protocol:* Not available. *Statistical code:* Available at GitHub (<https://github.com/corinne-riddell/InjuryDisparity/tree/master/Code>). *Data set:* Available at GitHub (<https://github.com/corinne-riddell/InjuryDisparity/tree/master/Data>).

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