Differences in Racial Disparities in Firearm Homicide across Cities: The Role of Racial Residential Segregation and Gaps in Structural Disadvantage

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Abstract: Background/Purpose: Little research has characterized racial differences in firearm homicide at the city level. In this study, we explicitly model trends from 2000 to 2017 in the gap in homicide rates between the Black and White populations of 275 U.S. cities.

Methods: We used latent trajectory analysis and latent multi-trajectory analysis to identify distinct groups of cities with similar trends over time in: (a) Black and White firearm homicide rates; and (b) the ratio of the Black to White firearm homicide rates. We used a hierarchical, random effects model to examine the impact of racial segregation and racial gaps in structural disadvantage on the extent of the racial disparity in firearm homicide in each city.

Results: We found that racial residential segregation predicts differences between cities in the magnitude of racial disparities in firearm homicide rates.

Conclusion: Reducing racial disparities in firearm homicide may require programs and policies that specifically address the adverse consequences of racial segregation.

Keywords: Firearm■Homicide■Racial disparities■Racial segregation■Structural racism

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INTRODUCTION

The Black-White racial disparity in firearm homicide has been widely recognized.[1–9] Nationally, in 2017, the age-adjusted firearm homicide rate among the Black population (17.7 per 100,000) was 7.6 times higher than among the White population (2.3 per 100,000).[10] While this overall racial disparity in firearm homicide has been extensively documented, what has received less attention is the fact there are vast *differences* between cities in the *level* of this racial disparity.[1–3] For example, Light and Ulmer reported that among 131 metropolitan areas, the difference between the Black and White homicide rates over the period 1990-2010 varied from nearly equal rates in Santa Barbara, California, to an excess of over 65 per 100,000 among Black people in New Orleans.[3] This immense difference between cities in the magnitude of the racial disparity in homicide presents an opportunity to identify the causes of this disparity. However, very little research has characterized racial differences in firearm homicide at the city level or examined factors that explain these differences.

To the best of our knowledge, only three studies have explicitly modeled observed differences in the gap between Black and White homicide rates across cities in an attempt to explain why some cities have much higher racial disparities in homicide than others.[1–3] Velez et al. examined differences in the Black-White gap in homicide rates across 126 large U.S. cities in 1990, finding that racial segregation and the gap in home ownership were the primary source of city-level differences in the observed gap in homicide outcomes between the Black and White populations.[1] Ulmer et al. investigated differences in the racial disparity in homicide across 232 Census places in California and New York using pooled data from 1999 to 2001.[2] They found that racial gaps in structural disadvantage—especially gaps in poverty and female household headship—influenced the size of racial gaps in homicide across the places. Light and Ulmer extended this work by examining the racial gap in homicide among 131 metropolitan areas throughout the U.S. using homicide data for 1989-1991, 1999-2001, and 2008-2010).[3] They reported that racial segregation and racial gaps in structural disadvantage were strong predictors of the magnitude of the racial disparity in homicide rates across these metropolitan areas.

There are four major limitations of these previous studies. First, although they modeled differences in the racial disparity in homicide rates across a wide range of cities, they did not report the magnitude of the homicide gap for each city. It is critical for city officials and policy makers to understand the level of their racial homicide disparity and how it compares to other cities in order to appreciate the extent of the problem, have the data necessary to trigger a response, and provide a benchmark upon which they can monitor and evaluate progress. We are not aware of any previous study that has reported the level of the racial disparity in homicide for a large number of cities across the U.S.

Second, the data used in the previous studies is rather old; only one included data beyond 2001 and that study only included data up to 2010. City-specific homicide data are now available through the year 2017. During the period 2010-2017, there were major changes in the pattern of firearm homicide, with rates rising dramatically during this period, both among the White and Black population.[10]

Third, only one of the existing studies used a sample of large cities across the United States. That study included all cities with a population greater than 100,000 in 1990.[1] However, between 1990 and 2010, there were 83 additional cities that crossed the 100,000 population mark.

Fourth, only one of the previous studies examined the trend in the racial homicide gap between the Black and White population over time and that study only looked at the trend in the average racial homicide gap across all the cities.[3] Given the tremendous increase in the overall firearm homicide rate over the past decade, what would be particularly compelling would be an analysis of differences between cities in these trends. It is critical to know not only how the Black and White homicide rates are changing over time, but how the level of the racial *disparity* presents itself across cities over time.

This study extends the previous research by: (1) reporting the level of the Black-White racial disparity in homicide at the city level for 275 cities across the United States; (2) using more recent homicide data; (3) including a wider range of cities, encompassing those which have grown in population since the previous research was conducted; (4) using latent trajectory analysis to identify groups of cities that share similar trends in their racial homicide disparities over time; and (5) using a panel of annual data covering 18 years rather than a single year or a discontinuous sample of years.

In this study, we explicitly model trends from 2000 to 2017 in the gap in homicide rates between the Black and White populations of 275 U.S. cities. Our primary predictor variables are the level of racial residential segregation in each city and the racial gap in various measures of structural disadvantage. We control for major factors known to be associated with homicide rates at both the city and state levels.

MATERIALS AND METHODS

Design overview

We obtained annual homicide counts, stratified by race, from the Federal Bureau of Investigation (FBI) Supplementary Homicide Reports (SHR) for the years 2000-2017. There were two parts to our analysis. First, we used latent trajectory analysis and latent multi-trajectory analysis to identify distinct groups of cities with similar trends over time in: (a) Black and White firearm homicide rates; and (b) the ratio of the Black to White firearm homicide rates. In addition to plotting the trends for each identified group of cities, we examined the degree to which the level of racial residential segregation in a city predicted that city's membership in a particular latent trajectory group. Second, we used a mixed model—a hierarchical, random effects, negative linear model—to examine the impact of racial segregation and other aspects of structural racism on the extent of the racial disparity in firearm homicide in each city (i.e., the ratio of Black to White firearm homicide rates), while controlling for a number of city-level factors known to affect homicide rates. The hierarchical model included random effects (random intercepts) for cities clustered within states and used standard errors that took this clustering into account.

Sample

As our analysis comprised the period 2000-2017, we included all U.S. cities with a population greater than 100,000 at the approximate midpoint of the study period (2010). In addition, we included cities that had a population of more than 100,000 in 1990, but which lost population and dropped below 100,000 by 2010. Two cities (Arlington, VA and Metairie, LA) were omitted from the sample because they do not report data to the SHR (it is reported at the county level) and two cities (Amherst, NY and Honolulu, HI) were omitted because of missing U.S. Census data. The final overall sample consisted of 275 cities (Appendix Table 1).

Data sources and measures

Race-specific homicide rates and racial homicide disparities. Black and White homicide rates (total, firearm-related, and non-firearm-related) were obtained using homicide counts from the SHR to the FBI Uniform Crime Reports. Professor James Fox of Northeastern University has assembled and provided us with, a complete SHR data set covering the years 2000-2017.[11] We

used this data set to obtain homicide counts by year for each city in the sample, stratified by race (Black vs. White) and method (firearm vs. non-firearm). The SHR has not consistently recorded ethnicity, so the race-specific counts include all Black victims or all White victims in the population, without regard to ethnicity. We therefore used this same classification for all other race-specific variables. Homicide rates were calculated by dividing the homicide counts by the race-specific city population. We used annual population estimates from the American Community Survey for the years 2000 and 2005-2017, and used linear interpolation to impute values for the years 2001-2004. The racial disparity in homicide for a given year was calculated as the ratio of the Black homicide rate to the White homicide rate. Because this ratio was not normally distributed, but skewed, we used the natural log of the Black-White homicide rate ratio as the outcome variable.

Racial residential segregation. We used the index of dissimilarity, a widely used measure of racial segregation that was developed by Massey.[12–15] The index of dissimilarity measures the degree to which the racial makeup of the neighborhoods (Census blocks) in a city reflect the overall racial composition of the city as a whole. For example, if a city had a population that was 70% White and 30% Black, then with complete racial integration, each Census block would consist of 70% White people and 30% Black people. The index of dissimilarity would be 0. On the other hand, if a city was completely segregated (i.e., no White people and Black people living in the same Census block), it would have an index of dissimilarity of 100. The formal definition of the index of dissimilarity is:

$$I = \Sigma|(p_b - p_c)| / 2,$$

where p_b is the proportion of Black people in block b, p_c is the proportion of Black people in the city as a whole, and the absolute value of the difference in these proportions is summed for all Census blocks in the city.

We obtained the race-specific population by Census block for each city from the 2000 and 2010 Decennial Censuses. For the trajectory analysis, we averaged the two values and treated racial segregation as a time-invariant variable. For the mixed effects analysis, we imputed the values for 2001-2009 through linear interpolation and for 2011-2017 through linear extrapolation based on the 2000-2010 trend.

Racial gaps in structural disadvantage. Using data from the U.S. Census,[16] we estimated the annual racial gap in eight measures of structural disadvantage: the unemployment rate, the labor force non-participation rate, the poverty rate, the percentage of the population living in rental housing, the percentage of single-parent households, the percentage of persons without a college degree, median household income, and the incarceration rate. The racial gap was defined as the ratio of the proportion among the Black population divided by the proportion among the White population. The racial income gap was operationalized as the median household income for households headed by a White person divided by that for households headed by a Black person. We calculated the income gap ratio in this way so that a value of greater than 1 would always indicate Black disadvantage. Finally, we estimated the annual incarceration gap as the percentage of incarcerated Black people divided by the percentage of incarcerated White people. This final measure was calculated using state-level data from the Bureau of Justice Statistics' National Prisoner Statistics reports,[17] as city-level data are not available. For the city-level measures, we used data from the moving 5-year average from the American Community Survey, as race-specific data were not available for many cities from the single year estimates. We had a complete annual series of data for incarceration, but for the other variables we had data for the years 2000 and 2009-2017. We used linear interpolation to impute the values for the years 2001-2008.

City-level control variables. We obtained a complete annual series of data on the non-homicide violent crime rate, the property crime rate, and the per capita number of law enforcement officers in each city from the FBI's Uniform Crime Reports.[18] The proportion of Black and Hispanic residents in each city was estimated using data from the U.S. Census, Annual Community Surveys, with interpolation of data for the years 2001-2004. We also calculated the annual population density for each city and controlled for region of the country (Northeast, South, Midwest, and West).

Latent trajectory analysis and latent multi-trajectory analysis

Latent trajectory analysis is the modeling of trends in a variable over time across data groups (in this case, cities) in order to identify latent groups or clusters of units (e.g., cities) with similar trends.[19–24] We used the *traj* procedure in STATA, which was developed and made available by Jones and Nagin.[20] The outcome variable was the annual racial gap in firearm homicide rates in a city, defined as the natural log of the ratio of Black to White firearm homicide rates in a given year. The time variable was simply the year (2000-2017). Since the natural log of the racial homicide gap was normally distributed, we used a cumulative normal distribution for the outcome variable. In deciding how many latent groups of cities to model and whether to model trends as linear, quadratic, or cubic, we were guided

Table 1. Average racial disparity in firearm homicide, segregation, population, homicide rates, and racial poverty gap – largest 50 cities, 2000-2017.

Cities	Black to white firearm homicide rate ratio	Index of dissimilarity	Total population	White population	Black population	Percent black	Black firearm homicide rate	White firearm homicide rate	Poverty gap
San Francisco	20.2	63.6	798,922	403,565	49,737	6.3	59.3	2.9	3.0
Minneapolis	18.9	64.6	382,348	253,147	68,336	17.8	31.3	1.7	3.2
Omaha	16.6	71.3	415,372	316,496	53,035	12.8	18.8	1.1	3.4
Boston	13.6	74.0	609,854	332,114	151,619	24.8	23.4	1.7	1.6
Seattle	13.4	66.8	607,524	424,328	46,465	7.7	16.9	1.3	3.0
Portland	12.7	63.1	571,563	445,737	35,529	6.2	14.1	1.1	2.5
Baltimore	11.0	77.1	626,073	193,559	398,133	63.6	48.3	4.4	1.9
Louisville	9.5	71.3	531,831	377,538	124,363	23.9	27.0	2.9	2.7
Miami	9.3	68.6	392,140	284,337	80,947	20.8	45.4	4.9	1.7
Indianapolis	7.5	68.0	810,279	524,555	216,060	26.6	30.6	4.1	2.0
Kansas City	7.3	72.1	454,621	276,853	134,732	29.7	46.7	6.4	2.7
Columbus	7.3	63.9	769,558	490,040	206,256	26.7	23.6	3.2	2.0
Wichita	7.3	57.3	369,775	275,551	41,190	11.1	18.2	2.5	2.6
New Orleans	7.0	75.4	382,402	121,498	241,400	62.7	65.4	9.3	2.6
San Diego	6.2	59.1	1,295,405	833,403	88,265	6.8	13.9	2.3	1.8
Virginia Beach	5.9	47.9	437,994	303,163	83,929	19.2	7.9	1.3	2.4
Tulsa	5.8	63.0	390,382	262,270	60,219	15.4	35.5	6.1	2.5
Jacksonville	5.8	61.6	809,751	495,555	246,343	30.4	19.6	3.4	2.5
Oklahoma City	5.4	62.3	566,340	382,057	82,907	14.7	22.6	4.2	2.3
Atlanta	5.1	81.6	433,368	168,010	243,546	56.4	30.7	6.0	3.9
Milwaukee	5.1	75.3	587,081	275,749	228,117	38.9	28.8	5.6	2.4
Nashville	5.1	60.1	592,055	376,648	165,317	27.9	21.0	4.1	2.3
Philadelphia	5.1	77.7	1,505,439	640,707	650,971	43.3	33.2	6.5	1.9
New York	5.1	75.7	8,252,648	3,626,666	2,075,135	25.2	10.3	2.0	1.6
Colorado Springs	5.0	51.6	407,363	325,631	25,705	6.3	12.6	2.5	2.2
Oakland	4.8	52.3	393,781	141,096	113,656	29.0	56.9	11.9	1.9
Raleigh	4.7	61.0	373,702	226,585	107,778	28.7	6.8	1.4	2.0
Chicago	4.7	85.8	2,747,374	1,213,193	925,864	33.7	33.9	7.3	2.5
Denver	4.6	65.7	604,900	443,177	60,526	10.0	18.2	3.9	1.9

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Cities	Black to white firearm homicide rate ratio	Index of dissimilarity	Total population	White population	Black population	Percent black	Black firearm homicide rate	White firearm homicide rate	Poverty gap
Charlotte	4.0	61.2	697,342	374,545	238,805	34.2	15.2	3.8	2.4
Las Vegas	3.9	42.3	567,904	388,695	63,323	11.1	45.6	11.7	2.0
Cleveland	3.9	77.9	411,987	166,263	214,832	52.1	17.3	4.5	1.8
Albuquerque	3.8	49.4	516,912	366,975	16,958	3.3	19.3	5.1	1.9
Fresno	3.5	52.0	485,093	261,788	38,667	8.0	30.7	8.9	2.0
Los Angeles	3.4	64.4	3,814,955	1,924,090	371,742	9.8	41.8	12.2	1.6
San Antonio	3.4	54.3	1,309,925	957,036	89,103	6.8	17.4	5.1	1.5
Mesa	3.3	53.8	453,089	376,274	13,788	3.0	8.3	2.5	1.9
Fort Worth	3.2	62.4	698,569	442,438	131,066	18.8	13.6	4.3	1.9
Sacramento	3.1	50.6	457,146	222,109	66,111	14.5	32.6	10.5	1.7
Austin	3.1	57.1	782,646	551,056	65,546	8.5	5.6	1.8	1.8
Tucson	3.1	45.4	517,043	369,759	23,694	4.6	21.3	6.9	1.4
Memphis	3.1	71.9	648,681	202,490	408,248	62.9	19.7	6.5	2.6
Phoenix	2.9	55.1	1,461,085	1,093,397	88,149	6.0	26.0	8.9	1.6
Arlington	2.9	45.4	363,027	232,803	66,794	18.3	7.0	2.4	1.6
Long Beach	2.8	51.6	465,649	226,165	62,915	13.5	17.2	6.2	1.6
El Paso	2.8	55.3	625,677	496,045	21,144	3.4	3.9	1.4	0.7
Dallas	2.7	68.0	1,222,881	700,161	297,531	24.3	24.9	9.1	1.7
Houston	2.4	69.5	2,091,081	1,175,516	497,625	23.8	20.0	8.3	1.6
Detroit	1.6	70.6	779,447	97,673	640,077	82.1	39.3	25.3	1.1
San Jose	1.2	50.9	947,688	435,890	30,035	3.2	3.3	2.7	1.6

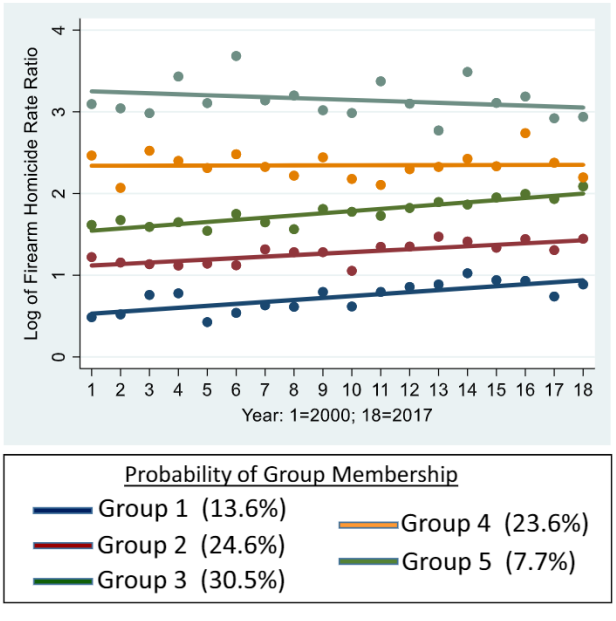
Table 2. Results of latent trajectory model: Trend in ratio of black to white firearm homicide rates, 2000-2017.

Group	Parameter	Estimate	Standard error	p-value
Group 1	Intercept	0.505	0.075	0.000
	Linear	0.024	0.007	0.008
Group 2	Intercept	1.101	0.098	0.008
	Linear	0.018	0.007	0.005
Group 3	Intercept	1.518	0.064	0.000
	Linear	0.027	0.006	0.000
Group 4	Intercept	2.339	0.077	0.000
	Linear	0.001	0.006	0.916
Group 5	Intercept	3.263	0.157	0.000
	Linear	−0.012	0.014	0.391
Effect of Racial Segregation on Likelihood of Group Membership				
Group 1	Baseline	Reference Group		
Group 2	Index Of Dissimilarity	0.029	0.028	0.303
Group 3	Index Of Dissimilarity	0.100	0.027	0.002
Group 4	Index Of Dissimilarity	0.097	0.026	0.002
Group 5	Index Of Dissimilarity	0.081	0.032	0.013

by measures of model fit, including the AIC and BIC (with lower values indicating a stronger model). After choosing the most appropriate model, we then evaluated whether residential segregation was associated with latent trajectory group membership by adding the index of dissimilarity as a time-constant variable. For each trajectory group, this produces an estimate of the likelihood of a city being in that group as opposed to Group 1 (which is the referent group) as the index of dissimilarity increases.

We also conducted a latent multi-trajectory analysis in which we modeled two outcomes at the same time (the Black homicide rate and the White homicide rate) in order to identify groups of cities with the same trends in both outcomes. Again, we included the index of dissimilarity as a time-constant variable in order to estimate the likelihood of each city being in a particular trajectory group as opposed to Group 1.

Figure 1. Latent trajectory model of trends in the log of the ratio of black to white firearm homicide rates, 2000-2017.



Mixed effects regression analysis

We modeled the racial homicide disparity in each city using a hierarchical, random effects linear regression. Our observations displayed two types of intra-class correlation. First, we had repeated measures of homicide rates in each city for 18 different years. Second, we had multiple cities within the same state. We modeled this hierarchical structure by including random effects for city nested within random effects for state. Accounting for the intra-class correlation of observations and the nested data structure is essential because a simple linear regression assumes that all observations are independent, but it is

Table 3. Results of latent multi-trajectory model: Trend in black and white firearm homicide rates, 2000-2017.

Group	Parameter	Estimate	Standard error	p-value
Black firearm homicide rate				
Group 1	Intercept	2.144	0.105	0.000
	Linear	0.152	0.044	0.001
	Quadratic	−0.021	0.005	0.000
	Cubic	0.001	0.000	0.000
Group 2	Intercept	2.794	0.091	0.000
	Linear	0.101	0.039	0.010
	Quadratic	−0.013	0.005	0.005
	Cubic	0.001	0.000	0.001
Group 3	Intercept	3.171	0.135	0.000
	Linear	0.149	0.060	0.013
	Quadratic	−0.017	0.007	0.021
	Cubic	0.001	0.000	0.024
White firearm homicide rate				
Group 1	Intercept	0.437	0.084	0.000
	Linear	0.108	0.036	0.003
	Quadratic	−0.015	0.004	0.001
	Cubic	0.001	0.000	0.001
Group 2	Intercept	1.117	0.082	0.000
	Linear	0.150	0.036	0.000
	Quadratic	−0.022	0.004	0.000
	Cubic	0.001	0.000	0.000
Group 3	Intercept	2.066	0.137	0.000
	Linear	0.164	0.059	0.006
	Quadratic	−0.021	0.007	0.003
	Cubic	0.001	0.000	0.003
Effect of Racial Segregation on Likelihood of Group Membership				
Group 1	Baseline	Reference Group		
Group 2	Index Of Dissimilarity	0.035	0.013	0.005
Group 3	Index Of Dissimilarity	0.051	0.018	0.004

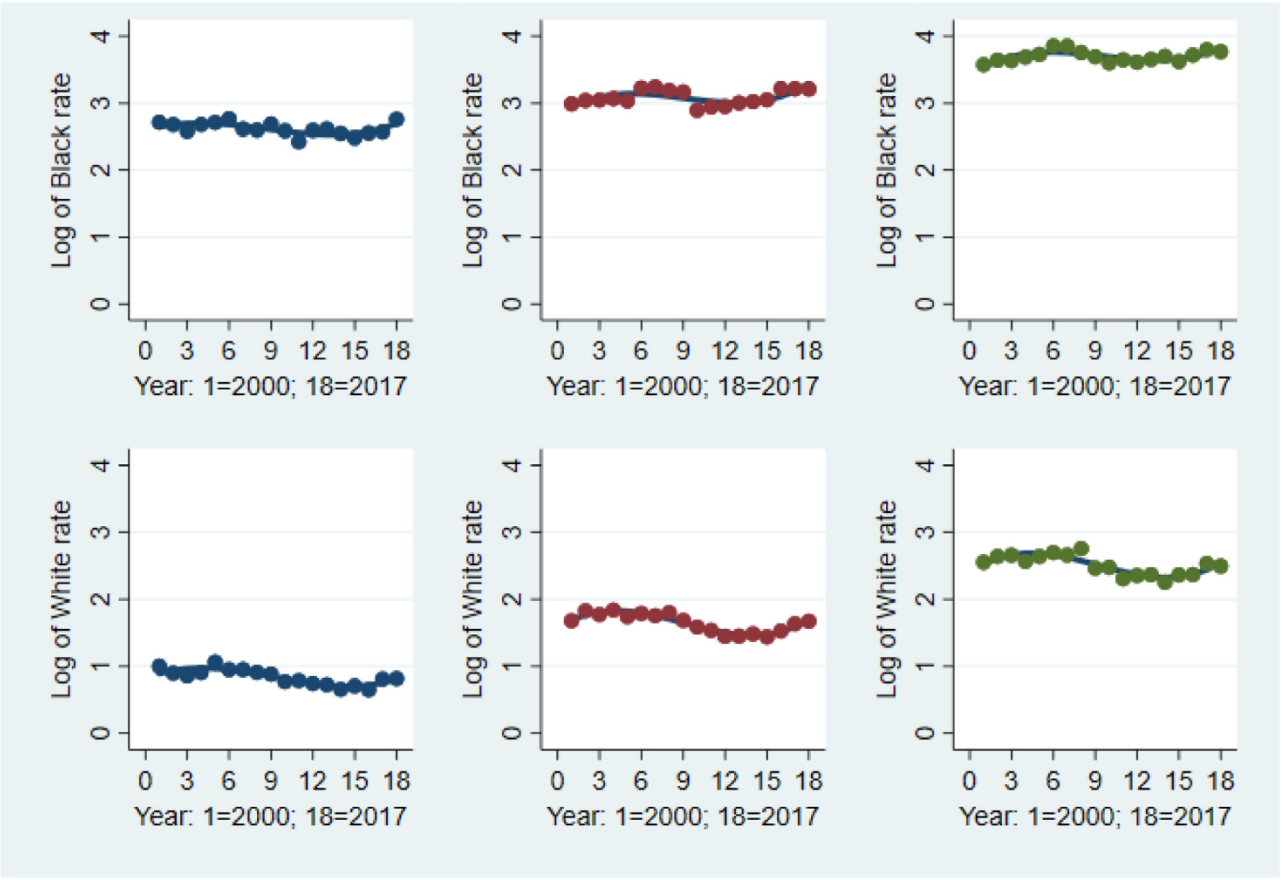
likely that repeated measures over time in the same city are correlated as are observations for cities located in the same state. We used robust standard errors that generate unbiased estimates even if assumptions about the nature of the correlation between clustered observations are not correct.[25] We controlled for all of the city-level variables listed above. In addition, we included an overall time trend and year fixed effects.

Because of high levels of collinearity between the measures of racial gaps in structural advantage, we could not include multiple gap measures in the same model. Therefore, we modeled each gap variable separately.

Because the outcome variables were not normally distributed across cities, but highly skewed, we report across-city averages and standard deviations as the geometric means and geometric standard deviations. Within-city averages are reported as arithmetic means.

All analyses were conducted using STATA version 15 (College Station, TX: StataCorp). The syntax used in the analyses is displayed in Appendix Table 2.

Figure 2. Latent multi-trajectory model of trends in black and white firearm homicide rates, 2000-2017.



RESULTS

Descriptive results

During the period 2000-2017, there were a total of 109,727 firearm homicides in the 275 cities in our sample, of whose victims 71,672 (65.3%) were Black and 34,996 (31.9%) were White. During the study period, the average (geometric mean) Black firearm homicide rate across the 275 cities was 10.3 per 100,000 (geometric standard deviation 0.8), while the average White firearm homicide rate was 2.1 per 100,000 (standard deviation 0.1) (Table 1; Appendix Table 1). The five cities with the highest average Black firearm homicide rates were St. Louis (68.1), Richmond, CA (65.5), New Orleans (65.4), San Francisco (59.3), and San Bernardino (57.1). There were no Black firearm homicides reported in 17 cities, although none had a Black population of greater than 5800. The five cities with the highest White firearm homicide rates were Gary, IN (28.7), San Bernardino (27.1), Detroit (25.3), Inglewood, CA (21.4), and Salinas, CA (20.7).

While the mean ratio of Black to White firearm rates across the 275 cities was 4.5 to 1 (standard deviation 0.2), the average Black-White firearm homicide rate ratio ranged from 0 (in 17 cities) to a high of 56.7 in Peoria, IL (Table 1; Appendix Table 1). The 10 cities with the highest racial disparity in firearm homicide rates were Peoria, IL (56.7), Berkeley, CA (51.7), Green Bay, WI (45.5), Albany, NY (31.5), Stamford, CT (28.2), Cedar Rapids, IA (27.5),

Table 4. Mixed effects regression: Log of ratio of black to white firearm homicide rates.

Variable	Regression coefficient	95% Confidence interval	p-value
Index of dissimilarity[a]	**0.20**[b]	**0.13 to 0.27**	**<0.0001**
Year	**0.03**[b]	**0.02 to 0.03**	**<0.0001**
Region (Reference = Midwest)			
Northeast	−0.07	−0.35 to 0.20	0.61
South	**−0.20**[b]	**−0.35 to −0.04**	**0.01**
West	−0.08	−0.28 to 0.13	0.47
Percent Black	**−0.03**[b]	**−0.03 to −0.02**	**<0.0001**
Percent Hispanic	**−0.01**[b]	**−0.02 to −0.01**	**<0.0001**
Violent crime rate (per 10 million)	0.00	−0.02 to 0.01	0.84
Property crime rate (per 10 million)	0.00	−0.01 to 0.00	0.18
Per capita officers	0.06	−0.03 to 0.15	0.18
Population density (per 0.01 square miles)	0.00	0.00 to 0.00	0.69
Poverty gap	**0.12**[b]	**0.01 to 0.22**	**0.03**

[a]*Odds ratio shown is for each 10% point increase.*
[b]*Statistically significant ($p < 0.05$) – also shown in bold type.*

Bellevue, WA (25.7), Cary, NC (25.7), Pittsburgh, PA (25.3), and Madison, WI (24.9). Among larger cities (i.e., the 203 cities with an average population greater than 200,000 over the study period), the 10 cities with the highest racial disparities in firearm homicide rates were Pittsburgh, PA (25.3), Madison, WI (24.9), San Francisco, CA (20.2), Indianapolis, IN (18.9), Omaha, NE (16.6), Boston, MA (13.6), Seattle, WA (13.4), Fort Wayne, IN (13.4), Portland, OR (12.7), and St. Paul, MN (12.6). Among cities with an average Black population of at least 25,000, the five cities with the lowest Black-White firearm homicide ratio were Garland, TX (0.8), Irving, TX (0.8), Inglewood, CA (1.2), Grand Prairie, TX (1.2) and San Jose, CA (1.2).

The average index of dissimilarity over the period across the 275 cities was 54.7 (standard deviation 0.7) (Table 1; Appendix Table 1). This measure of racial segregation ranged from a low of 26.2 in Killeen, TX to a high of 85.8 in Chicago, IL (Table 1, Appendix Table 1). The five most segregated cities were Chicago, IL (85.8), Ft. Lauderdale, FL (82.1), Atlanta, GA (81.6), Dayton, OH (79.4), and Cleveland, OH (77.9). The five least segregated cities were Killeen, TX (26.2), Moreno Valley, CA (28.5), Palmdale, CA (31.3), Fairfield, CA (32.8), and Victorville, CA (33.8).

The average Black to White poverty ratio across the 275 cities during the study period was 1.9 (standard deviation 0.1), ranging from a high of 6.4 in Rochester, MN to a low of 0.7 in Inglewood, CA and El Paso, TX (Table 1, Appendix Table 1). The proportion of the population that was Black averaged 9.8% (standard deviation 0.7), ranging from a high of 83.4% in Gary, IN to a low of 0.3% in Brownsville, TX and Laredo, TX.

Latent trajectory and latent multi-trajectory analysis results. Based on the model fit parameters, we found that a five-group, linear model was the most suitable to describe the latent trajectories in the racial disparity in firearm homicide rates over time (Appendix Table 3). Three of these groups displayed rising racial disparities in firearm homicide rates. These were the groups with the lowest ratios of Black to White homicide rates at baseline. For the remaining two groups, which consisted of cities with the highest ratio of Black to White homicide rates, we found no temporal trend (Table 2, Appendix Table 4, Figure 1).

In the latent multi-trajectory model, we found that a model with three latent groups and a cubic time trend best described the trends in Black and White firearm homicide rates. Moving from cities in group 1 to group 2 to group 3, the levels of both White and Black firearm homicide rates were higher throughout the study period (Table 3, Appendix Table 5, Figure 2). All three groups shared a similar trend, with parallel and increasing Black and White homicide rates between 2000 and 2005 (years 1-5 in the figure), decreasing rates between 2005 and 2013 (years 5-14 in the figure), and increasing rates between 2013 and 2017 (years 14-18 in the figure). What distinguished the groups was the baseline level of both the White and Black firearm homicide rates. As a city's index of dissimilarity

increased, its likelihood of being in a higher group also increased (Table 3).

Mixed effects regression analysis

In the mixed effects regression, the index of dissimilarity was positively and significantly associated with the ratio of Black to White firearm homicide rates, with the ratio increasing by 22% (95% confidence interval [CI], 13%-27%) for each increase of 10 in the index of dissimilarity (Table 4). Of the racial gap measures, only the poverty gap was significantly associated with the racial homicide disparity; a higher poverty gap was associated with a higher racial homicide disparity. For each increase of one in the ratio of Black to White poverty rates, the ratio of Black to White firearm homicide rates increased by 12% (95% CI, 1%-22%). The regression coefficient for the year time trend was positive (0.03) and significant, indicating a progressive increase (of approximately 0.6% per year) in the level of the racial disparity in firearm homicide rates. Compared to the Midwest region (the reference group), cities in the South region had a significantly lower racial disparity in firearm homicide. Cities with a higher percentage of Black and/or Hispanic residents experienced a significantly lower racial disparity in firearm homicide. For each one percentage point increase in the proportion of Blacks in a city, its ratio of Black to White firearm homicide rates decreased by 2% (95% CI, 2%-3%). For each one percentage point increase in the proportion of Hispanics in a city, its ratio of Black to White firearm homicide rates decreased by 1% (95% CI, 0%-2%).

DISCUSSION

To the best of our knowledge, this is the first paper to explicitly model observed differences in the gap between Black and White homicide rates in different cities and to identify groups of cities that share similar trends in their racial homicide disparities over time. We found that racial disparities in firearm homicide have increased in recent years, with the clearest upward trends in cities where these disparities were lowest in 2000. We found that racial residential segregation is an important predictor of differences between cities in the magnitude of racial disparities in firearm homicide rates. We also discovered that racial segregation does not affect the trend in the *absolute* Black and White firearm homicide rates across cities; rather, it is a predictor of the magnitude of the *disparity* between Black and White firearm homicide rates in a city.

Our findings are consistent with those of three previous studies, which found that racial segregation as well racial gaps in structural disadvantage influenced the Black-White homicide disparity.[1–3] This paper advances the previous literature by including the largest sample of cities to date (275), using more recent data (through 2017), and listing the data for each individual city rather than as an average. This is also the first paper to examine the trends of individual cities in their racial homicide disparities.

None of the groups of cities in the latent trajectory analysis experienced a decline in the magnitude in the racial disparity in firearm homicide rates during the period 2000-2017, and three of the five groups experienced a significant increase. Light and Ulmer did not report a significant change in the overall Black-White homicide gap from 2000 to 2010.[3] After extending the data to 2017 and using a continuous annual panel of data, it appears that there has been an increase in the Black-White racial disparity in firearm homicide among the three groups of cities with the lowest disparities in 2000.

There were two important findings from our multi-trajectory model. First, there was a uniform trend in both the White and Black firearm homicide rates throughout the entire study period. Cities did not appear to differ in the trends in Black and White firearm homicide rates; rather, what differed was the level of Black and White firearm homicide rates. Second, both Black and White firearm homicide rates appeared to increase across all groups of cities from 2013 to 2017.

The main findings from our trajectory analysis were consistent with the mixed effects regression analysis, which showed a significant increase in the Black-White firearm homicide disparity during the study period and a strong relationship between the level of racial segregation in a city and the magnitude of its racial disparity in firearm homicide rates.

Additionally, despite the proportion of both Black and Hispanic residents in a city being positively associated with absolute firearm homicide rates,[10] they were both associated with lower racial disparities in these rates. This is consistent with the "contact hypothesis,"[26] which argues that "increases in the relative Black population can reduce social distance and negative stereotypes by encouraging interracial contact."[3, p. 298] More interracial contact might in turn encourage more cooperation between people of different racial groups as opposed to fostering animosity that comes with segregation or separation. This could result in less racial discrimination as well as less structural racism.

Our finding that the disparity between Black and White firearm homicide rates is lower in the Southern region is consistent with the hypothesis that a "culture of violence" in the South—a legacy of the violence associated with maintenance of slavery—leads to higher rates of violence among the White population, thus reducing the observed racial disparity in firearm homicide.[27–36] Not only did

White slave owners use violence at times to discipline and control their slaves, but many non-slaveholding White men in the South served on slave patrols.[37] Several studies have demonstrated that the legacy of slavery has resulted in measurably higher rates of violence in the Southern region more than a century and a half later.[30–36]

Consistent with prior research showing that racial gaps in structural disadvantage are associated with higher racial homicide disparities,[1–3] we found that the racial poverty gap is a significant predictor of the racial disparity in firearm homicide rates in cities. It is important to note that it is not the absolute levels of race-specific poverty that predict the magnitude of the racial disparity in firearm homicide; rather, it is the gap between White and Black poverty rates that drives the racial firearm homicide disparity. In fact, neither the White poverty rate nor the Black poverty rate are significant predictors of the racial disparity in firearm homicide rates in our model; only the poverty gap is a significant predictor of this disparity.

Taken together, these findings demonstrate that the reason why some cities have higher levels of racial disparity in firearm homicide rates is that they have experienced higher levels of structural racism, manifested today by greater racial segregation and higher racial gaps in economic status. Racial segregation and gaps in family wealth are two of the aspects of structural racism that are most resistant to change. Residential racial segregation often ensures that resources (e.g., education, job opportunities, transportation) are distributed unequally according to race, even without intentional discrimination in how they are delivered. Moreover, race can influence residents' ability and willingness to leave neighborhoods where violence is rising. We found that U.S. cities whose residential patterns are more characteristic of this urban "apartheid"[38] display the greatest Black-White disparities in firearm homicides. This finding highlights the role of structural racism, rather than individual behaviors, in firearm homicide disparities and the potential to reduce these disparities by both actively eliminating barriers to resource access and furthering racial integration of communities. For example, Minneapolis, MN, where we found the second highest rates of racial homicide disparities among large U.S. cities (Table 1), recently prohibited single-family-only zoning, which had excluded residents of color from higher income neighborhoods.[39]

The major implication of our findings is that the problem of racial disparities in firearm homicide needs to be viewed, at least in part, as a structural problem rather than a problem of individual criminal behavior. This means that reducing racial disparities in firearm homicide may require structural changes that specifically aim to ameliorate the long-standing consequences of structural racism.

There are several important limitations of this paper. First, we did not examine disparities in Hispanic-White firearm homicide and the Hispanic population was included as part of the White population in our analyses. We were unable to include ethnicity in this research because our source for city-level homicide rates—the SHR—did not accurately record ethnicity throughout the study period. Additionally, we did not consider other racial disparities, such as high rates of violent victimization among Native American people that have documented elsewhere.[10] Future research, especially that using more recent data, should examine these disparities. Second, we only examined large urban areas and the findings may not be generalizable to nonurban areas. The 275 cities in our sample accounted for approximately 27% of the overall U.S. population. Third, the low Black population in a number of cities resulted in less stable rates. Nevertheless, our results remain similar even when we exclude cities with a Black population of less than 25,000.

Despite these limitations, this paper provides new evidence that structural racism plays a significant role in creating racial disparities in firearm homicide. To address this problem, structural change is needed. City officials must develop strategies to integrate their communities and to reverse the economic consequences of structural racism. Finally, it is crucial that we continue to monitor the racial disparity in firearm homicide over time. As our research found, levels of both Black and White firearm homicide have increased in recent years. Continued surveillance is important in order to determine whether city-wide policies are effective in reducing racial disparities in homicide outcomes.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

APPENDIX A. SUPPLEMENTARY DATA

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jnma.2020.05.014.

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