How socioeconomic inequalities explain the racial homicide gap: the case of Brazil

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ABSTRACT

This study evaluates the contribution of persons' socioeconomic characteristics and of the place where they live explain the racial homicide gap in Brazil. Using pooled data from the Brazilian Census and administrative records of mortality, we apply the Oaxaca-Blinder decomposition to identify the sources of the racial homicide gap between Blacks and Whites. Our results highlight that differences between the average characteristics of individuals and the place where they live explains up to two-thirds of the racial homicide gap. The smaller share of the racial gap in the probability of homicide is due to unobservable factors, which may be associated with the racial bias of the violence in Brazil.

Keywords: Violence; Homicide; Inequality; Racial bias; Oaxaca-Blinder decomposition.

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Introduction

Brazil presents one of the highest homicide rates globally. Between 2003 and 2011, the country lost about 455 thousand lives to homicides[4] (Mortality Information System - SIM/MS, 2021), more than twofold the number of violent deaths during the Iraq War (Hagopian et al., 2013). Homicide victims in Brazil are concentrated among young males, the poorest, least educated, and Blacks. In 2019, the homicide rate of Blacks (29.2 homicides per 100,000 people) exceeded by 2.6 times the homicide rate of Whites (13,9 homicides per 100,000 people). The homicide rate for Blacks also reduced at a slower pace than for Whites between 2009 and 2019, 15.5% against 30.5% (IPEA-FBSP, 2021). Blacks are also overrepresented among the lethal victims of police violence (CESeC, 2020) and represent the majority of homicide victims in the poorest regions, North and Northeast, which concentrate the highest homicide rates in Brazil. (IPEA-FBSP, 2020; Waiselfsz, 2016).

One hypothesis explaining racial inequalities in victimization is the racial invariance hypothesis, which suggests that structural and ecological factors explain the variation in violent crime rates observed among different population groups (Hirschi, 1969). According to this hypothesis, dominant groups would also exhibit high violent crime rates if exposed to the same social conditions faced by ethnic-racial minorities (Sampson & Wilson, 1995; Sampson et al., 2018). Socioeconomic inequalities between Blacks and Whites are exceptionally high in Brazil (Telles, 2004), which might help explain its high racial gap in homicides (Oliveira Junior, A., Lima, 2013; Vargas & Alves, 2010). For example, in 2018, the illiteracy rate was 9.1% for Blacks and 3.9% for Whites, and the poverty rate was 32.9% and 15.4%, respectively (IBGE, 2019). Brazilian Blacks are also overrepresented in the poorest and more violent regions and neighborhoods (França, 2018).

We evaluate how characteristics of the persons and of the place where they live explain racial disparities in homicide victimization in Brazil. Based on Cerqueira and Coelho (2015), we pooled microdata of the 2010 Brazilian Demographic Census with administrative records of mortality in the same year. We then fit non-linear logit models for the probability of homicide for Blacks and Whites as a function of individual and municipality-level characteristics. Next, we apply the Oaxaca-Blinder decomposition (Blinder, 1973; Oaxaca, 1973) to isolate and quantify the share of the racial homicide gap between Blacks and Whites due to differences between the average characteristics of the persons and municipalities (explained component) and differences due to coefficients or unobserved characteristics (unexplained component).

This empirical strategy allows us to test three main hypotheses. The first (H1) is that Blacks and Whites are exposed to different processes of homicide victimization, i.e., socioeconomic characteristics (such as income and education levels, and living in poor regions) affect homicides differently among Blacks and Whites (Cerqueira & Coelho, 2015, 2017; Truzzi et al., 2021). The second hypothesis (H2) states that the socioeconomic inequalities, including individual and municipality level characteristics, may explain the homicide gap between Blacks and Whites (Phillips, 2002; Steffensmeier et al., 2010; Wright et al., 2014). The third hypothesis (H3) is that individual characteristics are more important than the municipality-level characteristics, i.e., the place where Blacks and Whites live, to explain the racial homicide gap (Berthelot, 2019).

To the best of our knowledge, this is the first study to evaluate how characteristics of the person and place help explain racial disparities in homicide victimization in Brazil. Our results highlight that

[4] Homicides include deaths related to aggression, legal interventions, and war operations, whose International Classification of Diseases' codes are X85-Y09 and Y35-Y36, respectively.

social inequalities in individual characteristics, such as age composition, gender, marital status, education, and occupational status, are the main factors explaining racial homicide gaps in Brazil. We also discuss how unexplained factors, such as intra-municipal segregation and discrimination, represent nearly 40% of Brazil's racial homicide gap.

Literature review

The economics of crime has suggested different theories to explain the exposure to violence and criminality (Becker, 1968; Ehrlich, 1973). For example, the Lifestyle Theory (Hindelang et al., 1978) suggests that some social groups are more prone to experience criminal victimization due to their lifestyles, such as demographic characteristics and daily routines (commuting to work, for example). The Routine Activity Approaches Theory (Cohen & Felson, 1979) explains how crime rates vary over time and space, treating criminality as one feature within a larger system of activities rather than focusing specifically on criminal motivation (Kringen & Felson, 2014). The Social Disorganization Theory (Shaw & McKay, 1969) emphasizes the role of social changes, such as urbanization, mobility, ethnic diversity, socioeconomic inequalities, and family cohesion. These social changes may reflect social control and the adherence to norms in a community, which, in turn, are linked to violence, including homicides and violent crimes (Steffensmeier et al., 2010). Studies have already investigated these hypotheses estimating the influence of personal characteristics (Cerqueira & Coelho, 2015, 2017; Lo et al., 2013; Soares-Filho, 2011; Truzzi et al., 2021) and locational characteristics (Aransiola et al., 2021; Cerqueira & Moura, 2013; Justus et al., 2018; Phillips, 2002), or even both (Berthelot, 2019), on crime rates in Brazil and the United States.

One crucial research question within this broad literature is why some social groups are more affected by violence than others, especially when comparing Blacks and Whites. A common assumption of the general crime theories is the racial invariance thesis: the differences in violent crime rates among different population groups are due to structural factors (Unnever et al., 2016; Hirschi, 1969). According to this thesis, if the dominant group (i.e., the Whites) were exposed to the same social pressures and structural disadvantages faced by ethnic-racial minorities, they would exhibit similar violent crime rates (Sampson & Wilson, 1995; Sampson et al., 2018). Under this assumption, the relationship between violent crime and social disadvantages (e.g., female-headed households, low education, unemployment, poverty, and inadequate housing conditions) is consistent across different ethnic-racial groups (Peterson & Krivo, 2005; Pratt & Cullen, 2005). Therefore, there would be no direct relationship between ethnic-racial identity and violence (Sampson et al., 2018). The literature also suggests that the racial invariance thesis is valid for different types of crimes (homicide and other crimes against persons and property) and geographic levels (Light & Ulmer, 2016; McNulty, 2001; Phillips, 2002; Sampson & Wilson, 1995; Sampson et al., 2018).

Shihadeh and Shrum (2004) show that poverty, unemployment, and income inequality account for a disproportionate concentration of serious crime in Black neighborhoods. Other studies have also indicated that such structural inequalities help to partially explain the racial disparity in crime (Feldmeyer et al., 2013; Krivo et al., 2009; Lauritsen et al., 2018; Light &, 2016; Phillips, 2002; Sampson et al., 2005). Sampson and Wilson (1995) highlight neighborhood-based cultural and organizational mechanisms linking socioeconomic disadvantages to violence. The authors propose an integrated approach recognizing the interaction between structural and cultural drivers of crime and violence. They consider that race inequality leads to social isolation and, hence, spatial concentration of disadvantaged groups, giving rise to structural barriers and behavioral adaptations that weaken the social organization and hamper crime and violence control (Sampson et al., 2018).

In search of alternative explanations for racial differences in crime rates, studies have questioned the validity of the racial invariance thesis (Steffensmeier et al., 2010; Wright et al., 2014). According to Unnever and Gabbidon (2011), the historical and everyday experiences of being Black in a racialized society condition this group to unique experiences, such as the historical context defined by slavery, chronic and systematic exposure to racial discrimination, and oppression by the criminal justice system and other White-dominated institutions (Winant, 2015). Unnever and Gabbidon (2011) also recognized the role of socioeconomic differences on the crime gap between Blacks and Whites. However, the authors stress the importance of considering other race-specific drivers to explain violent crimes, such as insecurity, perception of police violence, perception of injustice regarding the criminal justice system, trust in public institutions (Unnever et al., 2016).

Studies in Brazil have also indicated that the historical past of slavery influenced the legacy of racial disparities in social conditions, access to justice, and vulnerability to lethal violence (Adorno, 1996; Costa Vargas, 2004; Hasenbalg, 1979, 1996; Oliveira-Junior & Lima, 2013; Ramos & Musumeci, 2005; Valle-Silva, 1980; Vargas & Alves, 2010). According to these authors, persistent social inequalities between Whites and Blacks are expressed, for example, by the low share of Blacks with a superior diploma, income gaps, the abusive conduct of the police apparatus, and the most severe punishments by the legal system on this portion of the population. For example, Vargas and Amparo-Alves (2010) suggest that vulnerability to police lethality in São Paulo is associated with the ethnic origin and social class. The authors highlight the importance of contextualizing police lethality within broader social patterns that characterize the city's urban social geography. Ceccato et al. (2018) highlight the geographic patterns of police homicides in Brazil, finding associations between police homicide rates and indicators of inequality, violence, impunity, organized crime, and police organization and training. Cano (2010) found evidence to support the hypothesis of racial bias in using lethal force by police officers in Brazil in the states of Rio de Janeiro and São Paulo. In his study, the author showed that Blacks and Browns are over-represented among victims of lethal police intervention in both Brazilian states.

Methods

Data and variables

We pooled two datasets: the sample of the 2010 Brazilian Demographic Census, from the Brazilian Institute of Geography and Statistics (IBGE, 2010); and the administrative records of the victims of violence in Brazil in the same year, from the Brazilian Ministry of Health's Mortality Information System – SIM/MS (SIM/MS, 2020). The sample of the 2010 Census is a stratified sample with information for nearly 11% of households in Brazil (IBGE, 2010). The SIM/MS information comes from the Death Certificates (DC), which follow the International Classification of Diseases – 10th revision (ICD-10) proposed by the World Health Organization (WHO). We filtered all homicide cases, which combines the ICD-10 *causa mortis* codes related to aggression (X85 to Y09) and legal interventions and war operations (Y35 to Y36) (Cerqueira & Coelho, 2017). We weight the observations from the Census using the sample weights provided by IBGE and assuming weight equals one for the data from the SIM/MS. Our final sample contains 15,272,342 observations for adults between 15 and 90 years old in 2010. Applying the sample weights, this sample represents 142.291.766 Brazilian citizens in 2010.

The SIM/MS provides individual-level information on race, gender, age, education, marital status, occupational status of the dead, and municipality where the homicide occurred. The same information for the living is available in the Census. The municipality-level information for both the dead and the living comes exclusively from the Census. We compute the municipal average values and matched the two data sources using by the municipality code where the person was living in 2010. In 2010, Brazil

had 5,565 municipalities, with an average population size of 34,278 inhabitants per municipality (IBGE, 2010).

Race is self-declared by the respondents in the Census and reported by an official coroner in the deaths certificates from the SIM/MS are reported by an official coroner (Brasil, 2006). Studies comparing the validity of administrative data with self-reported data for race/ethnicity in the United States have shown agreement in nearly 95% of the cases for Whites and Blacks (Jarrín, Nyandege, Grafova, Dong, & Lin, 2020). Prior studies in Brazil have also combined data on race from Census and administrative records (Cerqueira, 2013). Official racial categories found in the Brazilian Census and the SIM/MS are actually referred to as "colour". Interviewees self-declare by choosing one of the following "colours": Whites ("*brancos*"); Blacks ("*pretos*"); Mulattos ("*pardos*"); Yellow ("*amarelos*"); and Indigenous ("*indígenas*"). We aggregated Mulattos and Blacks into one single category (Blacks, representing 51% of the sample). This aggregation is a common approach in the socioeconomic literature in Brazil (Osorio, 2009; Telles, 2004). Since this study compares the racial homicide gap between Blacks and Whites, we excluded Indigenous and Yellow people (considered only for the municipal-level control variables), representing about 1.6% of the sample.

Table 1 presents descriptive statistics for all variables of analysis. Blacks are overrepresented among victims of homicides in Brazil. They represent nearly half of the Brazilians (56.2 p.p., according to IBGE [2021]), while the Black homicide victimization rate (0.0005, or 50 deaths per 100,000 Black people) is 2.5 times higher than that of the Whites (0.0002, or 20 deaths per 100,000 White people).

Table 1. Descriptive statistics (average) for selected variables by ethnic-racial group.

Variables	Description	Full sample	Blacks	Whites
Dependent				
homicide	1 (homicide victim), 0 (otherwise)	0.0003	0.0005	0.0002
Individual-level characteristics				
Black	1 (Black), 0 (White)	0.5075	1.0000	0.0000
man	1 (man), 0 (woman)	0.4845	0.4959	0.4727
single	1 (unmarried), 0 (otherwise)	0.5018	0.5600	0.4419
married	1 (married), 0 (otherwise)	0.3898	0.3474	0.4335
divorced/widower	1 (divorced, widower), 0 (otherwise)	0.1084	0.0926	0.1246
15 to 17	1 (15-to-17 year old), 0 (otherwise)	0.0717	0.0806	0.0625
18 to 24	1 (18-to-24 year old), 0 (otherwise)	0.1652	0.1779	0.1521
25 to 39	1 (25-to-39 year old), 0 (otherwise)	0.3235	0.3355	0.3111
40 to 59	1 (40-to-59 year old), 0 (otherwise)	0.2998	0.2864	0.3136
60 or more	1 (60 years old or more), 0 (otherwise)	0.1399	0.1196	0.1608
less than primary	1 (7 years or less of schooling), 0 (otherwise)	0.4507	0.5226	0.3767
less than secondary	1 (8 to 11 years of schooling), 0 (otherwise)	0.1917	0.1957	0.1877
secondary or more	1 (12 years or more of schooling), 0 (otherwise)	0.3575	0.2817	0.4356
work	1 (work), 0 (otherwise)	0.5907	0.5715	0.6105

(continue)

Table 1. (continuation)

Municipality-level characteristics				
ethnicity	Municipal index of ethnic-racial heterogeneity (range 0% to 100%)	42.75%	43.26%	42.23%
singles	Unmarried persons as a percentage of the municipality's population	55.18%	57.76%	52.51%
young (15 to 29)	Population ages 15 to 29 as a percentage of the municipality's population	26.84%	27.33%	26.33%

illiterate	Illiterate adults ages 20 and above as a percentage of the municipality's population	10.24%	12.23%	8.19%
unemployed	Unemployed persons as a percentage of the municipality's population	4.41%	4.70%	4.12%
income	Average monthly household income *per capita* in the municipality (R$)	789.79	696.61	885.82
subhousing	Percentage of households in the municipality with inadequate housing conditions	0.011%	0.014%	0.008%
urban	1 (predominantly urban municipality), 0 (otherwise)	0.8223	0.7929	0.8526
suburban	1 (suburban municipality), 0 (otherwise)	0.0855	0.1013	0.0693
rural	1 (predominantly rural municipality), 0 (otherwise)	0.0922	0.1058	0.0782
small city	1 (population less than 10,000), 0 (otherwise)	0.0671	0.0652	0.0690
medium city	1 (population between 10,000 and 50,000), 0 (otherwise)	0.2584	0.2845	0.2315
big city	1 (population of 50.000 or more), 0 (otherwise)	0.6745	0.6503	0.6995
north	1 (North), 0 (otherwise)	0.0745	0.1112	0.0366
northeast	1 (Northeast), 0 (otherwise)	0.2688	0.3732	0.1611
midwest	1 (Midwest), 0 (otherwise)	0.0728	0.0821	0.0632
southeast	1 (Southeast), 0 (otherwise)	0.4352	0.3738	0.4985
south	1 (South), 0 (otherwise)	0.1488	0.0597	0.2405
Observations		**15,272,342**	**7,821,651**	**7,450,691**
Observations (with sample weights)		**142,291,766**	**72,216,230**	**70,075,536**

Source. Prepared by the authors using data from IBGE (2010) and SIM/MS (2021).

The explanatory variables are divided into individual characteristics, municipality-level characteristics, and dummies for regions. Individual characteristics include variables for age, gender, marital status, education, and employment. The Black population is over-represented in the most vulnerable socioeconomic groups. For example, the share of people with less than primary education (up to seven years) is 38% for Whites and 52% for Blacks, while the employment-to-population rate of the Blacks is four percentage points lower than that of the Whites. Blacks are overrepresented among the unmarried and young people.

Municipality-level characteristics represent municipal averages for racial heterogeneity, family composition, age structure, education, unemployment, income, housing conditions, urbanization, population size. Based on Blau (1977), the ethnic-racial heterogeneity indicator varies between zero and one, with one being complete heterogeneity. The classification of housing conditions (low, medium, and high) is based on Catalá e Carmo (2021) and considers variables related to the quality of the household, sewage, pipped water, garbage collection and electricity. The classification of urban, intermediary, and rural municipality is based on IBGE (2017) and considers population size, population density and distance to the urban center. We also include dummies for regions to control unobservable differences between geographic regions in Brazil.

The Blacks live in municipalities with lower socioeconomic development than the Whites. For example, the average household income *per capita* where the Whites live is 27% higher than that of the Blacks. Illiteracy, unemployment, and the proportion of people living in inadequate housing conditions are higher in the municipalities where the Blacks live. While the spatial distribution of the Brazilian population is mainly concentrated in predominantly urban areas, the Black population concentrates more in suburban and predominantly rural areas than the White population. There is also a high concentration of the Black population in the poorest and more violent regions of the country (North and Northeast).

Empirical Strategy

Following Cerqueira and Coelho (2015), we first estimated logit models for the probability of suffering homicide separately for Blacks and Whites. The logit model is given by:

$$Prob\left[Y_i^g = 1 \middle| X_i^g\right] = \frac{e^{\beta^g X_i^g}}{1+e^{\beta^g X_i^g}} \quad (1)$$

Where $Prob\left[Y_i^g = 1 \middle| X_i^g\right]$ is the probability of the individual i, belonging to the racial group g, being victim of homicide ($Y_i^g = 1$). The vector β contains the coefficients associated with the explanatory variables from the vector X. We also This vector includes the regressors presented in Table 1 (individual characteristics, municipality-level characteristics). The value of e^{β_j} represents the odds ratio for the variable X_j, i.e, $Prob\left[Y = 1|X_j\right]/Prob[Y = 0]$

Equation (1) can also be represented by the linear model:

$$\frac{Prob\left[Y_i^g = 1 \middle| X_i^g\right]}{Prob\left[Y_i^g = 0 \middle| X_i^g\right]} = odds_i^g = \beta^g X_i^g \quad (2)$$

Where the dependent variable $odds$ represents the ratio between the probability of being victim of homicide and the probability of not being victim of homicide. The value e^{β_j} is the odds ratio, i.e., the ratio between the odds for $X_j + 1$ and the odds for X_j.

Next, we applied the Oaxaca-Blinder methodology (Blinder, 1973; Oaxaca, 1973) to decompose the racial differential in homicide victimization into two components: explained, which is due to the differences between the average values of the explanatory variables in vector X, and unexplained, which is due to the differences between the coefficients in vector β. Based on Yun (2004), the decomposition method for non-linear models can be given by:

$$\bar{Y}^W - \bar{Y}^B = \sum_{i=1}^{i=K} W_{\Delta X}^i \left[\left(\bar{X}^W \hat{\beta}^W\right) - \left(\bar{X}^B \hat{\beta}^W\right)\right] + \sum_{i=1}^{i=K} W_{\Delta \beta}^i \left[\left(\bar{X}^B \hat{\beta}^W\right) - \left(\bar{X}^B \hat{\beta}^B\right)\right] \quad (3)$$

In which:

$$W_{\Delta X}^i = \frac{(\bar{X}_i^W - \bar{X}_i^B)\hat{\beta}_i^W}{(\bar{X}^W - \bar{X}^B)\hat{\beta}^W}, W_{\Delta \beta}^i = \frac{\bar{X}_i^B(\hat{\beta}_i^W - \hat{\beta}_i^B)}{\bar{X}^B(\hat{\beta}^W - \hat{\beta}^B)}, \text{ and } \sum_{i=1}^{i=K} W_{\Delta X}^i = \sum_{i=1}^{i=K} W_{\Delta \beta}^i = 1 \quad (4)$$

Where the vector $\bar{X}^g$ contains the average values of the explanatory variables for each racial group g (superscript W for Whites and B for Blacks). The vector $\hat{\beta}^g$ contains the maximum-likelihood (ML) estimates of Equation (2). $\bar{Y}^g$ is the dependent variable's predicted mean for individuals in each population group g. In Equation (3), the left-hand side shows the total difference between Whites and Blacks regarding the probability of being a homicide victim. The right-hand side is the sum of the explained and the unexplained components. The decomposition proposed by Yun (2004) weights the contribution of each explanatory variable to the explained and unexplained components ($W_{\Delta X}^i$ and $W_{\Delta \beta}^i$, respectively).

Equations (3) and (4) describe the standard approach of decomposition, using the coefficients from the non-discriminated group (Whites, $\hat{\beta}^W$) as the reference of analysis. In this case, the decomposition shows how much the racial differential in homicide rates would reduce if Whites were exposed to the same poor socioeconomic conditions faced by Blacks (average characteristics $\bar{X}^B$ of Black individuals) (Phillips 2002). In our sensitive analysis, we also inverted the coefficients and regressors of Whites and Blacks to computed how much the racial gap in homicide rates would reduce if Black were exposed to the same improved socioeconomic conditions faced by Whites. In other words, we use the

coefficients of Black individuals ($\hat{\beta}^B$) and the average socioeconomic characteristics of Whites ($\bar{X}^W$) as references of analysis (Phillips, 2002).

The broad literature on the Oaxaca-Blinder methodology warns that for binary explanatory variables, the decomposition results depend on the choice of the base category (omitted). In line with the approach proposed by Yun (2004), this study adopts as a solution the estimation of the decomposition based on "normalized" effects, i.e. effects that are expressed as deviation contrasts from the grand mean.

Results

The determinants of homicide among Blacks and Whites

Table 2 presents the odds ratio estimates of the logit models for the chances of Blacks and Whites being victims of homicide in Brazil. Both estimates use controls for individual socioeconomic characteristics and place of residence aspects where Blacks and Whites live, i.e., controls for municipality-level variables and dummies for regions.

Table 2. Logit estimation for the Blacks' and Whites' chances of becoming a homicide victim (Brazil, 2010).

Variable	Homicide			
	Whites		Blacks	
	Odds Ratio	**SE (robust)**	***Odds Ratio***	**SE (robust)**
Individual-level characteristics				
man	6.4159***	(0.4130)	8.3405***	(0.5143)
single	1.4514***	(0.1534)	1.8520***	(0.1077)
married	0.4989***	(0.0273)	0.7068***	(0.0497)
15 to 17	1.4245**	(0.1988)	2.5952***	(0.3232)
18 to 24	3.0360***	(0.5232)	4.2564***	(0.3947)
25 to 39	2.4367***	(0.2670)	2.8913***	(0.2467)
40 to 59	1.3037***	(0.0917)	1.3470***	(0.0909)
less than primary	1.7674***	(0.3435)	2.0869***	(0.1606)
secondary or more	0.0911***	(0.0059)	0.1059***	(0.0158)
work	3.0832***	(0.1810)	2.8329***	(0.1670)

(continue)

Table 2. (continuation)

Municipality-level characteristics				
ethnicity	1.0660***	(0.0063)	1.0352***	(0.0092)
singles	1.0144	(0.0208)	1.0315**	(0.0137)
young (15 to 29)	1.0753	(0.0729)	0.9431**	(0.0433)
illiterate	1.0053	(0.0206)	0.9924	(0.0124)
unemployed	1.0822	(0.0526)	1.1494***	(0.0421)
ln(income)	1.9137***	(0.4647)	1.6054***	(0.2135)
subhousing	1.4195*	(0.2947)	0.6810	(0.1634)
urban	1.0334	(0.1223)	0.8266**	(0.0723)
rural	1.2590**	(0.1395)	0.9368	(0.1568)
small city	0.5370***	(0.1000)	0.5635***	(0.0834)
big city	1.7862***	(0.1546)	2.1728***	(0.2485)

geographic region	**Yes**		**Yes**	
Constant	8.66e-11***	(2.32e-10)	2.10e-08***	(3.61e-08)
Observations	**7,408,685**		**7,763,913**	
Test *LR*	**24,997.142*** **		**51,317.676*** **	
Pseudo-R^2 (McFadden)	**0.206**		**0.209**	
Count-R^2	**0.999**		**0.998**	
AIC*	**96,603.132**		**193,861.356**	

Source: Prepared by the authors using data from IBGE (2010) and SIM/MS (2021).
Note (1). Robust standard errors adjusted for 27 clusters (at Federative Unit level). ***Significant at 1%; **Significant at 5%; *Significant at 10%. **Note (2).** Regarding the block of geographic characteristics, the "Northeast" region was omitted. **Note (3).** Asterisks (*) indicate variables specific to each racial group.

The odds of being victim of homicide is higher among men, single individuals, the youngest (18 to 24 years), low educated, and employed individuals. While we cannot directly compare the estimates for Blacks and Whites (since they have different baselines), the results provide insights into the differences between homicides rates of Black and White individuals. Except for employment status, the net effect of all individual variables is more intense for Blacks than for Whites. For example, the odds of being a homicide victim for Black men is 8.3 than for Black women (6.4 for White men and women); the odds of a Black aged between 18 and 24 years is 4.3 times higher than the odds of a Black aged 60 years and over (3.0 for Whites). Appendix B (a, b) shows the racial differences in the probability of being homicide victim (Equation 1) by age and education. For example, the probability of a 20-years-old Black becoming homicide victims exceeds that of Whites by approximately 183%, and the probability of a Black individual with up to 7 years of schooling being homicide victim is 104% higher than for a White peer.

While Blacks and Whites individuals living the richest and most populous municipalities are more likely to be victims of homicide, the odds are particularly high for Blacks. For example, the odds of being a homicide victim for Blacks living in big cities 2.2 higher than that of Blacks living in medium cities (1.8 times higher for Whites). The likelihood of being homicide victims also increases with the racial heterogeneity in the municipality, for both Blacks and Whites. Poverty expressed as the proportion of households with inadequate housing conditions matters more for Whites than for Blacks: the higher the proportion of inadequate households, the higher the likelihood of Whites being homicide victims. In turn, the age structure and family composition in the municipality of residence matter more for the Blacks: the likelihood of a Black being homicide victim increases with participation of single individuals and reduces with participation of young people (15-29). Appendix B (d) measures the intensity (in percentage points) of the racial gap in the probability of being a victim of homicide between Blacks and Whites for each of the five Brazilian regions. The graph reveals that the racial homicide gap is more intense in the poorest regions (North and Northeast).

Decomposition of the racial differences in homicide victimization

Table 3 presents the Oaxaca-Blinder decomposition of the differences between Black and White populations in homicide victimization (Equation 3). We multiplied all estimates by 100,000 to have the differences in homicide rates measured by deaths/100,000 people. We compare the decomposition using the coefficients of Blacks ($\hat{\beta}^W$) and Whites ($\hat{\beta}^W$) as reference. Group 1 is the reference group (Whites for $\hat{\beta}^W$ and Blacks for $\hat{\beta}^B$) and group 2 is the comparison group (Blacks for $\hat{\beta}^W$ and Whites for $\hat{\beta}^B$). In general, the probability of suffering homicide for every 100,000 Black individuals (2.402%) exceeds the probability for every 100,000 White individuals (1.109%) by 116.6% (or 1,293 p.p.).

The decomposition reveals that, controlling by individual aspects, municipality-level characteristics and dummies for regions, up to 66% of the homicide racial differential (with $\hat{\beta}^B$) can be

explained by characteristics of the two groups (average values of the control variables). This result means that 66% of the difference in homicides between Blacks and Whites could be eliminated if Blacks were exposed to the "best" characteristics (the same socioeconomic and municipal conditions) similar to Whites individuals. The remaining 34% is due to victimization processes specific to each racial group (or unexplained effect). This last component indicates that, with Blacks and Whites under the structural conditions of White individuals (using $\hat{\beta}^B$), at least 34% of the racial differential in homicide would not be eliminated. Otherwise, when using $\hat{\beta}^W$, with Blacks and Whites under the Blacks' current structural conditions in Brazil, a relevant unexplained portion of the racial differential in homicide victimization could reach, with up to 53%. These results evidence that Blacks and Whites are subject to specific processes of homicide victimization.

Table 3. Oaxaca-Blinder decomposition for the probability of being a homicide victim per 100,000 inhabitants (Brazil, 2010)

Overall	Homicide			
	White $\hat{\beta}$ ($\widehat{\beta}^W$)	Perc. (%)	Black $\hat{\beta}$ ($\widehat{\beta}^B$)	Perc. (%)
Group 1	11.090*** (2.150)	100	24.020*** (3.080)	100
Group 2	24.020*** (3.080)	100	11.090*** (2.150)	100
Difference	-12.930*** (3.210)	100	12.930*** (3.210)	100
Explained	-6.130*** (1.580)	47.41	8.560*** (2.180)	66.20
Unexplained	-6.800** (3.130)	52.59	4.370* (2.380)	33.80
	Explained			
Individual-level characteristics	-6.670*** (1.400)	-	9.300*** (1.660)	-
Municipality-level characteristics	-0.287 (1.200)	-	0.400 (1.660)	-
Geographic characteristics	0.828 (1.640)	-	-1.140 (2.220)	-

(continue)

Table 3. (continuation)

	Unexplained			
Individual-level characteristics	-2.130 (3.160)	-	1.370 (1.810)	-
Municipality-level characteristics	123.34** (61.070)	-	-79.410*** (27.880)	-
Geographic characteristics	3.770 (4.940)	-	-2.430 (2.710)	-
Constant	-131.78** (62.630)	-	84.340*** (28.080)	-
Observations	**15,172,598**			

Source: Prepared by the authors using data from IBGE (2010) and SIM/MS (2021).
Note (1). Robust standard errors adjusted for 27 clusters (at Federative Unit level). ***Significant at 1%; **Significant at 5%; *Significant at 10%. **Note (2).** Coefficients and standard errors multiplied by 100,000, considering the probability of becoming a victim per 100,000 inhabitants. **Note (3).** Regarding the block of geographic characteristics, the "Northeast" region was omitted.

Discussion

Regarding the logit model (Table 2), considering the estimations with controls for municipal-level variables (Model 2), our findings are consistent with Soares-Filho (2011), Cerqueira and Coelho (2015, 2017), and Truzzi et al. (2021), which identified the same trends for homicides related to the variables of ethnicity-race, gender, and education. They also found an inverted-U relationship between age and the probability of being murdered for both Blacks and Whites. Similar to the present study, the authors verified that at 20 (peak of the chances of an individual being a homicide victim), the homicide death rates for Blacks exceed the rates for Whites by 164% (Truzzi et al., 2021).

Cerqueira and Moura (2013) and Aransiola et al. (2021) highlighted that demographic characteristics such as the proportion of young people in the population and the unemployment rate affect homicide rates in Brazil, and Aransiola et al. (2021) saw similar effects of household income, ethnic-racial heterogeneity, and population density. Adverse outcomes for the Black population are not unique to Brazil. Lo et al. (2013) identified highly disproportionate homicide rates among Blacks compared to Whites in the United States. According to Phillips (2002), demographic characteristics (such as the proportion of unmarried people, unemployment rate, ethnic-racial heterogeneity, and population density) are relevant factors related to homicide victim rates in that country.

In general, individual socioeconomic attributes and some local characteristics are relevant predictors of the proportion of homicide victims among Blacks and Whites. However, some variables, such as the proportion of young and unmarried (especially for Whites) and the proportion of illiterate adults at the municipal level, did not prove to be good predictors for any groups. Overall, the magnitude of most estimated coefficients tends to be greater for Blacks than Whites, suggesting that these population groups are exposed to different homicide risk levels, confirming hypothesis H1 of this study. These results converge with Cano's (1998), who analyzed the spatial distribution of violence in the city of Rio de Janeiro and found that the risk of lethal violence is more closely related to people's characteristics (income, education) than to territorial aspects (urban services, overpopulation).

Also for the Oaxaca-Blinder decomposition model, taking advantage of the estimations considering controls for individual aspects, municipality-level characteristics and dummies for regions, our findings are convergent to other studies. Cerqueira and Moura (2013) found that the set of socioeconomic and demographic variables used in their estimates explained 20% of the victimization differential between Blacks and non-Blacks in Brazil. Phillips (2002) identifies that differences between Blacks and Whites regarding family structure (such as marital status) and socioeconomic characteristics (such as education and employment status) contribute to the explained effect of the racial homicide differential in the United States.

To investigate how the racial differential of homicides is manifested throughout the Brazilian territory, we performed the Oaxaca-Blinder decomposition for each of the five Brazilian regions. In Appendix C, the results using $\hat{\beta}^W$ and $\hat{\beta}^B$ are disaggregated for each geographic region of the country. At the regional level, the results are similar, regardless of the decomposition type. In general, it is observed that the racial homicide differential is more relevant in the Northeast, Midwest, and especially in the North of the country.

Moreover, using $\hat{\beta}^W$ or $\hat{\beta}^B$, the spatial dynamics of the unexplained effect show the same trend: the unexplained share of the racial homicide differential is wider in Brazil's North and Northeast regions. The unexplained share amounts, respectively, to 91% and 92% (with $\hat{\beta}^W$) of the racial homicide gap between Blacks and Whites in these areas. In their "map of racism in Brazil", Cerqueira and Moura (2013)

identified in the states of the Northeast and North regions a greater correlation between the racial differential in homicides and the share of this differential not explained by socioeconomic variables.

The Oaxaca-Blinder decomposition results suggest important conclusions for this study. First, controlling for individual socioeconomic attributes and municipal-level aspects, only part of the racial differential in homicide victimization is associated with the worse structural conditions to which Blacks are subject (Cerqueira & Moura, 2013; Phillips, 2002; Steffensmeier et al., 2010; Truzzi et al., 2021; Wright et al., 2014), validating our hypothesis H2. Second, the high significance and participation of the unexplained effect in the composition of the racial differential reveals that Blacks and Whites are exposed to distinct processes of victimization by homicide. In addition to reinforcing the validity of hypothesis H1 in this study, these findings suggest that race is a central aspect to explain the victimization differential between Blacks and Whites (Cano, 2010; Cerqueira & Coelho, 2015, 2017; Truzzi et al., 2021; Unnever et al., 2016), evidencing a connection between racial discrimination and violence in Brazil (Vargas, 2004; Vargas & Amparo-Alves, 2010). Finally, these results validate our hypothesis H3 since the racial victimization differential and its components vary across Brazilian territory (Cerqueira & Moura, 2013; Truzzi et al., 2021). Overall, these results add evidence to the extensive literature contesting the validity of the racial invariance thesis (Steffensmeier et al., 2010; Unnever et al., 2016; Wright et al., 2014).

Final remarks

This study challenged the ethnic-racial invariance thesis by investigating the validity of three hypotheses under the Brazilian context. The first is that Black and White population groups are subject to distinct processes of victimization by homicide, with greater exposure of Blacks to lethal violence. The second is that the unequal structural socioeconomic and demographic conditions to which Blacks are exposed, compared to Whites, do not explain all the racial differences in homicides. Third, both the racial differential in homicide victim rates between Blacks and Whites and the "unexplained" portion of this differential tend to intensify in Brazilian North and Northeast, historically characterized by high levels of social inequalities and high mortality from violent causes.

One of the main findings of this study is that structural inequlities in individual socioeconomic attributes local demographic aspects of Blacks' and Whites' municipalities of residence contribute up to two-thirds (66%) of the racial differential in homicide victimization in Brazil. It means that even if Blacks and Whites had similar structural conditions, at least 66% of the racial differential in homicide would not be eliminated. These unexplained factors can range from a racial bias in the violence scenario in Brazil to individual or demographic characteristics not controlled by the model, such as the fact that the Black population is concentrated in more violent neighborhoods or microregions.

While this result does not allow us to validate the ethnic-racial invariance thesis, the structural conditions correspond to a relevant explanation of the racial differential in homicides, which means that reducing socioeconomic inequalities between Blacks and Whites presents a high potential in reducing the high rates of violent crimes to which Blacks are exposed. Among the sources of inequality, we highlight access to higher education, which is strongly associated with lower homicide rates.

It is noteworthy that this study has two limitations that future research should address. First, the cross-sectional nature of the sample limits the possibility of identifying the causality between ethnic-racial identity and the probability of homicide victimization, as it is not possible to follow the evolution of the victimization process and other control variables. Second, there are limitations due to potentially relevant variables that could not be included in the estimation of the empirical models. At the individual level, different personal aspects (e.g., daily habits and routines, commuting time) and socioeconomic attributes (such as average income) can affect exposure to lethal violence. In addition, the characteristics

of the location are also relevant predictors of this scenario (for example, quality of public lighting, policing, and other indicators of quality and access to public services and variables of social inequality). Thus, other studies can include this information, using databases that allow greater disaggregation (for example, at district and neighborhood levels).

Given the complexity in the Brazilian context of violence, this study reinforces, for public policymakers, the need to consolidate an official crime database in Brazil to guide actions and policies, given that limitations persist in the sources of official mortality records (Cerqueira, 2013). Given the centrality of the racial issue in the current scenario of inequality and violence, combating racial inequalities and other factors that affect criminality is one of the challenges that must be reinforced in the public policy agenda, especially in Brazil. Achieving this objective requires improvements in access, efficiency, and quality of public security services and the criminal justice system and initiatives to overcome social inequality in its diverse dimensions.

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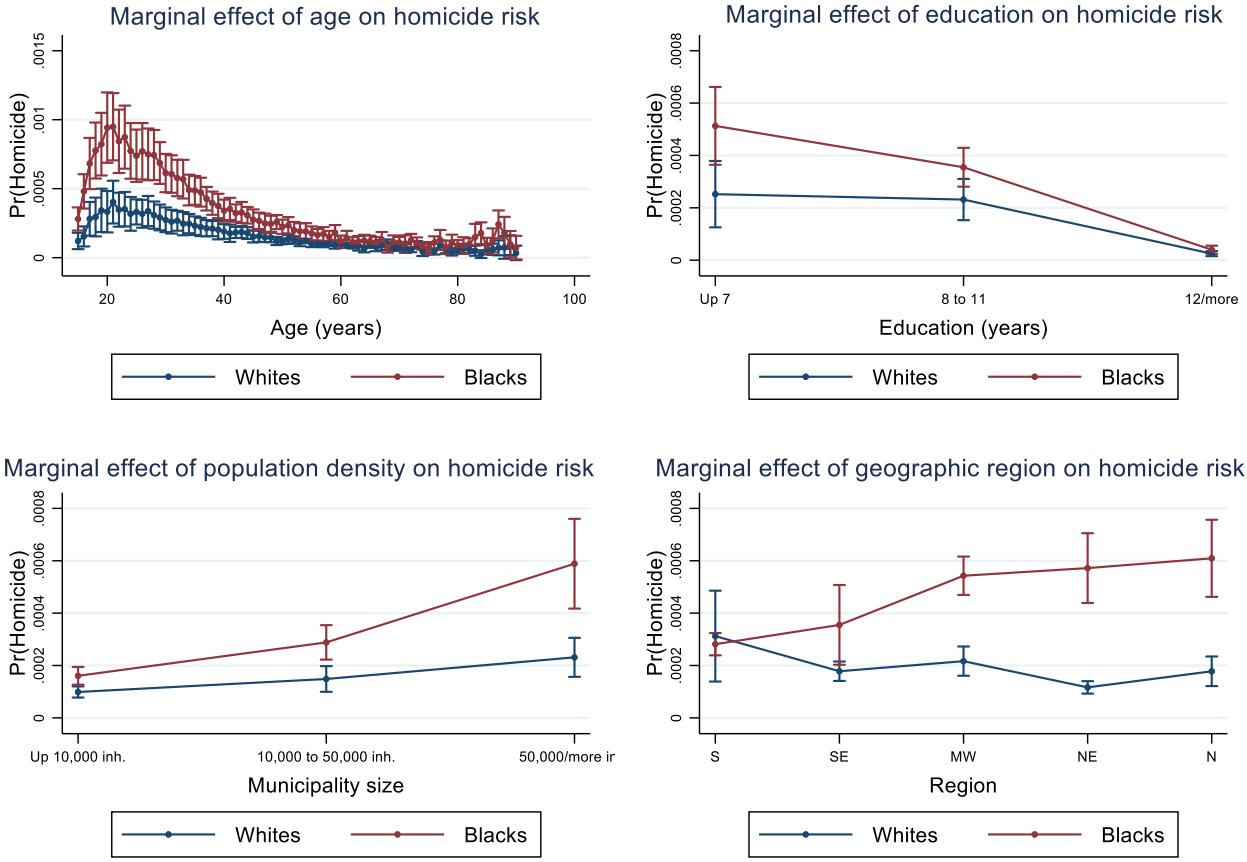
Appendix

Appendix A. Conceptual Matrix of the Municipal Rural-Urban Typology

Population ranges in densely populated areas	Percentage distribution of population in densely populated areas			
	> 75%	50 to 75%	25 to 50%	< 25%
Municipalities with a population of more than 50,000 in a densely populated area	Predominantly urban			
Municipalities with a population between 25,000 and 50,000 in a densely populated area	Predominantly urban	Predominantly urban	Intermediate	Predominantly rural
Municipalities with a population between 10.000 and 25.000 in a densely populated area	Predominantly urban	Intermediate	Predominantly rural	Predominantly rural
Municipalities with a population between 3.000 and 10.000 in a densely populated area	Intermediate	Predominantly rural	Predominantly rural	Predominantly rural
Municipalities with a population of less than 3.000 in a densely populated area	Predominantly rural			

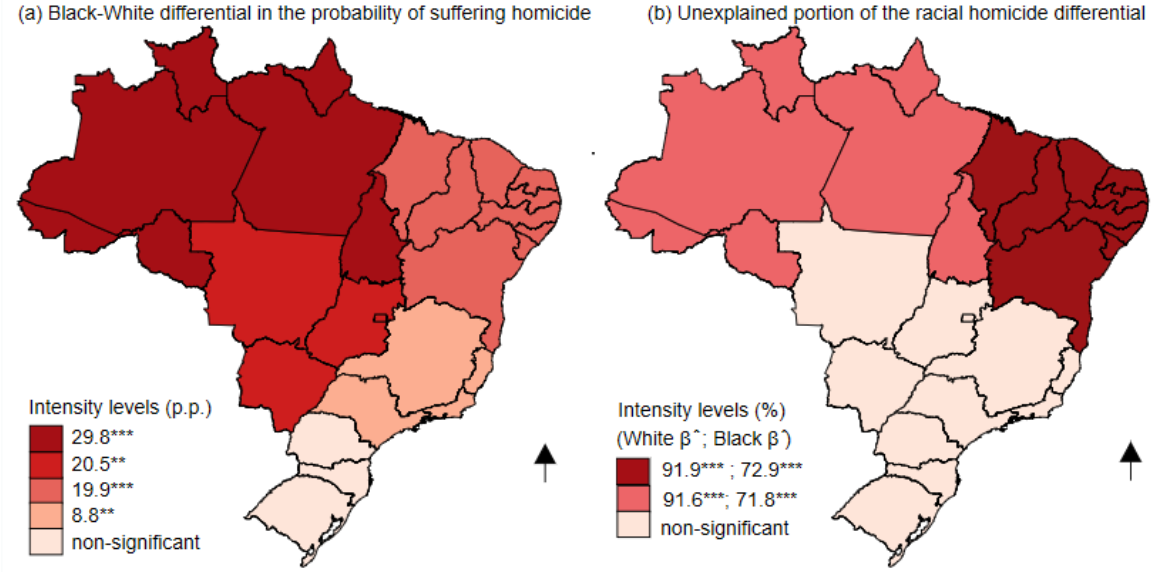
Source: Adapted from IBGE (2017).

Appendix B. Marginal effect of age, education, large geographic region, and municipality size on the probability of Blacks and Whites suffering homicide (Brazil, 2010).



Source. Prepared by the authors using data from IBGE (2010) and SIM/MS (2021).

Appendix C. Racial differences in homicides and price-effect intensity by major regions (Brazil, 2010).



Note (1). *** Significant at 1%; ** 5%; * 10%. **Note (2).** Coefficients and standard errors are omitted, but they are available from the corresponding author [BT] on request.
Source. Prepared by the authors using data from IBGE (2010) and SIM/MS (2021).