Tract level associations between historical residential redlining and contemporary fatal encounters with police

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Abstract

How does structural racism influence where people are killed during encounters with police? We analyzed geo-located incidents of fatal encounters with police that occurred between 2000-2020 in Census tracts that received a classification by the Home Owners Loan Corporation (HOLC) during the 1930's. Statistical models show that incidence rates of fatal encounters with police in formerly redlined areas are 66% more likely than in zones that received the most favorable "A" rating. These differences remain even when tract historical and contemporary racial compositions, along with contemporary economic conditions, are taken into account. The effects of contemporary racial composition and economic conditions overshadow the effect of zone classifications only in areas with high proportions of Black residents or residents in poverty (>60% or >30% respectively). These findings provide evidence of structural biases in policing rooted in historical segregation policies.

Keywords: Criminal Justice, Police Involved Deaths, Public Health, Demography, Social Inequality

Introduction

Policing and residential segregation play key roles in maintaining structural inequalities between people of color and white people in the United States. Fatal encounters with police are a leading cause of death among young men (Edwards, Lee, and Esposito 2019), and the increased risk of being killed by police on the basis of race is now a well-documented indicator of race based inequalities in the United States (Alang et al. 2017; Edwards et al. 2019; Ross 2015; Ross, Winterhalder, and McElreath 2020; Schwartz and Jahn 2020; Thomas et al. 2021). Residential segregation, along with the many inequalities in access to resources and essential services caused by it (Aaronson, Faber, et al. 2021; Nardone et al. 2020), is rooted in political decisions and institutions at the municipal, state, and federal levels (Logan and Molotoch 1987; Massey and Denton 1990; Sampson 2021). In the US, one such institution was the Home Owners Loan Corporation (HOLC), whose historic evaluations of neighborhoods beginning in the 1930's are the most well-known and accessible example of what is contemporarily known as "redlining" (Jackson 1980). These evaluations still have an enduring effect on the segregation patterns of American cities (Faber 2020). Contemporarily, at least 25% of the US population across 192 cities live in areas that received an HOLC evaluation¹, and while the practice was officially outlawed by the Fair Housing Act in 1968, the effects of redlining are evident today in disparities in wealth accumulation, access to resources, and public health across zones that received different classifications (Appel and Nickerson 2016; Hoffman, Shandas, and Pendleton 2020; Lynch et al. 2021; McClure et al. 2019; Nardone et al. 2020).

Recent scholarly attention on structural racism makes clear that the existent contemporary disparities in society are not solely the result of the private prejudices held by individuals, but are also the result of policies implemented at various levels of government, laws, social norms and economic systems that produce and maintain race-based group differences (Bonilla-Silva 1997; Ray 2019). Therefore, while the increased likelihood of experiencing criminal justice contact by people of color is due, at least in part, to the biases and personal characteristics of individual police officers (Ba et al. 2021; Pierson et al. 2020; Roscigno and Preto-Hodge 2021), structural and institutional factors are also important when explaining fatal encounters with the police.

¹ The HOLC created maps of 238 different cities, the 192 included here are all cities included in the Mapping Inequality Project. See *Appendix* for a discussion of the data collection.

Using geo-located incidents from the Fatal Encounters Database we analyze different HOLC zone classifications at the tract level, with historical and contemporary data from the US Census. We show that redlining correlates with the higher incidences of fatal encounters with law enforcement. Furthermore, historic and contemporary racial compositions, as well as contemporary economic conditions in Census tracts also predict the incidence of fatal encounters with the police, but the relationship between historic HOLC classification and fatal encounters with the police remains after taking these factors into account. We frame this analysis of police violence as a public health issue and place it alongside other issues of structural inequality and structural racism (Mesic et al. 2018; Problems 2018; Violence Subnational Collaborators 2021).

Redlined areas as a predictor of fatal encounters with the police

The HOLC was created 1933 as a part of the New Deal in order to alleviate the financial burden facing home owners, and help them to avoid foreclosure. Operating under the also recently created Federal Home Loan Bank Board (FHLBB), the HOLC introduced the practice of long-term housing mortgage. (Jackson 1980). A uniform system of appraisal based on the racial and socioeconomic characteristics of neighborhoods, as well as on housing sales trends and the quality of the housing stock, was developed and employed in cities across the nation (Ibid.). To determine which homes were to receive loans from the HOLC, the corporation created maps assigning grades to different neighborhoods to reflect their “mortgage risk” (Nelson and Ayers 2019). Neighborhoods deemed to have minimal risk were awarded an “A” rating, those areas that were still desirable received a “B” rating, those determined to be “declining” received a “C” rating, and finally neighborhoods determined to be “hazardous” received a “D” rating. HOLC neighborhood appraisals were shared with and used by subsidiary banking agencies throughout the entire federal banking system (Jackson 1980; Woods 2012). Through the 1937 Joint Committee of Appraisal and Mortgage Analysis, the HOLC appraisal techniques were shared with the Federal Housing Administration (FHA), influencing the latter’s mortgage underwriting policies for the following decades (Ibid.).

Redlining practices meant that the racial composition of a neighborhood was a key determinant of access to credit for its residents (Aaronson, Faber, et al. 2021; Aaronson, Hartley, and Mazumder 2021). This effectively shut down the flow of investments into minority and poor neighborhoods (Appel and Nickerson 2016) and legitimized the unequal distribution of resources

to those areas for an official period of approximately 35 years. However, even after the practice was officially discontinued, government-produced neighborhood ratings still factored into lending decisions by federally insured loans and private lending decisions (Massey and Denton 1990; Taggart and Smith 1981). Accordingly, residents of formerly redlined areas still had lower access to credit more than 40 years after redlining was officially abolished (Faber 2021).

The racialized differential access to resources initiated by redlining translated into several long-lasting effects on racial and social disparities. To illustrate the breadth of these effects, residents in formerly redlined areas are, for example, more exposed to poverty (Aaronson, Hartley, et al. 2021; Appel and Nickerson 2016), social mobility (Aaronson, Faber, et al. 2021), violence (Benns et al. 2020; Jacoby et al. 2018), environmentally hazardous conditions (Hoffman et al. 2020), poor health (Lynch et al. 2021; McClure et al. 2019; Nardone et al. 2020), and life expectancy (Graetz and Esposito 2021). Because of its racial undertones and far-reaching consequences, redlining practices are a prime example of structural racism.

Given their long lasting effects on other racial and social disparities, it is possible that the assignment of an HOLC classification is also related to the likelihood of fatal encounters with the police. There are, however, multiple possible mechanisms at work to explain this relationship. First, since individuals' perceptions of disorder are shaped by socioeconomic contexts (Sampson and Raudenbush 2016), the labeling of areas within cities by the HOLC as "hazardous", combined with the material outcomes caused by depriving them of resources, may have contributed to the idea that redlined areas are unsafe. Second, the material outcomes of resource deprivation create the pre-conditions for increased crime rates, which lead to more encounters with the police that may result in fatalities (Sciandra et al. 2013). Absent any concerted effort to upend these neighborhood hierarchies, path dependence suggests these mechanisms should have long term consequences.

Police officers often operate independently in the field, and the way that they approach situations is informed by both their personal experiences and perceptions about the neighborhood contexts where their encounters with the public take place (Klinger 1997). This means that the outcomes of interactions with police, such as fatal encounters, should account for neighborhood contexts (Lautenschlager and Omori 2018; Parker et al. 2008). However, above and beyond shaping individual officers' perceptions of the areas they are policing, neighborhood characteristics,

including their historically redlined status along with perceived or observed crime rates, also influence how agencies select which areas should be targeted with more aggressive policing activities. Adding to the informed behavior of individual police and agencies, neighborhood specific predictive policing algorithms built on skewed data create feedback loops of increased and more violent policing in areas dominated by minorities (Richardson, Schultz, and Crawford 2019), even as mounting evidence shows that such models can be inaccurate (Connealy 2019). One example of how the legacy of redlining informed policing practices are the safety injunction maps against gang activity in Los Angeles, CA, which largely follow the areas designated by the HOLC as hazardous (Bloch and Phillips 2021).

As we show, these path-dependent processes lead to higher incidents of fatal encounters with the police in historically redlined neighborhoods at the tract level even when their historical and contemporary racial and socioeconomic compositions are taken into account in statistical modelling.

Materials and Methods

Our analysis makes use of three separate data sources: the Fatal Encounters data for counts of people whose deaths involved interactions with the police including geocoded information on where the incident occurred (Burghart 2020; Finch et al. 2019), geocoded data on the HOLC neighborhood grades produced by the Mapping Inequality Project (Nelson and Ayers 2019) using historical maps and documents created by the HOLC, the US Census TIGER/Line geospatial data (Anon 2002; Ruggles et al. 2021) and the 2015 American Community Survey for demographic information on the characteristics of areas at the tract level. Our merging procedure first involved matching the geocoded locations of police involved deaths with the US Census tracts, then merging that with the geospatial data that included the HOLC grades. Since the HOLC maps used a different geographical unit, we matched the current census tracts with the HOLC graded zones with population weighted centroids. Using population weighted centroids matches tracts to the HOLC zones where most of the tract population is likely to reside and is a method implemented in previous studies using the HOLC data (Nardone et al. 2020). After this merging process we removed the graded tracts that had no residents and tracts whose population weighted centroids fell outside the HOLC graded zones, resulting in a tract level dataset that enables the comparison between the numbers of people that died in interactions with the police

between the different historical HOLC grades. The final dataset included 11,361 census tracts across 192 cities. The data on historical census tracts racial composition comes from the 1930's census and was provided by IPUMS National Historical Geographical Information System (Manson et al. 2021). Tract-level counts by race for that historical census were only available for 5,090 census tracts over 15 cities. For a more detailed description of the data and merging procedures see the *Appendix*.

To capture the most possible incidences of fatal encounters with police, and to follow the recommendations in previous studies to treat fatal encounters with police as an issue of public health (Alang et al. 2017; Bailey, Feldman, and Bassett 2021; Bassett 2015; Krieger et al. 2015; Violence Subnational Collaborators 2021), we have included all unique observations available in the Fatal Encounters database across a 20 year period from the beginning of their data collection cutoff time (2000) until the data was accessed for this analysis (2020). We do not adjudicate between encounters where the police might have intentionally or unintentionally used lethal force (for instance between a case reported as a “shooting” incident or an incident reported as “suicide”). We understand that this is a deviation from previous scholarship that has previously analyzed these data (Edwards et al. 2019; Schwartz and Jahn 2020), but the determination of which deaths were the result of intentional versus unintentional use of force is made by the data coders based on news reports of the incidents which have not been checked for validity. Additionally, since the Fatal Encounters data is largely based on local media reports the records become slightly less reliable further into the past since digitized records of incidents are less complete (Finch et al. 2019). It is possible that those missing records did not occur at random, introducing a systematic pattern that could skew the analysis. While it is our view that all deaths that occur during interactions with police are a part of the same public health problem and therefore should be included in the analysis, we have nevertheless included analyses which exclude unintentional use of force incidents and those incidents that occurring before 2010 as robustness checks in the *Appendix*. Exclusions of these types do not substantially alter the results of the analysis. After merging the geo-located coordinates from the Fatal Encounters database with the HOLC graded census tracts there were a total of 5,414 deaths across the 11,361 census tracts.

The maps we present show kernel density estimates of incidences for select cities and the bandwidth parameters for these estimates were calculated for each city based on the approach proposed by Bowman and Azzalini (Bowman, A. Azzalini 1997). The densities were estimated using the original geocoded Fatal Encounters data points.

To test the relationship between HOLC grades and fatal encounters with police we present point estimates from a Hierarchical Bayesian Negative Binomial (HBNB) model with city-level random intercepts and tract-level population offsets, we present the estimated Incident Rate Ratios from this model first. However, when estimating the effect of historical characteristics on contemporary outcomes there are potential mediating and confounding factors that should be accounted for (see for example: Acharya, Blackwell and Sen (Acharya, Blackwell, and Sen 2016)). We address these issues in two ways, first conditioning the effect of HOLC grades on contemporary population characteristics controls for a post treatment mediating factor, such as increases or decreases of proportions of minority residents in the decades since the creation of the HOLC grades that might influence the effect of HOLC classifications (Figure 4). Second, it is known that that the grade a tract received was largely influenced by the demographic characteristics of the area before the creation of the HOLC grades, and therefore the differences we see in incidence rates could be due to segregation patterns that predate the HOLC, this would represent a pretreatment confounder. In an attempt to control for this we have included a model with pre-HOLC designation demographic data from 1930 in one of the models (Figure 2: Bottom). This data was only available for 15 cities, comprising 2,164 incidents in 5,090 tracts most of which are the major urban centers in the Midwest and on the east coast.

The Figures of conditional effects are also from HBNB models with the same nesting structure as the point estimates, but with the HOLC grade effect conditioned on the different demographic and economic factors. As robustness checks we present models with alternative dispersal patterns, case selection criteria, and the exclusion of tracts that could be possible outliers in the *Appendix*.

Results

Figure 1 displays the average number of fatal encounters adjusted for population that occurred in HOLC grade classification in cities with 40 fatal encounters or more. Among these cities there is a clear pattern of more fatal encounters with police in places that received lower HOLC grades.

There is, for example, no city with on average more fatal encounters in the “A” grades than the “D” grades, with the highest concentrations of fatal encounters occurring in the “D” grades across cities. Furthermore, in the top 100 most deadly census tracts 53 of them are “D” zones, 38 are “C” zones, 8 are “B” zones and only one is an “A” zone (*adjusted for population see Appendix*).

Figure 1. Tract level averages of fatal encounters per 100,000 people with police in 40 most deadly cities with an HOLC grade adjusted for population.

As a visual example of where fatal encounters occur in cities, we have chosen to display the bivariate association between the spatial distribution of fatal encounters with the police and census tract HOLC grades in three of the 192 cities examined in Figure 2. The areas with higher

density of fatal encounters largely overlap with the census tracts covered by HOLC grades C and D, while most grades A and B have lower incidences. This pattern is present in both smaller cities (of which Oklahoma City is our example, left), more population-dense cities like Chicago (center), and cities with a larger urban sprawl like Los Angeles (right).

Figure 2. Spatial distribution of census tracts by HOLC grade classification (top row) and the deciles of a kernel density estimates of fatal encounters with police (bottom row). From left to right: Oklahoma City (left), Chicago (center), and Los Angeles (right). Dots show the location of Fatal Encounters.

In terms of analytic results, Figure 3 is the plotted estimated incident rate ratios from two Hierarchical Bayesian Negative Binomial Models (Bürkner 2017, 2018) with city level random intercepts and tract level population offsets. The top model includes all available tracts classified by the HOLC as well as proportions of residents of different demographic characteristics and income classifications. Each HOLC grade lower predicts higher incidents of fatal encounters with police ('B' $IRR= 1.28$ $CI= 1.06- 1.53$; 'C' $IRR= 1.44$ $CI= 1.20-1.73$; 'D' $IRR= 1.66$ $CI= 1.37-1.99$) with fatal encounters with the police being 66% more likely in formerly redlined areas

than the most favorable ‘A’ rating. Percentages of residents that are Black or Hispanic also predict more fatal encounters with police (*Black IRR= 2.89 CI= 2.45-3.39; Hispanic IRR= 1.52 CI= 1.26-1.84*). However, percentages of Asian residents negatively predicts fatal encounters with police (*Asian IRR= 0.56 CI= 0.36-0.85*). Finally, the proportions of residents in poverty, and the median income in tracts both predict and negatively predict fatal encounters with police respectively (*Poverty IRR: 2.98 CI= 1.62-5.53; (log) Median income IRR: 0.7 CI= 0.61-0.81*).

To account for the demographic compositions of neighborhoods before the creation of the HOLC grades, the bottom model (Figure 2) includes the tracts where historical demographic data was also available. Reducing the sample in this way did influence the estimates, however the same pattern remains with each HOLC grade predicting higher incidents of fatal encounters with police. In contrast, the percentages of Black residents and residents that were immigrants in the 1930’s are not strong predictors of contemporary fatal encounters with the police (*1930 Percent Black IRR: 1.13 CI= 0.80-1.59, 1930 Percent Immigrant IRR: 0.82 CI= 0.43-1.62*), suggesting that the relationship between HOLC grades and fatal encounters with the police is due to the path dependence of the creation of the grades, rather than the path dependence of pre-existing demographic characteristics of the neighborhoods alone.

Figure 2. Estimates from two Bayesian Hierarchical Negative Binomial Models with city-level random intercepts and population offsets. Top: model with the full sample of 192 cities HOLC classifications, proportions of residents in of different demographic characteristics, and income

classifications. Bottom: Model with the reduced sample of 15 cities with available historical tract level data and the addition of historical demographics for percent.

To account for the demographic characteristics of the neighborhoods after the creation of the HOLC Grades, the conditional effects of HOLC Grades against the proportions of residents that are in poverty (top left), Hispanic (top right), and Black (bottom left) are shown in Figure 4. These effects come from the model estimated using the full set of census tracts. The top left panel of Figure 4 shows that the formerly redlined zones have consistently high risk of fatal encounters with police even where there are contemporarily few people living in poverty, however the differences in conditional estimates between redlined tracts and the other grades converge with increasing levels of poverty. In a similar vein, the top right panel of Figure 4 shows that the conditional estimates for the different HOLC grades begin to converge with increased proportions of Hispanic residents, with “A” zones converging with the others in tracts

with around 50% Hispanic residents. Finally, the bottom left panel of Figure 4 shows that the effect of HOLC grades conditioned on proportions of Black residents is more pronounced in tracts with smaller shares of Black residents, and that “B” and “C” zones converge with “D” zones in Census tracts that have upwards of 60% Black residents. “A” tracts with high levels of Black residents are more deadly than those with low levels, however, unlike the two previous examples, the “A” tracts do not converge with the other zones even in tracts where the share of Black residents is greater than 60%.

Figure 4. Conditional effects of HOLC Grade with Proportions of Residents that are in Poverty, Hispanic, and Black

Discussion

Our analyses show how historical structural factors can influence the likelihood fatal encounters with the police. Whereas previous literature has focused on the likelihood of individuals to be killed by police, biases of individual police officers, or contemporary police policies targeted at mitigating use of force; this study shifts the focus to the historical indicators that predict where police violence might occur. Our results show that people are more likely to die during interactions with the police in Census tracts that received a “D”, or “redlined” classification, than

in tracts that received a more favorable rating from the HOLC. This finding remains after taking into account the proportion of black and immigrant residents that lived in the tracts prior to the creation of the HOLC grades, and after accounting for present-day demographic and socioeconomic composition.

In line with previous literature, proportions of residents living in poverty, residents that are Hispanic, and residents that are Black are also substantial predictors of tracts that are likely to have incidences of fatal encounters with the police. We also show a convergence in the likelihood of fatal encounters with police, where the effect of the HOLC grades diminish in tracts with higher proportions of people in poverty, residents that are Hispanic, and residents that are Black. We see this as evidence that both historical structural factors as well as contemporary demographic conditions work together to predict where fatal encounters with the police occur. An example of this being that the most dangerous census tracts are those that were formerly redlined and still have high proportions of Black residents.

It is possible that encounters with police, conditioned by areas with high crime, are responsible for the differences in incidents of fatal encounters with police between census tracts (Cesario, Johnson, and Terrill 2018). However, police encounters are themselves sources of bias, both in terms of where the police conduct their activities, and whether the public report crimes at all, so conditioning risk estimates on crime introduces these biases in any analysis of deaths during interactions (Ross, Winterhalder, and McElreath 2018; Ross et al. 2020). While imperfect, conditioning estimates on populations at the local level is the better option to capture potential encounters.

Previous literature has noted that police behave differently depending on different neighborhood contexts (Smith 1986; Terrill and Reisig 2016), and our analysis provides empirical evidence for the historical and structural foundations of those findings. The HOLC codes established a basis for neighborhood hierarchies and set forth a path for cities to distribute resources, further racially segregate their neighborhoods, and solidify norms about what areas are more problematic. This process imprinted a stamp on the collective memory of the cities that received the codes and continues to inform how police should behave in different areas. It also created the material and socioeconomic pre-conditions for crime in those neighborhoods (Sampson, Raudenbush, and Earls 1997; Sciandra et al. 2013). Although this study is unable to pinpoint the exact mechanism

linking the HOLC categorization to the incidence of fatal encounters with the police, we provide first evidence of a robust correlation between historical redlining and police violence. Future work should attempt to identify the mechanism behind the associations reported here. A first line of inquiry could focus on how neighborhood reputation informs policing decisions. A second line of inquiry could focus on the extent to which different rates of encounters with police in areas with high crime rates are responsible for the differences in the incidence of fatal encounters between tracts. However, due to the inherent bias in registered and reported criminal activity, following this second line of inquiry would require considerably improved data on police activity rather than relying solely on crime data.

Relatedly, data availability also limited the scope of our analysis to only include fatal encounters with police, the most extreme sort of police uses of force, precluding an analysis of other use of force types that did not ultimately end in a fatality. No official government data source can be used to reliably compare different areas, types of police violence, or trends over time. This lack of official data presents a considerable challenge in reducing police violence (Violence Subnational Collaborators 2021). We echo the call of previous researchers and activist groups for the Bureau of Justice Statistics to renew efforts to collect this information from local, state and federal agencies. Better and more reliable data collection must accompany any meaningful policy change to address police violence so its progress can be tracked over time.

Finally, regardless of the actual mechanisms linking HOLC classifications to police violence, our results stress the importance of addressing neighborhood inequality. Recently, in response to the Black Lives Matter movement protests against police violence, the Obama and Trump administrations have proposed their own initiatives to investigate and possibly curb fatal encounters with police² (Preito-Hodge and Tomaskovic-Devey 2021). Additionally, following the massive public protests that culminated after the killing of George Floyd, congress introduced the George Floyd Justice in Policing Act in February 2021 with the expressed support of the Biden administration (Anon 2021). If passed, this legislation would impose new data collection requirements on use of force incidents like those recommended here and in previous studies on police violence. It also lowers the criminal intent standard to convict law enforcement

² The Obama administration created the President's Task Force on 21st Century Policing (PTF21CP) and the Trump administration issued an Executive Order called the "Safe Policing Safe Communities" which banned chokeholds.

officers and codifies into law the restrictions some of the executive orders put in place, limiting the use of no-knock warrants and chokeholds (Bass 2021). These new measures will assuredly improve policing in the United States overall by raising standards and increasing the possibility for accountability. However, in light of the findings included in this study, in order to further reduce the incidents of fatal encounters with police, policies will need to go beyond implicit bias education, de-escalation training, and other restrictions on the behavior of individual officers. In addition to these recently proposed interventions, city and state governments will need to address the longstanding, neighborhood level inequalities whose roots date back to the HOLC codes of the 1930's.

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