The enduring impact of historical and structural racism on urban violence in Philadelphia

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ARTICLE INFO

ABSTRACT

Public health approaches to crime and injury prevention are increasingly focused on the physical places and environments where violence is concentrated. In this study, our aim is to explore the association between historic place-based racial discrimination captured in the 1937 Home Owners Loan Corporation (HOLC) map of Philadelphia and present-day violent crime and firearm injuries. The creators of the 1937 HOLC map zoned Philadelphia based in a hierarchical system wherein first-grade and green color zones were used to indicate areas desirable for government-backed mortgage lending and economic development, a second-grade or blue zone for areas that were already developed and stable, a third-grade or yellow zone for areas with evidence of decline and influx of a "low grade population," and fourth-grade or red zone for areas with dilapidated or informal housing and an "undesirable population" of predominately Black residents. We conducted an empirical spatial analysis of the concentration of firearm assaults and violent crimes in 2013 through 2014 relative to zoning in the 1937 HOLC map. After adjusting for socio-demographic factors at the time the map was created from the 1940 Census, firearm injury rates are highest in historically red-zoned areas of Philadelphia. The relationship between HOLC map zones and general violent crime is not supported after adjusting for historical Census data. This analysis extends historic perspective to the relationship between emplaced structural racism and violence, and situates the socio-ecological context in which people live at the forefront of this association.

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1. Introduction

There are many ways to evaluate the relationship between urban space, race and inequalities in violence. In the US, for example, firearm injury and death among Black men is proportionately higher than in any other racial group (Kalesan et al., 2014). To imagine that categories of racial and gender identities are sufficient to understand the 'the problem (Gee and Ford, 2011)'of urban violence, risks vast oversimplification. From an eco-social approach (Krieger, 2012), people are not just the 'at risk' or the 'injured; ' they represent the embodiment of a "multilevel dynamic and co-constituted social and ecological context," which shapes "health, disease, and well-being within and across historical generations" (Krieger, 2016). In this perspective, if we limited the cause and consequence of urban violence to Black men, we may easily conflate the complex processes that concentrate violence within specific urban places with the people who live there (Greenberg and Schneider, 1994). Sociologists from the Chicago School have demonstrated that certain city neighborhoods have maintained high rates of crime and violence over decades despite substantial change in the racial and ethnic makeup of the population in those areas (Shaw and McKay, 1942).

Emerging approaches to the reduction of violent crime and violent injuries are increasingly place-based, with focus on the urban

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environments where violence is endemic. Public health programs like urban greening and building remediation have shown promise in improving safety across large and diverse urban populations (Link and Phelan, 1995; Branas et al., 2011; Garvin et al., 2013; Branas and Macdonald, 2014; Kondo et al., 2015). Sociologists who study urban violence through a social disorganization perspective similarly emphasize the importance of place in creating the context of crime (Sampson, 2012). Accordingly, recent criminal justice strategies now consider urban places like block-level violence "hot spots" as an ideal target for law enforcement-based violence prevention (Braga et al., 2010; Koper et al., 2015).

In this study, our aim is to add a historical framing to the association between violence and city spaces. In their seminal studies of Chicago, Sampson and colleagues demonstrate how neighborhood crime and disorder are a legacy of the city's social and economic inequality (Sampson, 2012; Sampson and Morenoff, 2006; Sampson and Sharkey, 2008). Our purpose, here, is to explore how the distribution of urban violence is associated with historical forms of structural racism. We define structural racism as the institutions, ideologies, and processes that operate at a socioecological level and which are able to adapt to changing sociopolitical contexts and persist over time (Gee and Ford, 2011). We use as an exemplar, the city of Philadelphia, which has been both a mainstay of urban life in the United States (US) and the very setting in which Du Bois first described connections between racism, social inequality, and health (Du Bois, 1996).

As secondary goal we explore how maps can be used to historicize spatial relationships between violence concentrations and urban space (Pulido, 2000). The map we use is the 1937 Home Owners Loan Corporation (HOLC) map of Philadelphia which was created in the service of the Federal Home Loan Bank Board (FHLBB) (Fig. 1). The HOLC was commissioned by the Franklin Roosevelt Administration as part of New Deal in effort to stem the tide of housing foreclosures in wake of the Great Depression (Guttentag and Wachter, 1980). The HOLC together with the Federal Housing Association of 1937 became major actors who determined which urban areas were attractive for bank and financial service company investment and which were not (Guttentag and Wachter, 1980). In 1935 the HOLC began a city survey program to create residential security maps in 239 cities. These maps were used to indicate the relative likelihood that real estate investments would appreciate over time from the point of view their creators, who were often 'consultants' with local financial interests such as lenders, realtors and appraisers (Hillier, 2003).

HOLC map-makers in the 1930s assimilated racial and ethnic composition into their assessment of the worthiness of specific urban spaces for government-backed investment and economic development (Hillier, 2003, 2005; Crossney and Bartelt, 2005). The FHLBB Division of Research and statistics asked that map-creators grade neighborhoods in a quaternary system. A first-grade or green color zone represented areas assessed to be ideal for investment vis-a-vis affluent home buyers and plentiful space for development. A second-grade or blue zone was assigned to areas deemed well-developed and stable. A third-grade or yellow zone represented areas with evidence of decline and influx of what was termed a "low grade population," with a fourth-grade or red zone reserved for areas with dilapidated or informal housing stock and an "undesirable population" of Blacks, immigrants and Jews (Hillier, 2005).

The mapping practices that informed the development of HOLC maps (known more commonly as "redlining" for the red-zones on maps), was an explicit form of place-based discrimination (Hillier, 2003) intended to shelter government financial investment in the 'desirability' of white and higher income geographies. As Wilder describes (2000) in his study of the progressive decline of Brooklyn's Bedford-Stuyvesant neighborhood, the HOLC not only shifted financial resources across the city (in this case from North to South Brooklyn), it "drew a line of racial separation across the heart of the borough. (pp. 194)." In effort to sustain the availability of federal resources for neighborhood investments and housing value, white residents of mixed Brooklyn neighborhoods sought homogenous communities where financially "dangerous" Black neighbors were not welcome or pushed out.

In the case of Philadelphia, there is not sufficient evidence to support that the 1937 HOLC map was extensively used by local mortgage originators or that it led to direct divestment in minority communities (Hillier, 2003, 2005). The map is, nonetheless, a historic illustration of the racialized hierarchicalization of urban space (Aalbers, 2014) in New Deal era Philadelphia. The map's makers with a "rhetorical role in defining the configurations of power in society," recorded their interpretation of the racist social forces and ideologies of their time as "manifestations in the visible landscape (Harley, 1988, pp. 303)."

2. Methods

The HOLC map is a spatial representation of place-based racial discrimination in 1930s Philadelphia. We therefore designed an empirical spatial analysis to test the relationship between historically racialized assignments of urban space and the present-day distribution of the city's violence. Our units of analysis were 1940 Census tracts that have internal centroids located within the present day city limits of Philadelphia (n = 404; Fig. 2a).

2.1. 1937 HOLC zones

The main independent variables are the color-coded zones depicted in the 1937 HOLC map (Fig. 1). Following the work of Hillier (2003), we imported the map image as a raster layer into ArcMap v.10.3.1 (ESRI, 2014), then aligned this layer with Census 2010 blocks. Blocks were assigned to one of five categories (green, blue, yellow, red, or not zoned) in which their center point (internal centroid) was located. Most blocks were wholly contained within a single HOLC zone category, but due to some changes in street layouts over 80 years (e.g. new freeways), there was some minor misalignments between block boundaries and HOLC zone boundaries. Having digitally approximated the boundaries of HOLC zones (Fig. 2b), we then assigned Census 2010 blocks to Census 1940 tracts based on the location of their internal centroid. We calculated the proportion of land area in each 1940 Census Tract that comprised each of these designations.

2.2. 1940 census demographics

HOLC assessments were based, at least in part, on the demographic composition of neighborhoods. To account for the possibility that relationships we see between 1937 HOLC zones and present day violence is confounded by the demographic distribution of the city's population near the time of map creation, we calculated measures of population demographics from the 1940 decennial Census. These data are available from the National Historical Geographic System (Minnesota Population Center, 2016). In theory, demographic data from before 1937 would be preferable for this analysis, because of the possibility that the HOLC maps shaped the urban social landscape, and that 1940 demographic characteristics in fact mediate relationships between HOLC zones and present day violence (Petersen et al., 2006; Imai and Tingley, 2010). However, the 1940 Census provided more expansive demographic characteristics than the 1930 Census, and we considered it highly unlikely that the map, even if widely distributed, would have
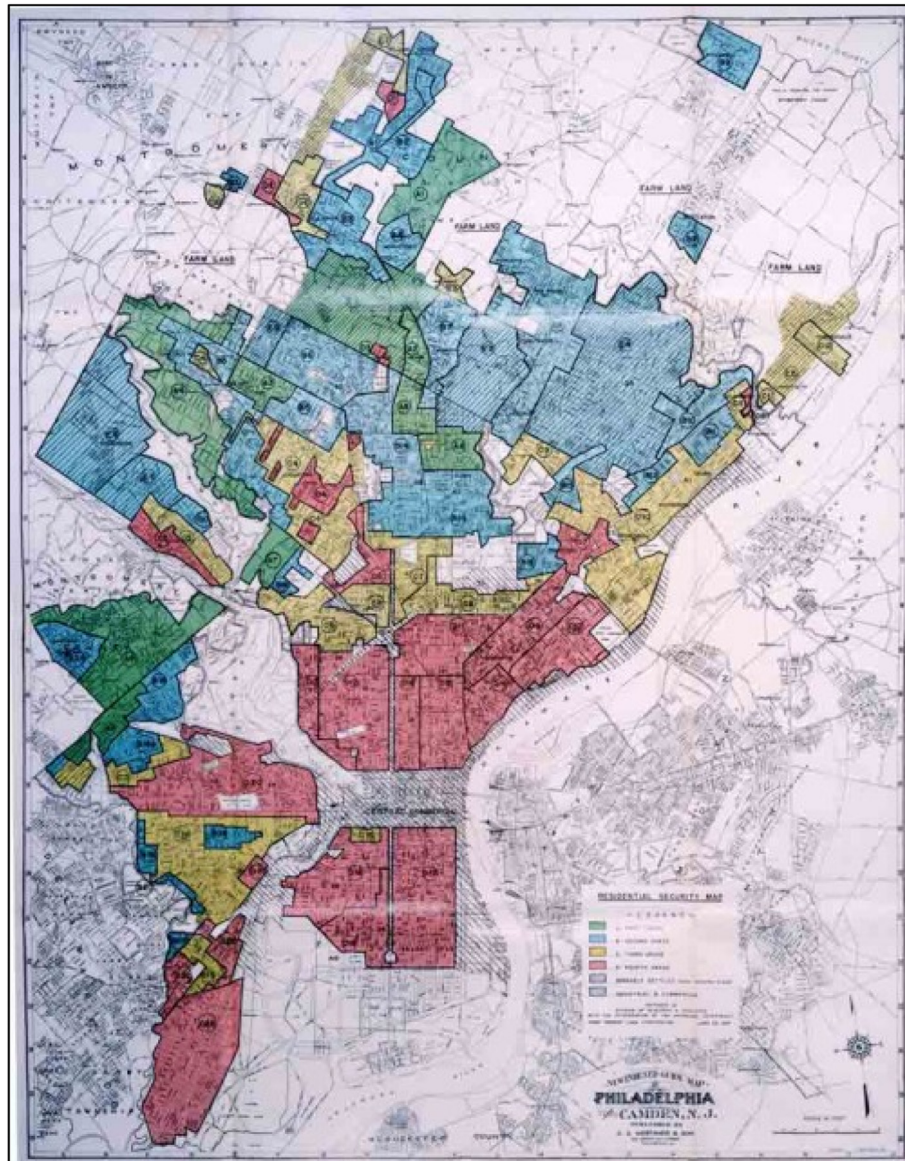
Fig. 1. 1937 Home Owners' Lending Corporation security map of Philadelphia, part of the records of the FHLBB (RG195) at the National Archives II (Cartographic Modeling Lab, 2003).

drastically altered the geographic distribution of the city residents over the course of three years.

To be considered a potential confounder of the relationship between 1937 HOLC zones and present day violence, 1940 Census variables must (i) relate to HOLC designations, (ii) affect subsequent land use in ways that could shape geographic distributions of violence (for example, areas that are persistently disadvantaged over decades), and (iii) not lie on the causal path between HOLC zones and violence (Rothman et al., 2008). Three measures available in the 1940 Census met these criteria: (1) the proportion of the population who were Black, (2) the median value of owner occupied homes (in 1940 $US), and (3) an index of historic 'concentrated disadvantage,' described below.

2.3. Concentrated disadvantage

Concentrated disadvantage represents compounded place-based economic disinvestment, social disorganization and political marginalization (Sampson, 2012). Previous research suggests internally consistent indices can be calculated using routinely collected Census variables. These include: the proportion receiving public assistance, the proportion of female-headed households, racial composition (percentage Black) and density of children (Sampson et al., 1997). Indices can be calculated using factor analysis or by taking a sum of the variables (Leventhal and Brooks-gunn, 2000; Andreias et al., 2010) to capture the construct of concentrated disadvantage in a single metric.

In the case of the 1940 Census, very few variables used in conventional measures of concentrated disadvantage were available. However, we considered that some 1940 variables would provide adequate proxies. For our concentrated disadvantage index we calculated the sum of: the proportion of the population aged ≥25 years without a high school certificate, the proportion of homes that were renter occupied, the proportion of homes without a radio, the proportion of homes without a mechanical refrigerator, the proportion of homes without central heating, and the proportion of
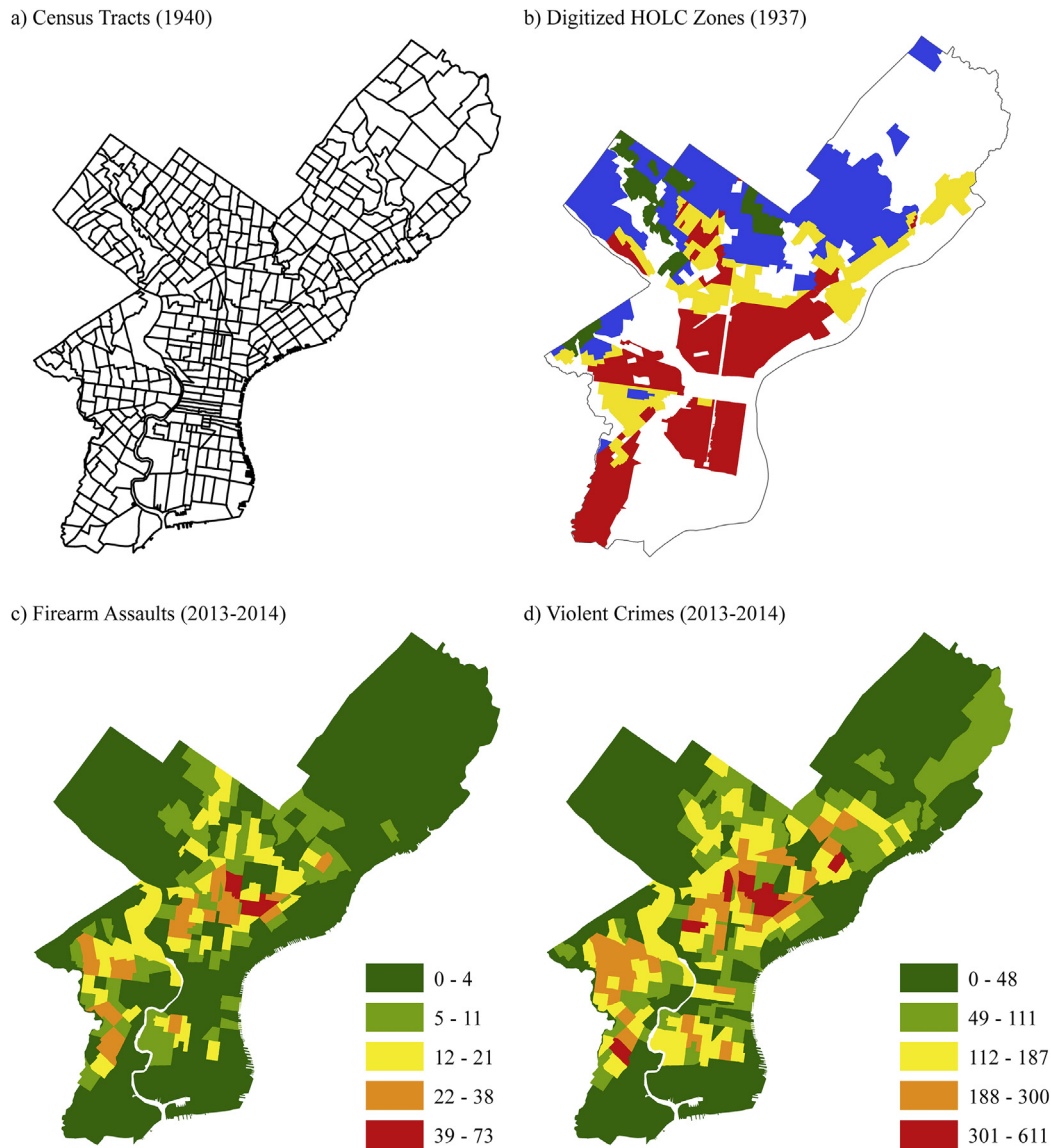
a) Census Tracts (1940) b) Digitized HOLC Zones (1937)

c) Firearm Assaults (2013-2014) d) Violent Crimes (2013-2014)

0 - 4	0 - 48
5 - 11	49 - 111
12 - 21	112 - 187
22 - 38	188 - 300
39 - 73	301 - 611

Fig. 2. Geographic characteristics, Philadelphia.

homes with more than one person per room. Measured in terms of Spearman correlation coefficients (Table 1), these variables were mostly moderately ($0.4 \leq \rho < 0.7$) or highly correlated ($\rho \geq 0.7$); the internal consistency was also high (Cronbach's alpha = 0.810). We considered other variables for inclusion in the index (e.g. proportion of men aged ≥ 14 years who were unemployed), but these measures were poorly correlated with other measures ($\rho < 0.4$) and likely had different social meaning in 1940 when compared to the present day. Median home value was moderately correlated with the index of concentrated disadvantage ($\rho = -0.443$).

2.4. Present-day violence

Our dependent measures were counts of (i) firearm assaults and (ii) violent crimes that occurred in Philadelphia in 2013—2014 and were recorded by the Philadelphia Police Department (PPD). The PPD routinely collects and maintains these data. We defined firearm assaults as any event in which a person was intentionally injured by a firearm by another person or groups of people, and violent crimes as any homicide, rape, robbery or aggravated assault.

Each event is documented by the street address on which it occurred (masked to the city block; e.g. 1000 block of Market St). We geocoded the point locations of all firearm assaults and violent crimes and then calculated counts of these events within the 1940 Census tracts (Fig. 2c and d).

2.5. Statistical analysis

We constructed Poisson models for counts of firearm assaults (Model 1) and violent crimes (Model 2) within the 1940 Census tracts. We created three different versions of each model. First, we included only the 1937 HOLC categorizations of red, yellow, blue and no zone, reserving green as a reference category. Second, we included only the 1940 Census measures of proportion Black, median home income, and concentrated disadvantage (standardized). Very few residents were recorded as races other than Black or White in 1940 (Table 2), so we reserved the proportion White and other race as a reference category. Third, we included all independent measures (i.e. the HOLC zones and the 1940 Census measures) in a single model. We expected there to be more present

Table 1
Spearman correlation coefficients; 1940 Census tracts Philadelphia (n = 404).

	1	2	3	4	5	6
1. Age ≥25 years without a High School certificate (%)	1.000					
2. Tenant occupied dwellings (%)	0.245	1.000				
3. Dwellings without a radio (%)	0.461	0.458	1.000			
4. Dwellings without a mechanical refrigerator (%)	0.676	0.566	0.719	1.000		
5. Dwellings without central heating (%)	0.412	0.278	0.689	0.644	1.000	
6. Dwellings with ≥1 person per room (%)	0.648	0.460	0.667	0.825	0.612	1.000

Table 2
Descriptive statistics; 1940 Census tracts, Philadelphia (n = 404).

	Mean	SD	Min	Max
Present Day Characteristics				
Shootings (2013—2014)	5.317	8.678	0	73
Violent crimes (2013—2014)	80.517	85.849	0	611
Population (ACS 5-year estimate 2014)	3777.238	2981.639	2	16013
HOLC Zone (% of land area)				
Red	27.817	39.396	0.000	100.000
Yellow	15.127	28.864	0.000	100.000
Blue	23.745	37.546	0.000	100.000
Green (reference)	4.745	17.403	0.000	100.000
No zone	28.565	38.150	0.000	100.000
1940 Census Variables				
White and other race (%)	90.023	19.020	0.000	100.000
Black (%)	9.878	18.994	0.000	100.000
Median house value (1940 $US)	2686	2590	0	16278
Age ≥ 25 years without a high school certificate (%)	77.835	16.685	0.000	100.000
Tenant occupied dwellings (%)	57.469	19.758	0.000	100.000
Dwellings without a radio (%)	5.629	11.166	0.000	100.000
Dwellings without a mechanical refrigerator (%)	38.515	26.809	0.000	100.000
Dwellings without central heating (%)	12.887	20.380	0.000	100.000
Dwellings with ≥1 person per room (%)	10.908	8.692	0.000	62.500

day violence in Census tracts with larger present day populations, so all models used present day population as an off-set variable. We estimated population size by taking the sum of the populations for all blocks with an internal centroid inside the boundary of each 1940 tract (using American Community Survey 5 year estimates of population size for 2014).

Conventional statistical methods assume that units of analysis are independent of one another, however when data are aggregated within spatial units, nearby units tend to be more alike than distant units (Tobler, 1970). To account for this possibility, our Poisson models included a conditional autoregressive (CAR) random effect as well as a spatially unstructured noise term which controlled for overdispersion (Waller and Gotway, 2004). Rather than a frequentist approach that relies on asymptotic estimates, we used a statistically efficient Bayesian procedure to fit the models to the data (Zhu et al., 2006). Where the 95% credible intervals around the median parameter estimate do not include a value of 1.00, the relationships can be considered well-supported (which is analogous to achieving statistical significance in standard regression analyses) (Lunn et al., 2000). We tested the extent to which the CAR term and noise term were spatially autocorrelated using global Moran coefficients.

We conducted analyses to assess the sensitivity of the results to model specification. First, we tested alternate constructions of the measure of concentrated disadvantage, systematically omitting the component variables and including other candidate measures (e.g. male unemployment rate). Second, we added the natural logarithm of each Census tract's land area as an independent variable, to account for the possibility that red zoned areas were more densely populated. Third, we recomposed the analyses using 2010 Census tracts as the units of analysis, and replaced the 1940 Census measures with corresponding measures from 2014 (i.e. American

Community Survey 5-year estimates of proportion Black, median household income, and concentrated disadvantage). Although we recognized that 2014 characteristics more likely mediated than confounded the relationships between 1937 HOLC zones and present day violent crime, we considered it was important to assess whether altering the year of the demographic measures materially affected the main associations of interest.

3. Results

In total, there were 2148 firearm assaults and 32,529 violent crimes in Philadelphia between 2013 and 2014. Of the 135.9 square miles that covered the 404 included 1940 Census tracts, 4.1% of land was categorized as grade-A or a green zone, 21.1% was categorized blue, 12.4% was categorized yellow, 19.8% was categorized red, and 42.6% was not graded or included in the 1937 HOLC evaluation. Census tract characteristics are presented in Table 2.

Model 1 evaluates firearm violence in relationship to the 1937 HOLC map categorizations (Table 3). In Model 1a, firearm violence is around 13 times higher in tracts that were exclusively categorized within a red zone in 1937 compared to tracts exclusively categorized as within a green zone (IRR = 13.1, 95% CI: 3.8, 47.4). Tracts categorized as yellow had more than 8-fold greater incidence (IRR = 8.8, 95% CI: 2.6, 30.5) of firearm violence, and tracts categorized as blue had 4-fold greater incidence (IRR = 4.2, 95% CI: 1.4, 14.1). After adjusting for 1940 Census measures these effects were attenuated (Model 1c), but parameter estimates remained strongly supported and progressive, or what might be considered, dose-responsive. Census tracts within historical red zones were associated with an 8-fold greater incidence of firearm violence (IRR = 8.7, 95% CI: 2.2, 36.3), yellow zones were associated with a 7-fold increase (IRR = 7.0, 95% CI: 1.9, 28.8), and blue zones were associated

Table 3
Bayesian conditional autoregressive Poisson models for counts of firearm assaults; 1940 Census tracts, Philadelphia (n = 404).

	Model 1a			Model 1b			Model 1c		
	IRR	(95%	CI)	IRR	(95%	CI)	IRR	(95%	CI)
HOLC Zone									
Green (reference)									
Blue (100% increase)	**4.212**	**1.386**	**14.055**				**3.904**	**1.179**	**14.239**
Yellow (100% increase)	**8.820**	**2.614**	**30.569**				**7.092**	**1.908**	**28.760**
Red (100% increase)	**13.144**	**3.773**	**47.371**				**8.732**	**2.241**	**36.343**
No Zone (100% increase)	**10.990**	**3.267**	**38.513**				**7.323**	**1.870**	**30.114**
1940 Census Variables									
Black (10% increase)				1.016	0.924	1.118	1.016	0.924	1.117
House value ($1000 increase)				0.918	0.841	0.997	0.946	0.865	1.036
Concentrated Disadvantage (z-score)				**1.387**	**1.018**	**1.884**	1.253	0.913	1.730
Proportion variance explained by spatial random effect	*1.000*	*0.986*	*1.000*	*1.000*	*0.985*	*1.000*	*0.999*	*0.980*	*1.000*

Nb. Bolding denotes credible intervals do not include the null value of 1.000, providing evidence of an association.

with a 4-fold increase (IRR = 3.9, 95% CI: 1.2, 14.2). Results of the sensitivity analyses were substantively similar to the results of the main effects models here and for all subsequent analyses.

Model 2 assesses the relationships for all types of violent crimes and the 1937 HOLC map categorizations (Table 4). In unadjusted analyses, when compared to green zones, red zones (IRR = 5.5, 95% CI: 2.5, 14.3), yellow zones (IRR = 4.2, 95% CI: 1.7, 10.4), and blue zones (IRR = 2.7, 95% CI: 1.2, 6.5) were associated with higher incidence of violent crimes. In Model 2c, after adjusting for 1940 Census measures these relationships were no longer supported. However, tracts that were not zoned in 1937 had 4.5 times more violent crimes than green-zoned tracts (IRR = 4.5, 95% CI: 1.6, 17.3) and tracts with more concentrated disadvantage in 1940 are associated with more violent crimes (IRR = 1.4, 95% CI: 1.1, 1.7).

Moran coefficients indicate that the conditional autoregressive random effects were significantly spatially autocorrelated for all models ($I > 0.5$; $p < 0.05$). As expected, in no case were the noise terms spatially autocorrelated ($-0.05 < I < -0.02$; $p > 0.05$).

4. Discussion

When we look at the 1937 HOLC Map in relationship to contemporary violence and firearm assaults, we find that the same places that were imagined to be areas unworthy of economic investment by virtue of the races, ethnicities, and religions of their residents are more likely to be the places where violence and violent injury are most common almost a century later. Even after adjusting for the socio-demographic factors that contributed to unfavorable historical assessment of these geographic areas, firearm injuries, which are arguably the most dangerous,

threatening and infectious consequences of violence (Rowhani-Rahbar et al., 2015) appear to occur most frequently in with historically red-zoned areas of the 1937 HOLC map. The association between the HOLC map zone and overall violent crimes is also noteworthy: in comparison to green or first-grade zones all other mapped zones have significantly and a nearly progressive increased likelihood of present day violent crime incidence; this association, however, was explained by demographic characteristics at the time the maps were produced.

This single ecological analysis does not prove the insidious confluence of historical structural racism and racialized concentration of violence exposure in urban space. It does, however, add historical dimension to previous studies that demonstrate how racial disparities in violent injury victimization and perpetration may be as much an issue of place as they are of people (Branas et al., 2017). The HOLC maps of the 1930s reflect historical perceptions of the quality of built environment, residents' races and ethnicities, and relative economic power. These same factors remain among the most important predictors of violence and violent injuries in today's urban landscapes (Krivo et al., 2009; Branas et al., 2011; Culyba et al., 2016). Black and Latino people are most likely to reside in disadvantaged urban environments and live their lives with exposure to, if not direct experience of, the physical, social and psychological consequences of violent crime and violent injuries (Krivo et al., 2009). We recently demonstrated that Black residents of Philadelphia have approximately 5-fold increased risk of being assaulted with a firearm compared to white residents, and that excess risk is independent of the median household income of the Census tract in which people live (Beard et al., 2017).

The relationship between dangerous urban space and specific

Table 4
Bayesian conditional autoregressive Poisson models for counts of violent crimes 2013–2014; 1940 Census tracts, Philadelphia (n = 404).

	Model 2a			Model 2b			Model 2c		
	IRR	(95%	CI)	IRR	(95%	CI)	IRR	(95%	CI)
HOLC Zone									
Green (reference)									
Blue (100% increase)	**2.711**	**1.282**	**6.534**				1.863	0.718	6.639
Yellow (100% increase)	**4.225**	**1.683**	**10.392**				2.415	0.800	8.882
Red (100% increase)	**5.518**	**2.466**	**14.325**				2.571	0.913	11.001
No Zone (100% increase)	**10.665**	**4.568**	**26.128**				**4.531**	**1.565**	**17.288**
1940 Census Variables									
White and Other Race (reference)									
Black (10% increase)				0.981	0.902	1.069	0.995	0.916	1.079
House value ($1000 increase)				0.906	0.852	0.955	0.946	0.888	1.001
Concentrated Disadvantage (z-score)				**1.451**	**1.199**	**1.774**	**1.354**	**1.124**	**1.656**
Proportion variance explained by spatial random effect	*0.925*	*0.766*	*0.999*	*0.960*	*0.859*	*0.998*	*0.959*	*0.842*	*0.997*

Nb. Bolding denotes credible intervals do not include the null value of 1.000, providing evidence of an association.

categories of city residents can be understood as a product of intergenerational social and economic exclusion. These exclusions, once purposeful and overt, have become less visible and indeed, illegal, under policies like the Civil Rights Act of 1964 and the Fair Housing Act of 1968. A prevailing theory maintains that while difficult to see without a historic perspective, place-based discrimination is enacted through racialized stigma whereby for, "neighborhoods and people labeled as hazardous, deleterious influences remain an inescapable generational dilemma (Woods et al., 2014)." The perception or designation of areas as disreputable or disordered, may set in motion long-term processes that reinforce stigmatized areas and contribute to the legacies of inequality (Sampson, 2012). Representations of urban space like the HOLC Maps have social meaning and create cascading feedback loops by encouraging people to move out of degraded areas whenever possible, leading to further stigmatization and future increases in concentrated disadvantage. Sampson (2012) contended that "collective (or intersubjectively shared) perceptions form a context that constrains individual perceptions and social behavior" (p.131). This logic partially explains why the disinvested neighborhoods are now heavily policed. Skogan (1990), found that high rates of crime and violence were associated with higher rates of neighborhood dissatisfaction, fear and intentions to move out. Sampson and colleagues (Morenoff and Sampson, 1997; Sampson, 1986) also observed that increases in homicide and robbery rates was associated with (white) population decline and increase in racially segregated poverty. When those with the means of residential mobility moved out, not surprisingly, crime and violence "hot spots" emerged and then became the target of intensive policing.

Massey (1990) argues that segregation, forged through the housing market, is a key element to the concentration of urban poverty and the intensification of social and economic deprivation among Black city residents. In 2010, Philadelphia was one of 21 US cities with the highest Black populations to live within extreme relative segregation in the context of the city (Massey, 2015). The isolation of Black city residents can have profound negative consequences for individuals and communities by creating barriers to the services of mainstream institutions and access to the formal labor market (Shihadeh and Flynn, 1996). Segregation also has well-established associations with health conditions including violent injuries and deaths (Williams and Collins, 2001; Crowder and Krysan, 2016; Sampson and Winter, 2016). Sampson et al. (2005) tested a suite of hypotheses on the etiologies of racial disparities in violence in the city of Chicago. Self-reported violence perpetration was 85% higher in Black respondents and 10% lower in Latino respondents, when compared to White respondents. After contextualizing these data with individual, family, and neighborhood factors, racial and ethnic differences were almost entirely explained by family structure, immigration history and neighborhood social context. Racial segregation in unequal neighborhood environments, therefore, may be understood as an essential and modifiable condition that explains racial differences in violence perpetration and victimization. Segregation in Philadelphia may have not been caused by a map, but the processes through which racialized steering in housing availability developed across the urban landscape is embedded well within it.

The 1937 HOLC map is a snapshot of a phenomenon that is both ecologic and sociologic. Hall writes that "to envisage the city as (a backdrop to life), is to misapprehend the way in which lived experience always unfolds in reciprocal engagement with … the urban landscape (Hall, 2008, pp. 72)." The use of a historic map provides a long-view into the eco-social reciprocity we see in today's Philadelphia. This is important lest we imagine that there are ahistorical, unmediated and natural differences between the people who live in urban ecologies that flourish and foster healthy conditions, and others, just a few miles, blocks, or houses away, who live in places considered dangerous and pathologic. And though untraditional in its approach to violence epidemiology, this kind of exploration is supported by work done by other to evaluate racialized urban eco-social relationships using maps. More than half a century ago, in the classic sociologic study urban racial dynamic in Chicago, *Black Metropolis* depicted a synergistic connection among seemingly disparate dimensions of place-based disadvantage (Drake and Cayton, 1945). More recently, oral histories, maps and news media that remarked on social controls within Philadelphia's mid-20th century public park system, have been used to illustrate the historical roots of fear of parks which has led to exclusion, particularly among Black women, from the benefit of these spaces (Brownlow, 2006).

This study, while novel, must be interpreted within the context of its limitations. It is well established that firearm violence and violent crime occur more frequently in places where the proportion of racial and ethnic minority residents are highest and social disadvantages like poverty and lower average educational attainment are spatially concentrated (Sampson and Wilson, 1995; Messner et al., 2004; Sampson et al., 2005; Beard et al., 2017). Some neighborhoods of Philadelphia may have been changed significantly since the 1930s. However, place-based population changes in Philadelphia are not as rapid as in many other cities with developing economies; gentrification in the Philadelphia is associated with a relatively slow pace of resident displacement due to high vacancy rates, and less advantaged residents, when displaced, typically move to similar less advantaged neighborhoods (Ding et al., 2016). It is also possible that Philadelphia's neighborhood conditions are what might be considered, 'temporally autocorrelated' within many areas of the city (places with lower income continue to have lower income over time), even from 1937 to 2014. In that context, the current study is limited to simple assessment of correlations between HOLC zones and present day violence and crime. We were able to adjust for some basic demographic characteristics assessed around the time the map was created (e.g. concentrated disadvantage), and found that these explained the relationships between HOLC zones and present day violent crime but not firearm assaults. One possible explanation is that places that were disadvantaged eighty years ago may also be disadvantaged now, and violence is a symptom (and perhaps also a cause) of this entrenched deprivation.

The 1937 HOLC map reflected some of the many factors that shaped the development of redlining and racial segregation in Philadelphia (Hillier, 2003, 2005). A thorough investigation of the dynamic inter-relationships over time that lead to such findings (e.g. between the racial and ethnic composition of resident populations, HOLC zones, mortgage lending practices, neighborhood socio-economic conditions, and crime and violence) are well beyond the scope of this paper; however our results suggest this will be an important area for further research. Such studies should consider the possibility that present day demographic characteristics mediate and/or moderate relationships between HOLC zones and present day crime and violence (Petersen et al., 2006; Imai and Tingley, 2010). Recent studies of contemporary racial bias in mortgage lending have been linked to disparities in conditions like breast cancer, and it is likely that actual mortgage lending data will yield the best estimates of the causative relationship between contemporary urban disinvestment and place-based disadvantages (Beyer et al., 2016). The 1937 map also did not categorize all areas of the city of Philadelphia and when compared to its present demography, information on several now-populated city spaces were not developed or residential in the 1930s. Finally, in our analyses we controlled for factors that are not in and of themselves

empiric realities but rather are defined by the context of their historical moment. We recognize that categories of race, ethnicity and definitions of poverty, concentrated disadvantage are social constructions that could never really 'adjust' for the complex eco-social milieu in which violent interactions take place. Nonetheless, we believe that this unconventional application of spatial analysis brings to light the way in which the representation of racially discriminatory thought illustrated within a historical map reflects back the violence and racialized social problems of Philadelphia today. It prompts future research to analyze historical documents and data to explore the relationship between the New Deal era policies that reified segregation across city landscapes and the urban health disparities that persist.

5. Conclusion

There is opportunity to critically evaluate the history inherent in maps and other representations of structural racism to conceptualize public health approaches to violent places that integrate the life course of the city itself. This kind of approach to injury prevention would extend the temporal frame through which we understand the associations between exposures and outcomes across generations and keep the ecological context in which people live at the forefront. Place-based innovations in public health and violence prevention may benefit from consideration of historic context, and focused attention on the urban spaces that retain, most deeply, the scars of a racist past.

Acknowledgement

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