Urban housing affordability, economic disadvantage and racial disparities in gun violence: A neighbourhood analysis in four US cities

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This study seeks to examine how urban affordability, and related issues of eviction and joblessness, are associated with gun violence in the United States. After discussing the theoretical importance of studying housing affordability, we provide a preliminary examination of how urban affordability moderates the relationship between other markers of economic disadvantage and gun violence. This study further considers whether these different indicators of disadvantage are associated with gun violence differently by majority Black and majority White neighbourhoods. This study rests on neighbourhood-level data from 4 large US cities. Through a series of fixed-effects models, our results reveal that changes in affordability are significantly associated with rising gun violence in general, particularly in majority Black neighbourhoods. Furthermore, joblessness and eviction are less influential in shaping gun violence in more affordable neighbourhoods, but more consequential in communities facing higher rent burdens. The study reiterates several recommendations about reducing unaffordability in urban communities, as well as recommending several avenues for future research on urban violence.

Key Words: gun violence, affordability, housing, disadvantage

INTRODUCTION

Housing affordability, defined here as the proportion of income used to pay for adequate housing, is a pressing social issue in the United States (US) and around the world (Gyourko *et al.* 2013; Wetzstein 2017; Schapiro *et al.* 2021). Despite wage stagnation concentrated among low-income Americans, rental housing costs continue to soar in many cities (Desmond 2018). This is true not only for notoriously costly cities like San Francisco and New York City but also smaller metropolitan centres like Detroit and Milwaukee (Desmond 2018; Schuetz 2020). Renting families now often spend more than half of their monthly income on housing with inadequate money left over for necessities like food, transportation and utilities. High rent burden disproportionately impacts the urban poor and especially affects Black and Hispanic families

(Pendall *et al.* 2016). Deep disparities in housing affordability are not only pervasive between cities but also *within* them, suggesting that inequalities driven by rent burden operate at the local level (Schuetz 2020). Incongruously, the affordability crisis continues to bear down on renters while home ownership has become more affordable in the wake of the Great Recession (Edmiston 2016). In 2020, the COVID-19 pandemic further highlighted the pressing issue of housing affordability as many Americans struggled to pay rent, avoid eviction and afford necessities for daily living (Jones and Grigsby-Toussaint 2020; Kang *et al.* 2020).

As the US grapples with a housing affordability crisis, questions remain regarding the consequences of this unprecedented shift among local communities. A significant issue that remains understudied is how housing affordability influences violent crime. As affordability, employment and evictions were all thrust into the national spotlight in 2020, so too was a rapid rise in urban gun violence (Hilsenrath 2020). One of the most enduring explanations for neighbourhood violence posits that poor economic conditions generate criminogenic conditions that result in higher levels of violent crime (Sampson and Lauritsen 1994). Researchers have sought to parse out how various elements of disadvantage affect neighbourhood crime rates including jobless poverty (Dollar *et al.* 2019), gentrification (Papachristos *et al.* 2011), foreclosure (Baumer *et al.* 2012); and residential instability (Boggess and Hipp 2010). However, no research has examined how housing affordability, alongside related consequences such as eviction, correspond to gun violence.

As such, we contribute to the body of research on economic disadvantage and gun violence in three important ways. First, this study advances the literature on the dynamics of socioeconomic disadvantage and crime by discussing the theoretical importance of housing affordability. Second, we then provide an initial test of how housing affordability influences gun violence above and beyond traditional related markers of neighbourhood disadvantage and whether housing affordability exacerbates other economic strains like joblessness and eviction to augment violent crime rates. Finally, given the disproportionate impact of unaffordable rental housing on disadvantaged communities of colour, we examine how unaffordability contributes to well-documented racial disparities in community gun violence. Communities of colour in major cities across America have recently experienced exceedingly high levels of gun violence (Hilsenrath 2020; Rosenfeld and Lopez 2020), necessitating an investigation into how ecological conditions related to housing drive the unequal distribution of neighbourhood violence in the US. We undertake this study by examining neighbourhood-level data from four American cities: New York, NY; Philadelphia, PA; Newark, NJ; and Cincinnati, OH.

Housing affordability and violence

A robust body of evidence documents a durable relationship between community economic disadvantage and crime. Two broad theoretical perspectives explain this relationship: absolute deprivation and relative deprivation (Pridemore 2008). According to the absolute deprivation perspective, structural disadvantage contributes to the erosion of critical social institutions, informal social control and collective efficacy, all of which heighten the risk for violence in communities by depriving them of essential resources to control and prevent crime (Sampson *et al.* 1999; 1997; Silver and Miller 2004). Absolute deprivation has been measured in myriad ways including the rate of poverty, level of unemployment and the number of female-headed households in an area (Foster 1998; Stansfield and Parker 2013). On the other hand, scholars argue that absolute deprivation is not the most salient contributor to community violence but rather that inequality amongst residents drives rates of violent crime (Blau and Blau 1982). From this vantage, differences in deprivation reify class and racial differences within communities, generating feelings of alienation, isolation, resentment and hopelessness that contribute to greater criminogenic behaviour (Ulmer *et al.* 2012). Relative deprivation is typically measured

as a function of the difference between a person's income and that of those with greater incomes among individuals or via ecological indicators of income inequality like the Gini index (Adjaye-Gbewonyo and Kawachi 2012).

Both absolute and relative deprivation influence community rates of violent crime (Burraston et al. 2019). However, research continues to demonstrate more consistent effects of absolute deprivation on rates of violent crime across time and place (Messner et al. 2004; McCall et al. 2010; Pridemore 2011). Yet absent from most theoretical discussions of economic disadvantage and violent crime is consideration for how housing challenges affect community violence. This omission remains even though adequate housing is a fundamental need and a human right in countries like France, Scotland and South Africa (Solomon 2020). Prior research has considered select housing issues in conjunction with violent crime rates but has typically been limited to issues of residential instability and mobility (Haynie and South 2005; Hipp et al. 2009; Boggess and Hipp 2010; Vogel et al. 2017). Much of this works find that residential instability (measured as the rate of involuntary moves in a particular location) is associated with increases in neighbourhood-level crime (Sampson et al. 2002; Pratt and Cullen 2005). Frequent moves disrupt important social networks, make it difficult to establish robust informal social controls and degrade social disorganization, all of which increases the risk for community violence (Sampson et al. 1997; 1999).

Related research on housing concerns finds that rates of both foreclosure (Baumer et al. 2012) and eviction (Alm 2018; Semenza et al. 2021) correspond to levels of crime. Some quasi-experimental research has also considered whether an increase in affordable housing is associated with changes in crime (Freedman and Owens 2011; Woo and Joh 2015). Whether through assessing the impact of new construction of affordable homes, or the evaluation of tax credit programs to help subsidize affordable housing units, results generally show either null or negative effects on violent crime (Kondo et al. 2018).

The limited research on housing and violence suggests a relationship between the two, but the narrow attention to residential mobility and acute housing disruption obfuscates the broader, fundamental impact of housing affordability on crime. The ability to pay rent with enough income left over to purchase necessities like food, clothing, health insurance, or medication is critical for ensuring well-being across a range of documented dimensions including mental health (Bentley et al. 2011; Baker et al. 2020), physical health (Meltzer and Schwartz 2016), healthcare access (Pollack et al. 2010), household food access (Kirkpatrick and Tarasu 2011) and educational and employment opportunities (Mueller and Tighe 2007). For low-income residents, the private rental market often locks families into a precarious state of persistent disadvantage as ever-rising rents and financial insecurity make it increasingly difficult to become upwardly mobile (Wiesel 2014; Borrowman et al. 2017). In short, unaffordable housing is a drain on resources that precludes the ability to properly function or flourish. As such, limited access to affordable housing represents a distinct form of deprivation that carries potential implications for violence in local communities.

Housing affordability can be linked to rates of violent crime via mechanisms of general strain theory with particular application to community differences in crime (Agnew 1999; 2001). A lack of affordable housing contributes to greater structural disadvantage and deprivation in communities, generating significant social psychological strain that may increase violence as strains concentrate in local areas (Agnew 1999; Warner and Fowler 2003). High rental costs are likely to affect significant proportions of low-income neighbourhoods, representing a salient form of community strain given its pervasive nature, high magnitude and potential accompanying perceptions of unfairness (Agnew 2001; 2013). In fact, households often confront unaffordable housing challenges over the course of many years (Wood et al. 2014; Baker et al. 2020). Families forced to spend a high proportion of income on rent may be left to choose which neces-

sities to forego each month, saddling those in already perilous renting situations with a unique form of housing strain that undermines all other financial decisions. Those living in unaffordable housing situations are thus exposed to an ongoing, tenuous financial existence that may engender negative feelings of anger, frustration and hopelessness. Compared to acute strains like violent victimization, the death of a loved one, or the loss of a job (Farrell and Zimmerman 2018), unaffordable housing represents more of a simmering, accumulating stressor that generates repeated anguish over time throughout the community (Botchkovar and Broidy 2013). Taken at the aggregate level, then, communities with less affordable housing may be at greater risk for heightened gun violence because of the distinct financial disadvantage perpetuated by disproportionately high rental costs.

Compounding consequences and racial disparities in violence

In addition to operating as a major financial stressor in and of itself, unaffordable housing may also exacerbate other types of neighbourhood economic disadvantage. As rents increase, people may become increasingly unable to afford other necessities and remain trapped in a dire financial situation. For example, the loss of a job is a significant life event that places major stress on individuals and their families (Price *et al.* 2002). However, for those already forced to spend a significant portion of their paycheck on rent with little left over, the loss of a job may result in the inability to pay rent at all or force families to forego other critical needs. In this way, lack of affordable housing functions as a kind of backdrop in communities to compound hardship in all other aspects of daily life (Edmiston 2016; Desmond 2018). This dynamic thus contributes to the experience of a much deeper form of persistent poverty in local neighbourhoods that is especially likely to engender community violence (Currie 2020).

Research regarding how housing affordability operates alongside other financial stressors to affect negative outcomes like community violence remains extremely limited. However, there is some initial evidence that unaffordable housing compounds other forms of financial disadvantage. For instance, households with rent affordability concerns are more likely to also have no car, to forego durable consumer purchases and spend a high proportion of weekly income on food (Bramley 2011). Those struggling to afford housing are also more likely to face eviction, leading to poorer health outcomes and greater financial insecurity (Desmond and Kimbro 2015; Desmond 2018), in addition to increasing the risk for involvement in crime (Alm 2018; Gottlieb and Moose 2018; Alm and Bäckman 2020; Semenza *et al.* 2021). Low-income residents may be at particular risk for eviction in neighbourhoods with less affordable housing, generating greater community turnover and making it difficult for residents to establish proper informal violence prevention controls (Sampson *et al.* 1997; 1999). Housing affordability stress and unemployment often co-occur, creating greater economic strain among families already living in deep financial precarity (McClelland 2000). More broadly, macro-level research on violent crime suggests that multiple aspects of economic disadvantage can function in concert with one another to influence rates of violence in neighbourhoods (Burraston *et al.* 2019).

Since Black communities are disproportionately likely to experience high rent burden in the US (Pendall *et al.* 2016), housing affordability may be an important contributing factor to the vast racial disparities in gun violence that exist across the US (Abt 2019; Currie 2020). Black Americans are far more likely than any other racial group to live in conditions of deep and chronic poverty, defined as remaining in poverty for at least thirty-six months (Edwards 2013). Black communities are thus not only the most likely to suffer from higher rates of severe economic disadvantage, but also face these conditions for much longer (Currie 2020). The intertwining dynamics of housing unaffordability, compounded economic strains and the risk of community gun violence outlined here then may be particularly salient for predominantly Black neighbourhoods. This contributes to a persistent cycle of deprivation and gun violence

that has proven particularly difficult to interrupt for decades in the most severely disadvantaged communities of colour in America, despite broad reductions in violence overall throughout the country (Rosenfeld and Lopez 2020). We thus turn to the present study to investigate these concerns using a neighbourhood-level analysis from four major US cities, explicitly examining the following research questions:

1) Is housing unaffordability (defined as a higher share of income going towards renting costs) associated with higher rates of urban gun violence?
2) Does housing affordability moderate the association of other financial strains (eviction and joblessness) with gun violence?
3) Is the association between affordability and gun violence present in majority Black and majority White neighbourhoods?

DATA AND METHOD

The dataset for the current study pulls together information at the census tract level for four US cities: New York City, Newark, NJ, Philadelphia, PA and Cincinnati, OH. These cities were primarily chosen given the availability of location-specific shootings data, enabling us to generate rates of gun violence at the neighbourhood level over time. Three separate time periods were created for each neighbourhood observation. Time period 1 represents 2006–10, time period 2 covers 2011–15 and time period 3 encompasses 2016–20. For each census tract, we collected data on shootings, housing affordability, eviction rates, economic indicators and demographic information. We obtained information on shootings from individual city police departments and calculated five-year averages (2006–10, 2011–15 and 2016–20), thus incorporating the most recent available data while accounting for any significant fluctuations in shooting rates across the three time periods. We were unable to obtain shootings data prior to 2006 because these police departments do not provide publicly available incident-based files prior to this time.

The key motivating reason for using time periods (instead of annual observations) is that our core measures such as poverty, affordability, joblessness are derived from 5-year averages produced by the US Census. The 5-year estimates are known as 'period' estimates collected over the five-year period. The primary benefit of this is increased statistical reliability for smaller populations including examining census tracts or other small units where single year estimates are not available or as precise (US Census 2020). Given the focus of the paper on affordability, a broader economic process that shifts more slowly over time, we further deemed looking at period effects to be more appropriate (as done in a previous study examining gentrification effects using the now discontinued 3-year estimates, e.g., Papachristos *et al.* 2011).

We merged shootings data with estimates of economic and demographic variables obtained from the corresponding 5-year estimates in the American Communities Survey (ACS), and data from the Eviction Lab, which provided information on the rate of evictions. We only included data from cities in our final dataset and not surrounding counties. For example, although the city of Philadelphia encompasses all of Philadelphia County, the actual cities of Cincinnati (Hamilton County) and Newark (Essex County) account for less than half of the census tracts in their respective counties. Additionally, eviction data were not available for 2 of the 5 boroughs (Queens's and Manhattan) in New York City during our study period. The final number of census tracts available for analysis is 1,775, of which 632 were majority Black as of the 2006–10 ACS estimates.

Dependent measures

Police departments from each of the four cities provided incident-based data on shootings and included both fatal and non-fatal incidents. We geocoded all incidents and generated counts per census tract in QGis (Version 3). To measure rates of gun violence, we use 5-year intervals (2006–10, 2011–15 and 2016–20) of police data to generate annual average total gun violence rates per 1,000 people. Rates based on multiple-year averages are desirable because they reduce the influence of fluctuations in yearly counts (Light and Thomas 2019; Ousey and Kubrin 2014). This is especially important when studying small geographic units such as neighbourhoods.

After determining the presence of neighbourhood clustering in shootings in cities, we include lagged measures of gun violence rates, measured as the average 5-year rate for all surrounding neighbourhoods of a focal neighbourhood. As in prior studies, we created this lag measure in GeoDa using a first-order queen contiguity criterion (Dollar *et al.* 2019; Steidley et al. 2017). Failure to address autocorrelation in this manner could lead to biased estimates (Marotta 2017). By including a spatial lag in our dependent variables, we effectively account for correlated errors where neighbourhood shootings are associated with the shootings of nearby neighbourhoods.

Independent measures

Affordability is measured with a commonly used ratio of the mean monthly rent in a neighbourhood divided by the mean monthly income (Schuetz 2020). The US Department of Housing and Urban Development recommends that no more than 30% of a household's income should be spent on housing costs. A higher rent-to-income ratio indicates that a neighbourhood is more unaffordable such that a greater percentage of household income is being spent on rent.

We obtained the eviction rate for each neighbourhood from the Eviction Lab, a research organization dedicated to the study of eviction in the US. (www.evictionlab.org). The Eviction Lab collected and reported data from all formal eviction records for the years 2000 through 2016. The Eviction Lab collected these data from court reports, record collections from online portals and from companies that carry out manual collection of records from the courts. Although evictions can happen informally outside of courtroom proceedings, the systematic reporting of formal evictions by the Eviction Lab offers a consistent way to measure variation in evictions across neighbourhoods over time. Our study specifically employs a measure of the eviction filing rate, referring to the ratio of the number of evictions filed in an area over the number of renter-occupied homes in that area (Eviction Lab 2016). The filing rate counts all eviction cases, including where multiple cases were filed against the same address in the same year. The number of homes occupied by renters comes from US Census estimates.

We utilized a single year's eviction filing rate for each time period in our analysis to establish uniformity across time periods and ensure the use of properly validated measures within the Eviction Lab data. To illustrate, since 2016 was the most recent year available for the eviction data, we chose 2016 as the year to represent 2016–20. Likewise, 2006 and 2011 were the years chosen to represent the other two time periods since they were the first years in each. Additionally, this strategy allowed us to maximize the use of eviction values that have undergone a process of external validation to ensure accuracy in our analysis (see www.evictionlab. org for a detailed discussion of their external validation methods). Several sensitivity analyses are included in our results, below, to assess how much the inclusion of eviction data changes other core findings.

Finally, we incorporate a measure of local employment opportunity that is more reflective of what Wilson (1996) described as the 'new urban poverty' in the US, incorporating the broad employment struggles of unemployed and low-wage workers. As developed by Dollar *et al.* (2019), we created a joblessness index that combines: 1) the percentage of the working age

population who are unemployed, 2) the proportion of the civilian population employed in the six occupation categories with the lowest median income (healthcare support, food preparation and serving, building and grounds maintenance, personal care and service, farming fishing and forestry, and material moving) and 3) the percentage of people over the age of 16 employed in managerial or professional occupations. These items were combined using a factor analysis (Eigenfactor = 1.6), generating an index where higher scores are indicative of more struggles related to joblessness.

Control measures

Our study accounts for a series of control variables commonly used in ecological research (Steffensmeier *et al.* 2010; McCall *et al.* 2013; Stansfield and Parker 2013; Steidley *et al.* 2017; Chamberlain and Hipp 2015; Dollar *et al.* 2019; Semenza *et al.* 2021), including another commonly employed measure of economic disadvantage: the percentage of families living in poverty. Other control measures include: the percentage of housing units that are renter occupied, the percentage of males over the age of 15 who are divorced, the percentage of the population who identify as African American, the ratio of females to males and a measure of recent immigration. Ample prior research documents that growth in recent immigration contributes to declines in violence (Wadsworth 2010; Ousey and Kubrin 2014). Drawing on this research, we combined: 1) the percentage of the population that is Hispanic, 2) the percentage foreign born and 3) the percentage who arrived to the US in the previous 10 years to create a factor of recent immigration (Eigenfactor = 1.76).

Several items included as variables here, such as poverty and unemployment, are often combined into an index to measure broader community disadvantage. There can be methodological reasons to do so, given significant correlations typically exist between poverty, joblessness and affordability. The correlations between these measures are presented in Appendix 1. In the present study, we are specifically interested in teasing out the differences between these items given our theoretical focus on the issue of affordability. Other prior studies have also sought to tease out discrete measures of disadvantage for theoretical reasons (Pridemore 2008; 2011; Steffensmeier *et al.* 2010; Stansfield and Parker 2013; Dollar *et al.* 2019). As an example, Steffensmeier *et al.* (2010) examined the impact of four discrete measures of disadvantage in a study of New York and California census areas, finding that poverty and educational deficits had a greater impact on homicide rates than unemployment or female-headed households. Additionally, Dollar and colleagues recently uncovered the relative importance of jobless poverty above and beyond measures of poverty alone, consistent with the arguments of Wilson (1996).

Since we are interested in establishing whether affordability, joblessness and eviction have significant independent effects for gun violence beyond other measures of disadvantage and mobility, we also keep these items separate. Like other studies examining discrete measures of disadvantage (e.g. Stansfield and Parker 2013), we took several steps to minimize concerns with multicollinearity, including: examining correlations between all independent variables; estimating models where each predictor variable is entered one at a time to examine for significant shifts in magnitude or direction of any coefficients; examining Variance Inflation Factor (VIF) scores; and combining collinear measures into a composite factor and assessing whether relationships are consistent with our main results. Each of these steps revealed no obvious signs of multicollinearity, enabling us to move forward with the separated item approach to analysis.

Analytic strategy

We estimated equations via fixed-effects models to model gun violence across the three time periods. Although data with repeat observations can be modelled with either fixed or random effects, we are specifically interested in assessing the effect of within-neighbourhood change. This

allows us to make stronger causal claims about the relationship between our key constructs and changes in gun violence by controlling for unobserved time-invariant characteristics of neighbourhoods with time-stable effects across the entire study period (Allison and Waterman 2002). However, a fixed-effects analysis has some drawbacks. In particular, our study will find smaller effect sizes than if we took a random-effects approach that considered changes both within and between neighbourhoods. But given the complicated economic changes occurring in large cities during this period, a fixed-effects approach can control for unobserved factors or processes that could be driving both shooting and economic trends, thus enabling a more theoretically rigorous approach (e.g., Papachristos *et al.* 2011). Furthermore, we used a Hausman test to explore the applicability of fixed over random effects. A significant test statistic ($\chi^2 = 67.3$) further confirmed the appropriateness of using a fixed-effects approach in our fully controlled model.

In modelling rare incidents over time like shootings or homicides, researchers traditionally create per capita rates by dividing the incident counts into the area population and estimating a linear regression (e.g. Parker and Stansfield 2015; Light and Thomas 2019). Alternatively, some researchers use count-based models (such as Poisson or negative binomial distributions) where the number of incidents represents the dependent variable, and models offset counts with the population size (Ousey and Kubrin 2014). Given that many of our neighbourhoods experienced no change in shooting rates between the two time points, negative binomial fixed-effects models would be restricted to only neighbourhoods that experienced change. Mindful of the limits of negative binomial fixed-effects models, we employ a traditional fixed-effects modelling approach. We did, however, replicate all analyses with negative binomial models to provide robustness to our findings and these results are available from the authors upon request.

Our analysis proceeds in three steps. First, we estimate fixed-effects models regressing the total shooting rate (log-transformed after adding a constant of 1) on each of the independent variables (Table 2, Model 1). In subsequent models, we introduce interactions between affordability and joblessness (Model 2) and affordability and eviction rates (Model 3) to assess the moderating role of affordability. In a subsequent analysis (Table 3), given disproportionate economic disadvantage and shooting rates in majority Black neighbourhoods, we compare predictors of shooting rates across majority Black and majority White neighbourhoods separately to determine whether neighbourhood type by racial composition moderates the dynamics explored here. Just over 200 census tracts in our sample did have a majority of either Black or White residents. Given the lower count of tracts with other majority population groups, we specifically assess whether disadvantages related to housing and affordability take on additional significance for the persistence of gun violence in majority Black communities compared to majority White neighbourhoods. All models include controls for time period to account for underlying temporal trends over the course of the study's timeline.

RESULTS

Table 1 displays all descriptive characteristics for the analytic sample. These affirm the relatively low incidence of shootings overall, averaging 1.2 shootings across neighbourhoods each year. Notably, more than 80% of shooting incidents are non-fatal while the remainder result in homicides. Although the rate of gun violence did decrease for both majority White and majority Black neighbourhoods over our study period, the gun violence burden is felt heavier in majority Black neighbourhoods. Significant variation in shootings also exists across cities in our sample, with New York experiencing the lowest average rate of shootings per 1,000 people (0.25), and Cincinnati the highest. The data also reveal the average affordability ratio is about .27, indicating that neighbourhoods in our sample typically meet the recommendation by the US Department of Housing and Urban Development (HUD) for less than 30% of income to be spent on rental

Table 1 *Descriptive statistics for full sample and by majority race/ ethnicity census tracts*

Variable	All Tracts (1,775)		Majority White (901)		Majority Black (632)	
	M	**SD**	**M**	**SD**	**M**	**SD**
Shootings Rate (x1000)	0.48	4.15	0.28	5.69	1.09	4.08
(Ln) Total Shootings Rate	0.18	0.42	0.07	0.30	0.40	0.60
Shootings Lag	0.51	2.15	0.34	1.61	0.97	2.75
Affordability Ratio	0.27	0.10	0.22	0.08	0.28	0.09
Poverty Rate	16.00	13.68	8.51	9.24	20.60	14.29
Eviction Filing Rate	9.05	9.05	4.53	4.92	13.91	10.41
Joblessness[+]	0.00	0.88	−0.58	0.76	0.40	0.70
Pct unemployed	9.80	6.56	8.10	5.66	12.33	7.09
Pct low-wage employment	17.28	10.21	10.93	6.93	20.72	8.73
% Black	28.21	32.09	5.48	8.11	77.65	13.46
% Renter Occupied	57.79	26.90	48.28	25.32	59.03	25.51
Recent Immigration[+]	0.00	0.93	−0.42	0.72	−0.29	0.70
% Divorce	8.27	4.01	7.91	4.38	9.31	3.52
F:M Sex Ratio	1.11	0.25	1.08	0.20	1.23	0.25

Note: + Indicates Composite Factor

expenses. However, this ratio varies significantly across neighbourhoods and time, with more rental affordability in majority White neighbourhoods. Prior research, alongside our descriptive analyses, documents the twin burdens of gun violence and deepening deprivation in urban communities of colour.

Table 2 presents the results of our first longitudinal model addressing the first research question of the study: whether higher housing unaffordability is associated with higher rates of urban gun violence. Model 1 shows that neighbourhoods with greater housing unaffordability (where a larger proportion of income is spent on rent) also experience an increase in shootings even after accounting for lagged shootings in nearby neighbourhoods. Although the poverty rate is not associated with gun violence, joblessness and eviction each significantly and positively correspond to an increase in the shooting rate. Next, Models 2 and 3 examine the moderating role of affordability for joblessness and eviction. The significant interaction terms in these models suggest that a combination of evictions in neighbourhoods with greater unaffordability are even more likely to experience an increase in gun violence. Similarly, the combination of more joblessness and unaffordability is associated with higher rates of gun violence. With the introduction of interaction terms, direct effects of joblessness and evictions on shootings disappear, suggesting that their association with violence is dependent on levels of housing affordability. Stated another way, joblessness and eviction are less influential in shaping gun violence in affordable communities but are associated with gun violence in communities facing a higher rent burden.

Turning to our third research question, given prior debates about racial invariance and neighbourhood predictors of crime, we examine whether the association between housing affordability and gun violence exists in both majority White and majority Black neighbourhoods. Housing affordability and eviction filings were both associated with gun violence in majority Black neighbourhoods, confirming expectation. Interaction terms were again added to assess the moderating role of affordability across neighbourhoods of different racial composition. As revealed in Model 2 of Table 3, the interaction of affordability and joblessness

Table 2 *Fixed-effects linear models estimating changes in total shootings*

	Model 1			Model 2			Model 3		
	B	SE	p	B	SE	P	B	SE	P
Lag Shootings	0.039***	0.008	<0.001	0.037***	0.008	<0.001	0.037***	0.008	<0.001
Affordability	0.309*	0.142	0.029	0.181	0.144	0.209	−0.082	0.184	0.653
Poverty	0.001	0.001	0.936	0.001	0.001	0.926	0.001	0.001	0.890
Eviction	0.006***	0.002	<0.001	0.006***	0.002	<0.001	−0.005	0.004	0.209
Joblessness	0.037*	0.014	0.011	−0.032	0.024	0.179	0.039**	0.014	0.006
% African American	0.005***	0.001	<0.001	0.005**	0.001	0.001	0.005**	0.001	0.001
Recent Immigration	−0.025	0.023	0.284	−0.033	0.023	0.152	−0.027	0.023	0.241
% Divorced	−0.001	0.003	0.722	−0.001	0.003	0.828	−0.001	0.003	0.810
F:M Sex Ratio	−0.028	0.046	0.553	−0.029	0.046	0.527	−0.036	0.046	0.435
Renter Occupied	−0.001	0.001	0.659	−0.001	0.001	0.734	−0.001	0.011	0.626
Constant	−0.064	0.095	0.505	0.001	0.096	0.988	0.063	0.102	0.538
Time 2	−0.013	0.016	0.405	−0.012	0.016	0.444	−0.014	0.016	0.379
Time 3	−0.074**	0.023	0.002	−0.076**	0.023	0.001	−0.078**	0.023	0.001
Affordability*Joblessness				0.440***	0.108	<0.001			
Affordability*Eviction							0.037**	0.011	0.001
Overall R^2		0.316			0.323			0.31	
# Neighbourhoods		1,775			1,775			1,775	
F		10.040			10.76			10.22	

Note: B: unstandardized coefficients, SE: standard error. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

produced an insignificant coefficient, with eviction and affordability each retaining significant associations with gun violence. In Model 3, however, the interaction term reveals that the eviction filing rate in majority Black neighbourhoods is more influential in shaping gun violence in more unaffordable census tracts. As revealed in Table 3, Model 4, our model did not explain a significant number of shootings in majority White neighbourhoods. Only the lag measure indicating spatial proximity of gun violence was significantly associated with gun violence in White neighbourhoods.

Supplementary analyses

Mindful of the assumptions and limitations of the above analyses, we conducted several supplementary analyses to explore the robustness of our findings pertaining to affordability, joblessness and gun violence. First, since the measure of eviction was a) only a single year observation for each period and b) unavailable for several of the New York City boroughs, all models were re-estimated without a measure of eviction included at all. This increased the number of census tracts available for analysis by 925. As displayed in Appendix 2, this analysis offers two additional findings from those presented in Table 2, above. Firstly, recent immigration is significantly and negatively associated with violence, consistent with evidence of the benefits of continued immigration in places like New York (Waters and Kasinitz 2013). Additionally poverty was positively associated with violence without eviction filings in the model. The central story about affordability and joblessness remained consistent. These indicators have both independent and additive associations for gun violence, above and beyond traditional markers of social disorganization and disadvantage.

Table 3 *Fixed-effects linear models estimating changes in total shootings, by majority race of neighbourhood*

	Model 1			Model 2			Model 3			Model 4		
	Majority Black			Majority Black			Majority Black			Majority White		
	B	SE	p	B	SE	p	B	SE	p	B	SE	p
Lag Shootings	0.028	0.015	0.067	0.027	0.014	0.076	0.028	0.015	0.062	0.038*	0.011	0.001
Affordability	0.761**	0.271	0.005	0.680*	0.300	0.024	.337	0.437	0.441	−0.081	0.230	0.724
Poverty	0.002	0.003	0.508	0.002	0.003	0.503	0.003	0.003	0.403	−0.001	0.002	0.624
Eviction	0.010**	0.003	0.001	0.010**	0.003	0.001	0.002	0.006	0.751	−0.006	0.004	0.105
Joblessness	0.017	0.047	0.734	−0.032	0.092	0.721	0.017	0.047	0.715	−0.023	0.015	0.124
Affordability*Jobless				.158	0.254	0.534						
Affordability*Eviction							0.059*	0.027	0.031			
F	7.76			7.19			7.29			3.41		
R²	0.228			0.221			0.232			0.106		

Note: B: unstandardized coefficients, SE: standard error. *p < 0.05, **p < 0.01, ***p < 0.001; All models include controls for race, immigration, renter-occupied housing, divorce, female: male sex ratio and time period.

Second, we are mindful of the probability that significant variation will exist between the cities used in our analysis, as well as within the neighbourhoods overtime. We re-estimated all models using a random-effects approach allowing inclusion of dummy variables for each of the counties in our sample. The central findings of the relationships between affordability, eviction and violence remained consistent, further suggesting that the effects are not simply being explained away by factors within one particularly county or city. We also replicated analyses for New York City separately to ensure results were not being driven by NYC alone. The results of these supplementary analyses are available in Appendix 3.

DISCUSSION

The main objective of this study was to examine the longitudinal relationship between housing affordability and gun violence across census tracts in four US cities. We also assessed how housing affordability moderates the influence of two important aspects of economic disadvantage on shootings in local neighbourhoods, eviction and joblessness, as well as how these dynamics operate differently in communities of colour compared to their majority White counterparts. The results produced three main findings. First, we found that changes in housing affordability have a significant influence on changes in gun violence, such that the rate of shootings in census tracts increases as housing becomes more unaffordable. Second, housing affordability moderated the association of both joblessness and eviction with violence, with eviction and joblessness more influential for gun violence in neighbourhoods that experience a higher rent burden. Finally, we found key distinctions in the ways housing affordability influences violent crime across communities by racial composition. Unaffordability and eviction filings were both significant predictors of gun violence in majority Black neighbourhoods but not majority White neighbourhoods.

Ecological research on crime in local communities has established that deprivation and disadvantage correspond with higher rates of crime (Pratt and Cullen 2005). Although broad measures of poverty, social disorganization and unemployment are often used to analyse the association between economic disadvantage and gun violence, these measures obscure the gradient of disadvantage that impacts different communities (Currie 2020). The ability to secure affordable housing with enough income left over to pay for basic necessities like food, utilities and medical care is critical for daily functioning and well-being. Yet, those living in local communities with increasingly unaffordable housing are burdened by high rents that can impose major financial strains, increasing the risk for violence throughout the neighbourhood. Deep, persistent poverty is particularly criminogenic and housing challenges remain an under-researched element of the stark disadvantage that exposes communities to further harm (Currie 2020).

Our results demonstrate that high rent burdens in local communities may serve to exacerbate additional financial challenges. In particular, joblessness and eviction both appear to generate greater risk for neighbourhood shootings in less affordable communities. Notably, these interactions were significantly associated with shootings in our main models yet other commonly studied predictors of violence were rendered statistically insignificant including poverty and rates of divorce. A lack of affordable housing may therefore play a substantial role in the generation of violence even more so than broader measures of disadvantage studied in past research.

Furthermore, a lack of affordable housing appears to be a distinct risk factor for gun violence in majority Black communities. Since communities of colour are disproportionately affected by high rent burdens, increasingly unaffordable housing may be a substantial factor in the perpetuation of racial disparities in the gun violence that claims the lives of tens of thousands of Americans each year. Our results show that unaffordable housing is an independent predictor of gun violence in majority Black neighbourhoods but not in majority White neighbourhoods.

Rates of eviction are also independently associated with gun violence in majority Black neighbourhoods but not in majority White neighbourhoods. Most critically, these two factors interact in majority Black neighbourhoods to influence gun violence, conditioning the independent effects for the individual constructs.

The findings presented in Table 3 highlight the importance of considering the ways that neighbourhood racial dynamics shape gun violence exposure. A long history of residential segregation and structural racism in the US has generated persistent social and economic disadvantage among many majority Black communities, generating many of the insidious conditions that allow gun violence to become embedded in local neighbourhoods (Rothstein 2017; Currie 2020). When considering the racial composition of neighbourhoods in our analysis, we find that our models accounting for structural disadvantages like affordability, eviction and joblessness explain far more of the variance in shooting rates in majority Black communities than in majority White counterparts. In fact, the dual disadvantage of eviction and housing unaffordability serves to be one of the only predictors of change in shooting rates in majority Black neighbourhoods while no measures of disadvantage predict shooting rate changes in majority White areas. This underscores the notion that gun violence in the US is a complex, multifaceted set of problems that affects communities in different ways (Wintemute 2015; Abt 2019; Rosenberg 2021).

Implications for policy

Our findings lend themselves to certain policy implications. First and foremost, continuously rising rental costs in cities are unsustainable and harm those already at significant economic disadvantage. Although many issues of housing affordability arise from local economic conditions, federal policies can still play a role in reducing rent burdens (Schapiro *et al.* 2021). The low-income housing credit can be boosted for developers and additional funding can be provided for the HUD to properly address the housing crisis (O'Donnell 2018). Regulatory barriers to housing such as restrictive zoning laws and land-use regulations that impede the construction of affordable apartments often make it difficult to find even moderately priced housing outside the most disadvantaged parts of many cities (Schuetz 2020). And such policies have been attributed to a 're-concentration' of poverty in some of America's cities (Jargowsky 2018). These barriers can be reduced through different strategies to enable equitable access to affordable housing. Some have suggested 'carrot and stick' policies to entice local governments to reform zoning laws, while other policies such as rent stabilization and just-cause eviction requirements can further serve to ensure more affordable housing and stability in low-income neighbourhoods (Schuetz 2019). Many households in disadvantaged communities do not receive federal housing assistance and the share of eligible households continues to decrease (Kingsley 2017). The most direct means of making housing more affordable to a greater share of the urban poor is ultimately for the federal government to provide appropriate housing subsidies, which have been associated with lower odds of housing instability and unaffordability (Schapiro et al. 2021).

Market strategies and exploitation tactics carried out by landlords also contribute to high rent burdens for the urban poor. Desmond and Wilmers (2019) assert that greater promotion and financial subsidy of home ownership can reduce rent burden by limiting the power of landlords afforded by a large supply of low-income renters. Black households have lower homeownership rates and wealth accrual than their White counterparts as a result of historic redlining and discriminatory practices (Joint Center for Housing Studies 2019). In many distressed communities, rents are higher than mortgage payments such that buying a home would reduce housing affordability issues for many households. Policies to provide down payment subsidies for those living in historically disadvantaged areas, for instance, as well as greater tax deductions for underrepresented groups may provide the necessary financial incentives for some to exit the rental market altogether.

Increasingly unaffordable housing and high rates of gun violence are pervasive throughout many cities in the US. As such, although there may be myriad policy approaches to reduce rental burdens in disadvantaged communities, enacting them in a piecemeal, short-term fashion will be unlikely to have sustained benefit for violence in local communities. Federal policies that provide long-term funding for housing assistance and uniform investment across the country are most likely to yield positive outcomes for reducing violence. Additionally, we anticipate that any gains afforded by improved housing affordability are likely to be bolstered when paired with acute violence prevention strategies in high-risk communities. Violence intervention programs like Operation Ceasefire in Boston (Braga et al. 2001) and Safe Streets in Baltimore (Webster et al. 2013) have been found to reduce gun violence by interrupting cycles of deadly retaliation and providing those involved with diversionary assistance. Though some suggest reducing gun violence by focusing on root causes such as economic disadvantage and high housing costs (Currie 2020), others recommend implementing more specific programs to directly reduce shootings (Abt 2019). We assert that a combined approach that addresses housing challenges alongside focused violence reduction programming may yield the greatest benefits for those communities most impacted by gun violence.

Limitations and future research

There are several limitations to the current study that present opportunities for future research. First and foremost, this study was limited to four US cities in large part because few police agencies make accurate incident-based shooting data available to the public. This is increasing through various open data initiatives, but the four cities selected here are among the few to have historical data available from more than 10 years ago. Although the FBI tracks homicides each year, this information is only available at the agency (city) level and there are currently no systematic, validated means of tracking non-fatal shootings in the US. Furthermore, neither data on homicides or non-fatal shootings are consistently available for public use for smaller areas within cities like census tracts or block groups. This makes studying the ecological factors that contribute to gun violence particularly difficult since variation in housing and economic disadvantage within cities is just as important as variation between them. Since non-fatal shootings occur at a ratio of four to one compared to homicides in the US, critical research on the causes and consequences of gun violence will require much improved data collection at multiple levels of the social ecology (Webster 2019; Hipple *et al.* 2020; Roman 2020).

Second, eviction data were not available for two New York boroughs. Although this does not diminish confidence in the results given the large number of diverse neighbourhoods used from several cities, future research should expand upon the cities and regions covered here. Third, our data are limited to information at the aggregate level across census tracts meaning that we cannot account for variation between individuals or households. Future research should consider employing multilevel analyses where possible to disentangle how key elements of housing struggles, financial hardship and well-being for families influence the risk of gun violence in communities.

Finally, we control for a range of important ecological and contextual factors known to correlate with rates of violent crime. However, it remains possible that certain factors are missing in our models that could lead to omitted variable bias. For instance, we could not account for community differences in collective efficacy because no measure of this was available in the census tract data used for this analysis (Sampson *et al.* 1997). As such, ecological researchers should strive to assess the role of other community-level factors in subsequent studies of housing challenges and gun violence.

Despite these limitations, our results underscore the importance of considering housing affordability and accompanying economic challenges as key risk factors for gun violence in local

communities. This is critical given the rising costs of housing and disconcerting recent increases in gun violence throughout many US cities. Notably, unaffordable housing disproportionately affects rates of shootings in communities of colour, which already suffer from greater deprivation and an outsize threat of gun violence. These findings, therefore, compel the need for an equitable approach to housing affordability that considers the long-term impacts of the housing policies that already perpetuate racial disparities of violence in America.

APPENDIX

Appendix 1. Correlations between key independent variables

	1	2	3	4
1. Affordability	1.00			
2. Poverty	0.67	1.00		
3. Eviction Filing Rate	0.28	0.36	1.00	
4. Joblessness	0.42	0.46	0.35	1.00

Appendix 2. Replication of Table 2, excluding the eviction filing rate

	Model 1			Model 2		
	B	SE	p	B	SE	p
Lag	0.010	0.003	0.001	0.010	0.003	0.001
Affordability Ratio	0.214	0.083	0.010	0.148	0.083	0.075
Poverty Rate	0.002	0.001	0.032	0.002	0.001	0.042
Joblessness	0.037	0.014	0.011	0.029	0.015	0.055
Divorce	−0.001	0.002	0.489	−0.001	0.002	0.618
Black	0.003	0.001	<0.001	0.003	0.001	<0.001
F:M Sex Ratio	−0.010	0.027	0.725	−0.018	0.027	0.520
Recent Immigration	−0.043	0.014	0.002	−0.046	0.014	0.001
Renter Occupied	0.001	0.001	0.409	0.001	0.001	0.465
Affordability*Joblessness				0.399	0.062	<0.001
T2	−0.032	0.012	0.008	−0.036	0.012	0.003
T3	−0.094	0.021	<0.001	−0.106	0.021	<0.001

Appendix 3. Replication of Table 2 with tracts from New York City only

	Model 1			Model 2			Model 3		
	B	SE	p	B	SE	p	B	SE	p
Lag	0.127	0.031	<0.001	0.115	0.031	<0.001	0.125	0.031	<0.001
Eviction	0.007	0.002	0.005	0.006	0.002	0.009	0.000	0.006	0.973
Affordability	0.290	0.123	0.018	0.198	0.124	0.110	−0.043	0.160	0.786
Poverty	0.002	0.002	0.221	0.002	0.002	0.217	0.002	0.002	0.226
Joblessness	0.044	0.030	0.136	−0.065	0.052	0.213	0.044	0.030	0.136
Black	0.006	0.002	0.006	0.006	0.002	0.005	0.006	0.002	0.005

Appendix 3. Continued

	Model 1			Model 2			Model 3		
	B	SE	p	B	SE	p	B	SE	p
Renter Occupied	0.002	0.002	0.357	0.002	0.002	0.329	0.002	0.002	0.335
Immigration	0.035	0.030	0.240	0.031	0.030	0.294	0.033	0.030	0.271
Divorce	0.010	0.004	0.017	0.010	0.004	0.011	0.010	0.004	0.017
F:M Sex Ratio	0.028	0.066	0.667	0.026	0.066	0.691	0.024	0.066	0.720
T2	−0.019	0.018	0.294	−0.021	0.018	0.254	−0.019	0.018	0.282
T3	−0.083	0.031	0.008	−0.091	0.031	0.004	−0.084	0.031	0.007
Afford_Jobless				0.373	0.146	0.011			
Afford_Eviction							0.022	0.017	0.213

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