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The Case for Studying Criminal Nonfatal Shootings: Evidence from Four Midwest Cities

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ABSTRACT

Using law enforcement data from four Midwest communities, we document the similarities and differences between criminal nonfatal and fatal shooting incidents, including the spatial dimensions of the events. We present a definition for a nonfatal shooting incident that guides our victim and incident characteristic comparisons. Our work suggests that law enforcement agencies should build capacity for standardized data collection surrounding gun violence to include nonfatal shootings especially for use in evaluations of gun violence prevention strategies.

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Introduction

Gun violence in the United States is a pervasive and costly public health issue (Wintemute, 2015), so much that the American Medical Association declared gun violence a public health crisis (Friedman, 2016). Exposure to gunfire is among a set of indicators that have been linked with negative health outcomes, particularly among youth (Bieler & La Vigne, 2014). A recent study estimated the cost for law enforcement services for an aggravated assault between $9,145 and $11,639 and between $144,278 and $176,517 (in 2010 dollars) for a homicide (Hunt, Saunders, & Kilmer, 2019). The healthcare costs for gun assaults nationally, for 2010, are estimated at $630 million (Howell & Abraham, 2013), and gun violence undermines the economic health of communities—negatively affecting job creation and opportunities (Irvin-Erickson, Bai, Gurvis, & Mohr, 2016).

Criminological research has traditionally focused on homicide incidents because they are most likely to come to the attention of law enforcement, increasing the reliability and validity of the measure (Black, 1980; Jackson, 1990; National Research Council, 2005). Nevertheless, homicides are rare events and capture only a small proportion of all firearm violence (Piquero, MacDonald, Dobrin, Daigle, & Cullen, 2005;

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Supplemental data for this article can be accessed here.

Pridemore, 2005). Recent research suggests that nonfatal shootings constitute the majority of all gun assaults, occurring approximately four times as often as gun homicides (Hipple & Magee, 2017). There is also emerging evidence that the survival rate for gunshot injuries is increasing—further broadening the importance of considering nonfatal gun assaults (Beaman, Annest, Mercy, Kresnow, & Pollock, 2000; Fowler, Dahlberg, Haileyesus, & Annest, 2015; Kalesan et al., 2017). Although there are a number of existing public health and epidemiological datasets that capture information on nonfatal shootings, for example the National Emergency Department Sample (NEDS), the Nationwide Inpatient Sample (NIS), and the Web-based Injury Statistics Query and Reporting System (WISQARS), these data systems are designed to collect data for surveillance purposes, not research (Annest & Mercy, 1998). Recent reports also question the reliability and validity of some of these surveillance data sources (Campbell, Nass, & Nguyen, 2018). Criminal justice data sources do not collect or report systematic data on nonfatal shootings, in part due to a lack of agreed upon definition (Hipple & Magee, 2017; Hipple, McGarrell, O'Brien, & Huebner, 2017).

We designed the current study to broaden the understanding of gun violence to include criminal nonfatal shootings. Data for the study are from four Midwest communities: Detroit, Indianapolis, Milwaukee, and St. Louis. The primary goal of this manuscript is to document the similarities and differences between nonfatal and fatal shooting incidents as well as victims, including the characteristics and the spatial dimensions of the events. The results highlight many similarities between nonfatal and fatal gun crimes, particularly at the incident level, but the scope and geographic concentration of the events differ. This work concludes with policy suggestions, including ways to better document the range of gun assaults, which law enforcement and policymakers could use as the basis for comprehensive gun crime reduction planning.

Research on gun crime

There is a growing body of research on gun crime that suggests it is not random and can be linked to people, groups, and places (Papachristos, Wildeman, & Roberto, 2015). The concentration of gun crime among small numbers of people, networks, and places points to risk factors that can be used to inform prevention strategies (Sherman, 2007). Classic criminological research demonstrates that crime, and violent crime in particular, are concentrated among a small number of individuals (Wolfgang, 1958; Wolfgang, Figlio, & Sellin, 1987). Gun crime disproportionately affects young men of color as victims and perpetrators—both of whom are more likely to have extensive prior criminal histories (Braga, 2008; Pizarro, Zgoba, & Jennings, 2011). Similarly, involvement in gun crime increases subsequent victimization (Wells & Chermak, 2011).

Gun crime also moves through networks of individuals. In fact, work in Chicago illustrates that exposure to gun violence and gun involved people increases the risk of gun crime victimization (Papachristos et al., 2015). The spatial proximity of inner city communities places other individuals at risk, and the concentration of crime and criminally involved people in a neighborhood can affect surrounding neighborhoods (Anderson, 1999; Huebner, Martin, Moule, Pyrooz, & Decker, 2016; Zeoli, Pizarro, Grady,

& Melde, 2014). These risks are magnified by the fact that the social networks of gang members include close and extended family members, many of whom are also neighborhood residents (Pattillo, 1998). Research also suggests that youth are afraid of victimization and carry guns at high rates for protection, even when the penalties for illegal gun carrying are known (Watkins, Huebner, & Decker, 2008)

The constant presence of crime guns in a community, particularly among small peer groups and gangs, further increases gun carrying and use. Research in Newark, New Jersey suggests that gun crime can be transmitted like an epidemic through peers, social networks, and communities (Zeoli et al., 2014). Using epidemic models where gun violence spreads through social interactions, Green, Horel, and Papachristos (2017) found that 63.1% of gun violence in Chicago could accounted for by social contagion. Likewise, violence often spills across neighborhood boundaries because of the mobility of gun-involved persons and the role of contagion in violence (Huebner et al., 2016), as well as through co-offending networks (Papachristos & Bastomski, 2018).

Gun crime also clusters geographically in poor neighborhoods, where residents, particularly men of color, can be reluctant to call on law enforcement because they do not trust the response (Clampet-Lundquist, Carr, & Kefalas, 2015; Gau & Brunson, 2010). Even within neighborhoods characterized by high levels of violence, gun crime clusters at small micro-places such as a small proportion of street segments and specific businesses (Braga, Papachristos, & Hureau, 2010; Schnell, Braga, & Piza, 2017; Weisburd, Groff, & Yang, 2012). This concentration of violence, and related exposure to violence, has been found to be a central predictor of involvement in gun violence, net of individual, demographic factors (Rowan, Schubert, Loughran, Mulvey, & Pardini, 2019). Crime is also spatially dependent, such that neighborhoods adjacent to high crime neighborhoods also tend to have higher rates of violence (Browning, Dietz, & Feinberg, 2004; Morenoff, Sampson, & Raudenbush, 2001; Rosenfeld, Fornango, & Rengifo, 2007). Therefore, greater attention to the spatial context of gun crime, especially nonfatal gun crimes, is necessary to uncover the social processes that make some places riskier than others.

The current study

Research about the concentration of gun crime among people, groups, and places, suggests risk factors that can be used to guide prevention efforts. A majority of this research is based on studies of homicide, or broader aggregates of violent crime, that include incidents that do not involve a firearm. While gun violence is a large umbrella that captures a wide range of behaviors and criminal incidents, the criminal justice system focuses primarily on gun violence that violates criminal law, a narrow subset of incidents. Figure 1 displays a suggested taxonomy of *criminal* gun violence that requires "an unlawful attack by one person upon another for the purpose of inflicting severe aggravated bodily injury" (Federal Bureau of Investigation, 2013). The categories are differentiated by the physical harm inflicted on the victim.

The third category (far right) is the most straightforward category in the taxonomy and has garnered the most empirical research. The second (middle) category in this taxonomy is noteworthy is that it differentiates nonfatal shootings where a person

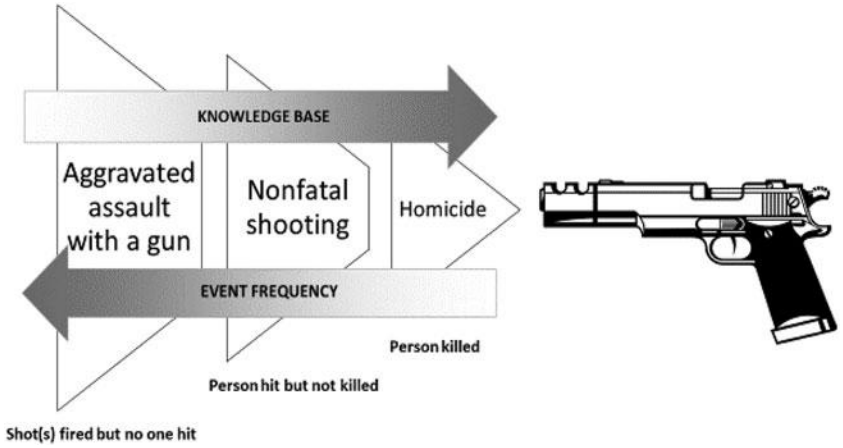

Figure 1. Taxonomy of criminal gun violence.

receives a penetrating gunshot wound but is not killed from the first category (far left) which includes incidents where someone fired a gun but did not hit anyone (see Hipple & Huebner, 2018; Hipple, Thompson, Huebner, & Magee, 2019; Huebner & Hipple, 2018). The current analysis focuses on the second and third categories of the taxonomy with the goal of providing a more nuanced understanding of nonfatal shootings.

Study sites

This study focuses on four Midwest cities: Detroit, Indianapolis, Milwaukee, and St. Louis, and is part of a broader study of gun violence (Hipple et al., 2017; McGarrell, Hipple, Huebner, & O Brien, 2019). Data for the study include criminal nonfatal and fatal shooting incidents that occurred in 2014 and 2015. During this time, much of the country was experiencing declines in homicides; however, the Midwest, and these four cities specifically, saw increases (Rosenfeld, Gaston, Spivak, & Irazola, 2017). The study sites were chosen to represent a range of communities; and the study sites were amenable to participating in this type of research. The sites are appropriate for this type of analysis because previous gun violence research has concentrated empirical efforts on a single, large metropolitan area, calling into question the representativeness and generalizability of the findings to other moderate sized cities (Cohen & Tita, 1999; Papachristos, 2009). In addition, including data from four cities helps capture the heterogeneity of places and gun crime, detail that is needed to develop effective and broad public policy, while acknowledging important local differences.

Table 1 displays the 2014 violent crime and homicide rates for the study sites. All four cities have violent crime and homicide rates well above the national average making these communities appropriate places to focus gun violence research efforts. Detroit, Michigan is 139 square miles and had an estimated population of 682,669 in 2014. The population is roughly 86% nonwhite. St. Louis spans 62 square miles and had an estimated population of 317,915 in 2014 and the population is 54% nonwhite (U.S. Census Bureau & Population Division, 2018). These two cities had the highest

Table 1. Violent crime and homicides in the project sites.

	2014 Violent crime		2014 Homicide	
	Number	Rate per 100,000	Number	Rate per 100,000
Detroit	13,616	1988.6	298	43.5
Indianapolis	10,768	1254.7	136	15.8
Milwaukee	8,864	1476.4	86	15.0
St. Louis	5,348	1678.7	159	49.9
National Average–MSAs		395.7		4.7

Source: FBI UCR.

homicide rates among the study cites—43.5 for Detroit and 49.9 for St. Louis; Detroit had the highest violent crime rate.

Indianapolis, Indiana spans 361 square miles and had an estimated population of 848,788 people in 2014, and the population is 38% nonwhite. Milwaukee, Wisconsin spans 96 square miles and had a population of 599,642 in 2014. The population is 54% nonwhite (U.S. Census Bureau & Population Division, 2018). Indianapolis and Milwaukee had comparable homicide rates at 15 per 100,000, but the violent crime rate was higher in Milwaukee than in Indianapolis. These two sites experienced substantially lower rates of gun crime during the study period compared to Detroit and St. Louis.

Data

Data for this study were collected from police records in each site, coded by hand, and compiled into a single dataset. There was no single, identical data source available at each site, such as the same records management system (RMS), which was appropriate to use for data collection; therefore, the data were obtained from varying sources. Several steps were taken to assure the quality of the data. At the outset of the project, the research team developed a data collection instrument that included criteria for coding nonfatal and fatal gun assault cases. The research documented the characteristics of the shooting incident, as well as victim characteristics.

The research team developed a very specific definition for a nonfatal shooting incident to guide the data collection instrument and to allow for cross-site comparison, given that no standard definition currently exists (Hipple & Huebner, 2018; Hipple et al., 2019; Huebner & Hipple, 2018; McGarrell, Hipple, Huebner, & O'Brien, 2019). A nonfatal shooting incident was identified using two criteria: the incident met the UCR and NIBRS definition of an aggravated assault and the victim suffered a penetrating gunshot wound caused by a firearm with a powder discharge (Beaman et al., 2000). Any incident or injury that lacked "criminal intent" like an accidental shooting or a self-inflicted gunshot wound was excluded from the sample. Incidents where the victim's wound was not caused by a projectile from a firearm with a power discharge such as an air rifle (e.g., BB gun) or flare gun were also excluded.

We captured information about each shooting incident such as the address including latitude and longitude coordinates, number of victims (single victim, multiple victims), and motive (interpersonal, drugs, robbery, other/unknown). We also collected detailed data on victims including age at the time of the incident, race (nonwhite, white), gender (male, female), number of gunshot wounds (one, more than one, unclear/unknown), and previous arrest record as documented by the respective

Table 2. Nonfatal and fatal shooting incidents and victims (2014-2015).

	Detroit[a]		Indianapolis[b]		Milwaukee[b]		St. Louis[c]		Total	
Site	n	%	N	%	N	%	n	%	n	%
Incidents										
Nonfatal shooting	446	83.5	802	75.2	1100	85.0	376	53.9	**2724**	**75.8**
Fatal shooting	88	16.5	264	24.8	194	15.0	322	46.1	**868**	**24.2**
Total	*534*		*1066*		*1330*		*698*		***3592***	
Victims										
Nonfatal shooting	563	84.0	889	76.0	1215	86.2	488	60.2	**3155**	**77.7**
Fatal shooting	107	16.0	280	24.0	194	13.8	323	39.8	**904**	**22.3**
Total	*670*		*1169*		*1409*		*811*		***4059***	

jurisdiction (no previous arrest record, previous arrest record). We collected as much detail as possible for each variable based on the site's data capacity and then recoded the data as necessary to make cross-site comparisons. In addition, a sample of data from each site was cross-coded to ensure inter-relater reliability. All incidents were geocoded to census block groups and overlaid with census data.

Due to data constraints, there is variation in the number and scope of data collected in each city. Data from Indianapolis and Milwaukee include all known nonfatal and fatal shootings that occurred in the sites during the study period (i.e., the population of criminal shootings). Detroit and St. Louis, the two study sites with markedly higher volumes of violent crime during the study period, were not able to capture every criminal shooting. Data from Detroit include all nonfatal and fatal shooting incidents occurring in the Detroit Police Department's 5th and 9th precincts. In St. Louis, all fatal shooting incidents are included. For nonfatal shootings incidents, researchers first drew a random sample of citywide incidents titled "aggravated assault with a gun" from the St. Louis Metropolitan Police Department RMS and then coded only those cases that met the nonfatal shooting definition.[1] Ideally, we would have preferred to capture all criminal shootings in all the sites but could not. We are statistically unable to compare the data across all sites. We instead will focus our discussion on the substantive similarities and differences between nonfatal and fatal shooting incidents and victims with the goal of describing the nature of gun crime in four distinct communities.

The total sample includes 2724 nonfatal shooting incidents and 868 fatal shooting incidents (n = 3592 shooting incidents). Table 2 displays the incident and victim counts by site. There are 4059 victims. As expected, nonfatal shooting incidents occured notably more often than fatal shooting incidents (i.e., gun homicides) although there was variation across sites. In Indianapolis, there were roughly 3.2 nonfatal shootings victims for every one fatal shooting victim. In Milwaukee, the ratio was 6.2 nonfatal shooting victims for every fatal shooting victim. The two study precincts in Detroit were quite similar to Milwaukee with just greater than five nonfatal shooting victims for every fatal shooting victim.

[1]There were 1,844 official UCR Aggravated Assaults with a Firearm in 2014 and 2,092 in 2015 in St. Louis. However, cases for this study were drawn from the St. Louis Metropolitan Police Department records management system and had not been officially screened for UCR. Using random digits, researchers sampled 614 cases from 2014 and 632 cases from 2015 (approximately one-third for each year) labelled 'aggravated assault with a firearm.' From those, 236 and 167 cases (2014 and 2015 respectively) met our nonfatal shooting definition and were included in this study.

Table 3. Shooting victim characteristics (2014-2015).

	Nonfatal		Fatal		Total			
Incident Type	*n*	%	*n*	%	*n*	%	χ^2	*p* Value
Victim Race							11.094	.001***
Nonwhite	2852	91.8	796	88.2	3684	90.9		
White	256	8.2	107	11.8	363	9.1		
Column Total	*3108*		*903*		*4011*	*100.0*		
Victim Gender							3.959	.047*
Male	2758	87.5	767	84.9	3525	86.9		
Female	395	12.5	136	15.1	531	13.1		
Column Total	*3153*		*903*		*4056*	*100.0*		
	M	*SD*	*M*	*SD*	*M*	*SD*	*t*	*p* Value
Age (n = 3949)	27.7	11.0	30.1	12.3	28.2	11.4	5.118	.000***
	n	%	*n*	%	*n*	%	χ^2	*p* Value
Victim number of gunshot wounds							113.202	.000***
One	2470	84.4	584	78.0	3054	83.1		
More than one	435	14.9	114	15.2	549	14.9		
Unclear/Unknown	22	0.8	51	6.8	73	2.0		
Column Total	*2927*		*749*		*3676*	*100.0*		
Victim previous arrest							72.605	.000***
No	1359	46.0	255	29.7	1614	42.3		
Yes	1595	54.0	604	70.3	2199	67.7		
Column Total	*2954*		*859*		*3813*	*100.0*		

*$p \leq .05$, ***$p \leq .001$.

Results

The characteristics of nonfatal and fatal gun assaults

In this section we present the characteristics of criminal nonfatal and fatal gun shootings for the full sample. Missing data differed across variables and were often dependent on characteristics of the site's data source.[2] With the exception of number of gunshot wounds, incident location, and motive, we deleted cases listwise when the variable of interest was missing and adjusted the sample size accordingly.

Victim characteristics

Table 3 displays the race, gender, and mean age for the full sample.[3] Victims were overwhelmingly male, nonwhite, and approximately 28 years old. While both nonfatal and fatal victims were significantly nonwhite ($\chi^2 = 11.094$; $p <= .001$), white victims made a slightly greater proportion of fatal victims. A similar pattern held true for gender. Most victims were male (86.9%), but fatal incidents had a larger proportion of female victims compared to nonfatal incidents (see Table 3).

Consistent with prior work (Grommon & Rydberg, 2014; Hipple & Magee, 2017), nonfatal shooting victims were younger than fatal victims. Nonfatal victims on average were 27.7 years old while fatal victims were 30.1 years old, a difference that is statistically significant ($t = 5.118$; $p < .001$). Where police data were available, we coded

[2]The Appendix available in the online supplemental material includes data on incident and victim characteristics by site.

[3]Data on victim characteristics were captured from police files. Data were not consistently or reliably available for ethnicity. Gender is presented as a binary construct.

Table 4. Shooting incident characteristics (2014–2015).

	Nonfatal		Fatal		Total			
Incident Type	*n*	%	*n*	%	*n*	%	χ^2	*p* Value
Number of victims							20.838	.000***
Single victim	2301	84.9	786	90.1	3087	86.3		
Multiple victims	411	15.1	78	9.0	489	13.7		
Column Total	*2712*		*864*		*3576*	100.0		
Location							32.003	.000***
Inside	742	26.2	279	34.2	1021	27.9		
Outside	1791	63.1	426	52.1	2217	60.7		
Unclear/Unknown	305	10.8	112	13.7	417	11.4		
Column Total	*2838*		*817*		*3655*	100.0		
Motive							57.936	.000***
Interpersonal	855	31.4	302	34.8	1157	32.2		
Drugs	241	8.8	147	17.0	388	10.8		
Robbery	461	16.9	115	13.3	576	16.0		
Other/Unknown	1167	42.8	303	34.9	1470	40.9		
Column Total	*2724*		*867*		*3591*	*100.0*		

*$p \leq .05$, ***$p \leq .001$.

the number of gunshot wounds for each victim.[4] The majority of all shooting victims (83.1%) suffered from a single gunshot wound. A slightly larger proportion of fatal victims (15.2%) experienced more than one gunshot wound compared to nonfatal victims (14.9%). This difference is statistically significant ($\chi^2 = 113.202$; $p < .001$). Finally, given the known victim-offender overlap in many violent crimes (Jennings, Piquero, & Reingle, 2012), we captured a conservative estimate of prior adult arrest as documented by the study jurisdiction. More than two-thirds of all victims had a previous arrest (67.7%). The proportion of fatal victims with prior arrests was greater than nonfatal victims (70.3% and 54.0%, respectively).

Incident characteristics

We first examined the number of victims per shooting incident. The number of victims per incident ranged from one to seven victims with the mean number of victims per incident slightly greater than one ($\bar{x} = 1.13$). Overall, the majority (86.3%) of shooting incidents were single victim incidents (Table 4) with 97% of all incidents having two or fewer victims and 99% having three or fewer victims. We then collapsed the discrete number of victim categories to create a binary variable comparing single victim incidents to multiple victim incidents across incident type. Roughly 15% of nonfatal shooting incidents had multiple victims compared to nine percent of fatal incidents. This difference is statistically significant ($\chi^2 = 20.150$; $p < .001$).

We also examined the physical location of the incident, that is, whether the shooting occurred inside a structure or outside. For this variable, we used the police department determination of the location if available, otherwise, researchers coded it based on information in the data source, such as the written narrative recorded by police. While empirical data are lacking to support this narrative, it is a common belief that law enforcement can only prevent crime in public places (see, for example Buerger, Cohn, & Petrosino, 1995). Almost 61% of all incidents in our sample occurred

[4]We did not have access to any medical records.

outside. A higher proportion of nonfatal shooting incidents occurred outside compared to fatal shooting incidents (63.1% and 52.1% respectively), and the difference is statistically significant ($\chi^2 = 32.003$; $p < .001$).

Table 4 displays the motives for each type of shooting incident. When known, homicide incident motives are reported to UCR so we used the police department determination of motive for the fatal incidents. For nonfatal shooting incidents, motive was determined by the researcher from narrative data. Motive was unknown for more than 40% of the nonfatal shooting incidents across sites. An unknown motive may be an artifact of the written incident narrative itself or, unlike fatal shootings, the lack of a requirement for officers to document or speculate about a motive. It could also reflect a lesser investigative emphasis in the case of a nonfatal shooting compared to a fatal shooting or may be due to victims' unwillingness to provide relevant information to the reporting officer or detective (Hipple et al., 2019). With this qualification of more unknown motives for nonfatal shootings in mind, fatal shootings were more likely to have a drug nexus whereas nonfatal shootings were more likely to involve robbery as a motive ($\chi^2 = 57.936$; $p < .001$).

Community characteristics

The goal of the second phase of the analysis was to describe the communities in which gun crime occurs and to consider if and the extent to which nonfatal and fatal gun crime clusters geographically. The analysis proceeded in two phases. First, we used principal components factor analysis to create a standardized index for concentrated disadvantage by combining percent unemployed, percent poverty, percent without health care, percent receiving food stamps, and percent of female headed households taken from the American Community Survey (U.S. Census Bureau, 2013). Next, we layered the locations of nonfatal and fatal shooting incidents over concentrated disadvantage by census block groups for each city (see Figure 2). In all cities, we see considerable overlap of nonfatal and fatal shootings with concentrated disadvantage.

In order to tease out possible differences in the geographic distribution of nonfatal and fatal shooting incidents, we identified hot spots for each incident type and determined the amount of overlap. We identified hot spots for nonfatal shootings by first sorting the block groups in the city according to the number of incidents. We then identified the riskiest block groups that accounted for 50% of all nonfatal shooting incidents and coded them as "hot spots." This procedure was repeated for fatal shootings incidents. Block groups that are hot spots for both nonfatal and fatal shootings are denoted as overlapping. The results for all cities are presented in Table 5 and data from Indianapolis and St. Louis are presented in Figure 3.

Our analysis revealed that shootings are heavily concentrated at the block group level in all four cities. In total, 15% of block groups account for 50% of the combined nonfatal and fatal shootings (i.e., identified as hot spots). In Detroit, 27% ($n = 53$) of the 193 block groups are hot spots. These incidents are even more concentrated in the other cities, where 50% of the shootings occur in just 20% of the 360 block groups in St. Louis, 15% of the 632 block groups in Indianapolis, and 11% of the 858 block groups in Milwaukee. Fatal shootings are only slightly more concentrated than

Figure 2. Locations of 2014-2015 fatal and non-fatal shootings overlaying concentrated disadvantage in (A) Detroit, Michigan; (B) Indianapolis, Indiana; (C) Milwaukee, Wisconsin; (D) St. Louis, Missouri. Nonfatal shootings are shown as white points, fatal shootings are shown as black points, and block group disadvantage is represented by a black color scale where darker values indicate higher disadvantage.

nonfatal shootings. In Milwaukee for example, half of the nonfatal shootings are concentrated in 8% of block groups while half of the fatal shootings are concentrated in 5% of block groups; similar results are seen in Indianapolis and St. Louis. In Detroit, there were 37 block groups designated as hot spots for nonfatal shootings compared with 21 fatal hot spots.

Table 5. Summary of nonfatal and fatal shooting hotspots in the study sites.

Site	Detroit	Indianapolis	Milwaukee	St. Louis	Total
Total Block Groups	193	632	858	360	2,043
Hot Spots[1]					
N	53	94	97	71	315
% within city	27	15	11	20	15
Nonfatal Hot Spot					
n	37	66	72	39	214
% within city	19	10	8	11	10
Fatal Hot Spot					
n	21	51	44	44	160
% within city	11	8	5	12	8
Dual Hot Spot					
n	5	23	19	12	59
% of hot spots	9	24	20	17	19

[1]Hot spots are defined as block groups which represent the upper 50% of the cumulative frequency distribution when block groups are sorted highest to lowest by the frequency of shootings.

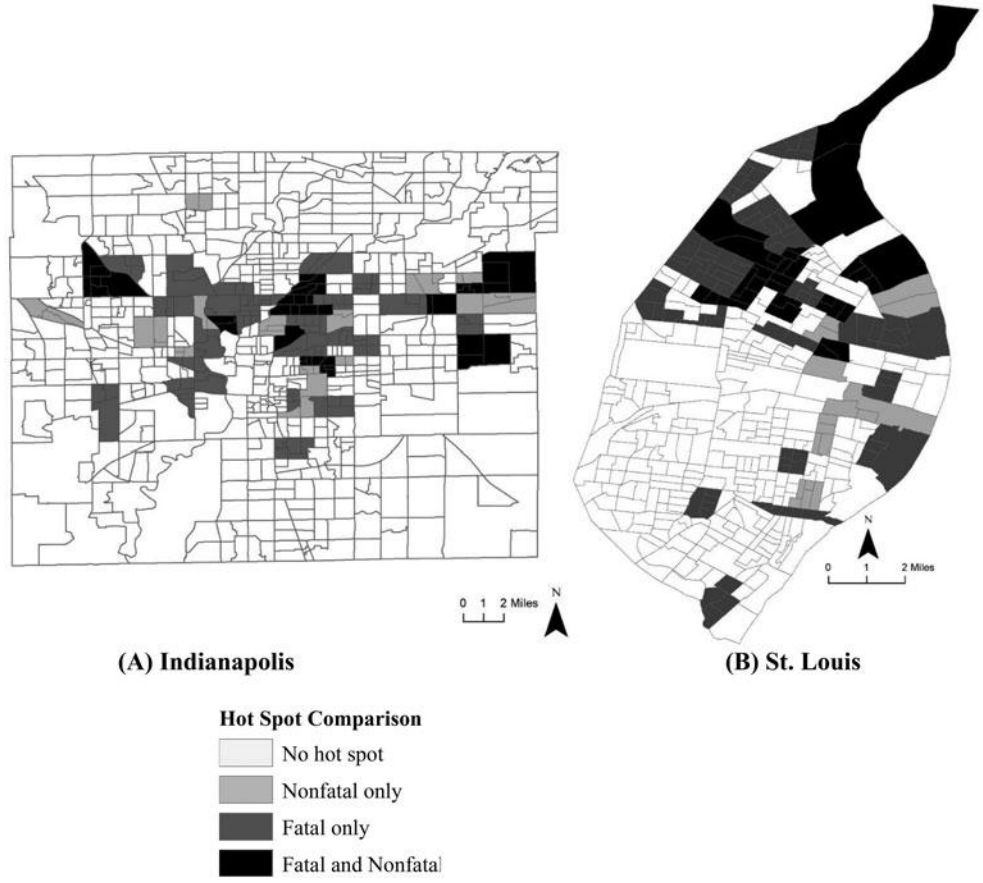

Figure 3. Nonfatal and fatal hot spot comparison in Indianapolis and St. Louis (2014-2015). Hot spot areas account for 50% of the cumulative frequency distribution. Gray areas indicate nonfatal (light gray) or fatal (dark gray) hot spot only, whereas black areas indicate overlap of nonfatal and fatal hot spots.

Although there is geographic concentration in nonfatal and fatal shooting incidents, there is little overlap between the hot spots for the two shooting classifications. Less than 20% of the hot spots are dual hot spots for nonfatal and fatal shootings across the four cities. The greatest amount of overlap is observed in Indianapolis where 24% of all hot spots are dual hot spots, and the least amount of overlap is observed in Detroit where just 9% of hot spots overlap.

The overlap in shooting hot spots is displayed in Figure 3, with two cities mapped for illustrative purposes. Fatal shooting hot spots in Indianapolis (Figure 3A) and St. Louis (Figure 3B) tend to cluster next to each other, whereas nonfatal hot spots are more dispersed around the fatal-only hot spots. Dual hot spots for both nonfatal and fatal shootings are spread across the center of Indianapolis, but cluster heavily on the north side of St. Louis. The results suggest that while there is concentration among nonfatal and fatal gun assaults, the spatial patterns of these shooting types are distinct.

In a supplemental analysis, we used procedures introduced by Wheeler, Steenbeek, and Andresen (2018) to test if the differences observed in the spatial patterns are statistically significant.[5] Overall, we found little evidence of statistically significant differences in the spatial patterns of nonfatal and fatal shootings. These analyses are included in the Appendix, available in the online supplementary material.

Discussion

Criminal gun crime represents a substantial public health issue, particularly among young men of color living in disadvantaged urban neighborhoods. This concentration of violence creates a vicious cycle of disadvantage, disorder, and violence (Abt, 2019). Yet, current official criminal justice data sources are unable to provide detailed data on about 80% of criminal shooting incidents. It is difficult to imagine other public health crises where the data systems only capture deaths while omitting other morbidity indicators (e.g., only capturing influenza deaths as opposed to the broader pool of influenza illnesses). Most criminological research has centered on homicide incidents, but there is a need to broaden the scope of this work to consider criminal nonfatal shootings. This project begins to fill this gap by comparing nonfatal and fatal shooting incident and victim characteristics for four Midwest cities.

Two important themes emerge. First, the results suggest that nonfatal shooting incidents are commonplace in the four communities, occurring at a ratio of four to one when compared to fatal shooting incidents. There are similarities in the victim and incident characteristics among the shooting types. The findings support existing research that highlights the predominance of these incidents among young men of color (Kalesan et al., 2017; Rosenberg, Ranapurwala, Townes, & Bengtson, 2017) and individuals who have had prior contact with law enforcement (Jennings et al., 2012). As anticipated, fatal shooting victims are more likely to experience multiple gunshot

[5]We used multinomial logistic regression to estimate differences in the proportion of nonfatal and fatal shootings that occurred in in each block group in the study. Using predicted probabilities and standard errors, we examined whether the differences were statistically significant, per Wheeler and colleagues (2018). See Appendix A in the online supplementary material for details.

wounds. This research highlights the common narrative that little separates a nonfatal shooting from a fatal shooting than perhaps poor aim and good medicine, or in fact chance (Cook, Braga, Turchan, & Barao, 2019).

Despite the consistency across a number of victim and incident characteristics, the differences deserve further attention. We find that nonfatal shooting victims were younger and had less extensive arrest records, and these incidents were more likely to involve robberies. These patterns may be suggestive of a developmental pattern whereby crime-involved young men become involved in criminal lifestyle patterns that may escalate to fatal shootings or fatal victimization. These patterns have been suggested in prior research (Dobrin, 2001; Hindelang, Gottfredson, & Garofalo, 1978) but would be very difficult to assess if data about criminal nonfatal shootings were not systematically captured.

The geographic analyses further suggest the need to distinguish nonfatal and fatal shootings. The descriptive results indicate that there are differences in the locations of nonfatal and fatal shootings. Although the supplemental analysis suggests these differences are not statically significant, we believe the descriptive differences identified are fundamentally important. There is ample evidence that place-based law enforcement strategies have the greatest potential for reducing crime generally and fatal shootings specifically (McGarrell et al., 2013; National Research Council, 2004, 2005). Our analyses suggest that developing an intervention based solely on homicide or fatal shooting data would potentially not be as effective for nonfatal incidents. For example, place-based interventions targeted at the highest risk places for fatal shootings would simultaneously target, at most, less than 25% of the nonfatal shooting hot spots (see Table 5). These distinct spatial patterns likely reflect the "rare event" quality of fatal shootings (Piquero et al., 2005; Pridemore, 2005) in contrast to nonfatal shootings. Prior research suggests that over time gun crime hotspots are highly stable (Braga et al., 2010) but the limitation of two years of fatal shooting data may be less stable estimates than would be the case with the more common nonfatal shootings. This possibility reinforces the need to collect data about both nonfatal and fatal shootings as well as emphasizes the need for an awareness that comprehensive gun crime prevention strategies based on fatal shootings will not like be effective across the full taxonomy of gun violence.

The findings of the study also highlight two broader and complementary needs for policy reform. The first reform should include the collection of systematic and detailed data on a range of firearm events. Although the movement from UCR to NIBRS may better inform the understanding of gun crime, NIBRS does not specify whether the firearm was discharged during the incident and whether a victim was struck by a bullet[6] (United States Department of Justice, 2018). Research of this type requires a national definition for a criminal nonfatal shooting and the record keeping capabilities to capture the related data. We present and apply one possible definition here that could be adopted. However, creating a standardized definition for a nonfatal shooting

[6]In 2016, the FBI announced that it would sunset the UCR Summary Reporting System and move exclusively to a national incident-based system. All U.S. law enforcement agencies would be required to begin reporting crime data under the NIBRS standard by January 2021. Injury categories include: apparent broken bone; possible internal injury; severe laceration; apparent minor injury; other major injury; loss of teeth; unconsciousness.

is only the first step, and, frankly the easier step, in addressing the need for comprehensive and comparable nationwide data on criminal shootings (see, for example, National Academies of Sciences, Engineering and Medicine, 2016, 2018).

Our work highlights a need to build law enforcement agency capacity for standardized data collection surrounding the entire taxonomy of criminal gun violence. Agencies are constrained by the technical limitations of their information systems. In many communities, the process of analyzing gun data is often dependent on manual data collection, as was the case for this project. Critically relevant information often exists exclusively in "text" fields like incident narratives and supplemental reports or are dependent on "check boxes" despite modern technical upgrades to RMSs. These factors can lead to an incomplete view and misrepresentation of the etiology behind firearm violence, which, in turn, may lead to incomplete policy and practice. Where possible, agencies could improve the systematic and automated process of nonfatal shooting analysis by structuring as much relevant information in dedicated fields in the RMS environment.

Secondly, law enforcement agencies should continue to build the organizational capacity to analyze and respond to gun violence. Law enforcement agencies and scholars should consider multiple data sources to examine criminal gun violence when available including: data from the criminal incident narrative, information in the computer-aided dispatch (CAD) call notes, investigation notes, and information generated by technologies like acoustic gunshot detection (e.g., ShotSpotter®). In the face of access to richer and more comprehensive information, many law enforcement agencies lack the processes, systems, and data integration capabilities to analyze nonfatal shootings. A parallel emphasis should be placed on how gun crime data are shared and analyzed once a standardized collection mechanism is in place. We acknowledge that these recommendations will require significant human, technological resources for most agencies and any automated data collection and retrieval will likely require costly changes to law enforcement RMSs and other technological infrastructures at the local and national levels (National Academies of Sciences, Engineering and Medicine, 2016, 2018).

Several models have been implemented in local communities that can be used to collect and analyze gun crime data in a systematic way. For smaller agencies, systematic incident reviews of nonfatal and fatal shooting incidents can be used both for measurement purposes and for gathering street level tactical and strategic intelligence on local gun crime (Hipple et al., 2017; Klofas et al., 2006). A key feature of crime incident reviews is input or street-level intelligence from line-level actors across the criminal justice system including, for example, the police, prosecutors, and probation and parole offices. For larger agencies, systematic review processes such as the Milwaukee Homicide Review Commission have shown great promise in reducing gun crime and increasing strategic responses to gun crime (Azrael, Braga, & O'Brien, 2013). In addition, Crime Gun Intelligence Centers can be used as the organizational basis in which to collect and analyze data surrounding firearm violence and to share it with strategic partners (Kraft, 2019) helping break down the silos where firearm-related incident data are often stored and reported.

This study is not without limitations. First, the availability of data elements varied by community, and data on shooting suspects was even more limited. These data may not be representative of criminal shootings in all communities and reflect only one period in time. Although data availability varied by site, and though there is overlap

between nonfatal and fatal shootings, the observed differences between nonfatal and fatal are also apparent across the four sites. These differences were most notable in terms of geographic variation. There were also differences in the spatial concentration and dispersion of shooting incidents across the four sites, though this may also reflect differences in sampling frames. Both the overlap and the variation in nonfatal and fatal shootings are an important considerations for future work of this type.

Consistent with prior research, these findings supported the overall relationship between neighborhood disadvantage and violent crime. The spatial overlap of nonfatal and fatal shootings also raises important questions for future research in terms of the micro-place factors generating this overlap (Weisburd et al., 2012). Future work should consider crime generators and crime attractors at the micro-place unit of analysis that could account for concentrations of nonfatal and fatal shootings (Brantingham & Brantingham, 1995). To date this study has not examined spatial characteristics at the micro-place level across the four cities but the patterns displayed in Figures 2 and 3 call for such an analysis.

In addition, these data reflect the types of information collected by law enforcement agencies and vary from those collected with a public health lens and should be considered accordingly. Certainly, utilizing law enforcement data about nonfatal and fatal shootings along with the type of public health data collected by, for example, the Centers for Disease Control (CDC) could increase our understanding of serious gun crime.

In conclusion, this study highlights the importance of developing a mechanism to collect and analyze criminal nonfatal gun crime data with the goal of developing broader and more nuanced gun policy. This work provides a potential model for replication by scholars using law enforcement data. The heterogeneity in nonfatal and fatal gun crimes suggest the potential omissions of extant work. In order to develop effective strategies to address gun crime, we must create "good data systems that provide consistent and comparable detailed information across sites and over time" (Hemenway & Miller, 2013, p. 2034). This work could be used to encourage the development of investigative tools for nonfatal shootings, similar to those developed for homicides (Police Executive Research Forum, 2018). Improved data systems, coupled with changed investigative techniques may ultimately reduce the divergence of clearance rates among these crimes more specifically (Cook et al., 2019) and improve public policy on gun crime generally. Finally, inclusion of nonfatal shootings is critically important for strengthening evaluations of gun violence prevention strategies. With the exception of the nation's largest cities, fatal shootings are too rare to provide stable estimates of gun crime. Including nonfatal shootings will provide much greater confidence in evaluation findings for critically important studies of gun crime prevention.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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