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Greenspace and Gun Violence in Detroit, USA

Gregory Breetzke¹

University of Pretoria, South Africa

Amber Pearson,² Shiqi Tao³ & Rui Zhang⁴

Michigan State University, United States of America

Abstract

Greenspaces have long been seen as providing an escape from the stressors of urban life, yet very little is known about the extent to which greenspaces and/or their immediate surroundings may actually serve as locations for violent crime. In this study, we used location quotients to compare the extent of gun violence in greenspaces with gun violence across the entire city of Detroit, as well as compare gun violence in greenspaces with gun violence occurring within a series of buffer intervals immediately surrounding these locations. Finally, we identified whether the socio-economic characteristics of the neighborhood in which a greenspace was located increases gun violence occurrence and identify what physical characteristics of greenspaces differentiate between high and low gun violence. We found that greenspaces themselves were associated with lower levels of gun violence, compared to other locations across the city. We also found no evidence that the deprivation level of the neighborhood in which a greenspace was located significantly impacted the risk of gun violence. In terms of physical characteristics, greenspaces with higher levels of greenness and more tree cover were correlated with higher gun violence. Explanations for these findings are discussed in the context of a city unique in the United States for its history, its present and its changing future.

Keywords: Greenspace, Gun violence, Detroit; Location quotients.

¹ Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria. E-mail: greg.breetzke@up.ac.za

² Department of Geography, Environment, and Spatial Sciences, Michigan State University, USA. E-mail: apearson@msu.edu

³ Department of Geography, Environment, and Spatial Sciences, Michigan State University, USA. E-mail: taoshiqi@msu.edu

⁴ Department of Geography, Environment, and Spatial Sciences, Michigan State University, USA. E-mail: zhangr50@msu.edu

Introduction

Examining the association between greenspace, their environs and gun violence is an important topic of investigation. This is especially true in the United States (US) given its high levels of gun violence as well as its large number of greenspaces including its national, state and urban parks. Regarding gun violence, it is well-documented that the statistics concerning this phenomenon in the US are alarming. Over one hundred people die from gun violence on average per day in the US (Hemenway, 2018), with the rate of homicide by firearms more than 25 times higher in the country than in other high-income countries (Igielnik & Brown, 2017). Of greater concern, however, is the fact that among 18–25 year olds the firearm-related homicide rate in the US is 49 times higher than that of other high-income countries (Grinshteyn & Hemenway, 2016) despite relatively similar rates of other types of crimes (Hemenway, 2016). According to the Centers for Disease Control and Prevention (2018) there were over 14,000 homicide deaths from guns in 2016 alone with the age-adjusted death rate for firearm-related injuries having increased by over 6% from 11.1 deaths per 100,000 population in 2015 to 11.8 in 2016.

In terms of greenspace, the US contains over 400 national park sites and countless state, regional and urban and city parks varying in quantity, quality and accessibility. According to the Trust of Public Land (TPL) (2018) there are over two million acres of urban parkland in the 100 largest cities in the US which collectively contain over twenty percent of the population of the country. Rather surprisingly, research investigating the nature of the spatial relationships between urban greenspaces and crime both in the US and internationally is limited. Of the research that does exist the vast majority have found a positive relationship between the presence of urban greenspaces and crime (see Boessen & Hip, 2018; Demeau & Parent, 2018; Kimpton et al., 2017; McCord & Houser, 2017) although there is a distinct lack of knowledge regarding the association between gun violence specifically and urban greenspaces. Moreover, the extent to which gun violence spatially diffuses around greenspaces in urban environments is less understood. Past theory suggests that greenspaces may act as crime generators in that they are easily accessible to the public and attract large numbers of people providing an increased opportunity for motivated offenders.

This study adds to this growing body of literature by investigating the association between gun violence and greenspace in the city of Detroit, Michigan. We focus on one type of greenspace, namely urban parks. The geographical focus area for this research makes this study unique for a number of reasons. First, Detroit has one of the highest levels of gun violence in the US (Grommon et al., 2017). In 2015, the city had the second highest homicide rate in the US despite having its lowest number of homicides in over 40 years (Federal Bureau of Investigation (FBI, 2016). Second, the city has experienced significant decline over the past fifty years, in its population, infrastructure and economy. This has resulted in increased levels of unemployment and housing vacancies with the city (Bentley et al., 2016; Sugrue, 2005). In July 2013, the city of Detroit filed for bankruptcy due to the preceding ten years of budget deficits running into the hundreds of millions of dollars (McDonald, 2014). One of the consequences of this development was the concomitant inability of the city to continue to manage public resources and services at previous levels, including some of its greenspaces (see Liang & Crawford, 2018). These combined factors make Detroit a unique setting to examine the association between

greenspaces and gun violence. Finally, from a data and methodological perspective, we use gun violence as our crime variable of interest. Most prior research has examined the relationship between urban greenspaces and various types of crime more generally. Here, we use a much narrower level of crime granularity, namely gun violence, as well as a novel spatial approach to measure this association, namely location quotients (LQ).

Literature Review

A limited number of empirical studies have been forthcoming testing the spatial relationship between greenspace and crime. This is largely due to the fact that greenspaces are most often grouped together with other categories of neighborhood features such as restaurants, bars and retail stores in aggregated studies which makes it difficult to determine the exact effect of greenspace on crime. Of the research that does specifically examine the spatial effects of greenspaces specifically on crime the majority find a positive association (see Boessen & Hip, 2018; Demeau & Parent, 2018; Groff & McCord, 2012; Kimpton et al., 2017; McCord & Houser, 2017). For example, Boessen and Hipp (2018) examined parks and the role of their nearby context in generating crime using data from nine cities across the United States and found that nearby land uses and socio-demographic characteristics are a key driver of crime being located within the park or nearby the park. McCord and Houser (2017) examined the relationship between neighborhood parks and crime in two very dissimilar cities in the United States, namely Philadelphia, PA and Louisville, KY and found in both instances neighborhood parks to be associated with increased crime levels in their immediate surroundings. Their study also highlighted the importance that underlying guardianship plays in explaining the criminogenic nature of neighborhood parks. In probably the seminal work in this area Groff and McCord (2012) examined the incidences of various types of crime in and around 247 parks in Philadelphia. The researchers found that violent, property, and disorder crime clustered within and around urban parks but that certain park amenities such as sporting facilities and lighting reduced the risk of crime occurring.

Later McCord and Houser (2017) examined crime in streets adjacent to parks (park environs) in Philadelphia and Louisville and again found spatial clustering of crime in the areas immediately surrounding parks in these cities. Again, the presence of certain amenities, in their case lighting and the provision of park benches, drinking fountains, and parking lots reduced crime within park environs. Findings from other studies employing a range of methodologies have also found a positive association between neighborhoods with parks and both residential (Crewe, 2001; Lockwood, 2007) and commercial burglaries (Hakim & Shachamurove, 1996). Outside the US, Kimpton et al. (2017) found a positive spatial association between crime and greenspaces in Brisbane, Australia while in Montreal Demeau and Parent (2018) found greenspaces were found to have a significant and positive effect on assaults, theft, and motor vehicle theft. The notion among the majority of these researchers is that greenspaces act as crime generators in that they attract large numbers of people into a locale including some potential offenders as well as victims.

The concept of crime generators is synonymous with crime pattern theory which explores the distribution and interaction of targets, offenders, and opportunities across space and time (Brantingham & Brantingham, 1991). The spatial crime theory motivates that offences are most likely to occur where opportunity spaces – places perceived by the

offender to contain attractive targets – intersect with awareness spaces – places about which an offender has specific environmental knowledge, for example a greenspace. From a crime pattern perspective, a greenspace is a common and predictable node that people periodically travel to and from and enjoy spending time in leading to an increased risk for offending and/or victimization. Accordingly, greenspaces may act as crime generators in that they are easily accessible to the public and attract large numbers of people providing an increased opportunity for motivated offenders. Likewise, the areas around greenspaces could also attract potential offenders as an increasing number of people travel to and from greenspaces reducing the effectiveness of neighborhood informal social controls. Greenspaces are however important and long-standing neighborhood institutions which feature prominently in the urban environment and have been shown to have many health-related and social benefits (see Besenyi et al., 2014; De Vries et al., 2016; Nichani et al., 2017; Zhang et al., 2017). Greenspaces themselves, and the spaces around them should engender feelings of safety and security among visitors and be conducive to positive social engagement and interaction. Any incidents of crime in these spaces should be of great concern since crime and/or the perception of crime in and around greenspaces has been shown to limit greenspace use (Han et al., 2018; Harada et al., 2017), and physical activity (Ries et al., 2009) particularly among the youth and in low income neighborhoods.

With hidden spaces and few guardians, greenspaces can also however foster delinquency particularly among the youth as they provide a physical space for young people to congregate often without adult surveillance (Kimpton et al., 2017). Interestingly, the quality and characteristics of greenspaces as well as the social composition of the surrounding neighborhoods seem to have a mediating effect on the greenspace-crime relationship (see Boessen & Hip, 2018; Groff & McCord, 2012; Wilcox et al., 2004). Greenspace quality in this instance refers to the level of greenness of the greenspace, the maintenance of greenspace structures and amenities, as well as the inclusion of safety features such as lighting (Sadler et al., 2017). High quality greenspaces may encourage visitation and concomitant social cohesion among legitimate greenspace users as well as provide enhanced monitoring by patrons providing a disincentive for criminal behavior, particularly at night (Garvin et al., 2013; Lorenc et al., 2012; Wolfe & Mennis, 2012). Low quality, unmaintained greenspaces may however be more criminogenic and provide opportunities for would-be offenders to gather without surveillance or fear of being caught if they engage in criminal activity (Kimpton et al., 2017; McCord & Houser, 2017). In terms of the neighborhood composition, Boessen and Hipp (2018) stress the importance of examining the broader neighborhood-level context within which crime occurs rather than simply identifying greenspaces as crime generators in and of themselves. In their study across nine cities in the US the researchers found that nearby land uses and socio-demographic characteristics were a key driver of crime being located in greenspaces. Previous work by Wilcox et al. (2004) also found that a greenspaces' positive association with violence was moderated by neighborhood instability with greenspaces in unstable neighborhoods associated with decreased violent crime in their study.

Despite the aforementioned studies, there are numerous theoretical reasons to suggest that, on the other hand, greenspaces may be associated with lower neighborhood crime. Among them being the fact that greenspaces should encourage surveillance by people

using the greenspaces legitimately thereby reducing the opportunities for criminal behavior, the so-called ‘eyes on the street’ axiom of Jane Jacobs (1961). Jacobs’ ‘eyes on the street’ observations are based on the tendency for the public to stop or prevent criminal behavior. In this sense, the public may provide community guardianship to collectively work to prevent or reduce crime. For instance, legitimate users of a greenspace such as walkers or joggers may reprimand people engaging in vandalism or contact law enforcement if they witness a crime. Conversely, certain greenspaces may have reduced internal and external visibility offering less opportunities for surveillance providing would-be offenders with greater opportunities for criminal behavior.

The Current Study

Research examining the association between greenspace and crime is in its infancy. Despite our increasing knowledge that greenspaces may increase the likelihood of crime occurring within their immediate and surrounding areas, our understanding of how greenspaces influence the risks of certain types of crime such as gun violence, in particular, is sorely lacking. In this study, we sought to expand upon the extant literature in a number of ways. First, we examine gun violence and do not aggregate to a general crime type. We hypothesize that gun violence will disproportionately occur in and around urban greenspaces. Second, we examine trends in neighborhood socio-economics of greenspaces alongside trends in gun violence. It could be, for instance, that greenspaces located in less affluent or more affluent neighborhoods are more likely to be targeted by would-be offenders. Third, we examine the concentration of gun violence in greenspaces and finally, determine whether certain physical characteristics of greenspaces such as the size or the level of ‘greenness’ may increase the risk of gun violence since, as previously discussed, greenspaces may act as either crime generators or deterrents.

Data and Methods

Data on gun violence in Detroit was obtained from the Gun Violence Archive (<http://www.gunviolencearchive.org/>), a non-profit organization that provides data on gun violence incidents across the US. All gun violence incidents in Detroit from 2014 to 2017 were extracted and geocoded. A total of 1266 gun-related incidences were recorded in Detroit over this four-year period (M per month = 26.4 incidences; M per day = 0.9 incidences).

Data on greenspaces in Detroit were obtained from the City of Detroit Open Data Portal, an online repository containing data on various aspects of the city including public records, permits and public safety. A total of 309 parks (greenspaces) were extracted for the city for 2016. One greenspace, Belle Isle, was surrounded by water and was removed resulting in 308 greenspaces used in the analysis. A number of characteristics were then calculated for each greenspace including size, percentage tree cover and level of ‘greenness’ (using NDVI) as well as the deprivation rank based on the socio-economics of the surrounding neighborhood/s (census block/s).

The percentage tree cover and level of ‘greenness’ of the 308 greenspaces were calculated using 21 composite National Agricultural Imagery Program (NAIP) images (from August 2016; one-meter resolution). These images were used to calculate NDVI values for each greenspace in order to determine the major type of land cover type

including trees ($NDVI \geq 0.25$). From this, we determined the percentage tree cover for each greenspace as well as the average NDVI to represent their overall level of 'greenness'. There is increasing evidence that the quality of greenspaces increases the risk of crime occurring (see Boessen & Hip, 2018; Wilcox et al., 2004); these variables were therefore included to provide some initial insight into these associations in a Detroit context. Finally, we assigned a deprivation score to each greenspace in Detroit using the Area Deprivation Index (ADI) from University of Wisconsin School of Medicine and Public Health. The ADI is an index of disadvantage that is calculated using a number of factors including income, education, employment, and housing quality for census blocks. The values of the index range from 1 to 10, with higher values indicating greater disadvantage. Originally created by the US federal government more than two decades ago, the ADI is an index of deprivation that has been successfully used in a number of studies linking neighborhood-level disadvantage with health and wellbeing (see Kind et al., 2014; Lantos et al., 2018). One common problem assigning a deprivation score to a greenspace is that greenspaces often cross over administratively-defined, spatially delineated neighborhood boundaries which makes it difficult to ascribe a single socio-economic indicator. This is particularly problematic for larger greenspaces which straddle multiple neighborhoods. In the event that a greenspace and its surroundings were completely contained within a neighborhood, then that greenspace was given the deprivation score of that neighborhood based on the ADI. In the event that the greenspace and its surroundings crossed over neighborhood boundaries, we calculated a mean deprivation index score based on the percentage of the greenspace that was located in each neighborhood. The deprivation score for each greenspace was then calculated, ranked, and classed into quintiles of low (1) to high (5) deprivation; three quintile groups had 62 greenspaces and two quintile groups had 61 greenspaces. Greenspaces in Quintile 1 (Q1) can be considered as being located in affluent neighborhoods (mean deprivation score = 6.21), whereas those in Quintile 5 (Q5) can be considered as being located in more deprived neighborhoods (mean deprivation score = 9.97). The location of the gun violence incidences as well as the greenspaces used in the study are shown in Figure 1 whilst the descriptive statistics for the 308 greenspaces utilized in this study are shown in Table 1.

Table 1. Physical characteristics of urban greenspaces in Detroit ($n = 308$)

	Min	Mean	Max	SD
Park area (m ²)	280	46,396	3,600,699	230,599
Percent tree cover	0	24.1	98.1	20.3
NDVI ^a	-0.53	0.12	0.43	0.13
Deprivation rank of greenspace neighborhood ^b	2.0	8.7	10.0	1.6

^a Negative values of NDVI (values approaching -1) correspond to water. Values close to zero (-0.1 to 0.1) generally correspond to barren areas of rock, sand, or snow. Low, positive values represent shrub and grassland (approximately 0.2 to 0.4), while high values indicate temperate and tropical rainforests (values approaching 1).

^b The values of the index range from 1 to 10, with higher values indicating greater disadvantage.

Figure 1. Location of gun violence incidents and city greenspaces in Detroit (2014–2017)



Empirical Analysis

A cross-sectional quantitative research design was employed to determine whether gun violence occurrences were higher than expected within or near greenspaces, compared to the city as a whole. As a relatively new quantitative measure of crime, location quotients (LQs) were employed to compare the extent of gun violence in greenspaces and their immediate, surrounding areas, compared to other areas across the city. Location quotients provide a view of crime patterns not easily obtained with the two more traditional crime measures (counts and rates) in that they provide a relative and comparative measure of a phenomena between areas. In this sense, a LQ provides a measure that indicates how different an individual area of interest is relative to the total area under investigation. In the context of this study, a LQ would show the extent to which gun violence incidences within and surrounding a greenspace depart from the overall proportion of gun violence throughout Detroit as a whole. For example, if a greenspace or the area surrounding it in Detroit has a LQ of 1, then that area has exactly the same relative frequency of gun violence as is found across the entire city. If an area surrounding a greenspace has a LQ of 0.5 then that area has half the amount of gun violence as the overall city and is perhaps a less risky area/greenspace in which to recreate. Conversely, if an area surrounding a greenspace has a LQ greater than 1, then gun violence is over-represented in that area indicating a relative concentration of gun violence. Being a relative measure and without dimension, LQs provide a more vivid measure of crime risk than for example the high and low indicators of crime rates. In criminological form, the LQ formula is expressed as follows:

$$LQG_e = (G_e/A_e)/(\Sigma G_e/\Sigma A) \quad (1)$$

where G_e is the count of gun violence locations in each research unit (e.g., greenspace environment, or buffers around parks), A_e is the area of the corresponding research unit. ΣG_e indicates the total count of gun violence incidents in the whole city, and ΣA is the total area in the city of Detroit.

In the study, we calculated LQs for the greenspaces themselves (including a 10-meter buffer around the greenspace boundary itself to capture the greenspace environ) as well as for a series of buffer intervals immediately surrounding greenspaces. This was done in order to determine the impact of greenspaces on gun violence in greenspaces themselves as well as in the areas immediately adjacent to them. It could be that would-be offenders are deterred by the surveillance of greenspace users and/or safety and security measures bounding the greenspaces and instead commit an offence at more easily accessible locations nearby (i.e., crime displacement). Buffer intervals of 100 meters, 200 meters and 300 meters were constructed around each greenspace because that distance approximates on average the length of a street block in the city although these can vary considerably. The density of gun violence in these four zones (i.e., greenspace environs; 100m; 200m; 300m) are then compared to the density of gun violence for the entire city of Detroit and represented as a LQ. Lastly, we conducted a sensitivity analysis to test our results obtained against the extent of gun violence around a randomly selected set of 308 locations in the city. This was done to mitigate a common criticism of LQs that they dilute the crime rate in comparison areas because they include places at which no crime could occur (for example, airport runways, tracts of undeveloped land, rivers, and so on) (Groff & McCord, 2012; McCord & Ratcliffe, 2009). For each of these 308 randomly selected

point locations, we constructed a 122-meter buffer and calculated LQs for these areas. A buffer distance of roughly 122 meters was selected so that the total area covered by the random point selection was the same as the total area covered by the existing 308 greenspaces used in the study (i.e., $308\pi(122\text{m})^2 = 1439.46$ kilometers squared). A comparison of gun violence across this ‘control’ group of 308 random areas with the 308 greenspaces allows us to be more certain of our findings and provides additional validity to the study. An ANOVA was used to determine whether the differences in LQs for the density of gun violence in greenspaces and for the 308 random areas was significant.

Next, we were interested in determining whether the socio-economic characteristics of the neighborhood in which a greenspace was located was related to the magnitude of gun violence in the greenspace and in its immediate vicinity. It could be, for instance, that greenspaces located in less affluent neighborhoods are more likely to be targeted by would-be offenders and that by aggregating all the greenspaces together in our analysis we lose the ability to unmask this association. LQs for each greenspace were then calculated and averaged per deprivation quintile and Spearman’s rank correlation coefficients and *p*-values determined at each buffer distance (between deprivation quintile and LQ). Finally, we were interested in examining the spatial concentration of gun violence in greenspaces in Detroit and calculated the percentage of greenspaces accounting for 50% and 100% of gun violence incidents and identified which physical characteristics of gated communities in Detroit were associated with the occurrence of gun violence.

Results

The results of the LQ analysis are presented in table 2. Overall, the density of gun violence in greenspaces in Detroit was found to be *substantially less* than across the city as a whole (0.33). These findings indicate that the risk of gun violence in Detroit is lower in greenspaces. Areas immediately surrounding greenspaces have, however, marginally higher densities of gun violence than that of Detroit, with both the 100 meters (LQ = 1.24) and 300 meters (LQ = 1.09) intervals exhibiting values higher than the overall city values. Interestingly, there was no gradient in gun violence as the distance from a greenspace increased; in fact, there is a slight decrease in gun violence at the 200-meter buffer (LQ = 0.99) compared with the 100-meter buffer. Lastly, using ANOVA we found gun violence densities in greenspaces to be significantly *lower* than in the areas around the 308 randomly selected points ($p < 0.001$).

Table 2. Location quotients of gun violence in greenspaces ($n = 308$), categorized by deprivation rank

	Overall	Low					High			
		Q1	Q2	Q3	Q4	Q5	R5:R1	rho	<i>p</i>	
Greenspace environ	0.33	0.01	0.51	0.49	0.11	0.52	52.00	0.40	ns	
100m buffer	1.24	0.60	1.49	1.87	1.48	0.75	1.25	0.38	ns	
200m buffer	0.99	0.79	1.39	1.05	0.81	0.93	1.18	0.48	ns	
300m buffer	1.09	1.04	1.00	1.15	1.40	0.84	0.81	-0.31	ns	
Random points ($n = 308$)	0.98	0.76	1.02	1.00	1.02	1.07			-	
							1.41	-0.67		

An examination of the relationship between the socio-economic characteristics of the neighborhood in which the greenspace was located and LQ of gun violence shows no noticeable socio-economic gradient (see Table 2). The average LQ values in quintile 5 (more deprived) were not uniformly higher than the average LQ values in quintile 1 (more affluent). All Spearman's rank correlation coefficients were non-significant indicating that greenspaces located in more deprived areas of Detroit were not significantly correlated with higher gun violence relative to greenspaces located in more affluent neighborhoods, or vice versa. The highest individual LQ scores were found at the 100-meter buffer in greenspaces located in quintiles 2-4 - loosely defined as 'middle-income' - while the highest mean LQ scores across all distance intervals was 1.10 (in quintile 2) and 1.14 (in quintile 3), respectively. We then investigated the concentration of gun violence in greenspaces. It could be that gun violence is disproportionately distributed throughout the 308 greenspaces in Detroit resulting in some distortion in the relationship between gun violence and greenspace. Results of this analysis (see Table 3) revealed that just under two per cent of greenspaces ($n=5$) accounted for half the gun violence reported within greenspaces over the four years in Detroit ($n = 1266$ total gun violence incidences within greenspaces 2014-2017), a remarkably skewed concentration. Incidentally, the largest greenspace in Detroit - which is more than three times bigger than the second biggest greenspace - recorded only one gun violence incident across all buffer intervals across the whole study period. At the 100-meter buffer, 25 greenspaces accounted for 50% of all gun violence incidences while 29 and 34 greenspaces accounted for 50% of gun violence over the four years further illustrating the skewed spatial concentration of this type of crime around greenspace. Encouragingly, the vast majority of greenspaces in Detroit have not had any gun violence incidences recorded at any buffer interval over the four-year study period, again emphasizing the fact that greenspaces appear to be relatively safe environments, at least in terms of gun violence occurrence.

Table 3. Concentration of gun violence in greenspaces

	Percentage of greenspace accounting for 50 per cent of gun violence	Percentage of greenspace accounting for 100 per cent of gun violence
Greenspace environ	1.62 ($n = 5$)	3.57 ($n = 11$)
100m buffer	8.12 ($n = 25$)	27.27 ($n = 84$)
200m buffer	9.42 ($n = 29$)	32.47 ($n = 100$)
300m buffer	11.04 ($n = 34$)	42.53 ($n = 131$)

Last, we sought to identify which physical characteristics of greenspaces in Detroit were associated with overall gun violence risk. This was done using partial correlational analysis as the technique provides a simple yet effective estimate to test the independent relation of each physical characteristic of greenspaces to gun violence. In each case, the effect of other physical characteristics is partialled from the simple correlation between a

given physical characteristic and gun violence in order to gain an alternative perspective of these relationships (see Table 4).

Table 4. Partial correlations between gun violence and the physical characteristics of greenspaces in Detroit ($n = 308$)

	Gun violence			
	Greenspace environ	100m buffer	200m buffer	300m buffer
Greenspace area (m ²)	-0.01	-0.06	-0.01	0
Percent tree cover	0.02	-0.09	0	0.09
NDVI	0	0.12*	-0.04	-0.13*
Deprivation rank of greenspace neighborhood	0.06	0.07	0.06	0.13*

Note: * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$.

Interestingly, no significant correlations were found within greenspaces themselves. At the 100-meter buffer, gun violence was however found to be positively correlated, 0.12 ($p < 0.05$) with greenspace NDVI. This suggests that when the effect of the other physical characteristics is controlled, gun violence is significantly associated with greenspaces with higher NDVI values at the 100-meter buffer interval. Likewise, with greenspaces, no significant correlations were found at the 200-meter buffer interval. Three significant correlations were found at the 300-meter buffer interval. When all other physical characteristics are controlled for gun violence was found to be negatively correlated -0.16 ($p < 0.05$) with the percentage of tree cover and with NDVI -0.13 ($p < 0.05$) and positively correlated with the deprivation rank of the greenspace. In other words, larger greenspace environments with higher greenness, more tree cover and lower deprivation (more affluent) were correlated with lower gun violence. No particular physical characteristic of greenspaces in Detroit appears to be associated with a higher gun violence across all buffer intervals, rather different characteristics seem to play a positive or negative role in the commission of these types of crime depending on the distance to the greenspace.

Discussion

Greenspaces are places where people can meet for their enjoyment and/or relaxation. They most often have numerous facilities and amenities that allow both adults and children to keep themselves entertained, and in some instances, allow them to learn about their country and/or city firsthand including its history, cultures, geography and ecology (Jarvis, 2007). They are also spaces where people could, and should, feel comfortable in that they provide access to nature which has been shown to have both physical and mental health benefits (see Annerstedt et al., 2012; Giles-Corti et al., 2005; Maas et al., 2009; Nutsford et al., 2013). In many respects, gun violence represents the opposite. This type of pandemic instills fear, evokes panic both among those directly affected by the incident but also by the general public who are insidiously exposed to gun violence incidents in the mainstream media and through social media. The phenomenon is also endemic to the United States. More than 200 Americans are murdered or assaulted with a gun every day

(Iroku-Malize & Grissom, 2019) with gun deaths in the country having recently risen to its highest level in 20 years (Centers for Disease Control and Prevention, 2017). The primary aim of this research was to investigate the effect greenspaces have on occurrence of gun violence. The geographical focus area for this work was Detroit, a city unique in the American landscape due to its relatively high despite declining violent crime rates and changing urban geography. We were also interested in determining whether the type of neighborhood in which the greenspace was located impacted gun violence occurrence and what physical characteristics of greenspaces differentiate between high and low gun violence in and surrounding their communities. Not only did the results of our research show that urban greenspaces in have a lower gun violence density than Detroit as a whole, but that they have a lower density of gun violence than areas surrounding a random selection of 308 locations in the city. Areas immediately surrounding greenspaces were found to have marginally higher gun violence densities than the city as a whole, although there was no monotonic increase nor decrease in gun violence as the distance from the greenspace increased. In fact, gun violence densities decreased at the 200-meter buffer and increased at the 300-meter buffer. These latter findings suggest that greenspaces could displace gun violence to areas immediately adjacent to them. Perhaps what is most interesting about the results of this study is the magnitude of difference between gun violence densities within greenspaces themselves and the areas immediately adjacent to them. Areas in and around the vicinity of greenspaces all have gun violence densities up to three times higher than that of greenspaces themselves which suggests that while greenspaces may deter gun violence, the areas surrounding them are still susceptible to gun violence although not at higher levels than across Detroit as a whole. We also found no evidence that the socio-economic background of the neighborhood in which the greenspace was located significantly associated with occurrence of gun violence. No linear gradient was found between gun violence densities occurring in more affluent neighborhoods compared to the most deprived neighborhoods, although greenspaces located in middle-income neighborhoods were found to have marginally higher gun violence incidences when compared to Detroit as a whole.

It is difficult to compare the results of this research with work conducted elsewhere given the limited among of studies that have examined this association as well as the contextual differences between Detroit and other cities in the United States, as well as cities globally. The alternate methodologies employed by other research of this nature also make comparisons problematic. These factors notwithstanding the results of our work lie mostly in contrast with most previous work including Groff and McCord (2012) who found that the presence of neighborhood greenspaces in Philadelphia and does in fact increase crime in the greenspace environs themselves as well as in their adjacent streets. Similarly, Boessen and Hipp (2018) found that neighborhood socio-demographic characteristics were a key driver of crime being located within or nearby greenspaces across nine cities in the United States (although excluding Detroit). We, however, found no clear distance decay pattern for the impact of various socio-demographics in or nearby greenspace on gun violence. More direct support for our findings has been found in Seattle where Wilcox et al. (2004) found that a greenspace's positive association with violent crime was moderated by neighborhood instability. Contrary to expectation, the researchers found that greenspaces in unstable neighborhoods were related to lower

violent crime. Where our results differ greatly from this previous research is the extent to which crime is different in greenspaces compared to the areas immediately adjacent to them. Our results indicate that greenspaces experience much lower densities of gun violence than do the surrounding areas; sometimes up to three times lower. Essentially, greenspaces in Detroit were found to be substantially less prone to gun violence than their surrounding areas, regardless of the socio-demographics of the underlying neighborhood.

One possible explanation for this result could be related to the state and subsequent use of greenspaces by residents of Detroit. Major funding cuts to the Parks and Recreation budget of Detroit between 2005 to 2013 has left some greenspaces with lower levels of maintenance than in the past. In fact, a recent report found that just under a third of all greenspaces in Detroit exhibited some form of vandalism and 32% had theft of fences (Loveland, 2015). According to McGraw (2015) roughly 10% of greenspaces in Detroit were found to have low maintenance levels, whereby they do not have the outward appearance as greenspaces but rather look similar to vacant lots. While substantial efforts have been made more recently to restore greenspaces in Detroit despite budget cuts, the city still faces major challenges in maintaining and uplifting their greenspaces and in encouraging use (Liang & Crawford, 2018). From an environmental criminological perspective, greenspaces may only be perceived as being crime generators if they actually attract users. The notion that a facility such as a greenspace can be seen as a crime generator, in particular, is based on the premise that people willingly and routinely go to the greenspace to engage in some form of activity. If residents are not attracted to the greenspace, the risk diminishes and so too does the notion that greenspaces generate criminal behavior. It could also be argued, however, that the lower quality conditions of some greenspaces could attract criminal behavior due to the lack of surveillance and/or guardianship. However, the results of our study suggest the opposite and much like high quality greenspaces may encourage visitation, low quality greenspaces could limit visitation and decrease the risk of criminal victimization, at least for gun violence. Of course, greenspace use in Detroit should be encouraged which places increased emphasis, from a planning perspective, on maintaining and upgrading existing urban greenspaces. There are currently a number of ongoing initiatives aimed at doing this in Detroit including ‘Adopt a Park’ a community initiative where community members partner with city parks by providing maintenance services, and the ‘Greening of Detroit’, an initiative in which community members volunteer to plant trees. Grassroot initiatives such as these are encouraging and suggest renewed attempts to maintain and upgrade urban greenspaces in Detroit are forthcoming.

Another possible explanation could be related to the fact that greenspaces are so prevalent in Detroit which would naturally limit the number of visitors to any given greenspace. The park system in Detroit was built for a population of two million residents but the population loss over the past few decades has resulted in fewer than 700,000 residents living in the city (McGraw, 2005). As a caveat to these explanations, it should be noted that the results of our research also indicated the highly skewed concentration of gun violence in greenspaces where a low number of greenspaces accounted for 50% and 100% of all gun violence incidences within greenspaces. It could be that a certain small number of greenspaces may act as crime generators in Detroit while the vast majority are safe, at least from gun violence. Moreover, our results also indicated that the physical

characteristics of greenspaces specifically related to the NDVI or levels of ‘greenness’ may play an enabling or disabling role in the commission of gun violence particularly in the surrounding areas. Future research is required to test the validity of these explanations.

There are a number of limitations, which are acknowledged in this study. First, is the under-reporting of gun violence. The analysis that was undertaken was done using data obtained from the Gun Violence Archive, an open-source data set. The GVA is the only source of data in the United States that provides a near-real-time online archive of gun violence incidents (both fatal and nonfatal) in all 50 states and the District of Columbia. Data are collected from more than 2500 media, law enforcement, government, and commercial sources daily. Given this, we are reasonably confident that the data obtained provides a relatively accurate depiction of the true magnitude and location of all gun violence incidents in Detroit. Besides, previous researchers have successfully used the GVA to validate the National Violent Death Reporting System (NVDRS) – the official source of data pertaining to violent deaths in the United States (Connor et al., 2019). Second, we did not assess the maintenance nor conditions of greenspaces (including availability of various facilities or lighting) in our analysis. We were weary of detracting from the original aim of this study, which is to compare the extent of gun violence in and surrounding greenspaces with gun violence across the entire city of Detroit and not to empirically test the physical characteristics of these spaces and their association with gun violence. This is an intention of future work. We ultimately felt that the short list of variables we examined best provided an overall picture of the main physical characteristics of urban greenspaces in Detroit. A number of the selected variables and their association with crime have also previously been examined in similar studies of this nature (see Groff & McCord, 2012; Troy & Grove, 2008). Third, we did not examine the impact that various built environment factors could play on gun violence particularly in areas adjacent to urban greenspaces. It could be, for instance, that areas adjacent to greenspaces which contain alcohol outlets and/or vacant lots could be at a greater risk for gun violence than areas without these facilities. However, to determine the individual impact that each built factor could play in the commission of a gun violence incident is complex and multifaceted and would require different techniques than those used here. The impact that these other built environment factors play on criminal behavior and physical activity patterns is important but was beyond the scope of this study.

Conclusion

The main aim of this study was to investigate the effect parks have on the occurrence of gun violence in a city unique in the American landscape, namely Detroit. In our analysis we found no clear spatial association between parks in Detroit and gun violence both within parks themselves as well as across a set of buffer distances away from parks. Moreover, results were invariant to the type of neighborhood in which the park was located. While this finding may be context-specific, the fact that this study is the first of its kind in the United States, and indeed anywhere, makes it highly important to future research. We also demonstrated the highly concentrated nature of gun violence around parks and highlighted certain physical characteristics of parks that can be effective in deterring (and enabling) criminal activity. We believe that the results presented here are sufficiently valuable to merit further investigation; and that they provide an important

empirical platform for future research investigating the association between gun violence and the surrounding public outdoor spaces.

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