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Open drug markets, vulnerable neighbourhoods and gun violence in two Swedish cities

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ABSTRACT

Gun violence is a serious issue in many countries across the globe. It has been shown that there is an elevated risk for a further shooting nearby within a short time span of a shooting incident, so-called near-repeat patterning. The present study presents new evidence on near-repeat patterning in Sweden, with a focus on neighbourhoods which the police have labelled as ‘vulnerable’ – deprived neighbourhoods where criminal networks have a large impact on local communities. Such neighbourhoods tend to have open drug markets, and to have high levels of gun violence. The present paper analyses the association of open drug markets and vulnerable neighbourhoods with gun violence and near-repeat patterning of gun violence in two Swedish cities. Our findings suggest that gun violence is strongly concentrated on open drug markets in vulnerable neighbourhoods, and that those locations in addition exhibit high risks for repeat shootings after an initial shooting event. We propose that the police can use this knowledge to improve practices to prevent or disrupt gun violence.

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Introduction

Gun and drug-related violence and homicides are global problems with local consequences (United Nations Office on Drugs and Crime, UNODC, 2013). Since illicit drug trade disputes are outside of the scope of the normal societal forms for conflict resolution, the groups involved in these conflicts tend to rely on violence to solve their disputes. Thus, having the ability to exercise violence can be hypothesised to be a key component for actors on the illicit drug market both in a preventive way – as deterrence – and in a conflict resolution way (Goldstein, 1985).

While it has been shown that there is a strong association between illicit drug markets and homicides in the U.S.A. during the 1990s, the same was not the case for Europe

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(Ousey & Lee, 2002). In the U.S.A., it has also been shown that there appears to be a link between drug market activity and gun carrying, although the findings are somewhat mixed (Blumstein, 1995; Felson & Bonkiewicz, 2013; Lizotte, Krohn, Howell, Tobin, & Howard, 2000; Seigny and Allen 2015).

With regard to the country at hand in the present study, Sweden, there has been a significant increase in gun violence in recent years, which is why it is of particular interest to study its association with other forms of illicit activity (Sturup et al., 2018b; Socialstyrelsen, 2018).

In the present paper, the link between illicit drug markets and gun violence is explored to understand where and when gun violence take place, which in turn could facilitate preventative efforts by the police and other actors. The study will consider differences in spatial and spatio-temporal concentrations of gun violence based on two different factors; the presence of open drug market locations, and deprived neighbourhoods with criminal network activity as opposed to other locations. It has been shown that the risk for gun violence at a location is substantially elevated in the weeks following a shooting (Sturup, Gerell, & Rostami, 2020), and such near-repeat patterning is therefore of particular interest. Prior studies have largely focused either on the near-repeat patterning of gun violence (e.g. Ratcliffe & Rengert, 2008; Sturup et al., 2020), or on the association of gun violence with drug markets (Contreras & Hipp, 2019; Zimring & Hawkins, 1997), but not on both near-repeat patterning and drug markets in the same study.

Contreras and Hipp (2019) found that violence was more common in disadvantaged street blocks with drug activity, but their key finding was that the protective effects of affluence appear to vanish with the presence of drug activity. There was less violence with more affluence unless the street block had drug activity. This has previously been suggested by Zimring and Hawkins (1997) who state that the surrounding environment could moderate the drug-violence link. Similarly, Ousey and Lee (2002) found that the link between an illicit drug market and violence was affected by city-level affluence. Gaston, Cunningham, and Gillezeau (2019) found that the more recent opioid drug epidemic in U.S.A. between 2015 and 2016 was associated with violence, in particular in disadvantaged counties.

It has been suggested that such violence stems from instability and competition at drug markets (Schneider, 2013). Ousey and Lee (2002) propose that a high level of *illegal* informal social control arises in locations with high deprivation and drug markets to fill the void of *legal* formal, and informal, social control. In places with few resources, drug markets tend to generate people resorting to violence to maintain control.

While there is a considerable body of the literature on violence in illicit markets, such as violence related to gangs in the U.S.A. (e.g. Moore, 1990; Klein, Maxson, and Cunningham, 1991; Decker and Van Winkle, 1994, 1996; Decker, 1996; Venkatesh, 1996; Howell and Decker, 1999; Decker and Curry, 2002), or the association between outdoor drug markets with the use of guns (Messner et al., 2007; Mieczkowski, 1992), and the spatial dependency between drugs and violent crime (Zhu, Gorman, & Horel, 2006), there is a need to examine in more depth the nature, scope, causes and impact of violence in the context of illicit drug markets. Furthermore, there are no studies on these topics in Sweden, and it is currently unknown whether findings from north American studies are applicable to Sweden, or even to Europe. This study aims to contribute to a greater understanding of violence relating to 'criminal gangs' in Swedish neighbourhoods and illicit drug markets in general and its spatial and spatio-temporal dependency in particular.

Near-repeat patterning of gun violence

Gun violence tends to be clustered in both time and space, and has been shown to exhibit near-repeat patterning, where an initial incident yields an increased risk for an additional incident nearby in both time and space (Ratcliffe & Rengert, 2008). Such near-repeat patterns appear to be strongest within one or two weeks, and within a few hundred metres (Mazeika & Uriarte, 2018; Ratcliffe & Rengert, 2008; Sturup, Rostami, Gerell, & Sandholm, 2018a; Wells, Wu, & Ye, 2012), although some studies have found weaker additional patterning at longer distances in both time and space (Ratcliffe & Rengert, 2008; Sturup et al., 2018a; Wells et al., 2012).

Near-repeat patterns have mostly been studied in relation to burglary, and mostly in the U.S.A. and UK. Two hypotheses have been proposed to explain the mechanism. The boost mechanism suggests a path-dependency solution, where one crime leads to more crimes. For burglary, this is often discussed through the lens of the offenders, or people they communicate with, being encouraged to follow up on a successful crime with more attempts in close proximity. The flag mechanism on the other hand suggests that the location temporally is more vulnerable to a crime, which is why criminals are drawn to the location independently of each other (Bowers & Johnson, 2004; Johnson, 2008; Tseloni & Pease, 2003). For gun violence, these mechanisms are somewhat different. Wells et al. (2012) found that near-repeat patterning of gun assaults differed across locations, with business locations being more likely to have follow-up shootings. The likelihood of a new shooting was also slightly elevated if the shooting was deemed to be gang related, and the follow up was more likely to be a homicide. This was interpreted as an indicator of escalation of violence (Wells et al., 2012).

A plausible hypothesis is that near-repeat patterning and escalation of violence to some extent is related to conflicts and retaliations (Ratcliffe & Rengert, 2008). To the extent criminal groups are tied to geographical locations, an attack with following retaliations are likely to exhibit near-repeat patterning. If a group from neighbourhood A attacks a group in neighbourhood B, we are likely to see a retaliation from neighbourhood B to neighbourhood A. This will usually be at some distance, so it will only be picked up at the longer distance bands in a near-repeat analysis. The group from neighbourhood A may however respond with their own retaliation, resulting in a second attack on the neighbourhood of group B within a relatively short time span. Such a chain of events will result in strong near-repeat clustering and can be considered as a type of boost mechanism since it is state dependent. At the same time, though it resembles how flag mechanisms result in a temporary geographical increase in vulnerability – the locations in which the criminal networks involved in the conflict can be found, are now flagged and exhibit an elevated risk for additional violence. As noted by Wells et al. (2012) understanding why some locations have elevated levels of near-repeat shootings would be of both practical and theoretical value. The practical aspect is highlighted by prior studies showing that an arrest reduces the likelihood of a follow-up event (Wheeler, Riddell, & Haberman, 2019; Wyant, Taylor, Ratcliffe, & Wood, 2012). Thus, it is of particular importance to make arrests in incidents with higher likelihoods of a follow up, to reduce subsequent violence, which in turn means it is of importance to identify indicators for shooting events with a high risk of follow ups. In the present paper, we attempt to do this by considering the patterning of gun violence in Sweden in relation to neighbourhoods with criminal networks and locations with open drug markets.

Gun violence and open drug markets in Sweden

Gun violence increased substantially in Sweden between 1996 and 2015 (Khoshnood, 2018; Sturup et al., 2018b). The increase appears to have continued since, with 43 cases of gun homicides in 2017 amounting to about twice the rate which was found from the 1990s up until the early 2010s (National Council for Crime Prevention, 2018; National Council for Crime Prevention, 2017). Between 2011 and 2017, Sweden witnessed 192 case of gun homicides, making it 2.0 gun homicides per 1 000,000 inhabitants (Khoshnood, 2019). This increase is unevenly distributed among the population, however, with lethal gun violence against women recording a decrease (Caman, Kristiansson, Granath, & Sturup, 2017), lethal gun violence against children reduced (Hedlund, Masterman, & Sturup, 2016), and most of the increase among men located in the younger age strata (Sturup et al., 2018b). In terms of the context of gun homicides, the increase is mostly attributed to criminal conflicts, while family- or partner-related homicides have decreased (National Council for Crime Prevention, 2015b; Sturup, Rostami, & Appelgren, 2011). This is paralleled by the decreasing share of gun homicides that are perpetrated with legally owned weapons, dropping from 25% in the early 1990s to 11–12% in the 2000s (National Council for Crime Prevention, 2015b). The increase in gun violence is also tied to deprived neighbourhoods with one study noting that almost the entire national increase between 2006 and 2014 in gun violence took place in such neighbourhoods (National Council for Crime Prevention, 2015a). In summary, gun violence has increased substantially, and much of the increase is tied to young men, deprived neighbourhoods, criminal conflicts and with illegal weapons being used. This parallels a development of growing street gangs in vulnerable neighbourhoods, which are often linked to incidents of gun violence (Police Authority, 2017).

Patterns of gun violence exhibit strong near-repeat patterns in Sweden, with a four-fold increase in risk of a shooting nearby after an initial shooting. While this association was weaker in Sweden's second largest city, Gothenburg (population 567,000), in comparison to Stockholm (population 965,000), the capital, as well as the third largest city, Malmö (population 317,000), significant patterns were found for all three cities (Sturup et al., 2018a). The near-repeat patterns are due to conflicts within or between criminal networks, which results in increasing intensity of gun violence as conflicts flare up. Gun violence has also been spatially and spatio-temporally linked to hand grenade attacks, with each detonated hand grenade in an area being associated with 1.7 more shooting incidents (Sturup, Gerell & Rostami, 2020).

In recent years, the open use and dealing of drugs have received increased attention in Sweden (Hennen & Gerell, 2019), and such open drug markets are a common problem in societies around the globe (UNODC, 2009). Such places tend to exhibit an array of crime or nuisance issues, for instance in the form of street drinking, littering, begging, violence, intoxication, visible drug injections, loud behaviours and open smoking of cannabis (European Monitoring Center for Drugs and Drug addiction, EMCDDA, 2015).

The open drug markets have some impact on community life through its impact on community order and the signal they send of lacking government control (Fast, Shoveller, Shannon, & Kerr, 2010; Sandberg & Pedersen, 2008). In the city of Stockholm, large shares of the population consider open drug markets to be a problem, with a large survey ($N=17,669$) showing that 18% of the whole population, and 43% of the population in

vulnerable neighbourhoods identify places where drugs are openly sold as a problem (City of Stockholm, 2018).¹

Vulnerable neighbourhoods in Sweden

While it is common to depart from the term 'Disadvantaged Neighbourhoods' in the international literature (e.g. Wilson, 1987; Hardin, 2009; Krivo & Peterson, 1996) or 'vulnerable places for public security' (e.g. Camacho-Collados, Liberatore, & Angulo, 2015; Mota, Figueiredo, & Pereira, 2020), the Swedish Police have introduced the term 'vulnerable neighbourhoods'. The problems in such neighbourhoods, have received both national and international attention in recent years (Police Authority, 2014; Police Authority, 2015, 2017, 2019a). A vulnerable neighbourhood is defined as a deprived neighbourhood where criminal networks impact on local community life. In the most recent report by the police authority, 60 neighbourhoods across Sweden were labelled vulnerable (Police Authority, 2019b).

The analysis upon which the designation of 'vulnerable' is defined, is based on a large survey with local police officers on how they perceive local problems and working conditions in each neighbourhood, combined with statistical data on unemployment, school results, and residency of known extremists and individuals with a criminal record. To be designated as vulnerable, a neighbourhood must have a low level of employment, low school grades, and to be perceived by the local police as having a local community that is, directly or indirectly, highly affected by criminal networks (Police Authority, 2017). Direct effects on the local community refer to threats and extortion against residents or individuals working in the community. Indirect effects refer to crime and disorder that is not particularly directed against residents in the neighbourhood, but which nevertheless has an impact, such as social unrest, public violence (shootings) and open drug markets, on the local community and may raise levels of fear. Open drug markets are considered by the police to be prevalent in all vulnerable neighbourhoods, and drug-related crimes are considered a major problem in those neighbourhoods (Police Authority, 2017).

The present study

There is a substantial international body of evidence from foremost North America, connecting deprived neighbourhoods, open drug markets and shootings with gangland activity. Little research has been conducted in a European setting, and research from Sweden is non-existent. Swedish police have recently initiated two separate data collections on open drug markets, trying to map and understand the phenomenon in parts of Sweden. The present paper links such data on open drug markets with data on vulnerable neighbourhoods and gun violence to explore whether gun violence and near-repeat patterning of gun violence can be better understood by considering the type of location where it occurs. The hypothesis is that a shooting that occurs in a location with openly sold drugs in a vulnerable neighbourhood will be more likely to be followed by a near-repeat shooting, as previously suggested by Ratcliffe and Rengert (2008). The near-repeat shooting does not necessarily have to be related to the drug market per se, but the criminal networks prone to participating in conflicts are closely tied to drug markets.

While Contreras and Hipp (2019) study monthly rates of drug activity and argue for temporal effects and large fluidity in drug market activity, the present study focuses on more stable open drug markets with a prolonged drug market presence. We test two different datasets for open drug markets and combine them with the presence of what the Swedish police define as ‘vulnerable neighbourhoods’. While this means we differentiate somewhat between two potential types of open drug markets – those in vulnerable neighbourhoods and those elsewhere, we acknowledge that there likely are other inter-drug market differences too that matter. Those will, however, not be covered in the present paper. We do this to improve our understanding of gun violence and criminal networks in Sweden, since gun violence and criminal networks are perceived to be a substantial and increasing problem in Sweden. Our hypothesis is that there will be a link between the presence of an open drug market and gun violence, and that such a link will be stronger if the open drug market is located in a vulnerable neighbourhood.

Method and Material

The present paper tests the association of gun violence with locations where drugs have been reported to be openly sold and with neighbourhoods that the police have designated as vulnerable. To operationalise open drug markets, we used two datasets on open drug markets, with differing methodologies and definitions. The datasets cover Stockholm county and the city of Malmö and represent a similar phenomenon in identifying locations where drugs are reportedly sold in the open. In the analysis, we present descriptive data on the clustering of shootings to such locations. We further build on previous findings on near-repeat patterns for gun violence in Sweden to analyse if the patterns are influenced by whether the initial shooting took place in a vulnerable neighbourhood and at a location where drugs have been sold openly according to police intelligence. We thus follow the research design of Wells et al. (2012) but focus on open drug markets and vulnerable neighbourhoods rather than different types of premises. The variables and data included are specified in Table 1, and each data-source is discussed in more detail below.

Near-repeat patterns were calculated using Jerry Ratcliffe’s (2009) near-repeat calculator to calculate observed-over-expected ratios (OE) and significance. Originator and repeat events were identified using the same software. We use Euclidean distances instead of Manhattan distances for simplicity. We use four bands each for distance and

Table 1. Variables, definitions and data-sources.

Variable	Definition	Malmö data	Stockholm data
Shooting	Confirmed incident of illegal firearm discharge	Malmö police	Stockholm police
Vulnerable neighbourhood	Deprived neighbourhood where the police perceive criminal networks to impact on local community	National police	National police
Open drug market: Drug market location	Specific location where neighbourhood police perceive drugs to be openly sold	Neighbourhood police officers in Malmö	NA
Open drug market: Open drug scene	A geographical area, sustained in time and space, where use and dealing of drugs takes place in the public and is perceived as problematic by authorities and/or the public	NA	Stockholm police, survey to local police districts

time, with a 200 metres distance band and a 14 days' time band employed. We opted for these choices as prior studies on near-repeat patterning in Sweden have shown that there are fairly small substantial differences across operationalisations (Sturup, Rostami, Gerell, & Sanholm, 2018a; Sturup, Gerell, & Rostami, 2020), while there has been some confusion among practitioners in interpreting many short temporal bands. Fewer and longer bands were therefore chosen to make interpretation of findings easier. For more discussion on the method, see Wells et al. (2012).

Since drug market data are available from spring and autumn 2017 for Stockholm and Malmö respectively, data on shootings and gun violence should be from 2017 and later. At the time of this study gun violence data for 2018 was, however, not available, and to increase power we have opted to use gun violence data prior to the drug market data in the analysis covering 2011–2017. Thus, most of the shooting's pre-date the drug market data, which is a limitation of the study. While most of the drug market locations, at least in Stockholm, are more than five years old, this is still problematic.

To achieve a more valid representation of the association between gun violence and open drug markets all analysis has been done on 2017 gun violence only as well, but this leads to much fewer incidents and larger temporal and spatial fluctuation. This can therefore be seen as a trade-off between validity and reliability. The full 2011–2017 dataset yields much better reliability in terms of statistical power to detect any significant associations. The 2017 dataset however is a much more valid depiction of how open drug markets could be associated with gun violence.

Stockholm county comprises 26 municipalities, 25 of which had at least one shooting. Stockholm is part archipelago, and for the area calculations only the land areas of the municipalities were included, this results in 4881 square kilometres of area being excluded.

Data on gun violence

Gun violence data were retrieved from the police in Stockholm and Malmö and captures confirmed incidents of illegal firearm discharges. A shooting is considered confirmed by the police if there is physical evidence such as a shell case or if multiple witnesses independently of each other confirm there has been a firearm discharge. The data are similar to the one used in Sturup et al. (2018a), but with 2016 and 2017 added (see also Sturup, Gerell & Rostami, 2020), and for Malmö the Burlöv municipality excluded. The Malmö data in total includes 308 shootings between the years 2011 and 2017, of which 65 occurred in 2017. For Stockholm County, there was 129 shooting incidents in 2017, but one incident was excluded due to not having an exact date. The Stockholm county data in total thus includes 650 shootings between the years 2011 and 2017, of which 128 occurred in 2017.

Data on open drug markets

The drug market data consist of two separate datasets; Stockholm county (collected in spring 2017) and the city of Malmö (collected in autumn 2017). In Stockholm county, we sent a survey to local police districts asking them to identify open drug scenes in their district defined as 'a geographical area, sustained in time and space, where use and dealing of drugs takes place in the public and is perceived as problematic by

authorities and/or the public'. Within the context of the survey, these locations are fairly large, and, to capture uncertainty, 200-metre buffers were added to the locations. In total, 48 open drug scenes were identified, translating to about 2 open drug scenes per 100 000 residents. One of the survey questions was regarding the age of the drug market, showing that the majority (60%) were at least five years old, and 48% being more than 10 years old. Open drug markets, at least in Stockholm, appear to be stable over time.

The dataset for Malmö is more geographically oriented in pinpointing small and exact locations for open drug markets. The data were collected in a research and development programme within the Swedish Police Authority. Researchers worked with local neighbourhood police officers to identify specific location where drugs are openly sold. The locations are typically very small and exact, and often scattered close to each other in a neighbourhood. Many of them were found in neighbourhoods classified as vulnerable, but several were found in other types of neighbourhoods. The resulting maps were then converted into shapefiles, and 200-metre buffers were added to capture the general area of such locations. In total, these 200-metre buffers cover a large share of the vulnerable neighbourhoods, for a total of 3.97 square kilometres. Additional open drug markets identified with the same method but outside of the neighbourhoods the police have been defined as vulnerable cover 1.26 square kilometres. The city in total covers 161.438 square kilometres, of which about 3.2% is within 200 metres of a location where drugs are reported to be openly sold.

The two datasets thus capture similar phenomenon, but there are also substantial differences. The Stockholm data is based on a clear definition of an open drug scene and captures well-known locations or areas where drugs are openly sold. The Malmö data are based on very small locations, typically a building or a street segment, where the police have reports and/or intelligence suggesting that drugs are openly sold. It should be noted that both datasets are based on police perceptions on where the practice of open-air drug sales take place, and we have not examined police statistics over drug crimes, which may or may not be taking place in the open. For one municipality in Stockholm county, we have both the Malmö-type of data and the Stockholm-type of data available. The Stockholm method here results in two large open drug scenes, while the Malmö-method results in three clusters of small drug locations, two of which are covered by the Stockholm data (Appendix 1, grey circles Stockholm-type data, grey areas Malmö-type data). While the two datasets are not identical, they do appear to capture a similar phenomenon.

Definition and operationalisation of vulnerable neighbourhoods

The national police define vulnerable neighbourhoods as having a low socio-economic status (SES) and criminal networks having a large impact on the local community. Local police departments are asked to nominate neighbourhoods they believe fulfil these criteria, and the national operations division of the police then analyse them and decide whether they are to be designated as vulnerable or not.

The national police collect registry data over school records and unemployment for the neighbourhood to determine if it fulfils the SES requirements of the definition. Impact on the local community is measured through a survey to the local police department where 184 variables are considered, ranging from youth gangs through organised crime to

extremism in addition to an ‘area-document’ where the local police describe the problems in the neighbourhood. While some registry data over reported crimes and known criminals is also used, it should be noted that the data is largely subjective – it measures where the local police consider there to be problems. As such it is likely that the process is influenced by differences among local police departments and/or the police officers tasked with responding to the survey. Nevertheless, it is a widely accepted definition in Sweden, and while it lacks academic rigour it does appear to at least partially capture some sort of real phenomenon. Currently, no external quantitative validation of vulnerable neighbourhoods exists but attempts at understanding this type of neighbourhood independent of police perceptions data have been made (National Council for Crime Prevention, 2017), and this development is expected to continue.

Results

General description

Table 2 holds descriptive data over the number of shootings and shootings per square kilometre taking place at different locations. As seen in Table 2, there are more shootings per square kilometre in Malmö than in Stockholm, and for both cities there are more shootings in vulnerable neighbourhoods and adjacent drug markets, and in particular where these two measurements are combined.

Since the drug market data is from 2017, but we employ data from 2011–2017 to increase statistical power; we consider changes in gun violence patterning before we move on to the main analysis. There are more shootings in 2017 than the mean yearly rate between the years 2011 and 2016 for both cities (60% more in Malmö and 48% more in Stockholm). An interesting difference, however, appears when considering the final column which shows the ratio of shootings in 2017 compared to 2011–2016. In Malmö, the increase is much larger around locations with open drug markets and/or in vulnerable neighbourhoods (between 94 and 98%), whereas in Stockholm the gun violence is on a fairly similar level at such locations in 2017 as it was for the full 2011–2016 time period. This implies that the increase in gun violence appears to be linked to the open drug markets and vulnerable neighbourhoods in Malmö, but not in Stockholm.

Table 2. Number of shootings and shootings per square kilometre for different types of locations, 2011–2017, Malmö municipality and Stockholm County.

Location	Area (Square km)	Shootings per square km 2011–2017 (N)	Shootings per square km 2017 (N)	Ratio 2017 vs 2011–2016
Malmö municipality	161.4	0.27 (308)	0.40 (65)	1.60
Stockholm county	6519	0.014 (651)	0.02 (129)	1.48
Malmö within 200 m of open drug location	5.2	4.45 (162)	7.69 (40)	1.97
Stockholm within 200 m of open drug location	22	1.1 (169)	1.1 (24)	0.99
Malmö in a vulnerable neighbourhood	5.118	3.88 (139)	6.64 (34)	1.94
Stockholm in a vulnerable neighbourhood	36.23	0.91 (231)	1.02 (37)	1.14
Malmö within 200 m of open drug location in vulnerable neighbourhood	3.97	5.2 (145)	9.07 (36)	1.98
Stockholm within 200 m of open drug location in vulnerable neighbourhood	7.495	2.34 (123)	2.13 (16)	0.90

Whether this is due to differences in data collection for open drug markets, to changes in open drug markets, or just random fluctuation is not possible to determine within the scope of this paper but warrants further future research.

The differences based on locations are striking, with shootings around open drug markets in vulnerable neighbourhoods exhibiting a 19 times higher density in Malmö than for the city as a whole, and shootings at an open drug scene in a vulnerable neighbourhood in Stockholm county being 98 times more common than the county as a whole. It should, however, be noted that a large share of the areas is uninhabited, and thus will tend not to have any shootings at all while still being included in the total area of the city. For Stockholm County, there are also large differences between municipalities. The county comprises 26 municipalities, with large differences in the number of open drug market locations, the number of vulnerable neighbourhoods and the number of shootings. Some municipalities have a fair share of open drug scenes, but very few shootings. The Täby municipality for instance has no vulnerable neighbourhood, six open drug scenes, but only one shooting during the observation period, and that shooting is not in the vicinity of an open drug scene (See [Figure 1](#); Upper right section shows Täby with several open drug markets visible but only one shooting). The opposite is true for Botkyrka municipality ([Figure 1](#), south part of the map), with three vulnerable neighbourhoods, two open drug scenes and 51 shootings (2011–2017), 15 of which within 200 metres of an open drug scene and 41 in vulnerable neighbourhoods. As mentioned in the data section, this is likely capturing different types of open drug scenes, where some types are more likely to be associated with gun violence than others, and where we hypothesise that open drug markets in vulnerable neighbourhoods will be more typical for a link to shootings.

This underscores the differences between open drug markets, and we now proceed to explore these differences based on whether the open drug scene is in a vulnerable area or not. In the case of Malmö, there are 42 times more shootings near an open drug market in a vulnerable neighbourhood than in the rest of the city. Note that parts of the buffers for these drug markets extend outside of the vulnerable neighbourhoods (See [Figure 2](#)), so in some cases there are more shootings for this measure.

There are also large differences within vulnerable neighbourhoods depending on whether a location is near an open drug market (36.5) or not (5.3). This should, however, be considered in light of the fact that large parts of the areas in vulnerable neighbourhoods which are not near open drug markets comprise uninhabited parks and similar. In vulnerable neighbourhoods, most of the built-up land is within 200 metres from an open drug market. This may also explain some of the differences more generally.

While we do advise some caution in interpreting the associations here since the drug market data largely covers built-up land in the most vulnerable neighbourhoods of the city, we can nevertheless conclude that concentrations of gun violence are strongly tied to these locations. Whether that is due to the open drug markets or not is however a more open issue that we cannot resolve based on the data available for this study.

Near-repeat patterns

We first test whether there is spatial clustering in the data using the average nearest neighbour function of ARCGIS. As expected, the data do exhibit strong spatial clustering

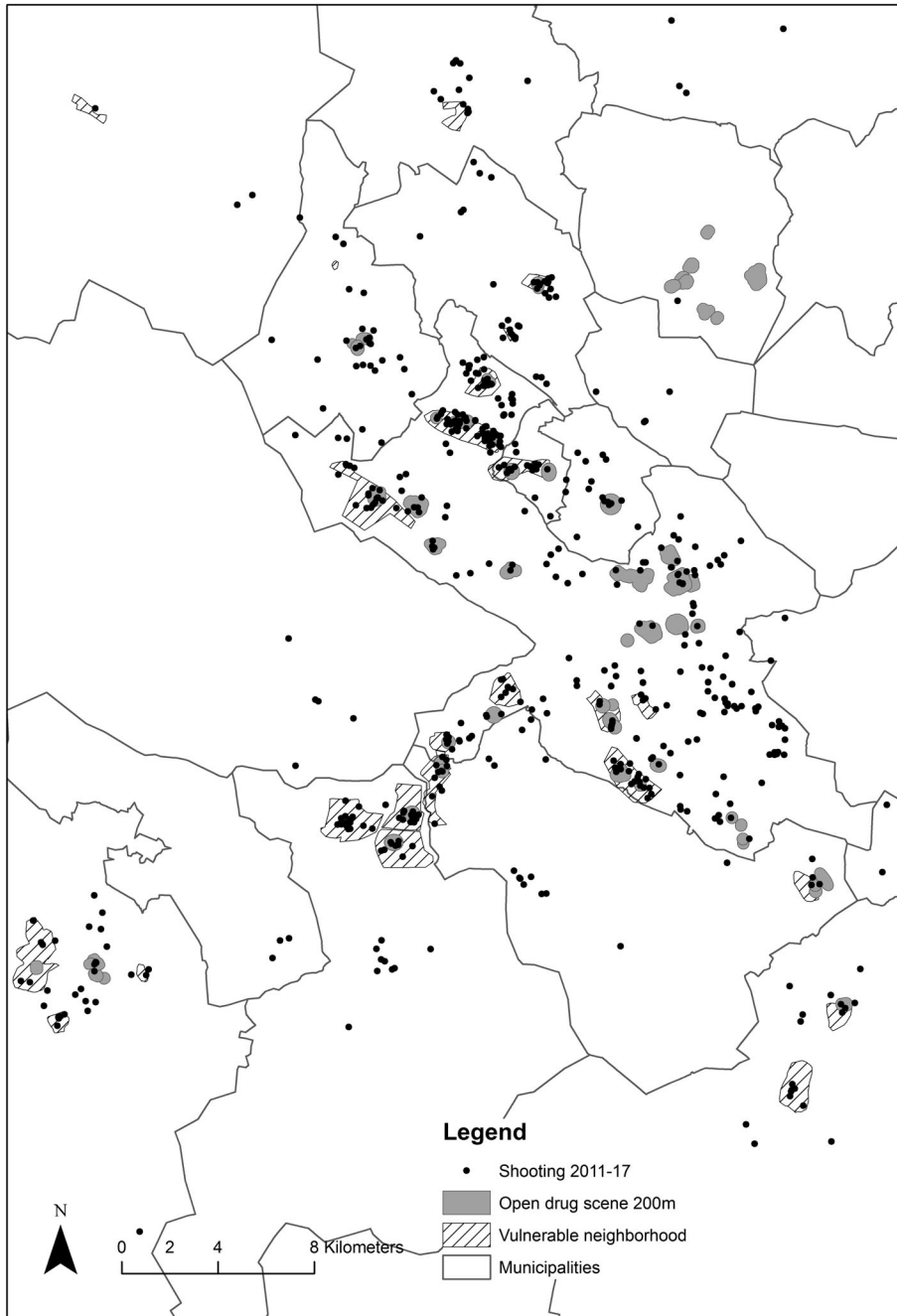


Figure 1. Stockholm county. Municipalities, open drug scenes, vulnerable neighbourhoods and shootings 2011–2017.

in both Stockholm ($Z\text{-score} = -30.7$) and Malmö ($Z\text{-score} = -14.9$) suggesting spatial and spatio-temporal analysis may be of interest. In the present paper, the main near-repeat analysis uses 200 m and 14-day intervals for the near-repeat analysis and four bands

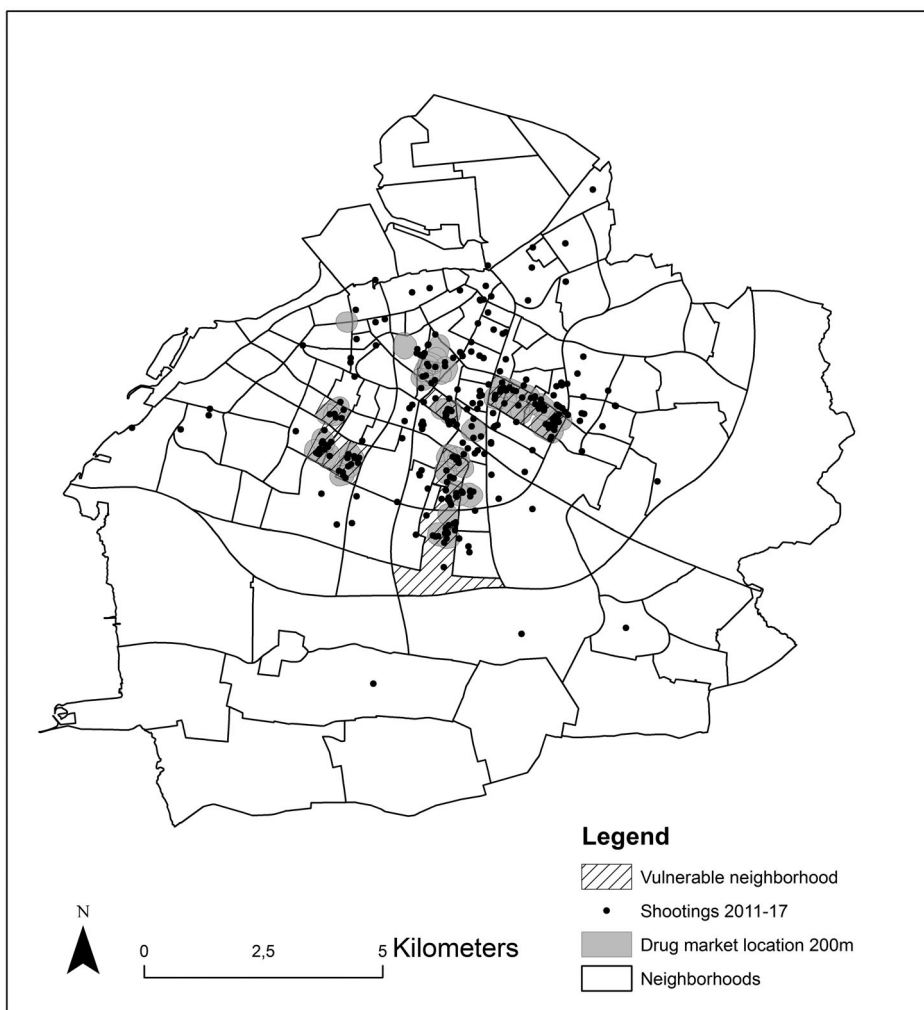


Figure 2. Malmö municipality. Neighbourhood boundaries, open drug market locations, vulnerable neighbourhoods and shootings 2011–2017.

for each dimension. While the near-repeat patterns per se are not the main interest of this paper, we present overall patterns first, before delving into the matter at hand of analysing whether there are any differences in the spatio-temporal patterning depending on the location of the originator event.²

In the city of Malmö, there is a 3.09 times higher risk for a shooting within 200 metres and two weeks after an initial shooting. In addition, there is an increase at 600–800 metres distance in both 0–14 and 15–28 days. There is an overrepresentation for some locations, but this should not be taken at face value as crimes are recorded to addresses which can comprise multiple nearby locations (Table 3).

For Stockholm County, we identify more near-repeat patterns. Within 200 metres, there are observed over expected ratios of about 3.7 for both the first two temporal bands. Overrepresentation remains across many of the spatio-temporal distances, with a

significant OE ratio found even in the last distance, with about twice the expected risk for a shooting week 7–8 after a shooting in 600–800 metres distance. The largest coefficient is however in the shorter time and space bands (Table 4).

Near-repeats and open drug markets in vulnerable neighbourhoods

In the analysis, we are interested in seeing whether the near-repeats are associated with drug markets in vulnerable neighbourhoods. Since such locations in the descriptive part of this paper was shown to have the strongest spatial concentration of shootings it would appear plausible that this will hold for spatio-temporal concentrations too. To consider this, we identified all shootings that were followed by another shooting within 14 or 28 days, and within 200, 400 or 600 metres. We consider these to be near-repeat shootings and use them in the analysis. We then break this down into originator shootings that took place by a drug scene in a vulnerable neighbourhood compared to one that was not at such location. The results are presented in Figure 3 (Malmö) and Figure 4 (Stockholm), with data shown in appendix 2 (Table A1) which shows the number of shootings, and the number of associated near-repeat shootings that follow for the two respective location types. This shows that a shooting in a drug market in a vulnerable neighbourhood in Malmö renders about twice as many follow-up shootings as a shooting elsewhere. The results are substantially similar for the years 2011–2017 data as for only using the 2017 data, in spite of the drug market data being collected late 2017. At 28 days and 400-metre distance, there are 0.40 following shootings if the first shooting was committed in an open drug market in a vulnerable neighbourhood, but only 0.15 if the first shooting took place elsewhere in the city.

For Stockholm County, the differences are even more evident when using the full 2011–2017 data, showing three times as many near-repeat events per shooting if the originator was at an open drug scene in a vulnerable neighbourhood. At the 400 m and 28 days band, there are 0.23 following shootings for an open drug scene in a vulnerable neighbourhood as compared to 0.05 if the first shooting occurred elsewhere in the city. For Stockholm, the 2017-only-analysis yields some differing results, with 0 near-repeat shootings within 200 metres and 14 days if the first event took place in a vulnerable neighbourhood. This is however not very surprising considering that just 16 shootings took place in such locations during that year, and while there is more fluctuation in these data the pattern is similar. There tend to be more near-repeat shootings if the initial event took place at an open drug scene in a vulnerable neighbourhood as compared to if it took place elsewhere in the county.

Table 3. Near-repeat patterns 2011–2017 in Malmö municipality, $N = 308$.

	0–14 days	15–28 days	29–42 days	43–56 days	57+ days
Same location	19.59**	4.23	0.00	2.27	0.69
Up to 200 m	3.09**	1.36	0.83	0.91	0.97
200–400 m	1.40	1.32	1.03	0.86	0.99
400–600 m	0.91	1.34	1.02	1.12	0.99
600–800 m	1.40*	1.40*	0.46	1.31	0.99
800 m+	0.93	0.96	1.02*	0.99	1.00*

** $p < 0.001$, * $p < 0.05$

Table 4. Near-repeat patterns 2011–2017 in Stockholm county, $N=651$.

	0–14 days	15–28 days	29–42 days	43–56 days	57+ days
Same location	5.98*	5.70*	5.96*	8.16*	0.74
Up to 200 m	3.73**	3.77*	2.24	1.55	0.91
200–400 m	2.27*	1.12	1.81*	2.81*	0.95
400–600 m	3.01**	1.83*	2.26*	2.09*	0.94
600–800 m	1.37	1.15	0.69	2.09*	0.98
800 m+	0.99	0.99	0.99	0.99	1.00*

** $p<0.001$, * $p<0.05$

Discussion

This paper aimed to establish when and where gun violence takes place, hypothesising that it would be spatially and spatio-temporally linked to deprived neighbourhoods and open drug markets. We show that gun violence in two major Swedish cities, Stockholm and Malmö, is strongly concentrated to open drug markets. The concentration is even more pronounced with open drug markets in vulnerable neighbourhoods. We also show that the risk of a new shooting following an initial shooting is substantially higher at such locations. This is similar to the theoretical link between neighbourhood

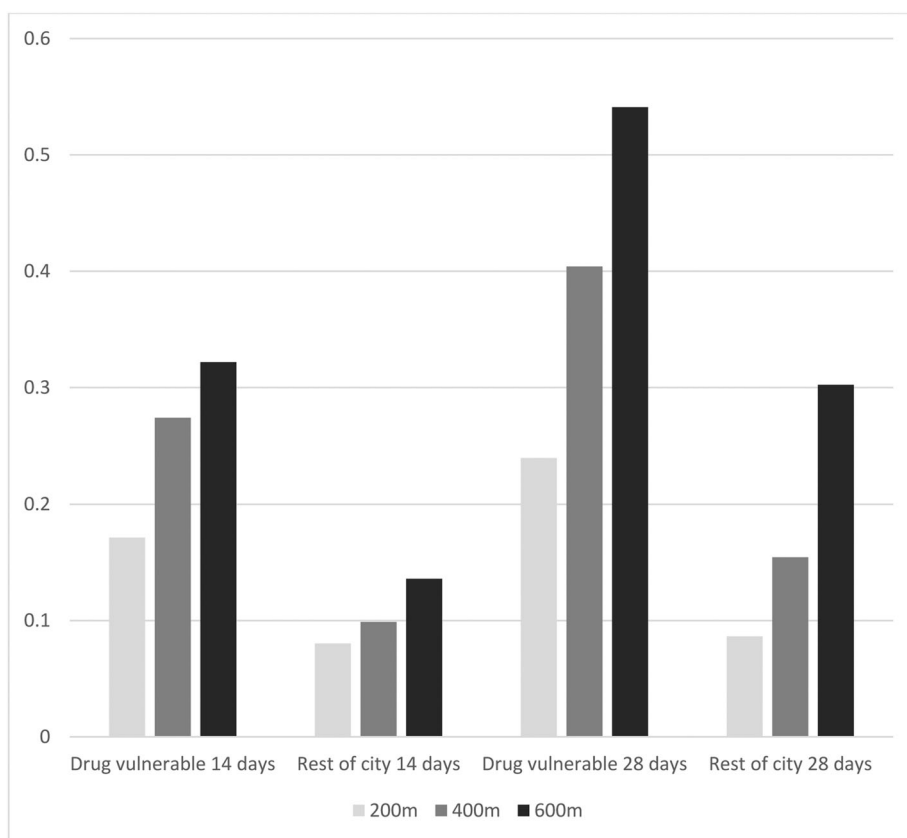


Figure 3. Number of following shootings per originator shooting with different cut offs in the Malmö municipality 1 January 2011 to 31 December 2017.

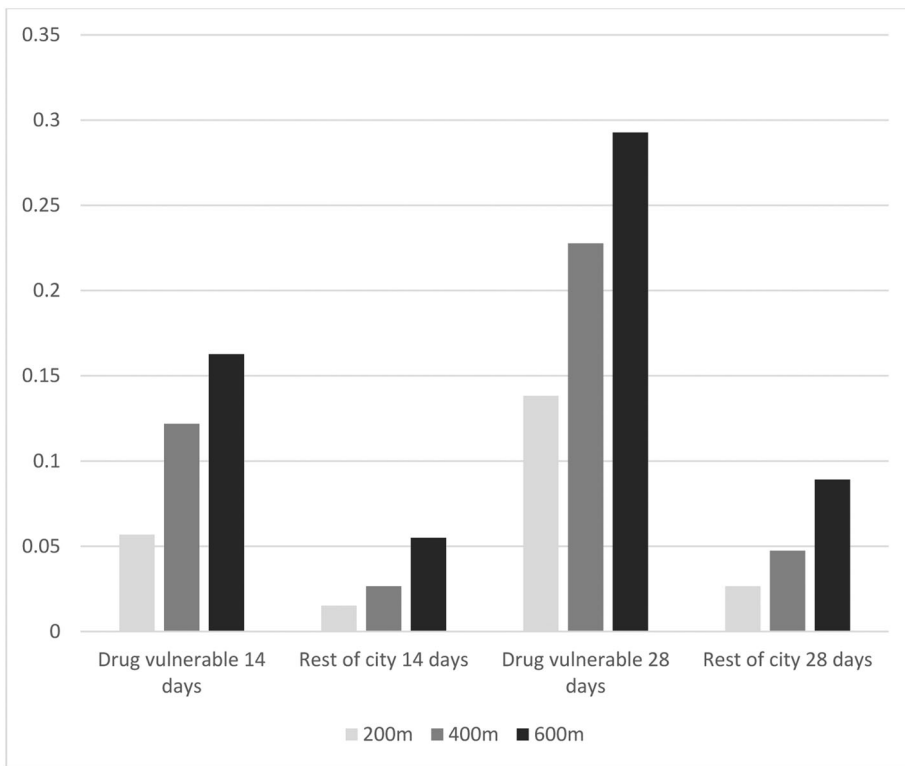


Figure 4. Number of following shootings per originator shooting with different cut offs in Stockholm County 1 January 2011 to 31 December 2017.

level social disorganisation and micro-level drug activity discussed by Contreras and Hipp (2019). While Contreras and Hipp (2019) however found that the impact of drug activity was larger in affluent surroundings, the present paper focuses on the difference between highly deprived neighbourhoods as compared to the rest of the city.

As mentioned above, open drug markets in vulnerable neighbourhoods are not just exhibiting spatial concentrations of gun violence, but also strong spatio-temporal concentrations. We note that there is a relatively high risk of a follow-up shooting taking place after an initial shooting, nearby and within a short time period. This risk is at least two times as high if the first shooting took place at an open drug scene in a vulnerable neighbourhood compared to if the first event took place elsewhere in the two cities. Gun violence is clustered in both time and space, and the highest risk identified for gun violence is identified at open drug scenes in vulnerable neighbourhoods in the weeks following an initial shooting event. This is in line with findings that crime prediction works best when combining geographical risk factors with crime data, rather than just using one of the two (Caplan, Kennedy, Piza, & Barnum, 2019).

These findings are consistent from two different cities and using two different measurements for locations with open drug markets. The two different sets of locations represent a smaller geographical perspective in the case of Malmö as opposed to a larger geographical perspective in the case of Stockholm county. For Malmö, the data only

comprise one municipality, and the drug market data are very micro in scale, with most of the identified locations being less than one street segment. For Stockholm, the data comprise the full county with 26 municipalities, and the drug market data identify larger areas with stable open drug scenes. The fact that the spatial and spatio-temporal associations between open drug markets, vulnerable neighbourhoods, and gun violence are so similar across these two different sets of geography and differing drug market operationalisations suggest that this is not just a local phenomenon, and perhaps even generalisable to a wider context of larger Swedish cities.

While the present study uses a different methodology than Ousey and Lee (2002), the results point to a similar direction. Drug markets have more gun violence than the city overall, and the strongest association of drug markets with violence are seen in neighbourhoods that the police have designated as vulnerable. Such neighbourhoods are by definition also deprived, echoing the finding of drug markets in resource-deprived cities showing the strongest association with homicides found by Ousey and Lee (2002).

As noted in the methods section, this can also be seen in terms of simple examples of municipalities in the data. The Täby municipality, which is one of the more affluent residential areas in Stockholm County (mean income in 2017, 441k SEK, Stockholm County mean 359k SEK), has several open drug scenes but no shootings at those locations, as compared to the socio-economically weaker Botkyrka municipality with fewer drug scenes, but profusely more gun violence linked to these scenes. This pattern suggests that the level of gun violence and its near-repeat patterning is not only driven by its conjunction to open drugs markets but is also affected by other underlying mechanisms, for example SES and the associated socio-demographical pattern of highly active criminals in criminal networks in vulnerable neighbourhoods. The violence could also stem from instability within an illicit market caused by oligopolistic and monopolistic drive from criminal network aiming to upholding controlling in the more lucrative drug market in the vulnerable neighbourhoods.

Future studies need to test the relationships identified in the present paper in relation to data over criminal networks more formally, and with the data available in the present paper we can only hypothesise such links.

The present analysis nevertheless represents a step forward in identifying operationally meaningful associations for the police and other actors to use in their proactive work against gun violence. In the city of Malmö, the present paper notes that a shooting near an open drug market located in a vulnerable neighbourhood was followed by about 0.4 new shootings within 4 weeks and 400 metres, or 0.58 new shootings within 4 weeks and 600 metres in the 2011–2017 time period. These numbers are approaching the level of risk that could warrant directed efforts at prevention even for a police force that is stretched thin. Targeted efforts to achieve firearms arrests have for instance been found to reduce gun violence in Philadelphia (Wheeler et al., 2019; Wyant et al., 2012), and although the effect is fairly short and/or small it may be worth the effort if the risk for a shooting is substantially higher than it normally is. While the rate of gun violence, and the rate of following incidents, was substantially lower in Stockholm county, it may be motivated to implement proactive efforts against gun violence and to disruption of criminal activity there as well. Interventions against gun violence based partly on drug market locations may therefore be relevant.

It can also be tempting to attempt to directly disrupt the drug markets themselves in order to get at the key players involved in the increasing gun violence in Sweden. While focusing on high-risk individuals within the framework of community violence is reasonable (Abt & Winship, 2016), it should be noted that some studies have found police interventions to disrupt drug markets may actually increase violence. Werb et al. (2011) in their systematic review found that the majority of studies on the link between law enforcement activities against illicit drugs and violence found that violence increased with more drug enforcement. Although unable to state any causal mechanisms with certainty they suggest it may be related to key players being removed from the drug market and the void being filled by up-and-coming figures that resort to violence to establish themselves, in addition to increasing efforts by criminal groups at violent countermeasures against law enforcement (Werb et al., 2011).

A limitation of this study is that much of the data are based on police perceptions, and thus may be considered as suboptimal. This applies both to which neighbourhoods the police classify as vulnerable and to the locations the police consider to be open drug markets. While we acknowledge that the data suffer from such limitations, we nevertheless believe that the data indeed does capture a real phenomenon, imperfect as it may be. Another limitation is that our main analysis uses data over shootings (2011–2017) that pre-date the drug market data (2017). This is a problem, but as we manage to replicate the main findings using the 2017 data only it does not appear to have a major effect on the conclusions. In addition, the Stockholm drug market data include age of the open drug scene, and most drug scenes have existed for more than five years. The findings therefore appear to be fairly robust in relation to this problem, but future studies are needed to establish whether the findings will hold.

Notes

1. Open drug markets have received further attention due to high profile incidents of parents picking up their kids from day-care located near an open drug market and being threatened by drug dealers (Hennen & Gerell, 2019). This has led many to speculate that open drug markets are a new phenomenon in Sweden but has also prompted some research on the topic.
2. We have also tested replicating the spatial and temporal bands used in a prior study on near-repeat shootings in Sweden. The core findings, with large observed-over-expected ratios in short time and space distances hold true using this new dataset, but some of the specific cells gain or lose significance reducing in somewhat altered results than those noted in Sturup et al. (2018a).

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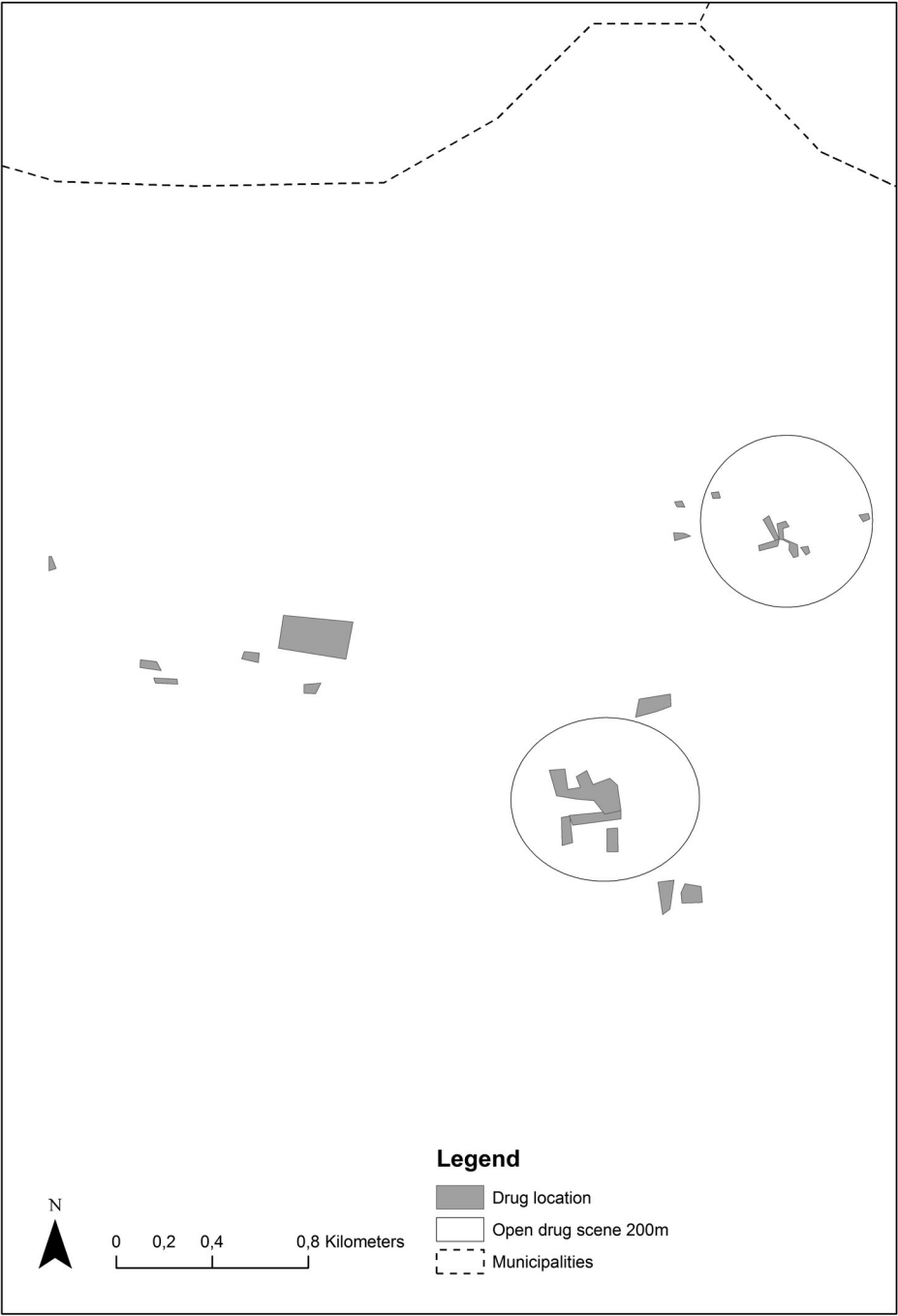
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Appendix 1

Figure A1. Open drug market data with two different operationalisations for the Botkyrka municipality where both methods were tested.



Appendix 2**Table A1.** Number of repeat shootings at different temporal and spatial distances, and for different type of originator even locations, 2011–2017 with 2017 only presented in parenthesis.

	N	14 days, 200m	14 days, 400 metres	14 days, 600 metres	28 days, 200 metres	28 days, 400 metres	28 days, 600 metres
Malmö: Drug market vulnerable neighbourhood	146 (37)	0.17 (0.11)	0.27 (0.22)	0.32 (0.32)	0.24 (0.22)	0.40 (0.35)	0.54 (0.68)
Malmö: Rest of city	162 (28)	0.08 (0.04)	0.1 (0.07)	0.14 (0.14)	0.09 (0.03)	0.15 (0.25)	0.30 (0.39)
Stockholm: Drug market vulnerable neighbourhood	123 (16)	0.06 (0)	0.12 (0.19)	0.16 (0.19)	0.14 (0.06)	0.23 (0.25)	0.29 (0.25)
Stockholm: Rest of county	527 (112)	0.02 (0.02)	0.03 (0.04)	0.06 (0.06)	0.03 (0.04)	0.05 (0.07)	0.09 (0.11)