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ORIGINAL ARTICLE

Repeat and near-repeat victimization in Campinas, Brazil: new explanations from the Global South

Silas Nogueira de Melo[1] · **Martin A. Andresen**[2] · **Lindon Fonseca Matias**[3]

Abstract Criminological research has consistently found that crime clusters in both space and time. A subset of this research has investigated repeat victimization (same victim re-victimized within a short period of time) and near-repeat victimization (places near the original victimization are at risk of victimization within a short period of time). Generally speaking, this research has found that repeat victimization occurs within a short time frame and near-repeat victimization occurs within a short distance and a short time frame. We contribute to this literature through an investigation of repeat and near-repeat victimization in a large Brazilian city. Studying five crime types we find strong support for repeat and near-repeat victimization, but the magnitude varies by crime type.

Keywords Repeat victimization · Near-repeat victimization · Spatial analysis · Space–time clustering · Brazil

✉ Martin A. Andresen
andresen@sfu.ca

Silas Nogueira de Melo
silasmelo@ige.unicamp.br

Lindon Fonseca Matias
lindon@ige.unicamp.br

[1] Department of Geography, University of Campinas and Institute for Canadian Urban Research Studies, Simon Fraser University, 51 João Pandiá Calógeras St., Campinas, SP 13083-870, Brazil

[2] School of Criminology and Institute for Canadian Urban Research Studies, Simon Fraser University, 8888 University Drive Burnaby, Burnaby, BC V5A 1S6, Canada

[3] Department of Geography, University of Campinas, 51 João Pandiá Calógeras St., Campinas, SP 13083-870, Brazil

Introduction

Research within criminology has long shown that there are spatial clusters of criminal events. Dating back almost 200 years, Guerry (1832, 1833) and Quetelet (1831, 1842) showed that criminal events concentrated in particular places and that those concentrations were relatively stable over time. Evidence for these spatial concentrations and stability was prevalent during the twentieth century in research that considered social disorganization theory (Shaw and McKay 1942) and continues to this day with the crime and place literature (Curman et al. 2015; Weisburd et al. 2012).

In addition to this research that finds spatial clustering of criminal events, there is a long history of finding temporal clustering of criminal events, also dating back close to 200 years (Quetelet 1842). And within this research there is a subset of research that investigates the spatial dimension of temporal crime patterns. Research has found that seasonal patterns of crime are greater in lower socio-economic areas (Harries and Stadler 1983; Harries et al. 1984; Breetzke and Cohn 2012) and that increases in crime at particular times of the year correspond with changing routine activities (Andresen and Malleson 2013). Moreover, the day of the week impacts the risk of victimization, again relating to routine activities (Uittenbogaard and Ceccato 2012).

This research has clearly identified that the spatial and temporal dimensions of criminal events are related, but there is a branch of the criminological literature that simultaneously considers the simultaneous clustering of space and time. This branch of criminological literature is the study of repeat victimization and near-repeat victimization. Repeat victimization considers that same targets, or places, getting re-victimized within some short span of time, usually within a few weeks; near-repeat victimization considers that after an initial victimization, places near the initial victim/target are at a greater risk of victimization within a short span of time—near is usually considered within a few hundred meters and within a few weeks.

In this paper, we contribute to this repeat and near-repeat victimization literature through analyses of this phenomenon considering five crime types (residential burglary, commerce burglary, residence robbery, passerby robbery, and vehicle theft) in the city of Campinas, Brazil. Though criminological research in the Global South is growing, more research studies, including replications, are important for the advancement of this field and understanding the generalizability of spatial–temporal crime analyses. We do so through the analysis of criminal event data in another Brazilian context (see Chainey and Silva 2016 for another recent article) and expanding the set of crime types considered for repeat and near-repeat victimization in the Global South. Overall, we find strong support for the presence of both repeat and near-repeat victimization. More specifically, repeat victimization is at its greatest risk immediately after the initial victimization and near-repeat victimization occurs quite close to the initial victimization and within short time spans, and the patterns of repeat and near-repeat victimization vary by crime type. However, we also provide some new explanations for these patterns from a Brazilian context.

Related research

Repeat victimization

Though the phenomenon of repeat victimization had been known in prior research, the beginnings of the empirical research on repeat victimization usually refers to Gottfredson's (1984) investigation that used the British Crime Survey. In his research, he found that 28% of personal crime (assault, for example) victims were repeatedly victimized, 39% of victims of household criminal events (burglary, for example) were repeatedly victimized, and 44% of victims of any criminal event were repeatedly victimized. In an effort to show this pattern in a more general sense, van Dijk (2001) and Farrell and Bouloukos (2001) investigated the presence of repeat victimization across many crime types and many places considering the International Crime Victims Survey. Generally speaking, they found that over 40% of victims had been re-victimized, but there is significant variation across crime types: car theft had the lowest rates of repeat victimization, whereas violence against women typically had the highest rates of repeat victimization. Moreover, repeat victimization was generally higher in Latin America.

Despite the high rates of repeat victimization, it has long been known that crime clusters in space. Consequently, it may simply be the case that these people are consistently in the wrong places at the wrong time, potentially based on their home location or their routine activities. In an effort to investigate this issue, Johnson et al. (1997) analyzed residential burglary data to estimate the statistical likelihood of repeat victimization based on where these criminal events already occurred. Overall, they found that residential burglaries were a rare event, only occurring for just over 3% of households. Moreover, repeat burglaries were highly concentrated in crime hot spots and neighborhoods of lower socio-economic class, with many repeat victimizations occurring within 4 weeks and most occurring within 6 months.

More recent research on repeat victimization has focused on North America but also more international contexts. Chainey and da Silva (2016) reviewed the international literature finding that repeat victimization rates ranged from 7 to 33%. In a recent analysis of repeat burglary victimization in Wuhan, China, Wu et al. (2015) found strong evidence for repeat victimization with an increased risk factor of 7.49 for re-victimization in the first 7 days; though there was a moderate increased risk for the following 7 days, it was not statistically significant. In the current research context of Brazil, Justus et al. (2015) found that approximately 95% of those surveyed in 2009 had not been a victim of theft, robbery, attempted theft/robbery, or physical assault—this is similar to previous research. However, the rate of repeat victimization was quite high: 23% (theft), 21% (robbery), 26% (attempted theft/robbery), and 27% (physical assault). Again, these rates of repeat victimization are similar to previous research. In the city of Belo Horizonte in Brazil, Chainey and da Silva (2016) found lower levels of repeat victimization than other research: approximately 3–5.5% in any given year (2012–2014) and 8.6% overall. However, consistent with previous research, if a repeat victimization is going to occur it will occur within 28 days and, more often, within 7 days.

Near-repeat victimization

Near-repeat victimization is a concept related to repeat victimization, but it is a more recent research area and is explicitly spatial. The near-repeat hypothesis essentially states that being close to a recently victimized person or property temporarily increases your own risk of victimization—close is defined in terms of both time and space. As such, near-repeat victimization adds a spatial dimension to repeat victimization. Morgan (2001) coined the term "near-repeat" in an investigation of residential burglary in Perth, Australia; however, Townsley et al. (2003) was the first journal article dedicated to the study of near-repeat burglary victimization, conducted in Brisbane, Australia.

The key to near-repeat victimization is that both time and space must be considered. In short, in order for near-repeat victimization to occur, the current criminal event must be spatially close to the original criminal event *and* temporally close to when the original criminal event took place. As such a statistical technique that can simultaneously identify clusters in time and space is necessary. In order to do this, Townsley et al. (2003) used the Knox test that can identify space–time clusters and is common in the detection of epidemiology. The output of the Knox test is a table organized by time since the original criminal event and the distance away from the original event. If a table cell (100–200 m away and within 7 days of an original residential burglary, for example) has a value of 1.5 that is statistically significant (statistical significance is determined through simulations and space–time clusters occurring by random chance), then houses that are 100–200 m away from the original residential burglary are 1.5 times at greater risk for one week. Using this method, Townsley et al. (2003) found strong evidence for the presence of near-repeat victimization, but only in particular areas.

The residential areas at greatest risk of near-repeat victimization were neighborhoods with homogeneity in residential developments (similar houses) and neighborhoods with the largest volume of active burglars. Subsequent analyses by Bowers and Johnson (2005) in the context of residential burglary found that near-repeat victimization tended to occur in relatively affluent areas of the city, opposite of repeat victimization; homes immediately next door were at the greatest near-repeat victimization risk; homes on the same side of the street were at the greatest near-repeat victimization risk; and homes with similar floor plans (housing homogeneity, as mentioned above) were at greater near-repeat victimization risk.

Despite identification of the near-repeat phenomenon in both Australia and the United Kingdom, with patterns of victimization that make theoretical sense, it could have still been argued that this was some statistical artifact of a few locations that had no real generalizability. Johnson et al. (2007) addressed this issue through a cross-national study of ten locations in five different countries: Australia, Netherlands, New Zealand, United Kingdom, and United States. Using the same methodology in all these locations would be able to address this issue. Johnson et al. (2007) found strong support for the near-repeat hypothesis in the context of residential burglary. Moreover, they found that near-repeat residential burglary victimization would occur within 200 m and 14 days. This shows the importance of

using relatively short intervals, both space and time, for investigating this phenomenon.

In addition to the evidence of the near-repeat victimization phenomenon in the context of residential burglary, there have also been some investigations for other crime types. Ratcliffe and Rengert (2008) found evidence for near-repeat victimization in the context of shootings, and Haberman and Ratcliffe (2012) found evidence for near-repeat victimization in the context of street robberies, both in Philadelphia and Pennsylvania. And Townsley et al. (2008) found evidence for near-repeat victimization in the context of insurgent activity in Iraq. Interestingly, they found that the near-repeat phenomenon would occur within a very short time interval (2 days) but a greater spatial interval (1 km). This variation in spatial and temporal time frames was also evident in Zhang et al. (2015) that investigated near-repeat victimization for residential burglary, street robbery, and aggravated assault in Houston, Texas. They found that near-repeat victimization was evident in residential burglary for up to 90 days and 2.5 km, whereas street robberies and aggravated assaults exhibited a near-repeat pattern for approximately one week but for 0.4 and 1.0 km, respectively. Clearly, multiple crime types and different contexts are necessary to further develop the near-repeat victimization research.

In recent years, research into the near-repeat phenomenon has moved outside of its traditional western territory. Chen et al. (2013) investigated near-repeat victimization for residential burglary in Beijing, China. Consistent with previous western research, they found that near-repeat victimization risk was present for 3 weeks and 200 m. Also in China, Wuhan, Wu et al. (2015) investigated residential burglary near-repeat victimization. They found very strong support for the near-repeat hypothesis, particularly within 3 weeks and 700 m; however, the near-repeat victimization risk did not fully dissipate until 5 weeks had passed. And most recently, with the most relevance for our analysis, Chainey and da Silva (2016) investigated residential burglary near-repeat victimization in Belo Horizonte, Brazil. They found that near-repeat victimization risk was present within 3 weeks and 500 meters of the original residential burglary.

Explanations for repeat and near-repeat victimization

There are two general explanations for repeat and near-repeat victimization: the boost effect and the flag effect. As discussed below, both prove to be important for understanding (near-)repeat victimization. There is also some offender choice-based research that has emerged in recent years that is instructive in this regard.

The boost effect refers to an increased risk of repeat or near-repeat victimization because an offender is returning to a place or area in order to exploit known opportunities. In the case of repeat victimization, items may have been left behind (too many items to carry, in the context of residential burglary) or there may be a return to steal the items that would be replaced by the owners since the original victimization. In short, offenders were able to read the area well for risk of apprehension and know there are suitable targets present so they return to the original scene of the crime or its general area. The boost effect is expected to decrease over time because potential victims will become saturated and/or aware of

the problem in an area; empirical support for the boost effect has been found internationally (Everson and Pease 2001; Kleemans 2001; Tseloni and Pease 2003, 2004; Bernasco 2008). The flag effect occurs simply because multiple offenders will flag the same target or place as a suitable target. This is also referred to as risk heterogeneity. Because of the nature of the place and/or area, there is simply just greater risk of victimization to the chances of being victimized again, or having a victimization close by, is highly probable (Pease 1998; Tseloni and Pease 2003, 2004; Bernasco 2008; Johnson et al. 2009). Using a computer simulation to identify the importance of the boost and flag effects in the context of repeat victimization, Johnson (2008) found that the flag effect (risk heterogeneity) could produce the spatial concentrations of crime, but the boost effect was necessary to generate the temporal pattern for repeat victimization. In other words, both effects were necessary to produce the repeat victimization phenomenon.

In our analyses we consider not just burglary but criminal events with moving targets such as robbery and theft. As such, because we are considering the aspects of repeat victimization and near-repeat victimization we do not solely consider targets to be the choice of the offender. Rather, offenders are choosing places to offend that can include stationary and mobile targets. Offenders identify places (repeat victimization), and the surrounding areas around those places (near-repeat victimization), as being good locations for criminal offending. This is supported by recent location choice research that has found criminals are more likely to offend in areas they have already offended within as well as nearby area (Bernasco et al. 2015; Lammers et al. 2015). We do not use a location choice model in our analyses, but invoke this concept as a justification for analyzing fixed and mobile targets at places for repeat and near-repeat victimization in Campinas, Brazil.

Data and methods

Campinas, Brazil

Campinas is the third largest city in São Paulo state with approximately 1.15 million residents (IBGE 2014). Campinas is in southeastern Brazil, approximately 90 km northwest of São Paulo city. The Campinas Metropolitan Region consists of 20 municipalities. Because of its size, Campinas is economically important in Brazil, consisting of approximately 1% of the country's gross domestic product. And though it is a prosperous Latin American city, it does have significant social and economic inequality with a crime rate that is above the national average (Melgaço 2011; Melo et al. 2016). The location of Campinas is shown in Fig. 1, with regard to Brazil as a whole, and within São Paulo State. In the outlying areas of Campinas there are some greenspaces, but most of these are in the outer municipalities of the Campinas Metropolitan Region. The city itself is primarily urban and suburban with no large bodies of water of parks/forests to have a significant restriction on the ability for near-repeat victimization to occur in particular places.

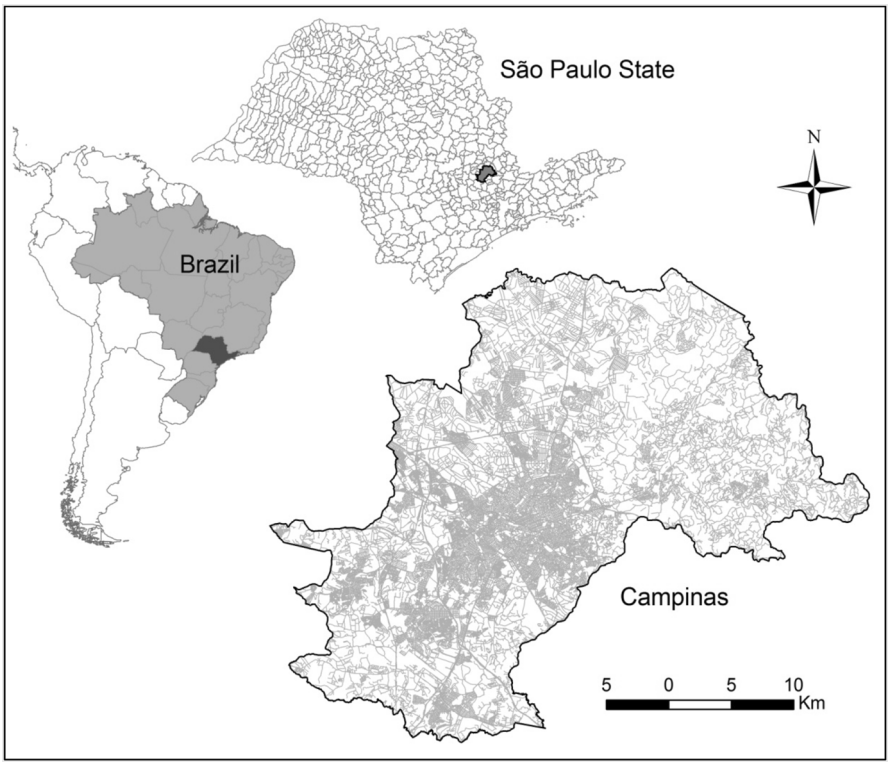

Fig. 1 Campinas, São Paulo state, and Brazil

Crime data

All crime data are from the Campinas Civil Police provided through Infocrim, their Criminal Information system. We were provided with all criminal events reported to the police from January 1, 2010 to December 31, 2013 for residential burglary, vehicle theft, commerce robbery, residence robbery, and passerby robbery. These data were provided with dates and addresses for geocoded coordinates that allow for the assessment of repeat and near-repeat victimization. Most often, geocoding quality is not ideal within the Brazilian slums/"favelas" (Davis Jr and de Alencar 2011); in order to avoid these issues, all criminal events occurring within the favelas were geocoded manually for data quality. With this manual geocoding in these areas, we were able to achieve 94% geocoding success rates, well above the minimum acceptable hit rate established by Ratcliffe (2004). Three of these crime types (residential burglary, residence robbery, and commerce robbery) allow for the analysis of victims/targets with fixed locations that is common in the near-repeat victimization literature. However, vehicle theft and passerby robbery are crime types that represent (potentially) different targets/victims at the same geographic location. This is similar to some of the more recent near-repeat victimization literature (Ratcliffe and Rengert 2008; Haberman and Ratcliffe 2012). Figure 2

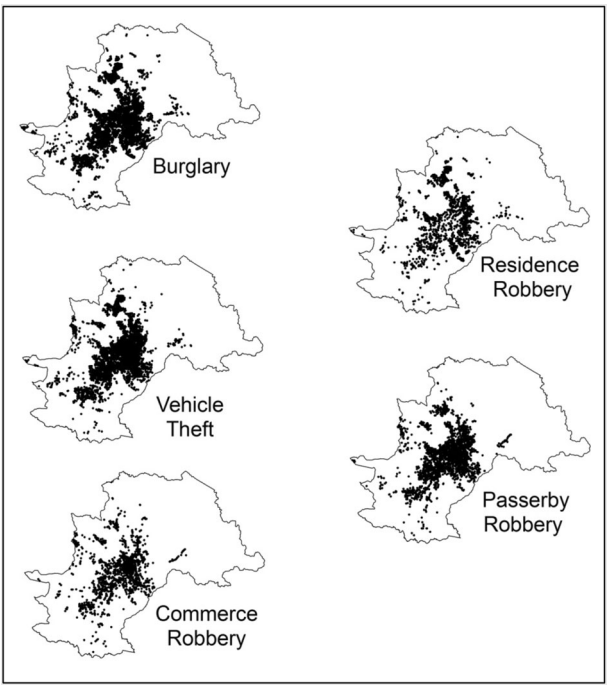

Fig. 2 Spatial distributions and concentrations, Campinas, 2010–2013

depicts the spatial distribution and concentration of criminal events analyzed, 2010–2013.

As shown in Table 1, passerby robbery and vehicle theft are the most prevalent crime types under analysis with over 3000 of each crime type occurring each calendar year. Residential burglary has approximately half the volume of criminal

Table 1 Counts and rates of crime types in Campinas, Brazil, 2010–2013

	2010	2011	2012	2013	2010–2013
Counts					
Burglary	1631	1704	1768	1315	6418
Vehicle theft	3332	3461	3471	3265	13,529
Commerce robbery	672	646	750	638	2706
Residence robbery	641	607	599	514	2361
Passerby robbery	4982	5057	4403	3976	18,418
Rates per 100,000					
Burglary	151.0	156.3	160.9	114.9	
Vehicle theft	308.5	317.4	315.9	285.2	
Commerce robbery	62.2	59.2	68.3	55.7	
Residence robbery	59.3	55.7	54.5	44.9	
Passerby robbery	461.2	463.8	400.8	347.3	

events, with commerce robbery and residence robbery having the lowest volumes of criminal events. The same relative ranking is present for the crime rates for each crime type. Having 4 years of criminal event data provides a long time span for the investigation of repeat and near-repeat victimization, whereas most previous research has data spanning one year.

Methods

In order to statistically test for simultaneous spatial and temporal clustering to identify the presence of repeat and near-repeat victimization we use the Knox test, consistent with previous research (Knox 1964). In short, relative risk of repeat and near-repeat victimization is presented by the numbers in the output tables. A number insignificantly different from unity means that there is no repeat or near-repeat victimization occurring. Numbers significantly greater than unity represent the relative risk of repeat and near-repeat victimization at their respective spatial and temporal bands, based on Monte Carlo simulation—because of the Monte Carlo approach, this may be better described as a modified Knox Test (see Johnson et al. (2007) for the first application of this modified Knox Test). In the repeat and near-repeat victimization literature, it is common to use 100 m spatial bands and 1 week temporal bands for the analysis: 10 spatial bands and 5 temporal bands.[1] 100-m spatial bands were chosen not only because of its common use in the extant literature but also because of the local context: the average length of a street block in Campinas is approximately 100 meters. We use these spatial and temporal bands and measure distance considering Manhattan distance rather than Euclidean distance because the latter has a tendency to underestimate distances (Rossmo 2000). All estimation is undertaken using Ratcliffe's (2009) Near Repeat Calculator, using 999 iterations.

Results

The output from Ratcliffe's (2009) Near Repeat Calculator is shown in Tables 2 through 6 for the various crime types. In all cases, there is evidence for the presence of repeat and near-repeat victimization, but the strength of that evidence varies by crime type. This shows the importance of investigating multiple crime types using the same method at the same location to get a better understanding of the repeat and near-repeat phenomena, one of the contributions of our analysis.

The results for burglary are shown in Table 2. The first set of results to note is those from repeat victimization, listed as "same location" in the tables. It should be clear from Table 2 that there is strong evidence for the presence of repeat burglary victimization in Campinas, Brazil. There is a statistically significant repeat victimization effect for up to 28 days. With regard to the risk of repeat victimization, the effect is greatest in the first week, showing almost a 900%

[1] We also undertook sensitivity analyses modifying these bandwidths. No qualitatively different results emerged.

Table 2 Burglary (near-)repeat analysis: Knox ratios in Campinas (Brazil) from 2010 to 2013

Distance (m)	Time (days)					
	0–7	8–14	15–21	22–28	29–35	More than 35
Same location	8.89*	2.58*	2.34*	2.09*	2.29	0.86
1–100	1.66*	1.73*	1.07	1.08	0.74	0.99
101–200	1.26	1.28	1.08	1.07	1.34*	0.99
201–300	1.25*	1.03	1.31*	1.14	0.97	0.99
301–400	1.46*	1.33*	1.02	0.87	1.25*	0.99
401–500	1.33*	1.06	1.10	1.11	1.17	0.99
501–600	1.28*	1.20*	1.00	1.07	1.06	0.99
601–700	1.31*	1.18*	1.07	0.93	0.94	1.00
701–800	1.16*	1.05	1.10	1.10	1.15*	0.99
801–900	1.10*	1.03	1.13	1.09	1.07	1.00
901–1000	1.02	1.07	1.08	1.02	1.08	1.00
More than 1000	1.00	1.00	1.00	1.00	1.00	1.00*

* Pseudo-$p < 0.05$

increased risk of burglary victimization. Starting in the second week from the initial victimization, the increased risk or victimization falls off drastically, but still notable at just over 250%. By the end of the 28 days, the risk falls off to 200%.

In terms of near-repeat victimization, the effect for burglary is most consistent within the first week of the original victimization. The increased risk of a burglary for a near-repeat is much lesser than that of repeat victimization. Within 100 m of the original victimization the risk of a burglary is 166% greater for one week. For the same temporal band, the increased risk of near-repeat victimization continues for up to 900 m, though the increased risk tends to be approximately 120–130% greater than by random chance. There is also a statistically significant near-repeat effect within 100 m for the second week after the original victimization. There are also some other statistically significant near-repeat effects, but they are too sporadic to comment about any patterns.

For residence robbery, as shown in Table 3, there is a very strong repeat victimization effect in the first week with there being a 1118% increase in risk during that time. After one week, however, the repeat victimization effect is no longer statistically significant. With regard to near-repeat victimization, there is less support. Only during the second week following the original victimization, at 300–600 m, does there appear to be any near-repeat pattern.

Commerce robbery, as shown in Table 4, is more similar to the results for burglary. For this crime type, the repeat victimization effect is statistically significant for up to 35 days. For the first two weeks the increased risk of re-victimization is just under 300%, but thereafter falls to approximately 200%—still a notable increase in risk. There is also a presence of a near-repeat effect within 200 meters of the original victimization: just under a 200% increased risk for the first week and 133% increased risk the second week. This near-repeat effect re-emerges at 300–500 and 700–800 m. We suspect that these gaps in the near-repeat effect are

Table 3 Residence robbery (near-)repeat analysis: Knox ratios in Campinas (Brazil) from 2010 to 2013

Distance (m)	Time (days)					
	0–7	8–14	15–21	22–28	29–35	More than 35
Same location	11.18*	1.27	2.38	0.00	0.00	0.88
1–100	1.68	2.38	1.69	0.97	1.22	0.97
101–200	1.12	0.82	1.92*	1.01	1.64	0.98
201–300	1.44	1.31	0.94	1.50*	1.27	0.99
301–400	1.08	1.76*	1.16	1.13	1.09	0.99
401–500	1.18	1.49*	1.26	1.27	0.70	0.99
501–600	1.01	1.42*	1.03	0.98	1.23	0.99
601–700	1.41*	1.26	1.27	0.98	1.38	0.99
701–800	1.31	1.06	0.96	1.18	0.94	1.00
801–900	1.14	0.98	0.81	0.99	1.16	1.00
901–1000	1.06	1.20	1.29*	1.10	1.35*	0.99
More than 1000	1.00	1.00	1.00	1.00	1.00	1.00*

* Pseudo-$p < 0.05$

Table 4 Commerce robbery (near-)repeat analysis: Knox ratios in Campinas (Brazil) from 2010 to 2013

Distance (m)	Time (days)					
	0–7	8–14	15–21	22–28	29–35	More than 35
Same location	2.92*	2.92*	1.96*	1.81*	2.05*	0.93
1–100	1.95*	1.27	1.35	1.25	0.78	0.98
101–200	1.33*	1.27*	0.93	1.15	1.01	0.99
201–300	1.16	1.15	1.08	0.93	1.11	1.00
301–400	1.31*	1.17	0.95	1.06	0.93	1.00
401–500	1.13*	1.06	1.13	1.04	0.95	1.00
501–600	1.03	1.26*	1.07	0.91	0.88	1.00
601–700	1.13	1.19*	0.86	1.01	0.96	1.00
701–800	1.22*	1.05	1.08	1.10	1.05	0.99
801–900	1.18	1.07	0.94	1.02	0.99	1.00
901–1000	1.11	1.06	1.00	1.15*	1.03	1.00
More than 1000	0.99	0.99	1.00	1.00	1.00	1.00*

* Pseudo-$p < 0.05$

due to the simple lack of presence of commercial establishments that are bound by land-use policies, particularly because there is a similar pattern of near-repeat effects for the second week after the original victimization. The increased risk of near-repeat victimization for these spatial and temporal bands is all in the range of 110–130%.

The results for passerby (street) robbery are shown in Table 5. This crime type has the weakest support for both repeat victimization and near-repeat victimization, though it is present. With regard to repeat victimization, there is a statistically

Table 5 Passerby robbery (near-)repeat analysis: Knox ratios in Campinas (Brazil) from 2010 to 2013

Distance (m)	Time (days)					
	0–7	8–14	15–21	22–28	29–35	More than 35
Same location	1.93*	1.38*	1.36	1.07	1.10	0.98
1–100	1.35*	1.22	1.26*	1.25	0.99	0.99
101–200	1.12	1.14	1.08	1.21	1.36*	0.99
201–300	1.13	0.98	1.08	1.21*	1.09	1.00
301–400	1.23*	1.12*	1.07	1.04	0.92	1.00
401–500	1.17*	1.04	1.16*	0.98	0.98	1.00
501–600	1.15	1.17*	1.02	1.04	1.05	1.00
601–700	1.10	1.20*	1.07	1.09	1.00	1.00
701–800	1.11	1.11	1.13*	1.03	1.07	1.00
801–900	1.10	1.05	1.08	1.11	0.98	1.00
901–1000	1.21*	1.04	1.16*	1.02	1.01	1.00
More than 1000	1.00	1.00	1.00	1.00	1.00	1.00*

* Pseudo-$p < 0.05$

significant repeat victimization effect for the first and second weeks after an initial passerby robbery at a location; the increased risks of repeat victimization are almost 200% and almost 140%, respectively. The near-repeat effect only emerges at the 100-m band and a few other sporadically within the first two weeks—115–135% increase in risk. This suggests that a robbery offender, after a successful initial criminal event, may try his or her luck again at the same location because they were able to read the environment well for committing such a crime. However, this near-repeat effect is short-lived because the offender does not wish to obtain the attention of the police. Another hypothesis is that type of crime is usually committed by young and not-dangerous criminals or drug users. In this case, it makes sense for the (near-) repeat criminal event to be in the same location or close by (100 m), because there are specific places within the city where the drug users are concentrated. Previous research has found that most often these offenders are caught after 2 weeks committing the crime and usually go to the jail increasing the incarceration mass in São Paulo State, minimizing a repeat phenomenon (Zaluar 1995).

And finally, the results for vehicle theft are shown in Table 6. There is a strong repeat victimization effect present for vehicle theft up to 35 days from the initial criminal event. The greatest increase in risk is present for the first week after the initial victimization, with a 263% increase in risk. However, though statistically significant, the increased risk for the subsequent 4 weeks is much lower as 135–150%. With regard to near-repeat victimization, this effect is generally present within the first week of the original victimization. Its strongest effect is within 100 m of the original victimization, showing an increased risk of 150%. As with commercial robbery and passerby robbery, there are "gaps" in the statistical significance of the spatial bandwidths. Again, it is expected that this phenomenon is due to the environmental availability of targets for this crime type.

Table 6 Vehicle theft (near-)repeat analysis: Knox ratios in Campinas (Brazil) from 2010 to 2013

Distance (m)	Time (days)					
	0–7	8–14	15–21	22–28	29–35	More than 35
Same location	2.63*	1.47*	1.51*	1.33*	1.36*	0.97
1–100	1.50*	1.16	1.10	1.34*	1.39*	0.99
101–200	1.12	1.07	1.14	1.07	0.99	1.00
201–300	1.22*	1.01	0.87	1.13*	1.02	1.00
301–400	1.11	1.08	1.07*	0.99	1.12	1.00
401–500	1.12*	1.05	1.06	1.06	1.10	1.00
501–600	1.06	1.05	1.07*	1.06	1.04	1.00
601–700	1.03	1.10*	1.00	1.15*	0.99	1.00
701–800	1.12*	1.12*	1.09*	1.09	1.01	1.00
801–900	1.04	1.08*	1.00	1.1*	0.99	1.00
901–1000	1.11*	1.08*	1.08	1.08*	1.04	1.00
More than 1000	1.00	1.00	1.00	1.00	1.00	1.00*

* Pseudo-$p < 0.05$

Discussion

Understanding the spatial and temporal patterns of crime is a highly active dimension of current criminological research. The importance of understanding these patterns is that they are relatively stable over time. Because of this stability, there are opportunities for crime prevention activities that improve the standard of living for those in the affected area. However, it is, therefore, important to understand the nuances of these spatial and temporal crime patterns in order to appropriately apply various crime prevention initiatives; also important is the role of replication in (social) scientific research to support the use of this research for justification in the implementation of such crime prevention initiatives.

In this paper, we have investigated the spatial–temporal crime patterns of burglary, commerce robbery, residence robbery, passerby robbery, and vehicle theft in Campinas, Brazil, considering both repeat victimization and near-repeat victimization over a four-year period. Through this application of repeat and near-repeat methods to Brazilian data, we contribute to the growing spatial–temporal crime analysis literature that considers research areas outside of the Western world. We also contribute to this literature through an analysis of five individual crime types using the same methods in the same place over an extended period of time. This allows for direct comparisons to be made across disaggregated crime types that has shown to be important for spatial analysis in both North and South America (Andresen and Linning 2012; Melo et al. 2015).

Despite our contributions, our analyses are not without limitations. Because of the temporal nature of our analyses, the time in which the criminal events occurred is important. One aspect that matters in the current context is when the crime

occurred relative to when it gets reported. This can be particularly important in the context of residential burglary because people may be away from the home for extended periods of time, particularly around vacation periods (Ratcliffe 2000). Given that we use a temporal bandwidth of 1 week, we do not expect this to have a significant impact on our results, but it is important to acknowledge this point. Additionally, our analyses are sensitive to the dark figure of crime given that we only consider criminal events reported to the police. However, there is little we can do with regard to this constraint. And finally, though the street network is primarily set up as a grid network within local areas, it does not follow a Manhattan Grid across the entire city. Because of the concern for "near" repeats being short distances, using Manhattan distance is the best approximation for the distance between criminal events, but it is not a perfect measure of distance for longer journeys.

Overall, we find support for both repeat victimization and near-repeat victimization. However, it is worth noting that repeat victimization appears to be more prevalent in a Brazilian context than near-repeat victimization, primarily for burglary. As stated in previous research, it is not uncommon for domestic housing infrastructure in Brazilian cities to have situational crime prevention measures such as perimeter fencing and security guards to improve safety (Chainey and da Silva 2016). As a consequence, housings without such situational crime prevention measures are more vulnerable to repeat victimization, and victimization in general once this lack of security is noticed. One potential explanation for less evidence for a near-repeat victimization effect in Campinas, Brazil, is that affluent areas with housing homogeneity, including condominiums, are often within gated communities with high walls, security guards, and closed-circuit television that allows for better protection in the immediate surrounding areas (Caldeira 2000). Regardless, as noted above, repeat victimization was always present, but near-repeat victimization did not have statistical support for all the crime types. Moreover, the repeat victimization effect was always much greater in magnitude than the near-repeat effect.

This result is understandable in the context of residential burglary because of the nature of Brazilian cities with their higher degree of security in some places and a lack of security in places such as the favelas (Chainey and da Silva 2016). Because of this higher level of security in some places, if an offender is able to breach that security once, a repeat victimization is highly likely because nearby homes may be more difficult to break into. This may explain the strong support for repeat victimization and the much weaker support for near-repeat victimization—the near-repeat phenomenon is more present in other developing countries. This also explains the magnitude of the repeat victimization result and that this results continues for much longer than the near-repeat result. However, it is important to note that because of the high degree of high-rise living (Chainey and da Silva 2016), the repeat victimization effect may be over estimated here, encompassing both repeat and near-repeat victimization because different apartment units in the same high-rise building share the same address.

The strongest case for repeat victimization was residential robbery with a 1118% increased risk. The explanation for that in the context of Campinas may be that

many buildings are being targeted.[2] Because of the presence of situational crime prevention measures in these buildings, it is very difficult for a building to be burglarized. Therefore, the unique way in which property-related theft may occur, but in a violent context, is a gang robbery in the buildings with many targets/residences. However, when the robberies are reported they have same (building) address. As such, as with residential burglary, there may be a near-repeat phenomenon going on in the sense that different units within one address are being robbed, but this does not emerge in our data.

Vehicle theft showed strong support in repeat victimization. In a Brazilian context, cargo theft or vehicle theft is used as an organized crime because they control this illegal activity in Brazil (Mingardi 2007). In Campinas (and the whole São Paulo State), the PCC (Capital's First Command—*Primeiro Comando da Capital*) is the main criminal organization (Adorno and Salla 2007). This result may be representing that this group usually prefers attack areas that they already know as areas with a state absence (boost effect).

Of particular interest is the variation in the effect of repeat and near-repeat victimization across the different crime types. Because of these variations, any expected impacts from crime prevention initiatives must be informed by information such that those who implement the crime prevention initiative(s) do not have false (high) expectations for any reductions in crime. Though other studies do assess the repeat and near-repeat phenomena considering multiple crime types, most often this research only considers one crime type.

Clearly, we have demonstrated the need for research into non-western contexts when examining the repeat and near-repeat phenomenon. Different social and economical structures present in these locations contribute to the results found here. The nature of the built environment has clear implications for the presence of repeat and near-repeat victimization because of security issues, and also because of the nature of data when measuring repeat and near-repeat victimization: two burgled/robbed apartments within one week in the same building do not represent repeat victimization but will appear to be given the way data are geocoded.

Lastly, regardless of whether a subsequent victimization is repeat or near-repeat, the strength of this result is quite strong in Campinas, Brazil. This points to the need for interventions with victims of these crimes, and their neighbors, because the likelihood of subsequent victimization is so high. In the context of passerby/street robbery and vehicle theft, there are clearly places in which offenders return to commit subsequent crimes. Different from the stationary targets in burglary and robbery, the targets for these crimes are changing, but there is something about the place in which these crimes occur. This supports the need for situational crime prevention and security implementations at these locations.

[2] See local media news: <http://g1.globo.com/sp/campinas-regiao/noticia/2012/09/casos-de-assaltos-condominios-crescem-83-em-campinas-e-regiao.html> and <http://g1.globo.com/sp/campinas-regiao/jornal-da-eptv/videos/v/casos-de-roubos-e-furtos-a-apartamentos-aumenta-na-regiao-de-campinas/3036199/ Accessed 14 October 2016.

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References

Adorno, S., and F. Salla. 2007. Organized Criminality in Prisons and the Attacks of the PCC. *Estudos avançados* 21 (61): 7–29.

Andresen, M.A., and S.J. Linning. 2012. The (In)appropriateness of Aggregating Across Crime Types. *Applied Geography* 35 (1–2): 275–282.

Andresen, M.A., and N. Malleson. 2013. Crime Seasonality and its Variations Across Space. *Applied Geography* 43: 25–35.

Bernasco, W. 2008. Them Again? Same Offender Involvement in Repeat and Near Repeat Burglaries. *European Journal of Criminology* 5 (4): 411–431.

Bernasco, W., S.D. Johnson, and S. Ruiter. 2015. Learning Where to Offend: Effects of Past on Future Burglary Locations. *Applied Geography* 60: 120–129.

Bowers, K.J., and S.D. Johnson. 2005. Domestic Burglary Repeats and Space–Time Clusters: The Dimensions of Risk. *European Journal of Criminology* 2 (1): 67–92.

Breetzke, G.D., and E.G. Cohn. 2012. Seasonal Assault and Neighborhood Deprivation in South Africa: Some Preliminary Findings. *Environment & Behavior* 44 (5): 641–667.

Caldeira, T.P. 2000. *City of Walls: Crime, Segregation, and Citizenship in São Paulo*. Oakland, CA: University of California Press.

Chainey, S.P., and B.F.A. da Silva. 2016. Examining the Extent of Repeat and Near Repeat Victimisation of Domestic Burglaries in Belo Horizonte, Brazil. *Crime Science* 5 (1): 1.

Chen, P., H. Yuan, and D. Li. 2013. Space–Time Analysis of Burglary in Beijing. *Security Journal* 26 (1): 1–15.

Curman, A.S.N., M.A. Andresen, and P.J. Brantingham. 2015. Crime and Place: A Longitudinal Examination of Street Segment Patterns in Vancouver, BC. *Journal of Quantitative Criminology* 31 (1): 127–147.

Davis Jr., C.A., and R.O. de Alencar. 2011. Evaluation of the Quality of an Online Geocoding Resource in the Context of a Large Brazilian City. *Transactions in GIS* 15 (6): 851–868.

Everson, S., and K. Pease. 2001. Crime Against the Same Person and Place: Detection Opportunity and Offender Targeting. *Crime Prevention Studies* 12: 199–220.

Farrell, G., and A.C. Bouloukos. 2001. International Overview: A Cross-National Comparison of Rates of Repeat Victimization. *Crime Prevention Studies* 12: 5–25.

Gottfredson, M.R. 1984. *Victims of Crime: The Dimensions of risk. Home Office Research Study*, vol. 81. London, UK: HMSO.

Guerry, A.-M. 1832. La statistique compare de l'état de l'instruction et du nombre des crimes. *Revue Encyclopédique* 55: 414–424.

Guerry, A.-M. 1833. *Essai sur la statistique morale de la France*. Paris: Crochard.

Haberman, C.P., and J.H. Ratcliffe. 2012. The Predictive Policing Challenges of Near Repeat Armed Street Robberies. *Policing: A Journal of Policy and Practice* 6 (2): 151–166.

Harries, K.D., and S. Stadler. 1983. Determinism Revisited: Assault and Heat Stress in Dallas. *Environment & Behavior* 15 (2): 235–256.

Harries, K.D., S. Stadler, and R. Zdorkowski. 1984. Seasonality and Assault: Explorations in Inter-Neighborhood Variation, Dallas 1980. *Annals of the Association of American Geographers* 74 (4): 590–604.

IBGE (Instituto Brasileiro de Geografia e Estatística). 2014. Cidades. http://www.cidades.ibge.gov.br/xtras/perfil.php?lang¼&codmun¼350950&search¼sao-paulojcampinas. Accessed 15 April 2016.

Johnson, S.D. 2008. Repeat Burglary Victimization: A Tale of Two Theories. *Journal of Experimental Criminology* 4 (3): 215–240.

Johnson, S.D., W. Bernasco, K.J. Bowers, H. Elffers, J. Ratcliffe, G. Rengert, and M. Townsley. 2007. Space–Time Patterns of Risk: A Cross National Assessment of Residential Burglary Victimization. *Journal of Quantitative Criminology* 23 (3): 201–219.

Johnson, S.D., K. Bowers, and A. Hirschfield. 1997. New Insights in the Spatial and Temporal Distribution of Repeat Victimisation. *British Journal of Criminology* 37 (2): 224–241.

Johnson, S.D., L. Summers, and K. Pease. 2009. Offender as Forager? A Direct Test of the Boost Account of Victimization. *Journal of Quantitative Criminology* 25 (2): 181–200.
Justus, M., T. Kahn, and H. Kawamura. 2015. Relationship Between Income and Repeat Criminal Victimization in Brazil. *EconomiA* 16 (3): 295–309.
Kleemans, E.R. 2001. Repeat Burglary Victimization: Results of Empirical Research in the Netherlands. *Crime Prevention Studies* 12: 53–68.
Knox, G. 1964. Epidemiology of Childhood Leukaemia in Northumberland and Durham. *British Journal of Preventive and Social Medicine* 18 (1): 17–24.
Lammers, M., B. Menting, S. Ruiter, and W. Bernasco. 2015. Biting Once, Twice: The Influence of Prior on Subsequent Crime Location Choice. *Criminology*. doi:10.1111/1745-9125.12071.
Melgaço, L. 2011. The Injustices of Urban Securitization in the Brazilian City of campinas. *Spatial Justice* 4: 1–19.
Melo, S.N., L.F. Matias, and M.A. Andresen. 2015. Crime Concentrations and Similarities in Spatial Crime Patterns in a Brazilian Context. *Applied Geography* 62: 314–324.
Melo, S.N., E. Beauregard, and M.A. Andresen. 2016. Factors Related to Rape Reporting Behavior in Brazil: Examining the Role of Spatio–Temporal Factors. *Journal of Interpersonal Violence*. doi:10.1177/0886260516658758.
Mingardi, G. 2007. The Role of Intelligence Work in the Control of Organized Crime. *Estudos Avançados* 21 (61): 51–69.
Morgan, F. 2001. Repeat Burglary in a Perth suburb: Indicator of Short-Term or Long-Term Risk? *Crime Prevention Studies* 12: 83–118.
Pease, K. 1998. *Repeat Victimisation: Taking Stock*. London: Police Research Group, Home Office.
Quetelet, L.A.J. [1831] 1984. *Research on the Propensity for Crime at Different Ages* (translated by S. F. Sylvester). Cincinnati, OH: Anderson Publishing.
Quetelet, L.A.J. 1842. *A Treatise on Man and the Development of his Faculties*. London: Edinburgh: W. and R. Chambers.
Ratcliffe, J.H. 2000. Aoristic Analysis: The Spatial Interpretation of Unspecific Temporal Events. *International Journal of Geographical Information Science* 14 (7): 669–679.
Ratcliffe, J.H. 2004. Geocoding Crime and a First Estimate of a Minimum Acceptable Hit Rate. *International Journal of Geographical Information Science* 18 (1): 61–72.
Ratcliffe, J. H. 2009. Near Repeat Calculator (version 1.3). Temple University, Philadelphia, PA and the National Institute of Justice, Washington, DC.
Ratcliffe, J.H., and G.F. Rengert. 2008. Near Repeat Patterns in Philadelphia Shootings. *Security Journal* 21 (1–2): 58–76.
Rossmo, D.K. 2000. *Geographic Profiling*. Boca Raton: CRC Press.
Shaw, C.R., and H.D. McKay. 1942. *Juvenile Delinquency and Urban Areas: A Study of Rates of Delinquency in Relation to Differential Characteristics of Local Communities in American Cities*. Chicago: University of Chicago Press.
Townsley, M., R. Homel, and J. Chaseling. 2003. Infectious Burglaries: A Test of the Near Repeat Hypothesis. *British Journal of Criminology* 43 (3): 615–633.
Townsley, M., S.D. Johnson, and J.H. Ratcliffe. 2008. Space Time Dynamics of Insurgent Activity in Iraq. *Security Journal* 21 (3): 139–146.
Tseloni, A., and K. Pease. 2003. Repeat Personal Victimization: 'Boosts' or 'Flags'? *British Journal of Criminology* 43 (1): 196–212.
Tseloni, A., and K. Pease. 2004. Repeat Personal Victimization: Random Effects, Event Dependence and Unexplained Heterogeneity. *British Journal of Criminology* 44 (6): 931–945.
Uittenbogaard, U., and V. Ceccato. 2012. Space–Time Clusters of Crime in Stockholm, Sweden. *Review of European Studies* 4 (5): 148–156.
van Dijk, J.J.M. 2001. Attitudes of Victims and Repeat Victims Toward the Police: Results of the International Crime Victims Survey. *Crime Prevention Studies* 12: 27–52.
Weisburd, D., E.R. Groff, and S.-M. Yang. 2012. *The Criminology of Place: Street Segments and Our Understanding of the Crime Problem*. New York: Oxford University Press.
Wu, L., X. Xu, X. Ye, and X. Zhu. 2015. Repeat and Near-Repeat Burglaries and Offender Involvement in a Large Chinese City. *Cartography and Geographic Information Science* 42 (2): 178–189.
Zaluar, A. 1995. The Drug Trade, Crime and Policies of Repression in Brazil. *Dialectical Anthropology* 20 (1): 95–108.
Zhang, Y., J. Zhao, L. Ren, and L. Hoover. 2015. Space–Time Clustering of Crime Events and Neighborhood Characteristics in Houston. *Criminal Justice Review* 40 (3): 340–360.