In a world called catastrophe: the impact of COVID-19 on neighbourhood level crime in Vancouver, Canada

Martin A. Andresen[1] · Tarah Hodgkinson[2]

Abstract

Objectives To test for statistically significant change in crime rates across neighbourhoods in Vancouver, Canada, resulting from social restrictions within the natural experiment of the COVID-19 pandemic.

Methods Differential local Moran's I is used to identify statistically significant change in crime patterns across Vancouver's neighbourhoods because of COVID-19. These changes are analysed with variables from social disorganization theory constructs using ANOVA.

Results At the neighbourhood level, all crime types have significant change during COVID, but not always at the city level. Different neighbourhoods have different changes in crime despite these changes appearing to be constant at the city level; local effects asre important to consider. Variables representing the constructs of social disorganization theory are able to predict these changes.

Conclusions COVID-19 has changed the patterns of crime in Vancouver, but most often in theoretically expected ways. Local changes are critical to understand crime during a pandemic.

Keywords COVID-19 · Crime · Vancouver · Social disorganization · Differential local Moran's I

✉ Martin A. Andresen
andresen@sfu.ca

Tarah Hodgkinson
thodgkinson@wlu.ca

[1] School of Criminology, Simon Fraser University, 8888 University Drive, Burnaby, BC V5A 1S6, Canada

[2] Faculty of Human and Social Sciences, Wilfrid Laurier University, 20 Charlotte Street, Brantford, ON N3T 2W2, Canada

Introduction

Exceptional events, like the COVID-19 pandemic, present an opportunity to investigate our theoretical explanations of the social world, crime and public policy (Barton, 1969; Drabek, 1986; Hodgkinson & Andresen, 2020). Shortly after the pandemic began (early 2020), governments around the world implemented and re-implemented lockdowns in an attempt to slow the spread, or flatten the curve, of viral infections and keep their populations safe. Some countries have been successful in relatively limiting transmissions by enforcing severe border restrictions, while others have experienced extensive lockdowns and continued restrictions as the virus continued to emerge. Social restrictions have taken different forms around the world, including lockdowns, mask requirements and social distancing, but have greatly impacted the flow of social life, including where, when and with whom people can spend their time.

In Canada, social restrictions had been moderate, compared to some areas of the world, leading to initial success in reducing infection and death (Government of Canada, 2021). More recently, however, COVID infections have increased dramatically, leading some areas of the Canadian medical community to prepare for a triage scenario.[1] As a result, additional restrictions were implemented, such as reducing travel in provinces like British Columbia to essential only and reducing school attendance to part-time. These social restrictions have created a natural experiment in social behaviour and should, in turn, affect rates of crime.

The literature on COVID and crime, reviewed below, has been conducted in regions around the world, considered several crime types and a variety of time frames. However, most of this research has been conducted at the city-level or larger. As a result, this has made it difficult to explore certain theories of crime, including neighbourhood-level predictors. In this paper, we consider changes in property crimes, violent crimes and nuisance crimes across official neighbourhoods in Vancouver, Canada. We test for changes in crime patterns across Vancouver neighbourhoods and then relate those changes using theoretical constructs from social disorganization theory to explore important questions about how these predictors affect crime during an exceptional event.

Related research

Theoretical consideration of exceptional events

Research on exceptional events (e.g. riots, terrorist attacks, natural disasters, pandemics) dates back over 50 years (Barton, 1969; Drabek, 1986). These events lead to changes in routine activities (imposed or otherwise) and, subsequently, collective behaviour (Quarantelli, 1993, 2007). Within the literature, three major

---

[1] https://toronto.ctvnews.ca/ontario-appears-to-avoid-worst-case-covid-19-triage-scenario-in-icu-but-concerns-remain-1.5413922

theoretical frameworks attempt to explain these changes, including the routine activity approach, social disorganization theory and altruism (Hodgkinson & Andresen, 2020; Zahnow et al., 2017).

Altruism, the development of social cohesion or institutional support, predicts that crime rates will remain the same, or decrease, because people or governments will come together during a crisis and help one another (Drabek, 1986; Zahran et al., 2009; Lemieux, 2014). In opposition, social disorganization theory posits that exceptional events may aggravate existing neighbourhood-level disadvantage and vulnerability resulting in increased criminal activity (Genevie et al., 1987; Davila et al., 2005; Prelog, 2016). Finally, the routine activity approach predicts that crime will change depending on the changes in the underlying opportunity structures resulting from the exceptional event. In other words, some crime types may increase and other decrease depending on shifts in suitable targets, motivated offenders and capable guardians (LeBeau, 2002; Zahnow et al., 2017; Zahran et al., 2009).

COVID-19 and crime

Research on the impact of the COVID-19 pandemic has been as widespread as the pandemic itself, including studies on COVID-19 and crime. Though the context of a pandemic is a public health crisis, Stickle and Felson (2020) and Eisner and Nivette (2020) have set out research agendas for criminologists to consider given the presence of this natural experiment. What we learn now may be instructive for ensuring both public health and community safety as this pandemic develops and as future pandemics emerge.

In the USA, and in the first known publication on COVID and crime, Mohler et al. (2020) found that most crime types did not change dramatically during the early stages of the pandemic in Los Angeles, CA, and Indianapolis, IN, aside from decreases in robbery and increases in domestic violence. Campedelli et al. (2020a) found similar results in Los Angeles, CA. Felson et al. (2020) found that residential burglary decreased significantly in the early stages of the pandemic in Detroit, MI. And Ashby (2020) found that most crime types decreased across 16 cities in the USA. Specifically, in the context of domestic violence, Piquero et al. (2020a) observed an immediate spike during the initial lockdown, followed by a decline in Dallas, TX, but there has been debate regarding these results (Reingle Gonzalez et al., 2020; Piquero et al., 2020b)—a more recent meta-analysis has shown domestic violence increased during the early stages of the pandemic (Piquero et al., 2021).

Internationally, Gerell et al. (2020) (Sweden), de la Miyar et al. (2020) (Mexico), Hodgkinson and Andresen (2020) (Canada), Halford et al. (2020) (England and Wales) and Payne et al., (2020, 2021) (Australia) all found similar results to those investigating the impact of COVID on crime in the USA. As the pandemic has progressed, more data have become available, allowing for researchers to test the effects of the ebb and flow of social restrictions. Andresen and Hodgkinson (2020), for example, found that once social restrictions were relaxed in Queensland, Australia, crime began to increase immediately. Langton et al. (2021) found similar

effects in England and Wales. And in a Chinese city, Borrion et al. (2020) found that crime increased after social restrictions to levels greater than pre-COVID.

Broadly, the research on COVID-19 and crime has found results consistent with opportunity theory. However, it is important to note that the units of analyses for these studies have been at the level of the city, or larger, and may conceal nuances of impact of COVID-19 on crime at the neighbourhood level. As such, the emerging studies of the impact of COVID-19 on crime at the neighbourhood level have considered additional theoretical constructs more directly connected to the neighbourhood level, social disorganization theory.

Campedelli et al. (2020b) and Moise and Piquero (2021) are the only known research studies to investigate the impact of COVID-19 on crime at the community, or neighbourhood, level. Considering communities across Chicago, IL, Campedelli et al. (2020b) found that predictors varied for their explanatory power of where decreases in crime (burglary, assault, narcotics and robbery) occurred. These results are consistent with the routine activity approach in that depending on how the pandemic changes opportunity structures, different crime types will be affected in different ways. Moise and Piquero (2021), as with other research, found a decrease in violent crime during the first 3 months of the pandemic in Miami-Dade County, Florida. More interesting, however, is that these authors, using two clustering techniques, found that, consistent with criminological research, prior to the pandemic, largely African American areas with high socio-economic disadvantage had clusters of violent crime. However, they found no evidence of violent crime clusters during the pandemic. This suggests that existing indicators of disadvantage may not be aggravated by an exceptional event like a pandemic, consistent with social disorganization theory.

In this paper, we examine the effect of the natural experiment of COVID-19 on crime trends in neighbourhoods in Vancouver, Canada. We contribute to the COVID-19 and crime literature through an analysis of the effects of neighbourhood characteristics on predicting changes in crime patterns across Vancouver neighbourhoods. We analyse 10 crime types using a local spatial statistical technique to identify statistically significant change and undertake a subsequent ANOVA analysis of these results using 24 variables that relate to social disorganization theory. We describe these 24 variables in the context of social disorganization theory below.

The current study

In order to investigate the effects of COVID-19 on police incidents across space, we analyse social disorder, property, violence and other offences across the official neighbourhoods of Vancouver, British Columbia. Vancouver has 22 official neighbourhoods, with an average of approximately 30,000 persons. Vancouver had a total population of approximately 630,000 persons. At this level of analysis, we obtained socio-demographic, socio-economic and housing data for all official neighbourhoods from Statistics Canada's 2016 Census of Population.

The official neighbourhoods of Vancouver are shown in Fig. 1. Vancouver is bordered to the west by the University of British Columbia and the Salish Sea, to the
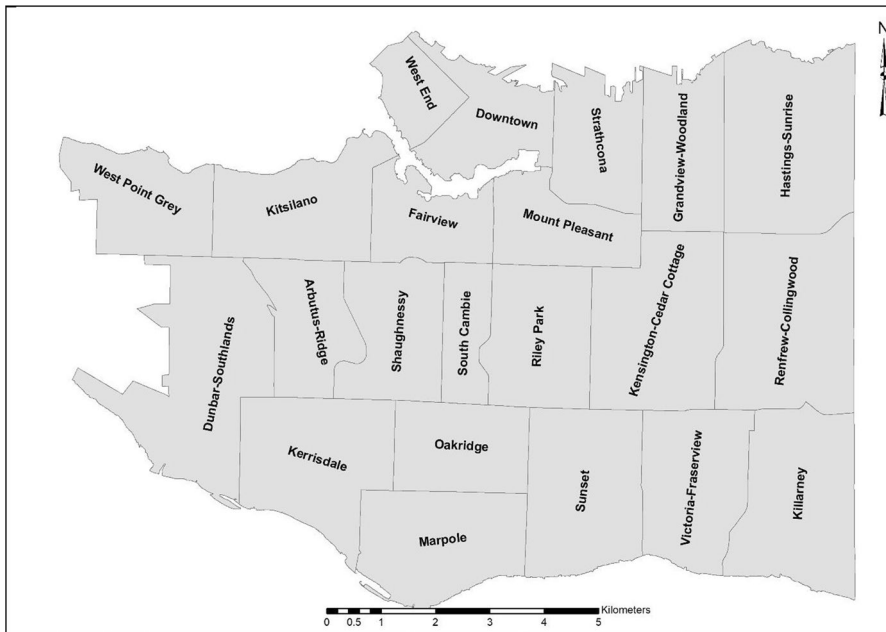
Fig. 1 Vancouver neighbourhoods

north by Burrard Inlet, to the south by the Fraser River and to the east by the City of Burnaby. Vancouver crime data is collected by the Vancouver Police Department. All surrounding jurisdictions are policed by the Royal Canadian Mounted Police. With an area of 114 square kilometres, Vancouver is the highest density city in Canada and the fifth highest density city (greater than 250,000 population) in North America.

As shown in Fig. 2, daily COVID-19 cases in Vancouver first emerged in February 2020. The first wave of COVID infections in Vancouver occurred during March and April 2020, with that wave ending in late spring due to the imposition of social distancing and other social restrictions. These social restrictions were subsequently relaxed, followed by increased infections rates. Since then, Vancouver has gone through 3 subsequent waves of infections, currently in the downward trend of wave 4. As such, aside from a short period of time in summer 2020, Vancouver spent March 2020 to February 2021 (the analysis period) in varying levels of lockdown and with high infection rates in the latter half of this lockdown.

Data

We use open-source data from the Vancouver Police Department (VPD) https://vpd.ca/police/organization/planning-research-audit/neighborhood-statistics.html and neighbourhood level data from the City of Vancouver's Open Data Portal https://opendata.vancouver.ca/pages/home/. The open-source police data include the

Fig. 2 COVID cases, by day, Vancouver, British Columbia Source. http://www.bccdc.ca/ health-info/diseases-conditions/ covid-19/data
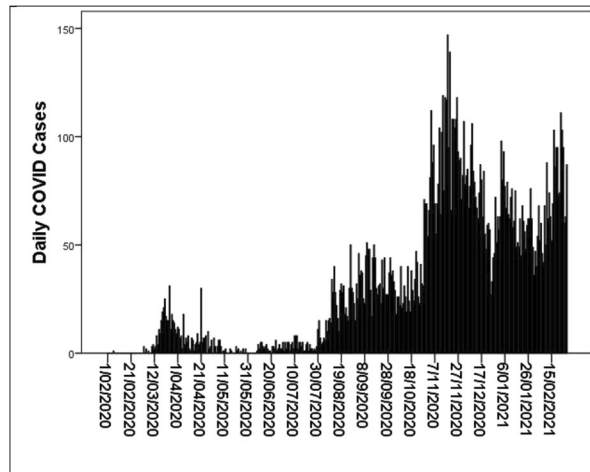
incident crime types: arson, assaults, burglary, mischief, robbery, sex offences, theft, theft from vehicle (TFV), theft of vehicle (TOV) and weapons. As shown in Table 1, these incident types vary significantly across crime types with property crime types dominating the overall crime count and assaults comprising the majority of reported violent crime. We analysed data from 01 March 2020 to 28 February 2021 for the lockdown period, measured as monthly counts. We compared these data to the average monthly counts for 2017, 2018, 2019 and 2020—using 3 years of data prior to COVID-19 to control for 2019–2020 being an aberrant year for any of the Vancouver neighbourhoods and also accounts for the presence of any seasonality in the data (Andresen & Hodgkinson, 2018; Cohn & Rotton, 2000; Farrell & Pease, 1994; Linning et al., 2017; McDowall et al., 2012).

As shown in Table 2, we obtained 24 variables from the census to measure the theoretical constructs of low socio-economic status, residential turnover, ethnic

Table 1 Crime type changes, Vancouver, 2017–2020 and 2020–2021

	Change (bold = significance)	Pre-COVID, average monthly counts	COVID, average monthly counts	Significance level
Assaults	**Increase**	344.9	370.4	0.003
Sex offences	Decrease	45.2	40.5	0.137
Robbery	Increase	48.8	50.4	0.585
Burglary	Increase	381.1	381.8	0.974
Theft of vehicle	**Decrease**	130.4	71.8	0.000
Theft from vehicle	**Decrease**	1223.5	701.2	0.057
Theft	Decrease	1065.3	744.2	0.141
Arson	Increase	19.1	27.7	0.150
Mischief	Increase	419.9	423.4	0.776
Weapons	**Increase**	63.8	89.8	0.022

Bold significance level is 5%

heterogeneity, family disruption and urbanization from social disorganization theory. Socio-economic status is captured considering government assistance (percentage of income), average family income, percentage of lone parent families, percentage low income (threshold defined by Statistics Canada), percent of the population with postsecondary education, the unemployment rate, new housing, housing under major repairs, average rent and average dwelling value. Government assistance is often interpreted as a measure of poverty but may include areas with high levels of (government) pension income. However, this variable is strongly and negatively correlated with income; as such it is expected to represent its common interpretation, albeit cautiously. Regardless, increases in government assistance, low income, unemployment and major repairs are expected to lead to high levels of crime and, consequently, increased probability of crime increasing during COVID-19 related lockdowns; increases in average family income, post-secondary education, new dwellings, average rent and average dwelling value are expected to result in crime decreasing during COVID-19 lockdown. Though many of these individual variables measure similar concepts within socio-economic status, previous (Canadian) research has shown the importance of using multiple measures of the economy and, consequently, socio-economic status to capture nuances within the economy (Andresen, 2015; Andresen & Linning, 2016).

Residential turnover is measured using the percentage of people who have moved in the previous year, the percentage of people who have moved in the previous 5 years and the percentage of rented households; increases in these variables are expected to lead to high levels of crime and, consequently, increased probability of crime increasing during COVID-19-related lockdowns. Ethnic heterogeneity is captured considering the percentage of recent immigrants (previous 5 years), the percentage of total immigrants, the percentage of those with Aboriginal identity,[2] the percentage of visible minorities and an entropy measure (Blau Index) for ethnic heterogeneity. From the theoretical perspective of social disorganization theory, increased levels of ethnic heterogeneity are expected to lead to increases in crime. This expectation is due, in part, to lower levels of social capital and social ties. Shaw and McKay (1942) are clear that this is a transitory relationship that is not present once immigrant populations have resided in the new country for a number of years; rather, they argue that immigrant criminal activity is a product of the neighbourhoods in which they live. Moreover, more recent research on immigration and crime is clear in finding that increases in immigration lead to decreases in crime (Andresen & Ha, 2020). Because of these complexities, our interpretations consider recent research and the original work by Shaw and McKay (1942).

Family disruption is measured using the percentage of lone-parent families. This variable is expected to lead to high levels of crime and, consequently, increased probability of crime increasing during COVID. Urbanization is measured considering a number of populations (census population, number of families and number of dwellings) and the percentage of apartments. All of these variables are expected

---

[2] Indigenous is more inclusive terminology than Aboriginal, but we use the term "Aboriginal identity" to be consistent with language usage by Statistics Canada in the Census of Population.

to lead to high levels of crime and, consequently, increased probability of crime increasing during COVID.

Lastly, we include the percentage of young males (15–24 years) and the percentage of single persons. We include the presence of young males to account for the known empirical regularity of age and crime (Hirschi & Gottfredson, 1983). And we include the presence of single persons because of their (positive) relationship with crime through routine activities and lifestyle exposure literatures (Kennedy & Forde, 1990). In most circumstances, these variables are expected to have a positive relationship with crime, but this theoretical expectation is reversed in the current COVID-19 context. We reverse this expectation because social restrictions should have a greater impact on crime in those places where there were more people with lifestyle activities outside of the home.

Methods: differential local Moran's I and ANOVA

The primary method of analysis employed here is differential local Moran's *I*. Differential Moran's *I* is a form of local Moran's *I* that identifies clusters that relate to change or difference. Local Moran's *I* classifies units of analysis (neighbourhoods in the current context) as having high or low levels of events, such as crime. These neighbourhoods are then identified as clusters in a number of categories: hot spots (high-high), cool spots (low-low) or places with negative spatial autocorrelation (high-low and low–high); these latter two cluster types are areas that have high crime (crime increases) but are surrounded by areas with low crime (crime decreases) and areas with low crime (crime decreases) that are surrounded by areas with high crime (crime increases), respectively.

Differential local Moran's *I* sorts areas based on differences for the same area. For example, these differences could be measured over time, such as the current context: average monthly counts pre- and post-COVID-19. As such, for each area/neighbourhood, the difference in the average monthly count of criminal incidents is mapped and identified into clusters. Based on the discussion above, these clusters then represent places that have the following characteristics: areas with increases in crime (during COVID-19) that are surrounded by other places that have increases in crime (high-high), areas with decreases in crime that are surrounded by other places that have decreases in crime (low-low), areas with decreases in crime that are surrounded by other places that have increases in crime (low–high) and areas with increases in crime that are surrounded by other places that have decreases in crime (high-low). The end result is a map (one for each crime type) that shows clusters of change pre- and post-COVID-19 in Vancouver neighbourhoods. In all of our analyses, we use first-order Queen's contiguity for our spatial weights matrix. Using this criterion our neighbourhoods have 1–7 spatial neighbours, with an average of 4.36.[3]

These clusters are then analysed using one-way ANOVA to investigate the relationship between social disorganization theory and changes in crime because of an

---

[3] Higher order contiguity does not change the qualitative nature of our results.

Table 2 Descriptive statistics, independent variables, Vancouver neighbourhoods, 2016

	Minimum	Maximum	Mean	Std. Deviation
Males (15–24), %	3.2	8.5	6.0	1.8
Single persons, %	39.5	70.4	48.7	6.4
Move, 1 year, %	11.8	25.0	16.8	3.6
Move, 5 years, %	34.0	64.1	45.0	9.0
Post-secondary, %	44.7	79.2	63.1	11.3
Unemployment rate	4.6	8.5	5.9	1.0
Government assistance, %	2.8	21.8	8.5	4.5
Lone parents, %	8.8	25.6	16.5	4.0
Average family income, $000 s	79.0	311.5	135.0	53.8
Low income, %	11.2	43.4	17.9	6.7
Immigrants, %	26.6	60.0	42.7	10.8
Recent immigrants, %	3.2	8.9	5.8	1.8
Visible minorities, %	20.1	84.2	51.7	19.5
Ethnic heterogeneity	36.0	88.5	61.3	16.0
Aboriginal, %	0.5	10.0	2.4	2.3
Apartments, %	9.3	99.2	49.5	28.1
Rented, %	21.7	80.8	47.5	15.4
Major repairs, %	3.6	10.6	6.9	1.7
Old houses, %	10.1	70.2	51.6	12.8
Average rent, $00 s	7.0	18.2	13.3	2.8
Average dwelling value, $000 s	670.8	3247.3	1637.4	817.5
Census population	7970	62,030	28,778.9	15,188.9
Number of families	2005	14,550	7333.2	3756.7
Number of dwellings	2875	35,105	12,931.8	8667.3

exceptional event. One-way ANOVA is used because of the low number of Vancouver neighbourhoods. Nonetheless, this method allows for the identification of theoretically derived expectations.

Results

The city level tests for changes (t-tests) in the various crime types are shown in Table 1, comparing the period March 2020 to February 2021 to the previous 3 years. Of the 10 crime types under analysis, only four showed statistically significant change during the COVID-19 period in Vancouver: assaults, theft of vehicle, theft from vehicle and weapons offences. Moreover, of these four crime types, there has been an increase in the violent crime types and decreases in the property crime types. This is in contrast to previous research on the early impacts of COVID-19 and crime in Vancouver (Hodgkinson & Andresen, 2020) and is simply due to the longer time series available now; when only considering the first 3 months during

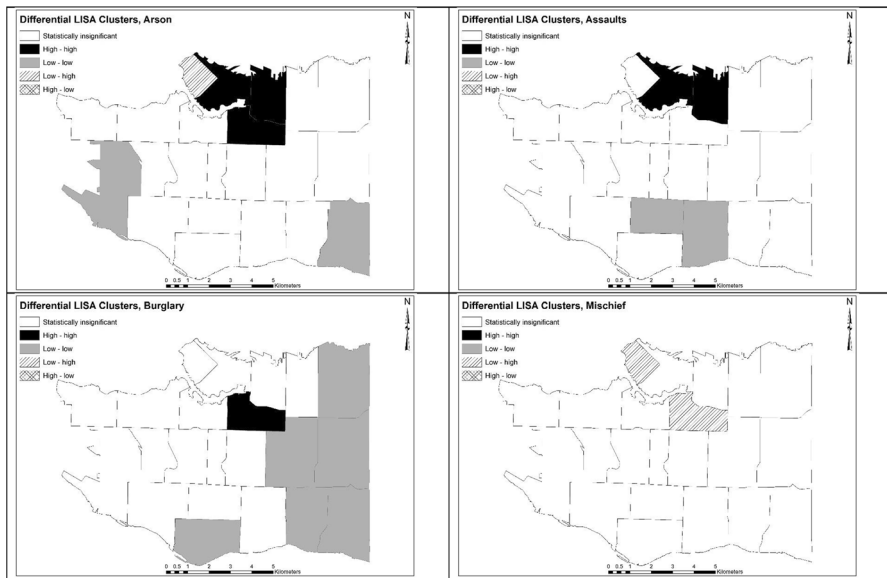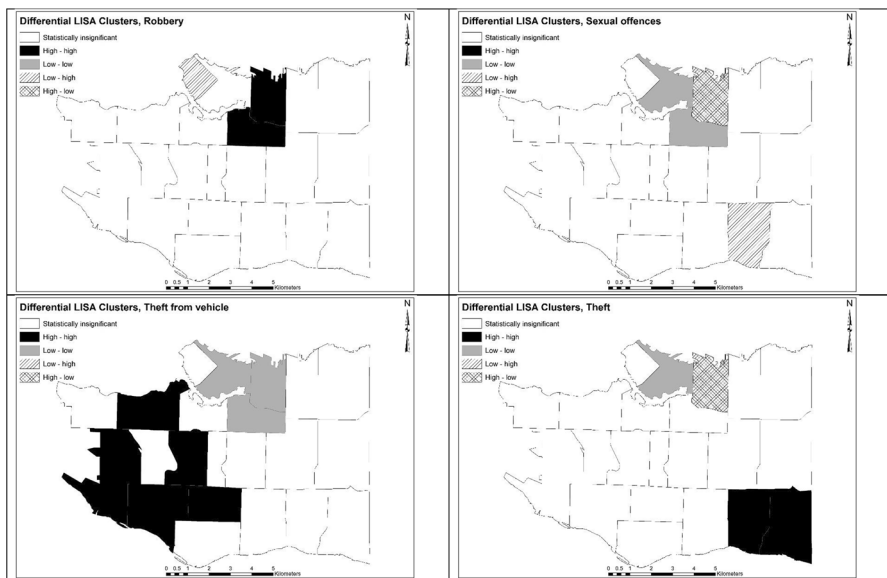**Fig. 3** Differential LISA clusters, Vancouver neighbourhoods

Fig. 3 (continued)

COVID-19, 7 of the 10 crime types (all but assaults, sex offences and robbery) had statistically significant changes in the same direction as shown in Table 1.

Turning to the output from the differential Moran's *I* clusters, Fig. 3, we can see a number of interesting results. First, each crime type shows statistically
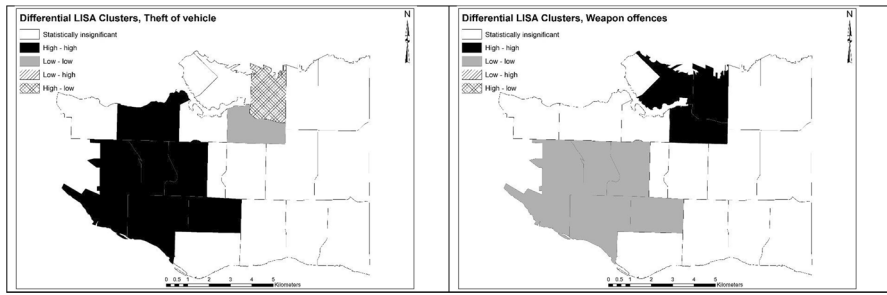
Fig. 3 (continued)

significant changes (increasing and/or decreasing) in at least one Vancouver neighbourhood, despite only 4 crime types having statistically significant change at the city level. This finding shows that either a small number of neighbourhoods are driving global statistical results, or city level results appear statistically insignificant because so few neighbourhoods exhibit statistically significant change. Additionally, most crime types show both statistically significant increases and decreases in crime, possibly leading to the statistically insignificant results for some crime types at the city level.

Considering the specific crime types, there are a number of interesting pattern changes. During the social restriction period, arson-, assault-, robbery- and weapon-related offences increased in the poorer areas of Vancouver (Downtown, Strathcona, Mount Pleasant) while decreasing in wealthier areas. Alternatively, theft, theft from vehicle and theft from vehicle-related offenses increased in areas that are wealthier (Kitsilano, Kerrisdale, Oakridge and Killarney), with decreases in poorer areas. Specifically, the downtown area (central business district) and surrounding neighbourhoods experienced more decreases than other neighbourhoods in property-related crimes (theft, theft from vehicle, theft of vehicle), an expected finding considering that most businesses were shuttered and workday traffic and parking would be essentially eliminated in these areas during the COVID-19 lockdown.

The ANOVA results comparing the local crime cluster types with the variables, discussed above, are presented in Tables 3 through 7, with statistically significant results that confirm our theoretical expectations shown in bold— post-hoc tests are not undertaken here because not all crime types have enough observations falling into the different local crime cluster types. The results for arson, Table 3, are generally as expected according to social disorganization theory. High crime areas (including low crime areas surrounded by high crime areas (Low–High clusters)) have higher rates of single persons, movers, low income and rented homes. Assault, Table 3, has its high crime clusters with higher rates of single persons, apartments and Aboriginal persons—it is critical to recognize that this latter relationship is representative of the well-documented high levels of (child) poverty and structural/institutional inequalities for Indigenous populations in Canada (MacDonald & Wilson, 2013). High crime clusters of assault are also characterized by lower levels of visible minorities and older homes.

Table 3 ANOVA results, means by cluster types, COVID – Pre-COVID changes, arson and assault

	Arson					Assault			
	Stat. Insig	HH	LL	LH	Total	Stat. Insig	HH	LL	Total
Males (15–24), %	**6.3****	**3.7****	**7.5****	**3.7****	**6.0****	**6.0***	**3.9***	**7.6***	**6.0***
Single persons, %	47.2**	58.0**	42.3**	57.5**	48.7**	47.6**	61.9**	45.6**	48.7**
Move, 1 year, %	**16.0****	**21.3****	**12.9****	**24.5****	**16.8****	16.5	21.2	15.4	16.8
Move, 5 years, %	**42.8****	**57.5****	**35.3****	**60.7****	**45.0****	44.2	55.0	41.8	45.0
Post-secondary, %	61.9	66.1	61.8	74.8	63.1	64.1	61.7	55.0	63.1
Unemployment rate	5.9	6.3	5.8	5.3	5.9	5.8	7.1	5.5	5.9
Government assistance, %	8.3	10.3	8.1	7.2	8.5	7.7	13.0	10.8	8.5
Lone parents, %	17.0	15.9	17.1	8.8	16.5	16.1	18.4	18.1	16.5
Average family income, $000 s	139.6	112.9	148.9	100.2	135.0	140.7	109.3	108.7	135.0
Median family income, $000 s	96.3	86.1	106.6	80.5	95.1	98.4	78.3	82.6	95.1
Low income, %	**16.3***	**26.9***	**15.0***	**21.7***	**17.9***	**16.2****	**32.7****	**18.5****	**17.9****
Immigrants, %	44.3	35.9	44.8	34.1	42.7	41.4	39.8	57.6	42.7
Recent immigrants, %	5.8	5.1	6.0	8.1	5.8	5.6	5.4	7.8	5.8
Visible minorities, %	54.9	40.3	55.2	28.6	51.7	49.5*	44.4*	79.2*	51.7*
Ethnic heterogeneity	58.7	73.1	51.0	88.5	61.3	61.0	68.9	56.5	61.3
Aboriginal, %	1.9	5.2	2.8	2.3	2.4	2.2**	6.2**	1.1**	2.4**
Apartments, %	**42.9****	**88.4****	**18.8****	**99.2****	**49.5****	47.0*	89.2*	32.6*	49.5*
Rented, %	**44.1****	**66.3****	**30.9****	**80.1****	**47.5****	45.7	69.0	42.7	47.5
Major repairs, %	6.7	7.6	6.6	7.4	6.9	6.9	6.9	6.5	6.9
Old houses, %	53.1	38.1	50.5	70.2	51.6	54.1**	32.8*	48.2*	51.6*
Average rent, $00 s	13.4	11.9	14.6	13.1	13.3	13.5	11.4	13.0	13.3
Average dwelling value, $000 s	1789.8	863.5	2062.0	670.8	1637.4	1686.9	893.5	1935.8	1637.4
Census population	10.0	10.3	10.1	10.8	10.1	10.1	10.2	10.0	10.1
Number of families	8.7	8.7	8.9	9.2	8.7	8.8	8.6	8.7	8.7
Number of dwellings	9.1	9.6	9.1	10.3	9.3	9.3	9.6	8.9	9.3

* and ** represent statistical significance at the 10% and 5% level; HH – High -high; LL – Low-low; LH – Low–high; HL – High-low. Bold indicates results that are both statistically significant and confirm theoretical expectations

Table 4 ANOVA results, means by cluster types, COVID – Pre-COVID changes, burglary and mischief

	Burglary				Mischief		
	Stat. Insig	HH	LL	Total	Stat. Insig	LH	Total
Males (15–24), %	5.9	3.2	6.7	6.0	**6.2****	**3.4****	**6.0****
Single persons, %	49.0	50.3	47.8	48.7	48.2	53.9	48.7
Move, 1 year, %	**17.6****	**21.5****	**14.1****	**16.8****	**16.2****	**23.0****	**16.8****
Move, 5 years, %	**46.6****	**62.6****	**37.9****	**45.0****	**43.3****	**61.6****	**45.0****
Post-secondary, %	67.1**	74.7**	51.2**	63.1**	61.9	74.8	63.1
Unemployment rate	5.9	4.7	6.1	5.9	6.0	5.0	5.9
Government assistance, %	7.4*	5.0*	11.8*	8.5*	8.7	6.1	8.5
Lone parents, %	15.7*	10.8*	19.4*	16.5*	17.2**	9.8**	16.5**
Average family income, $000 s	151.1	120.0	97.1	135.0	137.5	110.1	135.0
Median family income, $000 s	100.1	101.8	81.6	95.1	95.5	91.1	95.1
Low income, %	19.0	15.3	15.6	17.9	17.8	18.5	17.9
Immigrants, %	**39.9****	**28.0****	**52.3****	**42.7****	43.9	31.0	42.7
Recent immigrants, %	5.8	4.4	6.0	5.8	5.8	6.3	5.8
Visible minorities, %	**45.5****	**31.9****	**70.5****	**51.7****	53.8*	30.3*	51.7*
Ethnic heterogeneity	59.9	81.5	61.5	61.3	**58.9****	**85.0****	**61.3****
Aboriginal, %	2.6	3.0	1.9	2.4	2.4	2.7	2.4
Apartments, %	53.4	86.7	33.6	49.5	**45.2****	**93.0****	**49.5****
Rented, %	48.0	60.9	44.2	47.5	**45.2****	**70.5****	**47.5****
Major repairs, %	6.9	9.0	6.4	6.9	6.7	8.2	6.9
Old houses, %	54.3	48.6	45.5	51.6	50.8	59.4	51.6
Average rent, $00 s	14.2*	12.9*	11.1*	13.3*	13.3	13.0	13.3
Average dwelling value, $000 s	1826.9	803.5	1302.5	1637.4	**1727.4***	**737.1***	**1637.4***
Census population	10.0	10.4	10.5	10.1	10.1	10.6	10.1
Number of families	8.6	9.0	9.2	8.7	8.7	9.1	8.7
Number of dwellings	9.1	9.8	9.5	9.3	**9.2***	**10.1***	**9.3***

* and ** represent statistical significance at the 10% and 5% level; HH – High -high; LL – Low-low; LH – Low–high; HL – High-low. Bold indicates results that are both statistically significant and confirm theoretical expectations

Turning to burglary and mischief, Table 4, results are somewhat different. For burglary, neighbourhoods that have higher rates of population change (persons who have moved in the previous 5 years) are high crime cluster areas. Conversely, high crime cluster neighbourhoods are also characterized by higher rates post-secondary education, lower rates of government assistance, low income, immigrants and visible minorities. Though contrary to theoretical explanations with regard to socio-economic variables, this is consistent with recent research on residential burglary in Vancouver (Hodgkinson & Andresen, 2019a). For mischief, low crime neighbourhoods surrounded by high crime neighbourhoods have mixed results, potentially because of the combination of low and (surrounding) high crime: fewer young males, more movers, fewer lone parents, fewer immigrants

Table 5 ANOVA results, means by cluster types, COVID – Pre-COVID changes, robbery and sexual offences

	Robbery				Sexual offences				
	Stat. Insig	HH	LH	Total	Stat. Insig	LL	LH	HL	Total
Males (15–24), %	**6.3****	**3.5****	**3.7****	**6.0****	**6.3***	**3.6***	**6.8***	**3.7***	**6.0***
Single persons, %	47.0**	60.3**	57.5**	48.7**	47.3**	51.8**	46.3**	70.4**	48.7**
Move, 1 year, %	16.1**	19.4**	24.5**	16.8**	16.3**	23.2**	11.8**	17.4**	16.8**
Move, 5 years, %	**43.2****	**54.3****	**60.7****	**45.0****	43.5**	63.3**	34.0**	46.0**	45.0**
Post-secondary, %	62.7	60.7	74.8	63.1	**63.6****	**75.7****	**44.7****	**46.8****	**63.1****
Unemployment rate	5.9	6.6	5.3	5.9	**5.8****	**5.2****	**6.5****	**8.5****	**5.9****
Government assistance, %	8.0	13.4	7.2	8.5	**7.9**	**4.6****	**13.7****	**21.8****	**8.5****
Lone parents, %	16.7	18.2	8.8	16.5	**16.5****	**11.0****	**18.7****	**25.6****	**16.5****
Average family income, $000 s	140.5	99.5	100.2	135.0	140.8	129.8	96.8	79.0	135.0
Median family income, $000 s	97.6	78.6	80.5	95.1	97.5	101.5	79.2	55.4	95.1
Low income, %	16.5	29.4	21.7	17.9	**16.7****	**18.6****	**13.4****	**43.4****	**17.9****
Immigrants, %	44.1	33.7	34.1	42.7	42.9	34.0	60.0	39.5	42.7
Recent immigrants, %	5.9	3.9	8.1	5.8	5.9	6.0	6.9	3.3	5.8
Visible minorities, %	54.3	38.6	28.6	51.7	51.8	37.8	84.2	45.2	51.7
Ethnic heterogeneity	59.1	69.1	88.5	61.3	59.5	81.4	58.4	56.6	61.3
Aboriginal, %	2.0**	6.5**	2.3**	2.4**	2.1**	2.7**	1.3**	10.0**	2.4**
Apartments, %	**43.3****	**83.9****	**99.2****	**49.5****	**44.4***	**92.0***	**25.4***	**81.1***	**49.5***
Rented, %	**43.4****	**70.8****	**80.1****	**47.5****	**44.9***	**59.0***	**39.0***	**80.8***	**47.5***
Major repairs, %	**6.6****	**9.6****	**7.4****	**6.9****	6.9	6.3	5.2	10.3	6.9
Old houses, %	50.6	52.1	70.2	51.6	**54.6****	**29.4****	**38.9****	**55.6****	**51.6****
Average rent, $00 s	13.6	10.0	13.1	13.3	**13.6***	**14.4***	**10.6***	**7.0***	**13.3***
Average dwelling value, $000 s	1773.8	824.5	670.8	1637.4	1777.3	872.5	1441.6	845.6	1637.4
Census population	10.1	9.9	10.8	10.1	10.1	10.7	10.3	9.4	10.1
Number of families	8.8	8.3	9.2	8.7	8.7	9.3	9.1	7.6	8.7
Number of dwellings	9.2	9.2	10.3	9.3	9.2	10.1	9.2	8.7	9.3

* and ** represent statistical significance at the 10% and 5% level; HH – High -high; LL – Low-low; LH – Low–high; HL – High-low. Bold indicates results that are both statistically significant and confirm theoretical expectations

Table 6 ANOVA results, means by cluster types, COVID – Pre-COVID changes, theft and theft from vehicle

	Theft					Theft from vehicle			
	Stat. Insig	HH	LL	HL	Total	Stat. Insig	HH	LL	Total
Males (15–24), %	6.1	6.7	4.0	3.7	6.0	6.1**	7.1**	3.7**	6.0**
Single persons, %	47.6**	45.7**	53.4**	70.4**	48.7**	48.3**	44.2**	58.0**	48.7**
Move, 1 year, %	16.9**	11.9**	25.0**	17.4**	16.8**	16.3*	15.7*	21.3*	16.8*
Move, 5 years, %	45.0*	34.9*	64.1*	46.0*	45.0*	43.1**	42.7**	57.5**	45.0**
Post-secondary, %	64.7*	49.6*	76.7*	46.8*	63.1*	60.5	68.6	66.1	63.1
Unemployment rate	5.8**	6.0**	5.6**	8.5**	5.9**	5.8	5.9	6.3	5.9
Government assistance, %	7.5**	12.7**	4.2**	21.8**	8.5**	9.3	5.2	10.3	8.5
Lone parents, %	16.0**	19.3**	11.2**	25.6**	16.5**	16.9	15.6	15.9	16.5
Average family income, $000 s	142.0	97.4	139.7	79.0	135.0	118.9**	193.3**	112.9**	135.0**
Median family income, $000 s	98.5	81.7	101.1	55.4	95.1	90.6*	113.1*	86.1*	95.1*
Low income, %	16.7**	14.0**	21.9**	43.4**	17.9**	16.2**	17.3**	26.9**	17.9**
Immigrants, %	41.6	56.2	40.1	39.5	42.7	44.1	43.2	35.9	42.7
Recent immigrants, %	5.8	6.3	7.5	3.3	5.8	5.8	6.2	5.1	5.8
Visible minorities, %	49.6	77.9	43.7	45.2	51.7	55.0	49.4	40.3	51.7
Ethnic heterogeneity	60.4	61.6	81.2	56.6	61.3	64.1**	46.4**	73.1**	61.3**
Aboriginal, %	2.1	1.4	2.4	10.0	2.4	2.2*	1.6*	5.2*	2.4*
Apartments, %	47.6	26.9	97.4	81.1	49.5	45.7**	36.8**	88.4**	49.5**
Rented, %	46.0	39.6	57.2	80.8	47.5	47.9**	35.2**	66.3**	47.5**
Major repairs, %	6.9**	6.2**	3.6**	10.3**	6.9**	6.9	6.4	7.6	6.9
Old houses, %	55.0**	39.9**	10.1**	55.6**	51.6**	52.2*	58.1*	38.1*	51.6*
Average rent, $00 s	13.7**	10.8**	15.9**	7.0**	13.3**	12.5**	16.2**	11.9**	13.3**
Average dwelling value, $000 s	1760.9	1269.4	941.5	845.6	1637.4	1466.9**	2579.2**	863.5**	1637.4**
Census population	10.1	10.3	11.0	9.4	10.1	10.2	9.7	10.3	10.1

Table 6 (continued)

	Theft					Theft from vehicle			
	Stat. Insig	HH	LL	HL	Total	Stat. Insig	HH	LL	Total
Number of families	8.7	9.0	9.6	7.6	8.7	8.9	8.4	8.7	8.7
Number of dwellings	9.2	9.3	10.5	8.7	9.3	9.3	8.8	9.6	9.3

* and ** represent statistical significance at the 10% and 5% level; HH – High –high; LL – Low-low; LH – Low–high; HL – High-low. Bold indicates results that are both statistically significant and confirm theoretical expectations

but more ethnic heterogeneity, more apartments and rentals and lower average dwelling values.

Robbery, Table 5, has similar results to the previously discussed crime types, including fewer young males. Sexual offences are also consistent with much of the previously found relationships. Notable results are high crime clusters (including Low–High clusters) and have more young males, lower post-secondary, higher unemployment and lower average rent.

Theft, Table 6, has both high crime clusters (high-high and high-low) with high-low local crime clusters exhibiting a stronger and more consistent result. Theft from vehicle, Table 6, has high crime local crime cluster results that are counter to most theoretical expectations: fewer single persons, fewer movers, higher income, less low income, fewer apartments and rentals and high average dwelling values. During the pandemic, theft from vehicle increased in high socio-economic status neighbourhoods.

Theft of vehicle, Table 7, has results that resemble theft in one context, but theft from vehicle in another. Theft of vehicle has a similarity with theft in that high-low local crime clusters are far more consistent with theoretical expectations than high-high local crime clusters. In the context of comparing theft of vehicle with theft from vehicle, the results for high-high local crime clusters are largely inconsistent with theoretical expectations, as discussed above. Lastly, weapon offences have increased in neighbourhoods with more single persons, more movers, lower average income, more low-income families, more rentals and apartments, lower rent and lower average dwelling value.

Discussion

The COVID-19 pandemic is an exceptional event that created a natural experiment in which theories of crime could be further explored. Lockdowns, social restrictions, bans or restrictions on national and international travel have dramatically affected social life and collective behaviour. As discussed above, much of the current research on COVID-19-related restrictions and crime has shown initial decreases in criminal activity, followed by subsequent increases as social restrictions eased. This research has dominantly invoked the routine activity approach (Cohen & Felson, 1979) to explain these changes in accordance with changed opportunities. However, more recent research has emerged at the neighbourhood and community level that is also considering social disorganization theory and the impact of COVID-19 on crime in different neighbourhood contexts. In particular, this research is demonstrating that the changes in crime patterns are not merely a result of changes in opportunities. Based on our findings here, we believe this study contributes to this growing body of work suggesting that neighbourhood level factors correlate with the changing crime patterns during COVID-19.

In this study, we find that changes in particular crime types during COVID-19-related restrictions (arson, assaults, burglary, robbery and weapons offences) are consistent with social disorganization theory—an exceptional event will aggravate social inequalities and increase these crime types in socially disorganized areas. In

Table 7 ANOVA results, means by cluster types, COVID – Pre-COVID changes, theft of vehicle and weapons

	Theft of vehicle					Weapons			
	Stat. Insig	HH	LL	HL	Total	Stat. Insig	HH	LL	Total
Males (15–24), %	5.8**	7.2**	3.2**	3.7**	6.0**	5.8**	3.7**	7.7**	6.0**
Single persons, %	48.8**	44.6**	50.3**	70.4**	48.7**	48.6**	58.0**	43.5**	48.7**
Move, 1 year, %	16.9	15.7	21.5	17.4	16.8	16.6**	21.3**	14.8**	16.8**
Move, 5 years, %	44.5	43.0	62.6	46.0	45.0	43.8**	57.5**	40.7**	45.0**
Post-secondary, %	61.3	68.0	74.7	46.8	63.1	61.3	66.1	66.3	63.1
Unemployment rate	5.8**	6.0**	4.7**	8.5**	5.9**	5.7	6.3	6.1	5.9
Government assistance, %	9.1**	5.5**	5.0**	21.8**	8.5**	9.1	10.3	5.6	8.5
Lone parents, %	16.2*	16.5*	10.8*	25.6*	16.5*	16.3	15.9	17.4	16.5
Average family income, $000 s	117.9**	186.6**	120.0**	79.0**	135.0**	118.3**	112.9**	195.1**	135.0**
Median family income, $000 s	91.5**	109.0**	101.8**	55.4**	95.1**	92.1	86.1	108.9	95.1
Low income, %	16.2**	18.0**	15.3**	43.4**	17.9**	15.8**	26.9**	18.5**	17.9**
Immigrants, %	43.3	44.5	28.0	39.5	42.7	42.3	35.9	48.0	42.7
Recent immigrants, %	5.8	6.6	4.4	3.3	5.8	5.6	5.1	6.8	5.8
Visible minorities, %	53.9	50.8	31.9	45.2	51.7	52.3	40.3	57.0	51.7
Ethnic heterogeneity	67.3**	44.7**	81.5**	56.6**	61.3**	67.1**	73.1**	38.0**	61.3**
Aboriginal, %	2.3**	1.5**	3.0**	10.0**	2.4**	2.2**	5.2**	1.4**	2.4**
Apartments, %	49.4	38.2	86.7	81.1	49.5	47.8**	88.4**	31.1**	49.5**
Rented, %	49.4**	35.5**	60.9**	80.8**	47.5**	49.4**	66.3**	31.2**	47.5**
Major repairs, %	6.7*	6.3*	9.0*	10.3*	6.9*	7.0	7.6	6.2	6.9
Old houses, %	49.2	57.1	48.6	55.6	51.6	52.7	38.1	56.8	51.6
Average rent, $00 s	12.4**	16.3**	12.9**	7.0**	13.3**	12.4**	11.9**	16.6**	13.3**
Average dwelling value, $000 s	1355.5**	2566.0**	803.5**	845.6**	1637.4**	1383.1**	863.5**	2813.7**	1637.4**
Census population	10.3	9.7	10.4	9.4	10.1	10.3**	10.3**	9.5**	10.1**

Table 7 (continued)

	Theft of vehicle					Weapons			
	Stat. Insig	HH	LL	HL	Total	Stat. Insig	HH	LL	Total
Number of families	9.0*	8.4*	9.0*	7.6*	8.7*	**8.9***	**8.7***	**8.2***	**8.7***
Number of dwellings	9.4	8.8	9.8	8.7	9.3	**9.4****	**9.6****	**8.6****	**9.3****

* and ** represent statistical significance at the 10% and 5% level; HH – High -high; LL – Low-low; LH – Low–high; HL – High-low. Bold indicates results that are both statistically significant and confirm theoretical expectations

other words, neighbourhoods in Vancouver with lower socio-economic status experience statistically significant increases in crime, whereas higher socio-economic neighbourhoods experience statistically significant decreases in crime. These findings are consistent in both the differential local Moran's I maps and the ANOVA output.

However, we also found increases in property-related crime types in the wealthier neighbourhoods of Vancouver (theft, theft from vehicle and theft of vehicle); these increases are likely occurring in these areas because of increased target availability in these areas during lockdown—vehicles are located at home rather than being parked in central business district during the day. Additionally, these crime types (theft, theft from vehicle and theft of vehicle) have overall decreases at the city level, demonstrating the importance of neighbourhood level analyses; neighbourhood level analyses show how local areas within the entire study region can exhibit different results than the overall pattern of the study region. This study also shows the importance of investigating these phenomena at the local level as well as the entire study region to identify shifts in crime or potential displacement (Hodgkinson, et al., 2016, 2020).

The conflicting results highlight the importance of considering multiple theoretical, or exploratory, frameworks, at different geographical levels, to understand changes in crime during an exceptional event. Social disorganization theory proves to be instructive in explaining many of the neighbourhood level crime trends that are lost at the city-level analysis in other studies of COVID-19 and crime. Indeed, this study suggests that there are neighbourhood level differences in crime during the COVID-19 pandemic that cannot be explained by opportunity theories alone.

Part of these changes may be understood in the context of already existing changing patterns of crime. In Vancouver, for example, Hodgkinson and Andresen (2019a) found that the spatial patterns of residential burglary have been shifting in recent years into many of the wealthier areas of the city. They argue that this is, in part, due to changes in opportunity structures that relate to residential burglary: conventionally lower socio-economic areas (e.g. Fairview, Mount Pleasant, Strathcona) have experienced a lot of high-density development with higher levels of security than single family homes. During COVID-19, what may also be occurring but in a different context for theft of vehicle and theft from vehicle: because of decreased opportunities for these crime types in the central business district (the shuttering of the economy with people working from home), there are relatively more targets for these crimes in the wealthier areas of the city without secure parking. This is speculation at this point but would be consistent with the previous research that has considered residential burglary. Specifically, Hodgkinson and Andresen (2019a) found that residential burglary in Vancouver decreased more in areas with increased levels of security found in condominium complexes (e.g. underground secure parking, key fob door and elevator access). The wealthier areas of Vancouver have relatively more single-family dwelling and are, therefore, more vulnerable to vehicle-related theft with more people working from home. Regardless, our analyses have shown that social disorganization theory performs well when predicting where there will be increases in crime during the COVID-19 related restrictions in the neighbourhoods of Vancouver. However, it is important to note that our analyses do not control

for covariates or consider dynamic changes in socioeconomic and demographic characteristics.

Many of the places experiencing increases in crime during the pandemic are relatively poorer areas of the city that also experienced significant COVID-19-related job loss (Kantamneni, 2020). This is consistent with the collective behaviour literature that suggests an exceptional event exacerbates disadvantage in socially disorganized areas. Our study raises important environmental and social justice concerns related to crime and pandemic-related restrictions in these areas—see Kantamneni (2020) and Fisher and Bubola (2020) for discussions regarding those impacted most because of social restrictions and employment and economic inequality and COVID-19. For example, as similar pandemics emerge, policy makers may find it prudent to provide residents in these neighbourhoods with additional supports, rather than simply over-policing these areas.

It is important to note that these findings, and their corresponding societal implications, from our research are not without limitations. First, as with all of the research on COVID-19 and crime, we are limited in our analyses by available police data. Criminal events tend to only be approximately 20% of police activity (Wuschke et al., 2018). Second, it is possible because of the nature of the social restrictions, residents and neighbourhoods who have less means to shelter in place may be more visible to the police when other residents are staying home. As such, any criminal activity in these areas may too be more visible and there could be a risk of over-policing which would lead to an increase in crime rates in these neighbourhoods (Batko et al., 2020; Rountree et al., 2019). These neighbourhoods (Downtown, Strathcona and Mount Pleasant), as shown in our results, have experienced more increases in criminal activity than other areas of the city. Third, though 1 year of crime data, post advent of the current pandemic, is the longest follow up time series we are aware of, this is still a short time frame to fully understand the impact of the pandemic and subsequent social conditions on crime. Fourth, because of the number of neighbourhoods, we do not control for covariates or consider dynamic changes in socioeconomic and demographic characteristics. Fifth and finally, though instructive, our neighbourhoods are relatively coarse spatial units of analysis. The use of these neighbourhoods allows for the incorporation of a number of violent crime types, but limits the methodological approach that can be taken—multivariate analyses, for example. Moreover, the size of the spatial unit has long been known to impact the results of analyses (Malleson, et al., 2019), such that what we have found here may be specific to, or an artifact of, Vancouver's official neighbourhoods.

Despite these limitations, this research highlights the importance of a spatial perspective and local spatial statistical analyses when considering the impacts of a natural experiment. Moreover, the limitations outlined above highlight directions for future research. First and foremost, an expansion of data sources is necessary for future research. This may include other available data from police services or other public agencies. For example, police interactions with people with mental illness have been shown to be a significant component of police calls for service that have their own spatial and temporal patterns (Hodgkinson & Andresen, 2019b; Vaughan et al., 2018; Weisburd et al., 2018). And in the context of a pandemic, this population is likely to need further social support services that may, by default,

be initially responded to by police. Second, longer-term follow-up/evaluation periods of COVID-19's effect on crime should continue to be undertaken. Third, future research should consider multiple spatial units of analysis, if available, to ensure that results are not specific to one particular spatial unit of analysis and criminological theory. And fourth, similar spatial/neighbourhood analyses need to be undertaken in different contexts in order to investigate the generalizability of the current research findings.

Conclusion

In this study, we examined COVID-19-related restrictions in Vancouver, Canada, as a natural experiment to explore theories of crime and collective behaviour during exceptional events. In particular, we examined crime trends across 10 crime types in Vancouver's 22 neighbourhoods to determine if neighbourhood level variables related to social disorganization theory predict increases in crime in more socially disorganized neighbourhoods. In general, we find that social disorganization theory is useful in understanding crime trends at the neighbourhood level, save for residential burglary and theft/auto-theft that appear to be somewhat unique to the Vancouver residential context and the manner in which restrictions affected business and travel, having crime shifting into higher socio-economic areas. Findings suggest that the reliance on city-level crime data has resulted in a singular focus on opportunity theories and that future research should consider different spatial levels of measurement and predictor variables when theory testing COVID-19-related changes in crime.

Declarations

References

Andresen, M. A. (2015). Unemployment, GDP, and crime: The importance of multiple measurements of the economy. *Canadian Journal of Criminology and Criminal Justice, 57*(1), 35–58.

Andresen, M. A., & Ha, O. K. (2020). Spatially-varying relationships between immigration measures and property crime types in Vancouver census tracts, 2016. *British Journal of Criminology, 60*(5), 1342–1367.

Andresen, M. A., & Hodgkinson, T. (2018). Evaluating the impact of police foot patrol at The micro-geographic level. *Policing: An International Journal, 41*(3), 314–324.

Andresen, M. A., & Hodgkinson, T. (2020). Somehow I always end up alone: COVID-19, social isolation and crime in Queensland. *Australia. Crime Science, 9*, Article 25.

Andresen, M. A., & Linning, S. J. (2016). Unemployment, business cycles, and crime specialization: An analysis of Canadian provinces, 1981–2009. *Australian and New Zealand Journal of Criminology, 49*(3), 332–350.

Ashby, M. P. J. (2020). Initial evidence on the relationship between the coronavirus pandemic and crime in the United States. *Crime Science, 9*, Article 6.

Barton, A. H. (1969). *Communities in disaster: A sociological analysis of collective stresssituations*. Garden City, NY: Doubleday & Company.

Batko, S., Oneto, A. D., & Shroyer, A. (2020). *Unsheltered homelessness: Trends, characteristics, and homeless histories*. Urban Institute.

Borrion, H., Kurland, J., Tilley, N., & Chen, P. (2020). Measuring the resilience of criminogenic ecosystems to global disruption: A case-study of COVID-19 in China. *PLoS One, 15*(10), e0240077.

Campedelli, G. M., Aziani, A., & Favarin, S. (2020a). Exploring the immediate effects of COVID-19 containment policies on crime: An empirical analysis of the short-term aftermath in Los Angeles. *American Journal of Criminal Justice*. https://doi.org/10.1007/s12103-020-09578-6

Campedelli, G. M., Favarin, S., Aziani, A., & Piquero, A. R. (2020). Disentangling community-level changes in crime trends during the COVID-19 pandemic in Chicago. *Crime Science, 9*, Article 21.

Cohen, L. E., & Felson, M. (1979). Social change and crime rate trends: A routine activity approach. *American Sociological Review, 44*(4), 588–608.

Cohn, E., & Rotton, J. (2000). Weather, seasonal trends and property crimes in Minneapolis, 1987–1988. A moderator-variable time-series analysis of routineactivities. *Journal of Environmental Psychology, 20*(3), 257–272.

Davila, M., Marquart, J., & Mullings, J. (2005). Beyond mother nature: Contractor fraud in the wake of natural disasters. *Deviant Behavior, 26*(3), 271–293.

Drabek, T. (1986). *Human system responses to disaster: An inventory of sociologicalfindings*. Springer-Verlag.

Eisner, M., & Nivette, A. (2020). *Violence and the pandemic: Urgent questions forresearch*. New York, NY: Harry Frank Guggenheim Foundation

Farrell, G., & Pease, K. (1994). Crime seasonality: Domestic disputes and residentialburglary in Merseyside 1988–90. *British Journal of Criminology, 34*(4), 487–498.

Felson, M., Jiang, S., & Xu, Y. (2020). Routine activity effects of the Covid-19 pandemic on burglary in Detroit, March 2020. *Crime Science, 9*, Article 10.

Fisher, M., & Bubola, E. (2020). As coronavirus deepens inequality, inequality worsensits spread. *New York Times*, available online at: https://www.nytimes.com/2020/03/15/world/europe/coronavirus-inequality.html (accessed 09 July 2021).

Genevie, L., Kaplan, S. R., Peck, H., Struening, E. L., Kallos, J. E., Muhlin, G. L., & Richardson, A. (1987). Predictors of looting in selected neighbourhoods of NewYork City during the blackout of 1977. *Sociology and Social Research, 71*, 228–231.

Gerell, M., Kardell, J., & Kindgren, J. (2020). Minor covid-19 association with crime in Sweden. *Crime Science, 9*, Article 19.

Government of Canada (2021). Travel restrictions in Canada: Provincial and territorial restrictions. Retrieved from: https://travel.gc.ca/travel-covid/travel-restrictions/provinces

Halford, E., Dixon, A., Farrell, G., Malleson, N., & Tilley, N. (2020). Crime and coronavirus: Social distancing, lockdown, and the mobility elasticity of crime. *Crime Science, 9*, Article 11.

Hirschi, T., & Gottfredson, M. (1983). Age and the explanation of crime. *American Journal of Sociology, 89*(3), 552–584.

Hodgkinson, T., & Andresen, M. A. (2019a). Changing spatial patterns of residential burglary and the crime drop: The need for spatial data signatures. *Journal of Criminal Justice, 61*, 90–100.

Hodgkinson, T., & Andresen, M. A. (2019b). Understanding the spatial patterns of police activity and mental health in a Canadian city. *Journal of Contemporary Criminal Justice, 35*(2), 221–240.

Hodgkinson, T., & Andresen, M. A. (2020). Show me a man or a woman alone and I'll show you a saint: Changes in the frequency of criminal incidents during the COVID-19 pandemic. *Journal of Criminal Justice, 69*, Article 101706.

Hodgkinson, T., Andresen, M. A., & Farrell, G. (2016). The decline and locational shift of automotive theft: A local level analysis. *Journal of Criminal Justice, 44*(1), 49–57.

Hodgkinson, T., Saville, G., & Andresen, M. A. (2020). The diffusion of detriment: Tracking displacement using a city-wide mixed methods approach. *British Journal of Criminology, 60*(1), 198–218.

Kantamneni, N. (2020). The impact of the COVID-19 pandemic on marginalizedpopulations in the United States: A research agenda. *Journal of VocationalBehavior, 119*, Article 103439.

Kennedy, L. W., & Forde, D. R. (1990). Routine activities and crime: An analysis ofvictimization in Canada. *Criminology, 28*(1), 137–152.

Langton, S., Dixon, A., & Farrell, G. (2021). Six months in: Pandemic crime trends inEngland and Wales. *Crime Science, 10*, Article 6.

LeBeau, J. L. (2002). The impact of a hurricane on routine activities and on calls for police service: Charlotte, North Carolina, and Hurricane Hugo. *Crime Prevention and Community Safety: An International Journal, 4*(1), 53–64.

Lemieux, F. (2014). The impact of natural disaster on altruistic behaviour and crime. *Disasters, 38*(3), 483–499.

Linning, S. J., Andresen, M. A., & Brantingham, P. J. (2017). Crime seasonality: Examining the temporal fluctuations of property crime in cities with varying climates. *International Journal of Offender Therapy and Comparative Criminology, 61*(16), 1866–1891.

Macdonald, D., & Wilson, D. (2013). *Poverty or prosperity: Indigenous children in Canada*. Ottawa, ON: Canadian Centre for Policy Alternatives.

McDowall, D., Loftin, C., & Pate, M. (2012). Seasonal cycles in crime, and their variability. *Journal of Quantitative Criminology, 28*(3), 389–410.

de la Miyar, J.R.B., Hoehn-Velasco, L., & Silverio-Murillo, A. (2020), Druglords don't stay at home: COVID-19 pandemic and crime patterns in Mexico City. *Journal of Criminal Justice*, Article 101745

Malleson, N., Steenbeek, W., & Andresen, M. A. (2019). Identifying the appropriate spatial resolution for the analysis of crime patterns. *PLoS ONE, 14*(6), e0218324.

Mohler, G., Bertozzi, A. L., Carter, J., Short, M. B., Sledge, D., Tita, G. E., Uchida, C. D., & Brantingham, P. J. (2020). Impact of social distancing during COVID-19 pandemic on crime in Los Angeles and Indianapolis. *Journal of Criminal Justice, 68*, Article 101692.

Moise, I. K., & Piquero, A. R. (2021). Geographic disparities in violent crime during the COVID-19 lockdown in Miami-Dade County, Florida, 2018–2020. *Journal of Experimental Criminology*. https://doi.org/10.1007/s11292-021-09474-x

Payne, J. L., Morgan, A., & Piquero, A. R. (2020). COVID-19 and social distancing measures in Queensland, Australia, are associated with short-term decreases in recorded violent crime. *Journal of Experimental Criminology*. https://doi.org/10.1007/s11292-020-09441-y

Payne, J. L., Morgan, A., & Piquero, A. R. (2021). Exploring regional variability in the short-term impact of COVID-19 on property crime in Queensland. *Australia. Crime Science, 10*, Article 7.

Piquero, A. R., Riddell, J. R., Bishopp, S. A., Narvey, C., Reid, J. A., & Piquero, N. L. (2020a). Staying home, staying safe? A short-term analysis of COVID-19 on Dallas domestic violence. *American Journal of Criminal Justice, 45*(4), 601–635.

Piquero, A. R., Riddell, J. R., Bishopp, S. A., Narvey, C., Reid, J. A., & Piquero, N. L. (2020b). Reply to Gonzalez et al. *American Journal of Criminal Justice, 45*(6), 1111–1118.

Piquero, A. R., Jennings, W. G., Jemison, E., Kaukinen, C., & Knaul, F. M. (2021). Domestic violence during the COVID-19 pandemic: Evidence from a systematic review and meta-analysis. *Journal of Criminal Justice, 74*, Article 101806.

Prelog, A. J. (2016). Modeling the relationship between natural disasters and crime in the United States. *Natural Hazards Review, 17*(1), Article 04015011.

Reingle Gonzalez, J. M., Molsberry, R., Maskaly, J., & Jetelina, K. K. (2020). Trends in family violence are not causally associated with COVID-19 stay-at-home orders: A commentary on Piquero et al. *American Journal of Criminal Justice, 45*(6), 1100–1110.

Quarantelli, E. L. (1993). Community crises: An exploratory comparison of the characteristics and consequences of disasters and riots. *Journal of Contingencies and Crisis Management, 1*(2), 67–78.

Quarantelli, E. L. (2007). The myth and realities: Keeping the looting myth in perspective. *Natural Hazards Observer, 31*(4), 2–3.

Rountree, J., Hess, M., & Lyke, A. (2019). *Health conditions among unsheltered adults in the US*. Los Angeles, CA: California Policy Lab.

Shaw, C. R., & McKay, H. D. (1942). *Juvenile delinquency and urban areas: A study of rates of delinquency in relation to differential characteristics of local communities in American cities*. University of Chicago Press.

Stickle, B., & Felson, M. (2020). Crime rates in a pandemic: The largest criminological experiment in history. *American Journal of Criminal Justice, 45*(4), 525–536.

Vaughan, A. D., Ly, M., Andresen, M. A., Wuschke, K. E., Hodgkinson, T., & Campbell, A. (2018). Concentrations and specialization of mental health related calls for police service. *Victims & Offenders: An International Journal of Evidence-Based Research, Policy, and Practice, 13*(8), 1153–1170.

Weisburd, D., Cave, B., Nelson, M., White, C., Haviland, A., Ready, J., Lawton, B., & Sikkema, K. (2018). Mean streets and mental health: Depression and post-traumatic stress disorder at crime hot spots. *American Journal of Community Psychology, 61*(3–4), 285–295.

Wuschke, K. E., Andresen, M. A., Brantingham, P. J., Rattenbury, C., & Richards, A. (2018). What do police do and where do they do it? *International Journal of Police Science and Management, 20*(1), 19–27.

Zahnow, R., Wickes, R., Haynes, M., & Corcoran, J. (2017). Disasters and crime: The effect of flooding on property crime in Brisbane neighbourhoods. *Journal of Urban Affairs, 39*(6), 857–877.

Zahran, S., Shelly, O. T., Peek, L., & Brody, S. D. (2009). Natural disaster and social order: Modelling crime outcomes and disasters in Florida. *International Journal of Mass Emergencies and Disasters, 27*(1), 26–52.

Dr. Martin A. Andresen is a Professor in the School of Criminology at Simon Fraser University. His research interests are in crime at places, spatial criminology, and applied spatial statistics.

Dr. Tarah Hodgkinson is an Assistant Professor in the Department of Criminology at Wilfrid Laurier University. Her research interests are in crime prevention, policing, and mixed research methods.