

# **A street segment analysis of crime in a township: Evidence from South Africa**

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## **Abstract**

Street segments as a micro-level unit of analysis have become increasingly popular in spatial crime research with a plethora of studies having shown how crime spatially concentrates at this spatial scale. The vast majority of this research has, however, emanated from the United States and other ‘Westernized’ cities, with little attention on less developed contexts. Developing countries have different structural and design conditions from developed countries and this could be reflected in micro-spatial crime patterns. In this study, we undertook the first street segment analysis of crime in southern Africa with a particular focus on the township of Khayelitsha, located approximately 30 kilometers from Cape Town. Townships are uniquely South African urban settlements, borne out of repressive apartheid-era spatial planning policies. Results showed that violent, property, and sexual crimes concentrate spatially in Khayelitsha at the street segment level with substantial street-to-street variability. From a practical perspective, so-called ‘hot streets’ should be the primary focus of intervention by law enforcement agencies tasked with reducing crime in countries with far less resources than their Global North counterparts. We recommend replication of this analysis in other African contexts in order to build up a body of evidence to either support or challenge the notion of ‘crime concentration at micro-places’ commonly advocated by international scholars.

**Keywords:** street segment; crime; South Africa; Khayelitsha; micro-spatial

## **Introduction**

It is well-known that place greatly influences criminal behaviour with a range of studies finding the concentration of crime in space across almost all continents (Andresen, 2006; Brantingham & Brantingham, 1995; Breetzke, 2018; Curman et al., 2015; Favarin, 2018; Groff et al., 2010, Wuschke et al., 2021). Historically, researchers examining spatial crime concentrations have done so at coarse levels of aggregation (see Bursik & Grasmick, 1993; Kubrin & Weitzer, 2003; Sampson & Groves, 1989; Sampson et al., 1997) with the census tract being the most common in the United States, for example. Notwithstanding the inherent methodological problems of using pre-existing census geography in spatial criminology (see Bailey & Gattrell, 1995; Openshaw, 1984), there is a growing realisation, as outlined by Braga et al. (2017), that larger places, such as neighbourhoods, are spatially heterogeneous and may contain dramatically varying micro-environments which pose different risks for crime. Indeed, there are areas within neighbourhoods that may exhibit low, or no crime whatsoever. Consequently, only a particular micro-environment (i.e., street) within a neighbourhood may be responsible for the majority of crime occurring there with a combination of these high crime micro-places causing the larger neighbourhood itself to be perceived as being criminogenic; a problem known as ‘averaging’ (see Weisburd et al., 2009). This increased acknowledgement that finer street segments may provide a more accurate, and perhaps nuanced, indication of crime risk has led to a plethora of studies examining crime concentrations at the street segment level of spatial aggregation (Chainey et al., 2019; de Melo et al., 2015; Favarin, 2018; Umar et al., 2021; Weisburd et al., 2012; Weisburd & White, 2019; Wuschke et al., 2021). The vast majority of this research has, however, been undertaken in the developed world, with much less known outside this context. The present study aims to make a small but meaningful contribution in this regard by undertaking the first street segment analysis of crime in southern Africa. Specifically, we

conduct a street segment analysis of crime in Khayelitsha, a township located approximately 30 kilometers from the city of Cape Town on the southwestern tip of South Africa.

### **Literature review**

Undertaking a street segment analysis of crime is not new. A large body of work has examined how crime varies spatially at the street segment level (Curman et al., 2015; Favarin, 2018; Groff & Lockwood, 2014; Weisburd & Amram, 2014; Weisburd et al., 2012). The vast majority of this work has found how crime spatially clusters in a relatively few number of streets. One of the first ever 'micro-spatial' studies of crime was undertaken by Sherman et al. (1989) who mapped over 320,000 calls to police in Minneapolis and found that only three percent of addresses accounted for 50 percent of calls for police. In arguably the most seminal piece of work in this field, Weisburd et al. (2004) found that roughly four percent of street segments in Seattle, Washington, accounted for 50 percent of crime and, importantly, found that these figures remained relatively constant over a 14-year period (1989-2002). Later, Groff et al. (2010) replicated Weisburd's Seattle study but applied trajectory analysis to find groups of places that follow similar crime trajectories over a 16-year study period. The researchers found a number of instances where individual street segments had trajectories which were unrelated to their immediately adjacent streets indicating some level of inter-street crime variability. Similarly, Braga et al. (2010) examined the spatial stability of robbery at the street segment level in Boston, Massachusetts over a 29-year period and found that almost half of all robberies reported in Boston occurred in roughly eight percent of street blocks. They also found that only 12% of street segments had one robbery incident over the study period. In New York, Hermann (2012) undertook a spatio-temporal analysis of crime (from 2006 to 2010) and found that the majority of street segments experienced no crime across the five-year study period, further illustrating the disproportionate distribution of crime at the street segment level of

analysis. Finally, Hipp and Kim (2016) found that five percent of street segments across 42 cities in southern California accounted for crime at a range from 35% to 100%. Other studies in the US include those of Chalfin et al. (2021), Kim and Hipp (2018), Lee and Eck (2014), Pierce et al. (1988), and Weisburd et al. (2009), among others.

Studies outside the US have been less forthcoming but include Curman et al. (2015), who found similar spatial trends to those in the US with roughly eight percent of street segments in Vancouver accounting for 50 percent of crime. These patterns remained stable over time. Also in Vancouver, Andresen et al. (2017) investigated patterns of disaggregated crime types on street segments and found crime to be highly concentrated, regardless of crime type, with most street segment and intersection trajectories being stable over the study period. In Europe, Favarin (2018) undertook a street segment analysis of crime in Milan, Italy, and found four percent and 1.6 percent of street segments contained 50 percent of burglaries and robberies, respectively, while in The Hague, Netherlands, Steenbeek and Weisburd (2015) examined over 400,000 police crime records spanning a nine-year period (2001-2009) and found that 50% of all crime incidents occurred on roughly seven percent of street segments in the city. The researchers also compared crime concentrations at the street segment, neighbourhood and district levels and found crime to be more concentrated at the street segment level than at the other spatial levels. Finally, Weisburd and Amram (2014) conducted a street segment analysis of crime in Tel Aviv-Jaffa, Israel and also found substantial crime concentrations with roughly five percent of street segments accounting for 50 percent of crime. Remarkably, the researchers found that only 0.9 percent of street segments accounted for 25 percent of crime, indicating an intense concentration of crime at very particular places throughout the city.

Research articles emanating from outside the developed world are rare but recently a number of studies have emerged that largely support the concentration and stability of crime at this spatial scale. For example, in Campinas, Brazil, de Melo et al. (2015) found that roughly

four percent of street segments were responsible for 50 percent of crime and that roughly 29 percent of street segments accounted for 100 percent of crime in the city. A more recent study by Chainey et al. (2019) examined the spatial concentration of crime across 37 cities in South America and found that between 0.8 percent and 2.5 percent of street segments accounted for 25 percent and 50 percent of crime respectively, across all cities. In Jaipur, India, Mazeika and Kumar (2017) found four hotspots of crime, representing less than one percent of the total land in the study area, accounted for about 23% of burglary incidents while in Turkey, Duru (2010) examined the relationship between high schools, on-premise alcohol outlets, and coffeehouses, and crime on street blocks and found that as the number of these ‘target places’ increased on a street block, so too did the number of crimes. Importantly, the strength of this relationship varied by the type of place (i.e., strongest in on-premise alcohol outlets and weakest in high schools) and the type of crime, and was also moderated by neighbourhood social disorganisation. We are aware of only one study that has been undertaken in Africa thus far and that was done by Umar et al. (2021) who undertook a street segment analysis of crime in Kaduna, Nigeria. Using crime victimization survey data, the researchers examined the concentration of breaking-and-entering and domestic theft at the street segment level and found that roughly 11 percent of all street segments accounted for 50 percent of the two crime types. The results of this collective research provide further evidence for the ‘law of crime concentration at place’ espoused by Weisburd (2015) which suggests that certain percentage of places accounts for a fixed percentage of crime (e.g., 5% of street segments accounts for 50% of crime across different cities).

From a policing perspective, the increased awareness that crime concentrates spatially has informed a number of crime prevention strategies, notably hotspot policing. The rationale behind hot spot policing - which is aligned with the emergence of the broader intelligence-led policing paradigm (Weisburd & Telep, 2014) - is that directing a variety of police-led crime

control efforts towards areas abundant with crime (e.g., particularly a neighbourhood or street segment) will have a disproportionate effect on reducing crime outcomes. The strategy almost always involves the use of crime mapping techniques to first identify micro-places that have a disproportionate amount of crime (Braga et al., 2014) and then assigning appropriate operational and/or tactical resources to these places. A common (and early) critique of place-based policing interventions such as hot spots policing is that crime will simply displace to surrounding areas (e.g., Reppetto, 1976). While there is some evidence of crime displacement across a city (Hodgkinson et al., 2020), increasing evidence suggests that areas around targeted hotspots are more likely to be associated with the diffusion of crime control benefits than crime displacement (Bowers et al., 2011; Clarke & Weisburd, 1994; Weisburd et al., 2006).

The vast majority of studies evaluating the impact of hotspot policing on reducing crime outcomes has been undertaken in the United States (see Ariel & Partridge, 2016; Braga & Bond, 2008; Kochel et al., 2015; Taylor et al., 2011; Uchida & Swatt, 2013, among others) with researchers overwhelmingly finding that this prevention strategy works, to varying extents. Studies outside the United States are less numerous but have largely reinforced these findings. For example, in the United Kingdom (UK), Bland et al. (2021) found that adopting this strategy resulted in an up to 40% reduction in criminal incidents in 21 high-crime neighbourhoods in Bedfordshire, while Williams (2015) found similar reductions in crime in the West Midlands but also found that fewer policing units of longer duration in hot spot areas were associated with a greater reduction in crime, than more frequent shorter patrols. Interestingly, Sherman (2022) examined how hot spots policing has been used as a common law enforcement strategy in the UK and found that the strategy is moving away from traditional ad-hoc approaches *across* policing institutions towards building an evidence-base that uses continuous impact assessment *within* policing agencies and the hot-spots themselves. Other evaluations have occurred in Denmark (Attermann, 2017), Sweden (Marklund & Merenius,

2014), Columbia (Blattman et al. 2017), and Uruguay (Chainey et al., 2021) with statistically significant effect sizes most often found favouring the effects of hot spots policing in reducing crime outcomes at treatment places. Finally, a systematic review and meta-analysis of 65 studies containing 78 tests of hot spots policing interventions by Braga et al. (2019) found robust evidence that hot spots policing reduces crime outcomes and does not appear to result in the spatial displacement of crime into areas immediately surrounding targeted locations.

Notably absent in all this work, however, are studies emanating from Africa in general, and southern Africa, in particular, which is a shortcoming of existing research, since African cities possess vastly different urban spatialities and street network patterns in comparison to their Global North counterparts. South African cities, and their townships in particular, have unique spatial morphologies which can largely be attributed to its apartheid-era politically-charged urban planning practices with associated implications for policing (see Faull, 2016). Cities in Africa are also growing at an alarming rate. Indeed, according to Bearak et al. (2021) thirteen of the world's 20 biggest urban areas will be in Africa by the end of the century — up from just two in 2021 — as will more than a third of the world's population. Crime in Africa is also a major socioeconomic problem caused, at least historically, by the uneven distribution of wealth and power, and a labour surplus (Kibuka, 1980) but increasingly attributed to an increase in organized crime activity (Global Organized Crime Index, 2021). Further evidence of micro-spatial crime concentrations at this spatial level in Africa will add a measure of academic credibility and generalizability to past research that has examined this phenomenon.

### **The study area**

Khayelitsha is a township located on the urban periphery of Cape Town. In South Africa, a 'township' refers to a built-up residential area on the periphery of former Whites-only urban areas. Under the apartheid policy focusing on separate development, these areas were originally

reserved for non-White people only (i.e., Black African, Coloured and Indian population groups) although townships are still predominantly (>95,0%) inhabited by non-Whites. When they were established during the 1950s and 1960s they were never intended to grow into fully developed and independent communities with a complete infrastructure (e.g., shops, schools, community and recreational facilities, work places). They were seen as largely dormitory towns for mainly male migrant workers from the then 'Bantustans' or homelands<sup>1</sup>. Currently, most townships still include a more stable, higher socio-economic (chiefly lower middle class) area inhabited by people who have lived there for a long period of time or whose parents/relatives had lived there since the establishment of the township. These older and more established areas may have developed features such as taverns, clubs, recreational facilities and churches, which have turned such areas into fully fledged communities although most often still lacking in basic infrastructure and services. However, around or next to such areas more informal settlements and 'matchbox' developments that have sprang up since democracy. Although not intended, these differ little from the original dormitory towns. Writing about townships under apartheid, Chikane (1986) described them as typically characterized by widespread malnutrition, poor or non-existent health systems, ill-equipped and overcrowded schools, inadequate or non-existent social security, and high levels of unemployment.

Khayelitsha is the largest township in the Western Cape province of the country with a population of roughly 400,000 inhabitants, of which almost 99% are black African. It is one of last townships that was 'created' in apartheid South Africa in 1983 by the former apartheid government. The township was intended to house predominantly Xhosa-speaking black Africans and concomitantly provide a cheap form of migrant labour for the then former Whites-only neighbourhoods located in the central business district and surrounding neighbourhoods

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<sup>1</sup> The term "Bantustan" refers to an apartheid regime policy which set about the creation of "independent" homelands for black South Africans.



of Cape Town. Despite the arrival of democracy in 1994, Khayelitsha remains poor and socially and economically marginalised from Cape Town. Roughly 40 percent of residents of Khayelitsha are unemployed, with youth unemployment (aged 15-23) at over 50 percent (Statistics South Africa, 2011).<sup>2</sup> Approximately 74% of households have a monthly income of R3,200 or less (~US\$200). Notably, crime is of particular concern in Khayelitsha with the main policing precinct consistently among the most violent precincts in the country with contact crime<sup>3</sup> in particular almost double the national average (Crime Hub, 2021). Despite its high levels of crime, recent research in Khayelitsha has, however, shown how crime spatially concentrates in a relatively few number of neighbourhoods (see Breetzke & Edelstein, 2019) providing some initial local evidence of the ‘law of crime concentration at places’, albeit at an aggregate level. It is however, not yet known whether this spatial concentration of crime is amplified or more diffuse at the finer street segment level of analysis.

## **Data and methods**

### *Crime data*

The crime data used in this research study was obtained from the South African Police Service (SAPS)<sup>4</sup>. These data contain information pertaining to the location, and date and time of occurrence of crime committed in the Khayelitsha policing precinct over a five-year period:

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<sup>2</sup> This is the most recent census undertaken for which data is available. The 2021 census was postponed due to the Covid-19 pandemic and is in the process of being conducted (July 2022).

<sup>3</sup> ‘Contact crimes’ refer to when a person or people are injured/harmed or threatened with injury/harm during the commission of a crime. A further sub-category of ‘contact-related crime’ is used for violent crimes committed against property with the intention of causing damage to a person, for example arson or malicious damage to property.

<sup>4</sup> We are unaware of the geocoding accuracy of the crime data provided for us from the South African Police Services (SAPS). Crime data was provided in the form of x and y co-ordinates. The SAPS have previously used GPS devices to record crime in Khayelitsha in areas that are difficult to capture due to a lack of a formal address.

2012-2016<sup>5</sup>. Included in the crime data were unique identifiers for each crime, an x and y geo-coordinate, and the type of criminal offence recorded. From this dataset, a separate sexual (rape, attempted rape, sexual assault, and indecent assault), violent (murder, attempted murder, and common assault) and property (house, bank, and business robbery<sup>6</sup>, as well as common robbery with or without firearms) crime type was extracted in order to determine the extent to which the concentration of crime at the street segment level of analysis is uniform across crimes with varying motives and operandi. Khayelitsha experienced a total of 3,942 violent crime, 3,017 property crime and 666 sexual crime incidents during the five-year research period (total = 7625). Importantly, we do not aim here to specifically unpack reasons *why* certain categories of crime may or may not concentrate at the street segment level, rather the intention of this descriptive paper is to determine *if* crimes cluster at the street segment level in this unique context and provide some preliminary explanations for what we find.

It is important to note at this juncture that perhaps the biggest limitation of this study relates to the reliability and accuracy of the crime data we used. Crime is notoriously under-reported in Khayelitsha (see O'Regan et al., 2014) where residents have simply lost faith in the police to maintain law and order. Moreover, the geospatial accuracy of crime data in the country has also been brought into question (see Edelstein & Arnott, 2019). Faced with these challenges, spatial crime researchers in South Africa have two choices. Either undertake research with the only official and spatially replete crime dataset available, whilst acknowledging the limitations, or seek alternative ways of getting 'proxy' crime data. We choose the former option, knowing that what we find may not be the exact magnitude and

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<sup>5</sup> The 'Greater Khayelitsha reporting area' consists of three police precincts: Khayelitsha, Harare, and Lingeletu West. We only had access to police data for the Khayelitsha policing precinct. The total population in the Khayelitsha policing precinct is just under 160,000.

<sup>6</sup> Robbery is referred to as a property crime in South Africa. It consists of the theft of property by intentionally using violence or threats of violence to induce submission to the taking of it from another.

location of crime occurring during this study period in Khayelitsha but being relatively certain that the data we have broadly approximates its true magnitude and distribution. Previous researchers have speculated on how to undertake spatial crime research using alternative crime data sources both locally (see Faull, 2019) and internationally (Gray et al., 2017). However, these options (such as the use of casualty/trauma, and emergency medical services data) were not available to us for this research. As an aside, it should be noted that the under-reporting of crime is not a uniquely South African problem (see Jaitman & Anauati, 2020), neither is the under-reporting of crime necessarily ‘worse’ in more deprived regions of cities or countries when compared to more affluent areas. Recently, Buil-Gil et al. (2021) found that the ‘dark figure’ of crime in geographic areas in the United Kingdom for example, is larger not only in areas that are deprived but *also* in wealthy areas, dispelling the notion of the under-reporting of crime being synonymous with crime in less developed contexts. Their research confirmed previous findings in the US from Baumer (2002) who showed that citizens living in more deprived neighbourhoods, as well as those living in wealthy areas, are less likely to inform the police of a criminal incident.

### *Street centreline data*

A dataset representing the street centreline for the City of Cape Town was obtained from the City of Cape Town Open Data Portal<sup>7</sup>. This data consisted of line features that were segmented at every road intersection and were represented as the two block faces on both sides of a street between two intersections. There were 107,466 segments in the dataset with each segment containing a number of attributes including the road name, surface type, speed limit (in kilometres per hour) and segment length in metres, among others. Of this network, streets

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<sup>7</sup>Data downloaded from the City of Cape Town Open Data Portal from <https://odp-cctegis.opendata.arcgis.com/datasets/tct-road-centrelines/explore>

within the Khayelitsha policing precinct were extracted which resulted in a total of 1,400 street segments with an average segment length of roughly 112 metres, and a standard deviation of approximately 180 metres. The shortest length was just a few metres while the longest street segment was over 12 kilometres long. Given the high variability of street segment lengths we next decided to split the street segments into 50 metre ‘lengths’, while preserving street segments already split at intersections. This also resulted in some variability in street segment length as street segments did not obviously nest within 50 metre increments across intersections but the variability in length was significantly reduced and the median and modal street segment lengths were both 50 metres. We believe that this ‘normalisation’ provides a more accurate representation of crime at this spatial level since longer streets will necessarily contain more crime due to their increased length. Whilst we could have normalised the data by the length of the street (for example, crimes per metre) we felt that, from a policing perspective, knowing which sub-segments of a street contained more crime provided better information for law enforcement agents. The final study area street network had 3,253 street segments.

### *Analysis*

Following Weisburd and Amram (2014) and others, we converted a crime point’s location to a street segment using the Spatial Join tool in ArcPro. This resulted in a dataset representing crime incidents with corresponding segment identifiers. Note that crime incidents were only associated with one corresponding street segment, not multiple street segments (i.e., a single crime incident was only spatially associated to the nearest street segment ensuring that segments did not share the same crime incidents). Simple crime counts per 50 metre street segment were then calculated and mapped. We are aware that crime counts represent the discrete number of crime events, rather than estimates or ratios, and are greatly dependent on the crime data itself, which is vulnerable to under- and over-reporting. We decided, however,

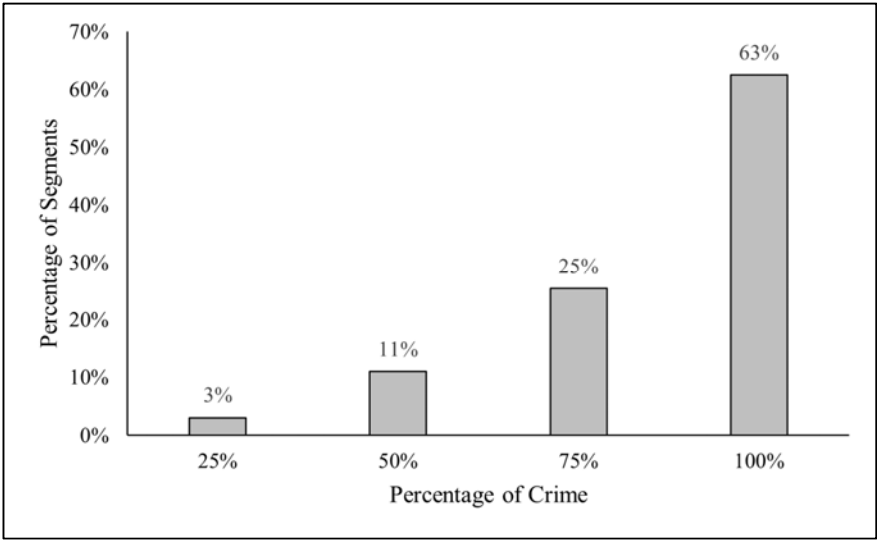
at this initial stage, to use counts to display the trends descriptively. Future research could aim to use more advanced geospatial techniques to further tease out the trends we find here.

## **Results**

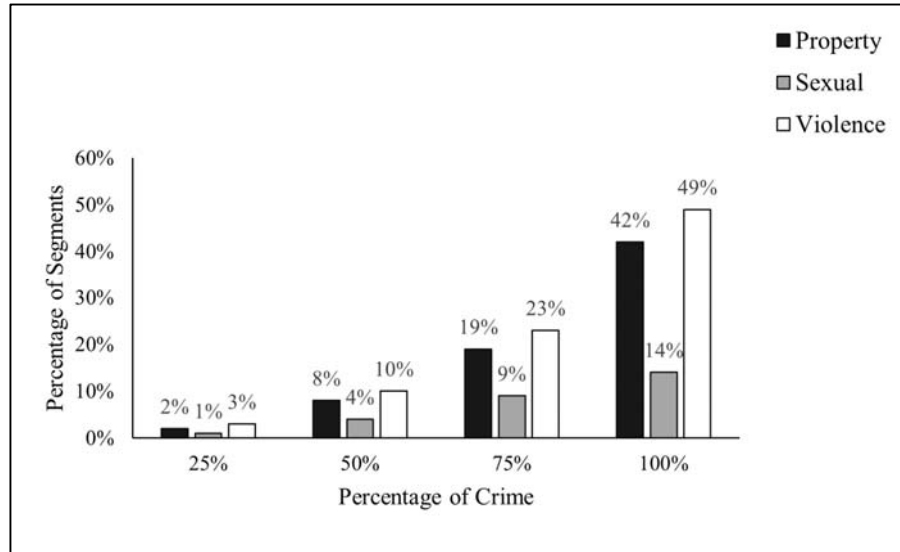
On average, there were 2.3 crime incidents per street segment across all crime types during the study period with the most crime-prone street segment experiencing 119 crime incidents in total. There were more violent crimes per street, followed by property crimes and sexual crimes, with violent crime also being the most dispersed throughout the study area. Roughly 37% of street segments (1,219 out of 3,253) in Khayelitsha did not experience any crime during the five-year study period. Violent crime was recorded in 49% (1,579) of street segments, while property crime was recorded in 42% (1,378) of street segments and sexual crime in 14% (454) of street segments, respectively. This preliminary analysis shows that despite its reputation for crime (see Breetzke & Edelstein, 2019), almost two-thirds of streets in Khayelitsha precinct experience no crime.

Figure 1 shows the percentage of street segments that account for various percentages of all crime in Khayelitsha. The results presented here are similar to past research which has most often found high concentrations of crime in a relatively small number of streets. Indeed, previous research has shown that between two and six percent of streets produce roughly half of all crime (see de Melo et al., 2015; Weisburd et al., 2004; Weisburd & Amram, 2014). Our results are more dispersed with 11% of streets producing half of all crime, but just three percent of street segments in the precinct containing 25% of all crime. Figure 2 shows the same percentages but for the three different crime types. Again, similar trends emerge with a low percentage of street segments accounting for a large percentage of crime, across all types. Violent crime is the most dispersed crime type followed by property crime and sexual crime.

Even so, just 327 street segments in Khayelitsha were responsible for half of all violent crime occurrences while 272 street segments were responsible for half of recorded property crime and 454 street segments were responsible for *all* sexual crime. Again, these findings are largely similar to the results of previous research (Weisburd & Amram, 2014; Weisburd et al., 2012). However, one notable point of difference is the varying extent to which the number of streets in Khayelitsha precinct have no crime. In the case of sexual crime, for example, roughly 86% of streets have no recorded incidents over the five-year study period.



**Figure 1:** Percentage of street segments that account for 25%, 50%, 75%, and 100% for all crime



**Figure 2:** Percentage of street segments that account for 25%, 50%, 75%, and 100% of violent, property and sexual crime respectively

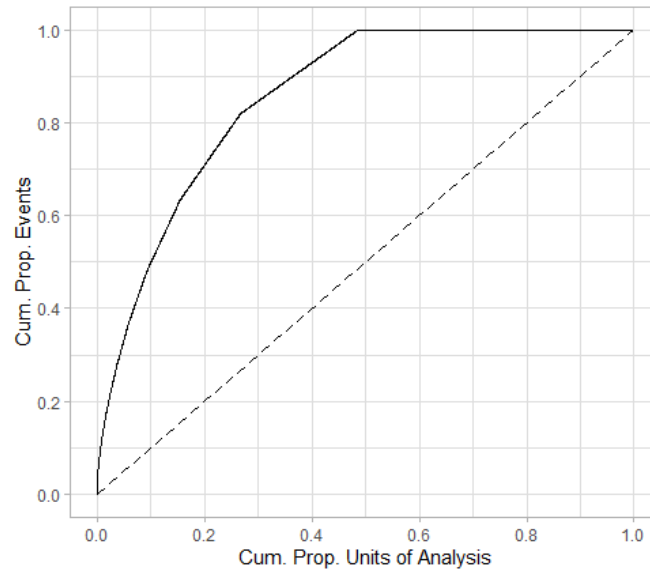
To further illustrate the crime concentration at the street segment level in Khayelitsha and to account for the fact that a large percentage of street segments experience no crime, we calculated variants of the Lorenz curve as well as the Gini index for each crime type. Initially developed to measure and visualize income inequality (Lorenz 1905), the Lorenz curve has been increasingly used to examine crime concentrations (see Bernasco & Steenbeek 2017; Umar et al., 2021). In these studies, the Lorenz curve is used to illustrate the cumulative proportion of crime occurring across spatial units, or street segments in this instance, with the greater the distance between the Lorenz curve and the line of maximum equality (for which x% of the street segments account for y% of crime), the more unequal the crime distribution.

While the Lorenz curve is an effective way to visualize inequity in crime distributions, the Gini index (Gini, 1912) highlights overall inequity of its distribution. After Umar et al. (2021), the index is the ratio (A/B) of the area of the chart between the expected line of equality and the observed distribution (i.e., A), and the area of the chart above the expected line of

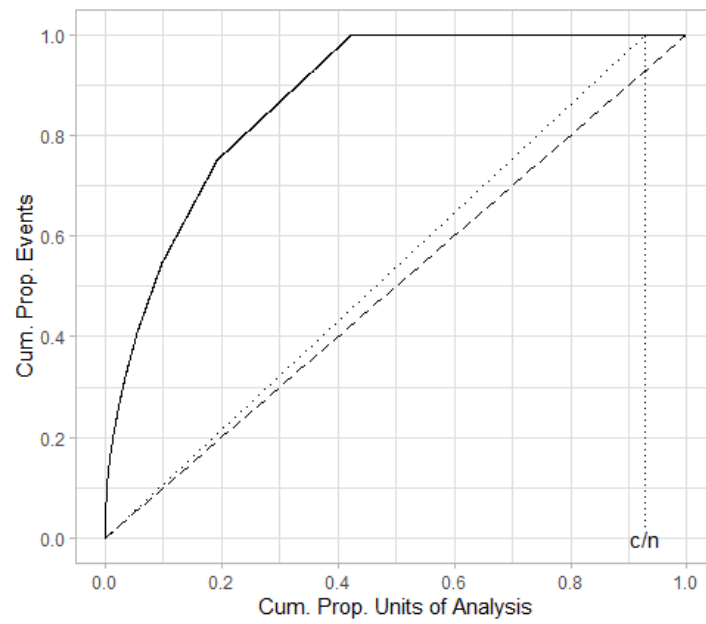
equality (i.e.,  $B - A$  is a subset of  $B$ ). The index ranges from zero which indicates that the distribution of crime across street segments is entirely equal, while a value of 1 indicates the distribution of crime is completely unequal, suggesting that all crime incidents occur in only one street segment. Analysis was done using the R package, 'lorenzgini', which was uniquely designed by Bernasco and Steenbeek (2017) for sparse crime data across small units of analysis (i.e., the generalized version). Specifically, when there are more spatial units than crime events (i.e. many street segments with no crime) as was the case in this study.

Figures 3-5 demonstrate the proportional distribution of property, sexual and violent crime events, respectively, across street segments in Khayelitsha using Lorenz curves. All figures once again demonstrate the spatial concentration of crime across all three categories with the curves for the observed distributions differing from expectation. These curves further demonstrate that sexual crime occurred on far fewer street segments than property crime and violent crime during the study period. In terms of the Gini Index, property crime was found to have the highest generalized Gini coefficient (0.73), followed by violent crime (0.71) and sexual crime (0.5). This indicates that property crime is the most spatially concentrated, whereas sexual crime is the most dispersed across all street segments in Khayelitsha.

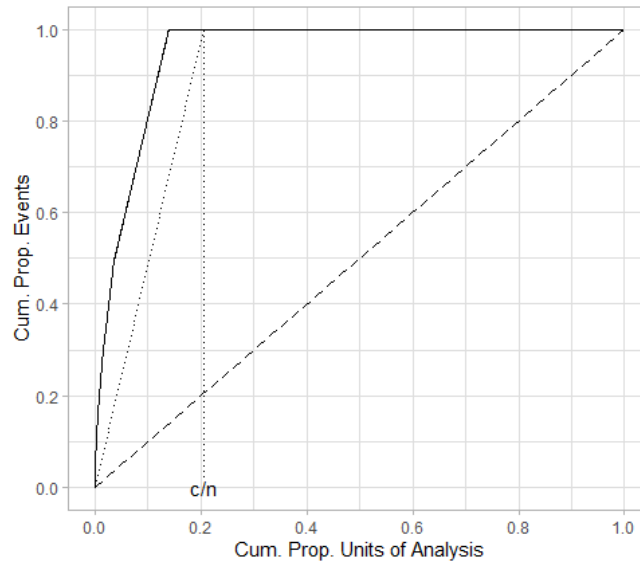




**Figure 3:** Cumulative concentration curve for violent crime



**Figure 4:** Cumulative concentration curve for property crime



**Figure 5:** Cumulative concentration curve for sexual crime

Figure 6 shows the street-by-street crime counts for Khayelitsha. It is noticeable that a large number of street segments along the outskirts of Khayelitsha contained little to no crime (1-2 incidents). Street segments with moderate crime (3-25 incidents) were scattered throughout the township, but were predominantly clustered together. A total of three street segments were in the highest crime streets (>75 incidents) category, and they collectively accounted for roughly four percent of all crime recorded. Figures 7-9 show the street-by-street crime counts for Khayelitsha precinct by crime type. In order to make the patterns comparable, we applied the same legend classes to each crime type. All three crime types exhibit the same general patterns, albeit with varying levels of intensity, with the ‘hottest’ streets located in the south-eastern region of the township. Again, the majority of street segments throughout the township experienced little or no crime, regardless of the crime type while substantial street-to-street crime variability exists with low crime street segments often being adjacent to higher crime street segments.



**Figure 6:** Distribution of all crime at the street segment level in Khayelitsha



**Figure 7:** Distribution of violent crime at the street segment level in Khayelitsha



**Figure 8:** Distribution of property crime at the street segment level in Khayelitsha





**Figure 9:** Distribution of sexual crime at the street segment level in Khayelitsha

## Discussion

The results of this study are consistent with previous research that has found clear spatial concentrations of crime at the street spatial scale (see Braga et al., 2010; de Melo et al., 2015; Hermann, 2012; Weisburd et al., 2004). All crime, as well as crime across the three individual categories, were all found to be spatially concentrated in a relatively few number of streets. The most concentrated crime type was sexual crime, followed by property crime, and violent crime. A number of factors may account for these trends, with the most prevalent being that these spatial concentrations simply reflect broader criminogenic processes (encompassing the built environment, social, economic and other factors) that are playing out at the street segment level in Khayelitsha. Indeed, Umar et al. (2021) argue that the spatial concentration of crime at the street segment level may simply reflect nothing more than the distribution of crime

opportunity at this spatial scale. Opportunities in this instance may be residential properties (for property crime) and/or other facilities in the built environment, such as alcohol outlets or schools (which have both been found to be spatially associated with crime, both locally (Breetzke et al., 2021; Matzopolous et al., 2020), and internationally (Pridemore & Grubestic, 2013)). In their research, Umar et al. used variations of the Lorenz curve and the Gini index to show how crime concentrated in Kaduna, Nigeria at the street segment level beyond the spatial distribution of crime ‘opportunity’. Other studies using similar methods include Steenbeek and Weisburd (2015); Johnson and Bowers (2010); and Davies and Johnson (2015). In our study, we did not ‘control’ for crime opportunities, per se, but rather, in a way similar to Amram and Weisburd’s (2014) study in Israel, provide a simple test for the ‘law of concentrations of crime at place’ proposition in a new and unique location. Future research could examine whether these concentrations intensify or dissipate after accounting for expectation, although it should be noted that identifying crime opportunities in Khayelitsha is challenging. This is largely due to the informal nature of the township where just over one half of all dwellings are shacks (Statistics South Africa, 2011), with limited to no formal street address. In terms of population, official statistics state the size of the township at just under 400,000 (Statistics South Africa 2011) but unofficial figures of up to 1.2 million have been noted (Cronje 2014), making risk based on population size or density prone to error. The township is also notoriously under-developed with relatively few formal built facilities. In fact, the first shopping mall in the township was only constructed in 2005; this for an area similar in population size to Atlanta (in the US) or Liverpool (in the UK). These combined factors make more comprehensive future micro-spatial research incorporating the underlying environmental backcloth harder to undertake, but the challenges are not unsolvable and certainly present an avenue for future research.

Importantly, the results of the research provide further evidence for the law of crime concentration at place in South Africa although at a much finer spatial scale than has previously been found in the country. In earlier work, Breetzke and Edelstein (2019) found crime at the coarser sub-place level in Khayelitsha to be spatially concentrated and temporally stable however these trends could mask sub-area spatial heterogeneity, as discussed earlier. Here we found greater spatial concentrations of crime at the finer street segment level of analysis. In her review of 44 empirical studies examining crime concentration at place, Lee et al. (2017) found that as the size of the spatial unit declines (from area to street segment and so forth), crime becomes more concentrated; this was found to be the case in a number of different countries. Here, for the first time, we have found the same evidence in South Africa with important associated implications for policing in Khayelitsha. Policing in the township has been described as ‘haphazard’ with police driven by gut-feel rather than crime intelligence (see O’Regan et al., 2014). The lack of competence by law enforcement agencies in the township led to the establishment of a formal Commission of Inquiry into policing in the township in 2012. The Commission was appointed to investigate allegations of police inefficiency in the township, as well as the breakdown in relations between the local community and the police. The results of the Commission were a series of recommendations (outlined in O’Regan et al., 2014) including the need to improve the three key crime intelligence functions including crime mapping, linkage analysis, and on-the-ground intelligence gathering. Crime mapping, in particular, is seen as a mechanism through which more effective policing can be undertaken in the future by highlighting areas of concern. Sadly, none of the proposed recommendations of the Commission’s report have been fully implemented (Stoltz, 2021), resulting in crime continuing to be a concern in the township.

The implications of this study from a policing perspective in South Africa are clear. Maximise the scant policing resources available by adopting a hot spots crime prevention

strategy in Khayelitsha. In truth a similar type of ‘saturation’ policing strategy has been sporadically employed by the SAPS over the past decade in certain high-risk neighbourhoods throughout the country. This has most often involved the large-scale deployment of police in high risk areas. The strategy has, however, had limited success with the main issues being its unsustainability, given the limited resources of the SAPS, coupled with the inability of other government departments to deliver developmental interventions at the necessary scale in identified high crime areas (Lamb, 2018). Another form of hot spots ‘policing’ intervention was implemented in Khayelitsha specifically in July 2019 when the South African National Defence Force (SANDF) was deployed in response to growing gang violence and endemic insecurity. The military intervention was directed at known gang crime hotspots and result in a decrease in crime in affected areas, at least anecdotally (Sullivan, 2020). While the planned intervention was geographically targeted at known hotspots, the military ‘occupied’ these areas for three months (which was subsequently extended by another six months), rather than conduct periodic patrols (before departing in March 2020). Hot spots policing as a crime prevention strategy has yet to be formally adopted by the SAPS, despite increasing evidence that crime clusters spatially in the country (Breetzke et al., 2021; Horn & Breetzke, 2009). In fact, a study in Khayelitsha by Breetzke and Edelstein (2019) found between 7% and 9% of neighbourhoods produced 50% of rape; between 5% and 12% of neighbourhoods produced 50% of robberies; and between 8% and 16% of neighbourhoods produced 50% of assaults. More recently, Edelstein et al. (2021) found clear spatial and temporal clustering of crime in one township adjacent to Khayelitsha, namely Nyanga, and similarly argued that crime could be dramatically reduced in these areas if police were able to visit these hot spots during patrols. The results of this previous work, combined with the results of this study (conducted at a much finer level of spatial aggregation) suggest that the formalised and structured use of hot spots policing should potentially reduce crime in Khayelitsha.



Indeed, the results of this research suggest that these interventions would not need to be numerous to have an exponential effect. If only 358 streets are responsible for 50% of all crime, then geographically targeting these ‘hot streets’ with operational and tactical policing units could possibly reduce the risk of crime occurring in these locations. In this sense, it does not really matter whether there are ‘crime opportunities’ present in these locations but rather that police are simply aware of *where* they are before attempting to understand *why* they are there. Previous geographically-targeted policing interventions have had significant impacts upon crime (Weisburd & Green, 1995; Braga & Weisburd, 2010; Haberman & Ratcliffe, 2015; Braga et al., 2014); South Africa could potentially follow suit.

## **Conclusion**

The main aim of this research was to undertake a street segment analysis of crime in a township. In accomplishing this goal, we believe we have made the following important contributions to the extant literature: First, crime is spatially concentrated at the street segment level in South Africa. While this may be considered a somewhat trivial finding by international spatial crime researchers, the fact that this study is the first of its kind in southern Africa, and only the second in Africa as a whole, makes it a highly significant one. Second, crime is spatially concentrated at the street segment level in a context that is extremely poor – this was also found across all crime types. According to the World Economic Forum (2016), Khayelitsha is one of the five biggest slums in the world with an estimated 32% to 46% of households in the township living in severe poverty. It also has one of the highest rates of violence in the world, outside a conflict zone (Luthy-Kaplan, 2015), with one in three children under 18 likely to become a victim of sexual violence (Inter-Ministerial Committee 2017). This is a context as distant and distinct from the vast majority of cities in the Global North as you are likely to find. Finally, this study is the first in Africa to use official police records to map crime at this spatial scale. While the

limitations of using police data have been outlined earlier, it represents the most official dataset available for researchers to undertake this type of replicable research. Future research could potentially utilize other data sources (as outlined by Faull, 2019) to examine micro-spatial crime trends in other contexts in South Africa or across Africa and demonstrate ways in which ‘crime opportunities’ on streets could potentially influence risk. As a first step, however, we believe that the results presented here, whilst descriptive, are sufficient to merit further investigation and provide an important platform for future micro-spatial crime research in South Africa.

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