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Leslie W. Kennedy

Rutgers University - Newark

Joel M. Caoplan

Rutgers University - Newark

Eric L. Piza

CUNY John Jay College

Amanda L. Thomas

CUNY John Jay College

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Environmental Factors Influencing Urban Homicide Clearance Rates: A Spatial Analysis of New York City

Leslie W. Kennedy¹, Joel M. Caplan², Eric L. Piza³, and Amanda L. Thomas⁴

Abstract

Recent commentary has raised concerns about the extent to which major cities in the US have confronted serious problems in closing homicide cases. In this paper, we explore the conditions under which clearance rates improve by looking at the experience across New York City, where there is one police agency that operates in locations that are very different from one another in terms of risk factors that contribute to crime. Using one agency provides a control on the administrative differences that appear across other jurisdictions that have been studied, usually through cross-national analysis. Our analysis uses Risk Terrain Modeling (RTM) to identify environmental features that relate to closed versus open homicide cases using one year of New York City Police Department (NYPD) data. This analysis will be supplemented with an investigation of precinct-wide social structure variables to examine how context matters in influencing closure rates.

Citation

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¹ School of Criminal Justice, Rutgers University Newark

² School of Criminal Justice, Rutgers University Newark

³ John Jay College of Criminal Justice, City University of New York

⁴ John Jay College of Criminal Justice, City University of New York

Introduction

Media reports have recently raised concerns about the extent to which major cities in the US have confronted serious problems in closing homicide cases. Homicide clearance rates have consistently fallen over recent decades, from about 80% in the 1970s to around 60% by the 2010s (Carter & Carter, 2016). While the precise reasons for this substantial fall in clearance rates is unclear, scholars have noted that the police investigatory practices have largely remained unchanged over the past several decades (Horvath, Meesig, & Hyeock, 2003). In this sense, investigations stand in stark contrast to the crime prevention function of policing (Eck & Rossmo, 2019). Police crime prevention activities have been largely informed by contemporary research confirming the spatial clustering of crime events and the recognition that proactive, problem-solving activities are more effective than reactive strategies applied routinely in all cases (Eck & Rossmo, 2019; Lum & Koper, 2017). Recent research suggests the principles that have enhanced crime prevention activities of police may also improve homicide clearance rates (Braga & Dusseault, 2018; Eck & Rossmo, 2019).

We build upon this body of research by exploring how place-based crime forecasting techniques may inform our understanding of homicide clearance. Our analysis uses Risk Terrain Modeling (RTM) to identify environmental features that relate to closed versus open homicide cases. While prior research has applied RTM to test whether the concentration of spatial risk factors influences the effect of police enforcement actions (Piza & Gilchrist, 2018), in addition to research that examines RTM analysis of violent crime documented in Kennedy, Caplan, and Piza, 2018, the current study is the first to explore such issues in the context of police investigations. Using data from New York City, we explore the conditions under which clearance rates improve by looking at the experience of one police agency that operates in

locations that are very different from one another in terms of risk factors that contribute to crime. Through an analysis of one agency's experience, we can control for administrative differences in contrast to comparisons across other jurisdictions that have been studied, usually through nation wide analysis. This analysis is supplemented with an investigation of precinct-wide social structure variables to examine how context matters in influencing closure rates.

Review of the Literature

Homicide clearance

Homicide clearance has been a focus of study by criminologists for decades. Riedel and Boulahanis (2007) examined the confusion around the precipitous drop in clearance rates that occurred from the 1960s, where about 90% of all cases were cleared by arrest, which then plummeted to about 65% by 2005 and more recently reported by the FBI UCR as 62% in 2017 (FBI, 2017).

According to Riedel and Boulahanis (2007) homicide clearance involves the following:

...cases that are cleared by arrest are solved for crime reporting purposes and require that the perceived offender has been arrested, formal charges have been brought up against him or her, and the case has been turned over to the court for prosecution. ...Although most cleared homicides are cleared by arrest, there is a second type of clearance, labeled "exceptionally cleared." Traditionally, exceptionally cleared cases are those that are classified as "solved" and included in the overall clearance rate but for whatever reason, a lawful arrest has not been made. (p. 153)

There are a number of factors that can influence a jurisdiction's clearance rates. In disentangling these findings, Keel, Jarvis and Muirhead (2009) set out to explore why clearance rates stay low. They examined this problem using five different criteria:

1. management and resources. These included the amount of personnel and administrative support provided to investigators and prosecutors in pursuing a case;

2. investigative procedures. These involved the extent to which detectives are able to obtain information from witnesses and victims to help in the investigation;
3. analytical processes. These pertained to the degree to which investigators had access to technology and analytical techniques that helped in identifying offenders;
4. contextual and demographic factors. These relate both to the characteristics of the communities in which the homicides were taking place and to the size of the police jurisdictions affected;
5. political influences. The importance of media accounts and political concerns about rising crime and how that relates to the extent to which activities by police, prosecutors and other judicial authorities are influenced in the priority they give to clearing homicide cases.

In a recent analysis of an intervention administered in the Boston Police Department, Braga and Dusseault (2018) report gains in clearance rates as a result of added resources for homicide detectives. Further, in a survey of 55 agencies, Keel et al. (2009) found support for the idea that an increase in management resources, improved investigative procedures, and application of advanced analytical improvements could improve clearance rates, a finding which was also reported by Wellford, Lum, Scott, Vovak, and Amber (2019) and Cook, Braga, Turchan, and Barao (2019). But, importantly, they report the offsetting salience that contextual and demographic factors had in suppressing reporting by victims and distrust that kept victims from providing testimony to assist in arrests.

Maguire, King, Johnson and Katz (2010) explored the competing effects of circumstances and administrative practice competing effects of circumstances and administrative practice on clearance rates. Interestingly, they found that interagency cooperation impeded case

clearances as homicide cases began to increase; but, with the growth in homicide occurrence, a lack of interagency cooperation can also impede clearance. This research was set in the context of the rise of gang related violence and an increased reluctance of victims to come forward in support of adjudication of the cases, which they identified as impediments to clearance. In other research, comparing US trends with Canada, Regoeczi, Kennedy, and Silverman (2000) showed the importance of a number of factors; for the US this included gender of victim, age and circumstances around the offense, where only the latter influence clearance rates in Canada. The relevance of circumstances surrounding the offences, as well as the characteristics of the victims and offenders influenced US rates. These findings were also supported by Jarvis and Regoeczi's (2009) research, as they found that the relevance of circumstances surrounding the offenses and the characteristics of the victims and offenders also impact homicide clearance rates in the US. Further, in a recent paper, Regoeczi, Jarvis and Mancik (2020) examined a national sample of homicides and concluded that social context, including the effects of different social statuses of victims, can be an important factor relevant to clearance outcomes. Their study led them to suggest that research on clearance rates could benefit from more community level inquiries, including the effects that differences across economically diverse neighborhoods have on these inquiries.

Additionally, research conducted by Petersen (2016, 2017) has begun to examine homicide clearances by evaluating two separate criteria outlined previously by Keel, Jarvis and Muirhead (2009). In his most recent piece, Petersen examined how important contextual and demographic factors at the neighborhood level (for Los Angeles County, California) may influence homicide clearance rates. In sum, Petersen (2017) found that although there are multiple non-racial variables that influence homicide clearances, homicides that occur in

predominately minority areas remain less likely to be closed. Importantly, his research not only included key individual-level covariates, he also incorporated multiple neighborhood-level covariates and agency-level covariates. Prior to conducting this research, Petersen (2016) also evaluated how neighborhood factors might influence the media's coverage of homicide cases throughout Los Angeles County, California. In this study, Petersen (2016) found "that the level of economic disadvantage and percentage of minority residents in/around the crime scene neighborhood negatively affect the presence/absence and rate of newspaper coverage" (p. 25).

Along these lines, Brunson and Wade (2019) report on willingness to testify about homicides from interviews of 50 young Black men, who were residents of high-crime neighborhoods in Brooklyn and the Bronx. They found that these individuals had considerable knowledge about illegal gun markets and the resulting bloodshed. They concluded that, "distressed milieus reliably fail to produce cooperative witnesses as a result of the cumulative impact of anti-snitching edicts, fear of retaliation, legal cynicism, and high-risk victims' normative views toward self-help" (Brunson & Wade, 2019, p. 623). When Brunson and Wade (2019) discuss 'distressed milieu' they are referring to locations in which there is sufficient social disorganization to make the concerns about being vulnerable to retaliation and reprisal real enough to compel potential witnesses to avoid testifying. Like the other research reported above this work has concentrated on the characteristics of victims and offenders when looking at what defines the circumstances that influence homicide outcomes. While social disorder may create these conditions of non-compliance, there is little known about how this manifests itself in terms of the spatial allocation of risky features in the environment that influence clearance rates. For example, is the presence of environmental features such as bars or section VIII housing contributing factors to this sense of vulnerability? If so, does this vulnerability spatially manifest

across locations? Knowing how these risk factors configure to create conditions that frame the difficulties that police face in collecting facts and statements about homicide cases would assist in clearing them.

For example, Griffiths and Tita's (2009) study sought to explain why public housing developments in Los Angeles were plagued with considerably higher violent crime rates than areas that were similar across multiple socio-demographic variables. As such, they attempted to determine whether or not housing developments could be categorized as "hotbeds," "magnets," and/or "generators" of violent crimes. After reviewing 20 years of homicide data from the Southeast Policing Area of Los Angeles, they not only characterized these developments as "hotbeds" of violent crime but they also concluded that a majority of these violent crimes were committed by offenders who resided within said developments (Griffiths & Tita, 2009).

Crime generators and attractors

Understanding the collective influences of environmental features that attract crime and generate illegal behaviors has proven valuable for policing (Brantingham & Brantingham, 1995; Brantingham, Brantingham, Song, & Spicer, 2020; Kennedy et al., 2018; Braga, Turchan, Papchristos, & Hureau, 2019). The Law of Crime Concentration (Weisburd, 2015), Crime Pattern Theory (Brantingham & Brantingham, 1981), Theory of Risky Places (Kennedy et al., 2018; Kennedy, Caplan, Piza & Buccine-Schraeder, 2016), and other theoretical frameworks within the domain of criminology and criminal justice (Quetelet, 1984; Park, McKenzie & Burgess, 1925; Shaw & McKay, 1942; Brantingham & Brantingham, 1981, 1995; Wikström, 2010). Brantingham and Brantingham (1995) explain that spatial crime patterns, and their stability over time, are a function of the 'environmental backcloth' of the area under study. This

backcloth is dotted with “crime attractors” and “crime generators.” Attractors include features of the environment that entice offenders to come to places to commit crime. Generators are represented by increased opportunities for crime that emerge from the collection of more people into areas following specific types of behavior, simply because of the increased volume of interaction taking place in these areas. Certain features of the landscape exert spatial influences on human behaviors that can affect a place’s vulnerability to crime, which is why crimes emerge, cluster and persist over time (Brantingham & Brantingham, 1995; Caplan & Kennedy, 2016; Brantingham et al., 2020; Kennedy et al., 2016; National Academies of Sciences, Engineering, and Medicine, 2017). Braga and Clarke (2014), Kennedy, Caplan and Piza (2018), Barnum, Caplan, Kennedy and Piza (2017), and others (Braga & Weisburd, 2010) present compelling evidence to focus on certain types of environmental features at chronically crime-prone areas because these features increase the probability crime will occur by attracting offenders, enabling illegal behavior, and confounding agents of social control in their efforts to contain or suppress their negative outcomes. Also, the work of Simon (1999) and Leovy (2015), in their studies on homicide investigation, support examining features of the built environment and their influence on case processing.

Environmental theories and related research provide some insights into how individual persons select and use the environments that they occupy and the impact that this has on crime outcomes. The potential for varied homicide clearance rates across different geographies may also rest on similar notions that these crimes occur where characteristics about the places differentially affect their solvability. Perhaps where some homicides occur there also exists particular features of the landscape that create unique settings that limit or foster police investigations. This reasoning further accommodates the ideas of situational crime prevention,

Rational Choice Theory, and Opportunity Theory (Clark & Eck, 2005; Clarke, 1997; Guerette & Bowers, 2009; Hunter & Jeffery, 1997) as it relates to a motivated offender's selection of certain locations for homicidal acts (Cohen & Felson, 1979; Groff & La Vigne, 2002; Cohen, Kluegel, & Land, 1981). Particular aspects of the spatial contexts of places could be perceived as raising the risk that homicides will be solved easier, perhaps due to lines-of-sight or witness participation, for example, that could make some areas less suitable locations for homicides by offenders who do not want to be caught.

The limitations in managerial resources committed to clearing homicide cases combined with efforts to enlist witnesses and victims to participate in prosecuting cases creates real problems for investigators and judicial officials. But, in most research on this topic, attention has been focused on cross-jurisdiction comparisons operating on the assumption that both administrative and contextual factors can be used to explain outcomes, without understanding their relative importance. To disentangle the effects of these two explanations, we set out to control for administrative procedures and political commitment through the examination of one police agency, the New York City Police Department (NYPD), which operates in a wide variety of communities and throughout five boroughs. Applying this control on inter-agency differences, assuming an across department commitment to pursue homicide cases in an evenhanded way, allows us to explore in detail the impacts that contextual factors have on influencing clearance rates at micro places throughout the jurisdiction. These contextual factors can include the demographic and socio-economic characteristics of neighborhoods, in addition to the varying impacts that the different environmental conditions across the city might have in affecting these results. The combined effects of some features or qualities of the landscape, such as, drug

markets, public housing, and so on could influence crime reporting or the suppression of information available to police in leading to an arrest.

Study Setting, Data and Methods

Crime in New York City

Collectively, scholars have concluded that crime, at the national level, decreased dramatically during the 1990s (Blumstein & Wallman, 2006; Levitt, 2004; Walker, 2015; Weisburd, Telep, & Lawton 2014). Despite this acknowledgement, a contentious debate surrounding the reasons for that decline and whether some cities experienced a greater decrease than others still continues. For example, some researchers suggest that the crime decline experienced throughout NYC was unparalleled (Weisburd et al., 2014; Zimring, 2007), especially when examining the twenty-year time period from 1990 to 2010 (Weisburd et al., 2014). However, other researchers have suggested that the crime decline experienced in NYC was not completely unique when compared to other major American cities and the conditions that allowed the decline to occur are far more complex than originally thought (see Baumer & Wolff, 2014; Bowling, 1999; Fagan, Zimring, & Kim, 1998; Levitt, 2004). This continued debate caused NYC to become an epicenter of both policing and crime-based research.

Although there is a sizeable body of research that examines these issues as they pertain to the crime decline experienced throughout NYC, this review focuses on those studies that examined homicides, as this study looks to examine open versus closed homicide cases. Fagan and colleagues (1998) begin by examining the homicide trend for the city as it compares to other cities throughout the U.S. and then examined the homicide trend for NYC by borough for the years 1990 through 1995. In agreement with other research, Fagan et al. (1998) concluded that

the homicide decline for that period of time was not unprecedented. That being said however, their research found that new patterns emerge when homicide data is disaggregated by weapon (i.e., gun), gender and age. For example, Fagan et al. (1998: p. 1289) found that homicides committed with a firearm initially increased before falling back to previously levels whereas non-firearm homicides trended downward from start to finish.

Messner and colleagues (2007) examined the possible effects that both broken windows policing and the cocaine market had on homicides across NYC police precincts from 1990 to 1999. They concluded that “the effects of misdemeanor arrests and cocaine prevalence emerge for gun-related but not for non-gun-related homicides” (Messner et al., 2007, p. 386). Very similar to this study, Chauhan and Kois (2012) examined the effects that misdemeanor enforcement and drug markets have on gun-related homicides at the precinct level in NYC from 1990 through 1999. Two very important findings emerge from this study. First, their analyses revealed, “one quarter of NYPD precincts were responsible for driving the overall decrease in homicide rates” (Chauhan & Kois, 2012, p. 20). Second, and very similar to previous work, their final results were mixed, thus alluding to the fact that no single aspect examined could be linked inextricably to the homicide decline of the 1990s (Chauhan & Kois, 2012).

Furthermore, there were two additional studies that also examined the decline in homicides in NYC from 1988 through 2001. This first study, conducted by Rosenfeld and colleagues (2007), critically examined the impact of order-maintenance policing (via proactive policing of quality of life offenses) on both homicides and robberies. Their research found that in the precincts where arrests for quality of life offenses increased, both robberies and homicides decreased (Rosenfeld et al., 2007, p. 366). Additionally, they also reported that as the level of disorder decreased in each precinct, so too did the amount of homicides and robberies (Rosenfeld

et al., 2007, p. 367). Interestingly, these findings differ from Greenberg's (2014) study, as he only focused on examining the effects that misdemeanor arrests had on homicides, robberies and aggravated assaults. In sum, he found "no evidence that misdemeanor arrests reduced levels of homicide, robbery, or aggravated assaults" (Greenberg, 2014, p. 154) and suggested that the decline experienced for these felony crimes must have been a result of the intersection of other factors.

In agreement with the key findings from this review, Karmen (2000) believes that the 1990s crime drop was the result of the intersection of a multitude of factors during that time period. For example, Karmen (2000) posits that some of the following conditions could have played a pivotal role in the crime decline: (1) the recovery of the economy; (2) the change in the number of students that not only finished high school but also entered college; (3) the weaning crack epidemic and the de-escalation of the arms race associated with the drug market; (4) the changes in the police department, which ranged from the technological improvements, the overall reengineering of the department, and the switch to more proactive policing styles; (5) the increase in the prison population; and even (6) the residual impact of the AIDS epidemic (pp. 257-258). Despite the mixed findings of the collective research, there is one aspect that remains constant – from 1990 through 1998, homicides dropped 72 percent (i.e., from 2,245 to 633) in NYC (Karmen, 2000, p. 25).

NYPD

The NYPD employs just over 35 thousand uniformed officers (NYPD, 2016) with approximately fifty-seven hundred detectives assigned to the Detective Bureau (NYPD, 2018). The Detective Bureau is organized across the eight patrol boroughs (i.e., Manhattan North,

Manhattan South, the Bronx, Brooklyn North, Brooklyn South, Queens North, Queens South and Staten Island), each of which have their own homicide squad (NYPD, 2018). On average there are anywhere between 10 to 20 detectives assigned to each, with the exception of Brooklyn North and the Bronx, where the averages are slightly higher and may range between 20 and 30 investigators. Typically, homicide detectives remain assigned to cases in their respective boroughs and only under the most extreme circumstances would they be temporarily allowed to aid in homicide cases in another patrol borough.

In the early 1990s, Commissioner Bratton restructured the NYPD in an attempt to decentralize the agency (Nagy & Podolny, 2008). He aimed to grant the Commanding Officers more autonomy within their commands (that is, so that they could deal with their individual crime issues and constituencies in a manner that suited their distinct needs) while also allowing the upper command staff the ability to maintain control over the decisions and actions of commanding officers (Nagy & Podolny, 2008). For our purposes here, it is noteworthy that the general administrative rules were common across the department and differences among precincts did not rise to a level that would create significant or distinct differences in intentions to clear homicide cases or the resources devoted to achieving these outcomes for every reported homicide.

Homicide data

Homicide incident clearance data was obtained from the Washington Post. In 2018, the news agency ran a story that mapped more than 52,000 homicides in major American cities across the United States (Lowery, Kelly, Mellnik & Rich, 2018). New York City provided two years of data to the Washington Post, from 2016 through 2017, which we used for this study. These geo-located data, including the incident location, whether an arrest was made, and basic

demographic information about each victim, were made publicly available online via GitHub in comma-delimited format (<https://github.com/washingtonpost/data-homicides>). Consistent with the FBI Uniform Crime Reporting Program, homicides were operationalized as murder and non-negligent manslaughter but excluded suicides, accidents, justifiable homicides and deaths caused by negligence. Homicides were closed by arrest when police reported that to be the case. Cases were counted as closed without arrest if they were reported by police to be “exceptionally cleared” -- whereby there was sufficient evidence to make an arrest but an arrest was not possible (for example, the suspect died). All other incidents were classified as having no arrest, thus remaining open or uncleared. Homicides are considered “cleared” if they were closed with an arrest or by the above mentioned, “exceptionally cleared.” Based on the Washington Post data, the national clearance rate for homicide was determined to be 49%; the clearance rate for homicides in New York City was 64%. Table 1 shows counts of these data for the NYC Boroughs examined in this study. Figure 1 presents hot spot maps of cleared and uncleared homicide cases in New York City. While there are several spatial overlaps, it is also evident that distinct areas of the city exhibit clusters of only cleared or uncleared cases.

FIGURE 1: Distinct areas of New York City exhibit clusters of cleared or uncleared homicide cases.

Table 1: Descriptive Information for Homicides in New York City

Borough	Area (Sq. Mi.)	Total Homicide Cases	Open Cases (%)	Closed Cases (%)	Precincts
Manhattan	22.80	87	21 (24.1%)	66 (75.9%)	22
Brooklyn	69.50	238	99 (41.6%)	139 (58.4%)	23
Queens	109.20	97	36 (37.1%)	61 (62.9%)	16
Bronx	42.50	169	62 (36.7 %)	107 (63.3%)	12

Environmental Factors

Potential environmental factors that could influence homicides and related clearance rates at particular places within New York City’s environmental backcloth were obtained from

NYPD's National Institute of Justice "Policing by Place" project (award #2013-IJ-CX-0053), archived with the National Archive of Criminal Justice Data (NACJD). These data measures were initially informed by professional insights provided by the NYPD and related spatial datasets were originally obtained by the NYPD as shapefiles compiled from numerous local government agencies: the Department of Consumer Affairs, Department of Financial Services, Department of City Planning, Department of Environmental Conservation, Department of Information Technology and Telecommunications, Department of Parks and Recreation, the New York City Housing Authority, and the New York State Liquor Authority. As recommended by Caplan and Kennedy (2016) these data were then ground-truthed for accuracy and checked for construct and content validity by the NIJ research team. In total, we obtained 45 environmental features of the New York City landscape as potential risk factors (see Appendix I for the complete list).

Risk Terrain Modeling (RTM)

Risk Terrain Modeling (RTM) was used to conduct spatial analyses of the relationships between cleared and uncleared homicide cases and environmental factors of the NYC landscape. RTM offers an evidence-based and statistically valid way to diagnose spatial relationships among datasets, and to identify locations where the likelihood of particular outcomes will be high (Kennedy, Caplan & Piza, 2011). Detailed instructions for conducting RTM are available in the extant literature (Caplan & Kennedy, 2016; Caplan, Kennedy, Barnum & Piza, 2014). Risk terrain models were produced using RTMDx softwareⁱ, which has been used for similar purposes in several research studies across multiple jurisdictions. Caplan and Kennedy (2016) provide details about the RTM process and statistical methods performed by RTMDx, which involve

Bayesian probabilities, cross-validations, and Poisson and negative binomial regressions.

RTMDx outputs are tabular and cartographic; for each significant risk factor, tabular outputs include a relative risk value (RRV), which is the exponentiated factor coefficient (i.e., relative weight), and the optimal operationalization and distal extent of spatial influence. A risk terrain map is also produced with relative risk scores (RRSs) assigned to each micro place to convey the full range of relative spatial risks of outcome events (i.e., un-cleared homicides) throughout the study area.

RTM is a key tool in risk based policing (Kennedy, Caplan, & Piza, 2018). As Kennedy, et al. (2018) explain, RTM extends the investigation from the crime incidents to the spatial contexts in which these incidents emerge or persist, offering the analytical assessment needed to inform police decision-making. RTM provides the framework for diagnosing these factors in a way that helps us understand the circumstances under which crime occurs. Risk terrain maps articulate micro-level places where conditions are suitable for illegal behavior and most likely for crimes to occur. Further, RTM has been shown to articulate officers' "gut" feelings and perceptions of risk at places beyond merely referencing past occurrences of reported crimes. RTM provides an indication of what risk factors might be at the root of crime problems and, thus, helps police devise a problem solution. In this way, RTM helps to make information that comes from complaints about problem areas actionable and relevant to service delivery and public safety and its outputs would be particularly useful in sorting out the factors that contribute to homicides. It should, as a consequence, be equally insightful in providing clues to assist in clearing these homicides when they occur.

RTM Analysis

As pointed out above, although NYPD is a single organization that serves the entire City of New York, administrative and command distinctions can exist across boroughs based on local contexts. A citywide RTM analysis would generalize such distinctions, but could miss nuances of the micro settings within each borough where homicides could occur. For this reason, separate risk terrain models were run for each borough, using the same analysis parameters for each. We specified a cell size of 200 feet and a block length of 400 feet (the average block length in NYC) as units of analysis for RTM (Caplan, Kennedy, & Piza, 2013). Prior empirical research by Taylor and Harrell (1996) and Taylor (1997) suggests that “behavior settings” are crime-prone places that typically comprise just a few street blocks (Taylor, 1988). Groff and Lockwood (2014) show that the spatial influences of environmental features located in these settings extends no further than just a few blocks and decays with distance. Based on these insights, we decided not to evaluate spatial influences beyond 3 blocks for our study.

Additional parameters for the RTM included operationalization, maximum spatial influence, and analysis increments. Operationalization refers to how the spatial influence of each environmental feature will be tested. Caplan (2011) explains that the spatial influence of environmental features may be operationalized as proximity (i.e., being near a feature increases risk) or density (i.e., a cluster of features increases risk). RTMDx can test both operationalizations and empirically select the most appropriate one. Maximum spatial influence defines the geographic extent to which environmental features’ influences on crime extends (i.e., the influence of bars may extend to one, two or three blocks). Because research has found that the spatial influence of features typically extends within just a few blocks, we tested the spatial influence of each environmental feature to a maximum extent of three blocks. Finally, analysis

increments refer to the level of detail at which spatial influence is assessed (i.e., half-block or whole-block increments). Appendix 1 displays this parameter for each feature tested.

Results of the RTM analyses for cleared and un-cleared homicide cases in each Borough (Manhattan, Brooklyn, Bronx and Queens) are displayed in Table 2. Maps, such as Figure 2 depicting the combined spatial influences of significant risk factors and the highest risk places within each model, were exported from RTMDx software as ArcGIS shapefiles. Relative risk scores (RRS) for each micro-place in the risk terrain map was then standardized as a Z-score (for comparisons across all eight models) and used as the independent variable for subsequent regression analyses, discussed below.

Table 2: Risk Terrain Modeling findings for open and closed homicides

Risk Factor	Manhattan Open	Manhattan Closed	Brooklyn Open	Brooklyn Closed	Queens Open	Queens Closed	Bronx Open	Bronx Closed
Drug Markets		D/400/ 3.6	D/400/3 .1	D/400/2 .4				
Housing Authority Developments	P/200/5. 8		P/1200/ 2.5	P/1200/ 2.32	P/1000/ 11.1		P/400/4 .6	
Food Pantries or Soup Kitchens	P/1000/ 7.4		P/1200/ 2.6			P/1200/ 3.0		
Grocery Stores Licensed to Sell Beer or Wine		D/400/ 3.6	P/600/2. 55	P/600/2. 3			D/1200/4.11	
Liquor – Off Premise						P/1200/ 9.6		D/1000 /4.1
Check Cashing							P/800/2 .6	
Laundromats					D/1000 /4.95			P/1000/ 4.1
Grocery Franchise/Chain Stores Licensed to Sell (only) Wine							P/200/1 9.8	

Key: P=proximity; D=density/Spatial influence distance/Relative Risk Value (RRV)

Figure 2: Risk Terrain Maps of Homicide Cases in Queens Borough

Regression Analysis

Following the identification of significant risk factors, we measured whether the relative risk scores (RRS) for open and closed cases significantly predicts the status of homicide incidents. We explored this research question through a logistic regression model with the 590 homicides occurring during the study period as the unit of analysis. The dependent variable was a binary measure with solved cases coded as “1” and open cases “0.” The models have two independent variables of interest. The first is a standardized measure of the RRS for closed homicides. The second is a standardized measure of the RRS for open homicides. For both independent variables, RRS values were standardized according to the range of cell values throughout the surrounding borough. Each homicide was assigned the value of its encompassing cell. If RRS values are truly predictive of homicide status, then we would expect the RRS for

closed cases to be significantly related to increased likelihood of case closure and the RRS for open cases to be significantly related to decreased likelihood of case closure. The effect of both RRS variables on homicide clearance were reported as Odds Ratios (OR).

To control for the effect of neighborhood factors on homicide investigations, we include a concentrated disadvantage index as a control variable. This variable was an index of the standardized values of the following measures, which were all collected at the precinct level from the Infoshare Online website (<http://www.infoshare.org/main/public.aspx>): percentage of families receiving food stamps, percent black or Hispanic residents, percentage of families below the poverty line, percentage of single headed female households with children, and median household income. All measures were 5-year averages (2012-2016). Standard errors for all model covariates were calculated across each of the 72⁵ police precincts in our study setting to control for any unobserved precinct-level effects on homicide clearance (e.g., number of detectives, investigative strategy, etc.).

Findings are presented in Table 3, below. Both the RRS for closed and open cases were statistically significant with effect sizes in the expected direction. For every 1-unit increase in the standardized RRS for closed cases the likelihood that a homicide would be solved increased by 25% (OR=1.25; p=0.04). For every 1-unit increase in the standardized RRS for open cases, the likelihood that a homicide would be solved decreased by 20% (OR=0.80; p<0.01). These

⁵ Currently, there are 77 precincts in NYC. However, the Staten Island precincts were removed from this analysis to minimize the possibility of confounding factors affecting this analysis. For example, SI is the only borough that does not have transit districts and police service areas, which may limit the resources that could potentially support each precinct detective squad in investigating the homicide. Second, in terms of size, there are only four precincts in SI, when there are 12 in the Bronx, 22 in Manhattan, 23 in Brooklyn, and 16 in Queens. Third, in studying NYC crime trends, this was also done in previous research (see Fagan et al., 1998). Lastly, the Central Park precinct was removed from the analysis because it is the only non-residential precinct in NYC. Thus, there are only 72 precincts in the final analysis.

findings show that spatial risk factors, as identified through RTM, may influence the solvability of homicide events in New York City.

Table 3: These findings show that spatial risk factors, as identified through RTM, may influence the solvability of homicide events in New York City

	95% C.I.				
Covariates	OR	SE**	p	Lower	Upper
RRS for closed cases ^z	1.25	0.13	0.04	1.01	1.54
RRS for open cases ^z	0.80	0.04	<0.01	0.72	0.88
Concentrated disadvantage index*	0.97	0.02	0.23	0.93	1.02
Constant					
Log likelihood	-370.38				
Wald X ² (3)	24.92				
^z Standardized measure					
* Standardized index including: % food stamp recipients, % Black & Hispanic residents, % poverty, % unemployed, % single female headed households with children, and median income. All variables measured at the precinct level.					
** Standard errors clustered across 72 precincts (excludes Staten Island & Central Park)					

Discussion and Conclusions

This study provides a unique insight into the differential effects of geo contextual factors influencing homicide clearance. In this paper, we explored the spatial conditions under which closure rates improve by looking at the experience across New York City, where there is one police agency that operates across boroughs that are very different from one another in terms of risk factors that contribute to crime. Using one agency provides a control on the administrative differences that appear across other jurisdictions that have been studied, usually through cross-national analysis. Our analysis used RTM to identify environmental features that relate to closed versus open homicide cases in NYC over a 2-year period. We then conducted a logistic

regression analysis to see the level to which spatial risk scores predict whether individual homicide incidents were closed via NYPD investigations. In doing so, this work extends previous research on homicide clearance.

Our results demonstrate a strong effect of physical environments and the related situational contexts these settings have on communities affected by homicides located there, addressing the issues of community context raised by Regoeczi et al. (2020). Specifically, our findings provide support for research completed by Brunson and Wade (2019) that living in socially disadvantaged communities connects to lower clearance than in other locations. The effects of public housing, vacant properties, and other contributors to disorder in communities with few resources may lead to a climate of lower cooperation and distrust of the police in helping them solve crimes. Further, the effects of these other factors, such as, drug markets, soup kitchens or laundromats, create situational contexts among people who interact with these places that alter the likelihood of clearance within boroughs and across boroughs. For example, public housing significantly impacts open homicide cases in all four boroughs tested, but only those located near soup kitchens in Manhattan or Brooklyn are the most likely to remain open cases. The fear of retaliation documented in the aforementioned prior research studies could be higher in these locations, supporting a pattern of non-compliance that leads to the consequence of lower levels of homicide clearance. This study demonstrates that micro places within a jurisdiction could affect non-compliance with police investigations among people who routinely interact with these settings due to fear of retribution that ethnographers and police scholars have documented.

From a policy perspective, our findings support the efforts that have been proposed by agencies such as the NYPD to address the stubbornness of non-clearance results by adding more officers and other city services to address the issues that emerge from communities that fear both

reporting to the police and its perceived consequence. Recognizing the limitations uncovered through previous research, the NYPD has introduced the Neighborhood Policing Plan (NPP) to address this environmental aspect. Under this plan, each precinct was restructured into only four or five patrol sectors, where each sector has a radio car with two police officers assigned who answer the calls for service in that sector and two neighborhood coordinating officers (NCOs). According to then Assistant Chief Monahan, NCOs operate as “part patrol officer, part community officer, part detective, and part intelligence officer” (NYPD, 2016). Adding this second layer of coverage to each sector allows officers the critical time necessary to get out of their patrol cars and reconnect with the community in which they serve, in an attempt to break down the barriers between the community and the police officers that serve that community (NYPD, 2016). A second way in which the NYPD tried to improve procedures is evident in their restructuring of the Department in March of 2016. During this time period, the NYPD created a unified investigations model, joining the two major investigative bureaus (i.e., the Organized Crime Control Bureau and the Detective Bureau) (NYPD, 2018). Reorganizing the detective bureau in this manner allowed for all investigative squads to fall under one central authority (i.e., the Chief of Detectives) (NYPD, 2018), making information sharing and dissemination easier; recognizing that there was a need for “a geographically based investigation structure” (NYPD, 2017, p. 65). Changing the organizational structure of the Detective Bureau from a decentralized model to a more centralized model allowed for an important change in how information was shared and distributed within the department. This change was necessary as the residual impact of the previous restructuring of the department in the 1990s eventually led to less intra-agency cooperation and minimal information sharing between specialized units. In sum, reorganizing the investigative units in this way significantly strengthened intelligence sharing among them.

Under this unified investigations model, NCOs (neighborhood coordinating officers) and patrol officers work in tandem with the detectives assigned in that precinct, allowing for information to move more fluidly within the organization (NYPD, 2017). An example of this can be viewed through the progress made in a homicide case that occurred in Queens, which received a significant amount of press coverage (NYPD, 2019). In July 2018, a nurse was found strangled to death in the confines of the 105th Precinct (in Queens). The detectives from this precinct, along with the detectives assigned to Queens South Homicide Squad, were eventually able to identify the suspect “who had met the victim on a dating app” (NYPD, 2019, p. 22). The suspect was then “apprehended in a Los Angeles motel room by the Fugitive Enforcement Division, who were working in concert with the US Marshals and the LAPD, [where] he was holding another woman captive” (NYPD, 2019, p. 22).

Future research on this topic can seek to explore in greater detail the connections between neighborhood conditions, as laid out in our analysis of risk factors, and willingness of community members to participate in investigations and trials of offenders. This type of mixed method approach would help clarify the successes and failures that police face in clearing these crimes and help institute effective solutions going forward.

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Appendix I

Risk Factors included in the analysis

Amusement or Theme Parks; Billiards; Fire Houses; Housing Authority Developments; Pedestrian Plazas; Public Pools; Recreation Centers; Playgrounds, Courts, or Neighborhood/Community Parks; Senior Centers; Subway Entrances; Drug Markets (via Drug Arrest Data); Adult Clubs; Banks; Bars or Night Clubs with Liquor Licenses; Check Cashing Businesses; Chemical Dependency Facilities; Cinemas; Court Houses; Food Pantry or Soup Kitchens; Gas Stations; Homeless Shelters; Hospitals; Hotels or Motels; Houses of Worship; Laundromats; Retail Stores Selling Liquor for Off-Premise Consumption; Businesses Selling Liquor for On-Premise Consumption (e.g., Bars); Alcohol-only Retail Stores (i.e., Packages Liquor Stores); Mental Health Facilities; Parking; Pawn or Second Hand Stores; Post Offices; Private Schools; Public Schools; Colleges or Universities; Scrap Metal or Auto Dismantle Businesses; Tourist Attractions; Drug Stores Licensed to Sell Beer or Wine; Grocery Stores Licensed to Sell Beer or Wine; Grocery Franchise/Chain Stores Licensed to Sell (only) Beer; Grocery Franchise/Chain Stores Licensed to Sell (only) Wine; Grocery Stores Licensed to Sell Beer (only); Stores Licensed to Sell Wine (only); Restaurants Without On-Site Seating; Restaurants with On-Premise Seating. This data has also been used for similar purposes in prior spatial research set in NYC (i.e., Caplan, Kennedy, Piza & Barnum, 2019; Feng, Piza, Kennedy, & Caplan, 2018).

¹ From the Rutgers University Center on Public Security: www.rutgerscps.org/software.html