Article

Examining the Environmental Characteristics of Drug Dealing Locations

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Abstract

Illicit drug dealers who operate in open-air markets must access customers in the face of risks posed by law enforcement, customers, and competitors. However, researchers purport that the environmental characteristics of certain locations may allow dealers to balance these competing demands. This research utilizes risk terrain modeling to identify the environmental characteristics of drug dealing locations in Chicago, Illinois, and compares these characteristics across different types of drugs. Results show that a number of place features increase the risk of drug dealing. Although many of these features are common to locations for all types of drug dealing, there are some variations. The findings provide insight into the environmental context of drug market locations, which has implications for researchers and practitioners.

Keywords

drug dealing, risk terrain modeling, RTMDx, spatial influence

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Introduction

Illicit drugs are distributed in many ways, but one particular system operates at the street level as an open-air market (May, Harocopos, Turnbull, & Hough, 2000). In open-air markets, drug dealers must simultaneously access customers while minimizing a variety of risks (Eck, 1995). Some locations may be more suitable for drug dealing than others. For example, one study conducted in Jersey City, New Jersey, found that 46% of drug sales arrests occurred at only 4.4% of all places (Weisburd & Green, 1995). These locations may exhibit disproportionately high levels of drug dealing because they have a particular set of environmental characteristics that allow dealers to balance the unique demands of operating an open-air market (Kennedy, Caplan, & Piza, 2011). That is, some locations contain particular features of place that produce ideal or "ecologically advantageous" conditions for crime (St. Jean, 2007).

Environments influence drug dealing (Harocopos & Hough, 2005), but only a handful of studies have examined the environmental characteristics of drug dealing locations (Bernasco & Jacques, 2015; Eck, 1995; McCord & Ratcliffe, 2007; Rengert, Ratcliffe, & Chakravorty, 2005; Robinson & Rengert, 2006; St. Jean, 2007). Furthermore, with the exception of Eck (1995), previous studies rarely examine potential variation in the characteristics of drug dealing locations by drug type. This research seeks to explore the environmental characteristics of locations where cannabis, heroin, crack, and cocaine are sold. In doing so, we seek to address two primary research questions as follows:

> **Research Question 1:** Are certain place features risk factors for drug dealing?
> **Research Question 2:** If place features are risk factors for drug dealing, to what extent are they the same or different across locations where different types of drugs are sold?

In the following sections, we review the literature on drug market locations and build a conceptual framework for the study. Next, we describe how we utilize risk terrain modeling (RTM; Caplan, Kennedy, & Miller, 2011) to investigate our primary research questions. Finally, the results of our analyses are presented and then discussed with regard to their relevancy for future research and practice.

Drug Market Locations

Definitions vary, but drug markets can refer either to broad national, state, or citywide markets centered on illegal drugs, or specific marketplaces in which

highly concentrated drug activity occurs among a small group of people or at a specific location (Reuter & Pollack, 2012). Here, drug markets reference the latter. Theories pertaining to drug market locations primarily rely on two broad but complementary theoretical perspectives. The first includes a rational choice perspective, which suggests that both drug dealers and drug buyers will engage in a rational decision-making process, albeit bounded by the most readily available information, in determining where to sell and buy drugs (Clarke & Cornish, 1985). From this perspective, drug dealing is likely to be located at places that drug dealers and buyers perceive to provide a sufficient measure of reward relative to the risks of engaging in illicit activity.

Second, the environmental perspective (Wortley & Mazerolle, 2008) includes both routine activities theory and crime pattern theory and contextualizes location decisions. Routine activities theory posits that drug market location is the result of the legitimate activities of offenders and victims, both of whom happen to converge at a specific time and place that is absent sufficient guardianship (Cohen & Felson, 1979). Crime pattern theory (Brantingham & Brantingham, 2008) explains this process by locating individuals' routine activities within the context of the environmental backcloth—a dynamic system composed of roads, buildings, and features of place. The backcloth shapes legitimate activities and can create conditions in which both dealer and buyer can easily find each other and conduct business with minimal risk. Some places within this backcloth are more likely to bring together offenders and victims absent guardianship because they contain crime generators and crime attractors (Brantingham & Brantingham, 1995). Whereas the former refers to features that attract a large number of people for otherwise legitimate purpose (naturally increasing exposure), the latter refers to features that specifically draw people, given their well-known criminal opportunities.

From these theoretical perspectives, Eck (1995) developed a "general model" of illicit retail marketplaces. According to Eck (1995), dealers and buyers have two primary concerns. First, like in legitimate retail markets, dealers must be able to access customers and vice versa. However, unlike legitimate retail markets, dealers cannot utilize commonly used methods of advertising as such methods would put them at risk of legal sanction. Thus, the accessibility problem must be resolved in other ways, either through social networks—essentially word of mouth advertisement—or through routine activities—selling at locations that provide quick and easy access to many people at a given time. The second concern is security. Unlike legitimate retail markets, drug dealers face two substantial problems: risk of arrest by law enforcement and the risk of disputes (e.g., with other dealers or customers), as drug markets lack formal third parties (e.g., courts) to resolve

disagreements. The social network and routine activities solutions are also used to resolve problems of security. Whereas in the social network solution, dealers rely on buyers' reputation to avoid law enforcement and potentially disagreeable customers, a routine activities solution allows dealers to exploit locations that are familiar and have particular characteristics that increase control and privacy of transactions. Eck (1995) found support for his general model using drug arrest data in San Diego, observing that cocaine dealing primarily aligned with a routine activities solution and methamphetamine with a social networks solution.

Subsequent research on drug market location has been consistent with Eck's (1995) general model. For example, by interviewing active drug dealers in Chicago, St. Jean (2007) identified three important aspects of a location that made it ideal for dealing. The first was that locations should be near the areas of high activity and major transportation routes so that it bolstered customer accessibility and allowed quick escape, features appealing to both concerns about access and security. Second, reflective of security concerns, ideal locations should be near legitimate activity to allow for deniability, or the ability of a dealer to claim, if stopped by law enforcement, that he or she was there for some legitimate purpose (e.g., shopping for groceries, waiting for a bus). Finally, dealers searched for locations that had what St. Jean termed "enablers" or other nearby resources (e.g., a stash house) that could enhance security.

Together, rational choice and environmental theories work synergistically to explain drug market locations. Dealers consider both dimensions of legal economic activity (i.e., access to customers) and dimensions of illicit activity (i.e., security) when determining where to sell. Moreover, perceptions of the surrounding environment inform these concerns.

Environmental Indicators of Access and Security

The above findings speak to the main theoretical concerns—customer access and security—that lead to drug market locations. Furthermore, they lay the groundwork for assessing the environmental characteristics of locations that align with those concerns. St. Jean (2007) referred to locations with particular characteristics that provide access and security as ecologically advantageous; defined formally as "features or reputations that make [places] differentially useful or attractive to offenders, especially crime entrepreneurs" (St. Jean, 2007, p. 52). As St. Jean (2007) explained, drug dealers proactively solicit locations that are ecologically advantageous. For example, Eck (1995) suggested that locations with features indicating high levels of daily activity may provide a better environment for drug dealing than less frequented locations.

Such locations are familiar, easy to get to, and likely to draw plenty of potential customers. St. Jean (2007) also found support for the attractiveness of similar locations as they allow deniability to dealers.

McCord and Ratcliffe (2007) explicitly studied the connection between drug arrests and place features. They found that drug arrests clustered within a few blocks of various features, such as check-cashing centers, beer establishments, pawnshops, subway stations, halfway houses, homeless shelters, and drug treatment centers. However, in subsequent statistical analysis controlling for socio-demographic variables, only beer establishments and subway stations were significantly related to drug arrests. In a similar analysis, Rengert et al. (2005) found clustering of drug arrests near taverns, liquor stores, check-cashing stores, homeless shelters, and social service centers. When controlling for various socio-demographic variables, highway access ramps, check-cashing stores, liquor stores, and homeless shelters were related to drug arrests. However, taverns and social service centers predicted decreased counts of drug arrests. Rengert et al. (2005) classified features as access or activity features, consistent with the theoretical dimensions of drug market locations described by Eck (1995) and St. Jean (2007).

Using interviews with active drug dealers and systematic social observation, Bernasco and Jacques (2015) sought to understand how dealers decide, in terms of customer access and security, where to solicit customers and where to sell their drugs. They found that places with high levels of legal activity, and therefore large number of potential customers, such as bars, clubs, hotels, and coffee shops, were important to dealers. With regard to security, they found that dealers cared more about access to customers and generally disregarded various elements of guardianship such as closed-circuit television cameras (CCTV), informal social controls, and police presence. Instead of relying on the environment for protection from law enforcement, they made small behavioral adjustments (e.g., walking instead of standing still, using stash spots to hide their drug supply) to increase security while remaining in a highly accessible location.

Drug Market Location and Drug Type

Extant research establishes the importance of customer accessibility and security to open-air drug markets, and further, that particular characteristics of locations can resolve these concerns. However, an important question is if a particular location is ecologically advantageous, will many different types of drugs be sold at that location? On one hand, it is plausible that different drugs would be sold at different locations if there are particular drug-related considerations that make certain locations ecologically advantageous for

selling some drugs but not others. For example, different types of drugs may have different consumer populations (Curtis & Wendel, 2000; May et al., 2000), which may require dealers to find locations most convenient to their relevant population. Furthermore, different types of drugs may have different sellers (Curtis & Wendel, 2000). For example, gangs are well-known participants in the illegal drug trade (Decker, 2000; Decker & Van Winkle, 1994) and are known to be violent (Rosenfeld, Bray, & Egley, 1999). Gangs may use violence to defend profitable locations from competitors selling other types of drugs. Third, some drugs (e.g., crack) may come with stiffer penalties (Yeh, 2015) creating different risks from law enforcement. Similarly, because prices and availability vary among drug types (Office of National Drug Control Policy, 2012), they may generate distinct risks from customers and rivals in the form of theft or robbery. For example, Felson and Bonkiewicz (2013) found that gun possession in drug markets varies by drug type, with the best predictor of gun ownership being the price of the drug.

Rengert (1996) explained that if certain locations are profitable enough, other drug dealers may move in to capitalize on excess profits, even without fear of retribution from competitors. Indeed, there may be many benefits for dealers who utilize the same locations to move their products. One study found evidence of agglomeration economies, or spatial clustering, of drug markets (Taniguchi, Rengert, & McCord, 2009). Taniguchi et al. (2009) provided a number of reasons why markets for different drugs may share locations. For example, location sharing can provide a natural source of protection. Essentially, the threat from police is diluted as the number of dealers in the same area increases. Moreover, by location sharing, dealers can share the fixed costs of operating an illicit market (e.g., lookouts). Finally, customers have imperfect knowledge of the illicit retail marketplace. By locating near one another, dealers can establish a reputation at a particular location, making it a well-known source of drugs.

In sum, accessibility and security may be tied to the particular type of drug that is being sold. Certain place features may resolve these concerns, which lead to different drugs being sold in different locations. Conversely, accessibility and security may be universal concepts, in that ecologically advantageous locations for drug dealing transcend the particular considerations of the drug being sold. Instead, when a particular location is ripe for drug dealing, many dealers will move in to capitalize on the ecologically advantageous space.

The Study

This study seeks to expand on the current understanding of drug market locations by utilizing RTM to examine the environmental characteristics of

locations where different types of drugs are sold. RTM is a tool for geospatial risk assessment that is designed to identify crime-prone locations as a function of criminogenic place features (i.e., risk factors) that come together to increase crime risk (Caplan et al., 2011). As such, RTM is well suited for investigating the environmental characteristics of locations where drug dealing flourishes.

Drug markets have been examined within several RTM-based studies, but to date, have been incorporated as a potential risk factor for other types of crime (e.g., Caplan, Kennedy, & Baughman, 2012; Caplan et al., 2011; Drawve, Moak, & Berthelot, 2016; Irvin-Erickson, 2014; Kennedy et al., 2011; Moreto, Piza, & Caplan, 2014). However, unlike other place features such as bars, grocery stores, or pawnshops, drug markets are not static physical features; instead, they are dynamic social features dependent on a wide range of phenomena and not necessarily tied to a single location (Rosenblum et al., 2014). Moreover, research by Lum (2008) demonstrated that the spatial distribution of drug markets and crime can vary in important ways. Thus, it is important to understand the environmental characteristics of drug markets themselves. This study focuses on locations where cannabis, heroin, crack, and cocaine are sold and, in doing so, seeks to address two primary research questions. First, are certain place features risk factors for drug dealing? Second, if place features are risk factors for drug dealing, to what extent are they the same or different across locations where different types of drugs are sold?

Data and Method

The setting of this study is Chicago, Illinois. Chicago is 234 square miles in size with a total population of approximately 2.7 million. Chicago tends to outpace much of the nation with regard to crime. As such, it comes as no surprise that Chicago has historically served as an epicenter of criminology and criminal justice inquiry. A primary advantage of conducting research in Chicago is the vast quantity of freely available data. Chicago's online data portal[1] provided data on many variables relevant to this study, including crime, 311 service requests, business licenses, and public facilities. Additional data[2] for this study were obtained from the Chicago Police Department or from Infogroup.[3] All data were collected at the *xy*-coordinate level and prepared for analysis in Esri's ArcGIS 10.2.1.

Risk Terrain Modeling

There is a general process of RTM (e.g., see Caplan, Kennedy, Barnum, & Piza, 2015) that begins with selecting an outcome event, time period, and study

setting. Next, place features that may increase the risk for the outcome event must be selected for inclusion in the RTM based on theory, empirical testing, or practitioner insight. The spatial influence of each place feature to be included in the RTM must be operationalized to a grid of raster cells representing the study setting. This produces a set of separate but standardized layers with values representing the spatial influence of each feature at every place (i.e., cell) throughout the study setting. These layers are then combined to produce a single composite risk terrain. Again, each cell contains a value; however, the composite risk terrain value indicates the combination of spatial influences of all features present or absent at each place throughout the study setting. At this point, this model is "unweighted" (i.e., all features are expected to be positively and equally related to the outcome event). However, common statistical techniques (e.g., logistic regression; Caplan et al., 2011) can be utilized to validate and weight risk layers.

Outcome Events

Following previous research on drug markets[4] (Eck, 1995; Johnson & Ratcliffe, 2013; McCord & Ratcliffe, 2007; Rengert et al., 2005; Weisburd & Green, 1995), the outcome events for this study were drug arrest incident locations for the manufacture or delivery of cannabis, heroin, crack, and cocaine between 2010 and 2014.[5] As mentioned, research identifies both open and closed drug markets (e.g., Eck, 1995). This study focuses on environmental characteristics that make particular locations ecologically advantageous, and as such, is most applicable to open-air drug dealing. Therefore, only drug arrest incidents that occurred in a public space were utilized.[6] This provided a total of 3,388 cannabis arrest incidents, 4,459 for heroin, 1,772 for crack, and 235 for cocaine.

Model Factors

Overall, 28 place features were selected for analysis based on theoretical expectations or existing empirical research (Bernasco & Jacques, 2015; Eck, 1995; Harocopos & Hough, 2005; Hope, 1994; McCord & Ratcliffe, 2007; Rengert, 1996; Rengert et al., 2005; Robinson & Rengert, 2006; St. Jean, 2007) that such features would make drug dealing more likely by enhancing accessibility or security. The final set of features is displayed in Table 1. For ease of interpretation, we classified features with regard to the dimension of ecological advantage they are likely to fulfill. Examples of security features include 311 calls for broken street lights, foreclosures, or problem landlords. Examples of accessibility include grocery stores, taverns, rail stations, homeless shelters, liquor stores, and highway access ramps.

Table 1. Counts and RTMDx Analysis Parameters for Testing of Place Features.

Place features	*n*	Operationalization
Security features		
311 calls for broken street lights	9,999	Density
Affordable housing	211	Both
Public parking garages	491	Both
Foreclosures	15,305	Both
Parks	558[a]	Proximity
Problem landlords	45	Both
Accessibility features		
Apartment complexes	391	Both
Banks	367	Both
On premise liquor	2,382	Both
Filling stations	448	Both
Late hour establishments	155	Both
Packaged goods	1,190	Both
Retail food	11,699	Both
Secondhand dealers	349	Both
Taverns	956	Both
Bus stops	10,711	Both
Grocery stores	933	Both
Homeless shelters	29	Both
Laundromats	173	Both
Liquor stores	926	Both
Night clubs	128	Both
Pawnbrokers	68	Both
Rail stations	124	Both
Retail shops	235	Both
Schools	1,021	Both
Variety stores	124	Both
Youth centers	185	Both
Highway access ramps	1,126[a]	Proximity

Note. Additional parameters for all place features. Spatial influence: Three blocks. Analysis increments: Whole blocks. RTMDx = Risk Terrain Modeling Diagnostics.
[a]Feature count prior to being converted to points.

Model Parameters

Four RTMs were completed using the Risk Terrain Modeling Diagnostics (RTMDx) Utility (Caplan & Kennedy, 2013), a software application produced by the Rutgers Center on Public Security to automate many of the

processes involved in RTM (Caplan, Kennedy, & Piza, 2013). Standard parameters across models were utilized so that the results of each model could be meaningfully compared with one another. First, all models were set to aggravating, which instructs RTMDx to search for positive spatial relationships between each feature and the outcome event. Next, because variations in crime are expected across places (Groff, Weisburd, & Yang, 2010), the block length and cell sizes for each model were specified as the mean (426 ft.) and half the mean (213 ft.), block length in Chicago, respectively (Caplan et al., 2013). With regard to the analysis, this means that RTMDx modeled Chicago as a continuous surface of 213 × 213 foot raster grid cells (N = 143,963).

Operationalization, analysis increments, and maximum spatial influence were specified for each place feature as it was entered into the model. Operationalization describes how the spatial influence of each feature is modeled, for example, as a function of proximity to features or density of features (Caplan et al., 2013, p. 21). Proximity reflects the risk associated with being within a specified distance of a location and is operationalized in RTMDx using Euclidean distance. In contrast, density considers the risk associated with being in a location where certain features cluster. Density is operationalized in RTMDx using kernel density. To allow RTMDx to empirically determine the best operationalization, both proximity and density were tested for most features included in the models[7] (Caplan et al., 2013). Finally, research has shown that the spatial influence of place features is limited to just a few blocks, or less, of those features (Groff & Lockwood, 2014). Therefore, the maximum spatial influence of each feature was tested to an extent of three blocks at increments of one block. In sum, the spatial influence of each feature was analyzed as a function of proximity at one, two, and three blocks and as a function of density at one, two, and three blocks. These parameters generated 159 independent variables for analysis in each RTM.

Statistical Analysis

RTMDx empirically identifies risk factors for a specified outcome from a large set of potentially relevant factors. The statistics utilized by RTMDx in this process are described in detail by Heffner (2013). Briefly, each model begins with the outcome event (i.e., drug arrest incident locations) and the 159 independent variables (i.e., spatial influences of potentially risky place features) that were operationalized for testing. The model builds an elastic net penalized regression model assuming a Poisson distribution of events. To avoid problems with multiple comparisons, RTMDx uses cross-validation. At this point, the initial large set of variables is reduced to a smaller set of

variables. However, RTMDx continues with a bidirectional stepwise regression procedure to further reduce this set of variables. Two modeling processes are used: one assuming a Poisson and the other a negative binominal distribution of events. The Bayesian information criterion (BIC) is measured for a null model and then re-measured again as each new variable is added to the model. RTMDx continues iteratively—adding and removing variables and measuring the BIC score—until the addition or removal of a new variable does not allow the model to surpass the BIC score of the previous candidate model. The final model that is chosen has the lowest BIC score between the two distributions.

Results

Table 2 displays the final results of each RTM, including place features (i.e., risk factors) that increase the risk of drug dealing. For each risk factor, the model presents the optimal spatial operationalization (i.e., OP), spatial influence (i.e., SI), and a relative risk value (i.e., RRV).[8] Operationalization describes how each risk factors influences its surroundings, either as a function of being near those risk factors (i.e., proximity) or within an area where those risk factors cluster (i.e., density). Spatial influence pertains to the extent of influence to one (i.e., 426 ft.), two (i.e., 852 ft.), or three blocks (i.e., 1,278 ft.). RRVs weight each risk factor relative to one another within each model.

Overall, the RTMs identified 11 risk factors for cannabis dealing, 12 for heroin dealing, 11 for crack dealing, and three for cocaine dealing. For cannabis dealing, the riskiest feature was foreclosures; locations within approximately two blocks of a foreclosure were about 10.21 times as likely to witness an arrest for cannabis transactions as other places absent any risk factors in Chicago. In fact, foreclosures represented the riskiest feature for heroin (RRV = 4.95), crack (RRV = 11.12), and cocaine (RRV = 16.56) dealing, and all models consistently indicated that the risk of drug dealing was higher within about two blocks of foreclosures. Foreclosures were about 2 to 5 times as risky for all drug markets as the next riskiest feature within each model.

A number of security and accessibility features were identified. Locations with broken street lighting, affordable housing, foreclosures, and problem landlords were at higher risk for cannabis, heroin, and crack dealing. These features are likely to be associated with lack of guardianship, which provides a measure of security for drug markets to operate. In terms of accessibility, locations containing filling stations, retail food establishments, bus stops, grocery stores, liquor stores, and schools were at higher risk for cannabis, heroin, and crack dealing. Such features are likely to increase customer accessibility because they are easy for drug dealers to get to, familiar, and likely to

Table 2. Optimal Risk Terrain Model Specifications for Cannabis, Heroin, Crack, and Cocaine Arrest Incidents in Chicago, 2010-2014.

	Cannabis		Heroin		Crack		Cocaine	
Risk factor	OP, SI	RRV	OP, SI	RRV	OP, SI	RRV	OP, SI	RRV
Security features								
311 calls for broken street lights	D, 1,278	1.63	D, 1,278	2.43	D, 1,278	1.88	—	—
Affordable housing	P, 1,278	1.52	D, 1,278	1.73	P, 1,278	1.46	—	—
Public parking garages	—	—	—	—	—	—	—	—
Foreclosures	P, 852	10.21	P, 852	4.95	P, 852	11.12	P, 852	16.56
Parks	—	—	P, 1,278	1.17	—	—	—	—
Problem landlords	P, 1,278	2.48	P, 1,278	2.85	P, 1,278	3.62	—	—
Accessibility features								
Apartment complexes	—	—	—	—	—	—	—	—
Banks	—	—	—	—	—	—	—	—
On premise liquor	—	—	—	—	—	—	—	—
Filling stations	P, 426	1.69	P, 1,278	1.57	P, 1,278	1.61	—	—
Late hour establishments	—	—	—	—	—	—	—	—
Packaged goods	—	—	—	—	—	—	—	—
Retail food	P, 1,278	2.22	P, 852	1.37	P, 852	1.60	P, 426	3.11
Secondhand dealers	—	—	—	—	—	—	—	—
Taverns	—	—	—	—	—	—	—	—
Bus stops	D, 426	1.78	D, 426	1.63	D, 426	1.39	—	—
Grocery stores	P, 852	2.07	P, 1,278	2.65	P, 852	2.47	D, 1,278	2.26
Homeless shelters	—	—	P, 1,278	2.20	—	—	—	—
Laundromats	—	—	—	—	—	—	—	—
Liquor stores	P, 426	2.09	P, 1,278	1.33	P, 426	1.95	—	—
Night clubs	—	—	—	—	—	—	—	—
Pawnbrokers	—	—	—	—	—	—	—	—
Rail stations	—	—	—	—	—	—	—	—
Retail shops	—	—	—	—	—	—	—	—
Schools	P, 1,278	1.39	P, 1,278	1.45	P, 1,278	1.41	—	—
Variety stores	P, 1,278	1.46	—	—	P, 1,278	1.32	—	—
Youth centers	—	—	—	—	—	—	—	—
Highway access ramps	—	—	—	—	—	—	—	—

Note. OP = operationalization (P = proximity, D = density); SI = spatial influence (1 block = 426 ft.); RRV = relative risk value.

be heavily populated with potential customers. Overall, the idea is that the presence of these risk factors at particular locations enhances ecological advantage and makes drug dealing more likely. In contrast, locations absent

these risk factors will have a lower risk for drug dealing because they lack the ecological advantages provided by risk factors if they were present. An important nuance is the spatial influence of particular risk factors. For example, being within three blocks of an affordable housing unit increases the risk for cannabis (RRV = 1.52) and crack (RRV = 1.46) dealing. However, locations where affordable housing units clustered were at higher risk for heroin dealing (RRV = 1.73). Notably, 15 of the 28 features were unrelated to any type of drug dealing, including public parking garages, apartment complexes, banks, on premise liquor establishments, late hour establishments, packaged goods stores, secondhand dealers, taverns, laundromats, night clubs, pawnbrokers, rail stations, retail shops, youth centers, and highway access ramps.

Our models do not allow us to distinguish whether security is "more important" than accessibility, or vice versa. However, across all models (excluding cocaine), security features were associated with, on average, 2.6 to 4 times as much risk for drug dealing, compared with access features, which were associated with 1.7 to 1.8 times as much risk. Moreover, the riskiest features (i.e., foreclosures and problem landlords) for drug dealing pertained to security. Perhaps, the most conservative statement that we can make is that security *and* access appear to be important for locations associated with dealing of various types of drugs.

Locations where the influence of risk factors *came together* had much higher levels of risk for any type of drug dealing. For each model, RTMDx produced a composite risk layer with values—relative risk scores (RRS)—at every location representing the weighted combination of risk factors' influence. For cannabis, the mean RRS at places was 45.26 (*SD* = 78.73) and ranged from a value of 1 at the lowest risk places to 2,418.8 at the highest risk places. The mean RRS for locations was 29.02 (*SD* = 54.13) for heroin and ranged from a low of 1 to a high of 1,673. Locations ranged from a low of 1 to a high of 3,578.4 for crack with a mean RRS of 41.66 (*SD* = 86.96). For cocaine, the mean RRS was 23.92 (*SD* = 27.80) and ranged from a low of 1 to a high of 116.4. Figure 1 displays the distribution of high-risk locations, defined as having RRS greater than 2 standard deviations above the mean, by drug type throughout Chicago.

Figure 2 reveals that many locations that are high risk for dealing one type of drug are also high risk for another type of drug (i.e., areas shaded black). This makes sense, as the models demonstrate substantial overlap in risk factors. Moreover, the risk factors were similar with regard to the way in which they influenced their surroundings (i.e., OP) and the extent of their influence (i.e., SI). For example, risk was higher as a function of proximity near foreclosures, problem landlords, filling stations, retail food establishments, grocery stores, liquor stores, and schools. Risk was higher at locations with a high concentration of broken street lights and bus stops. Furthermore, the

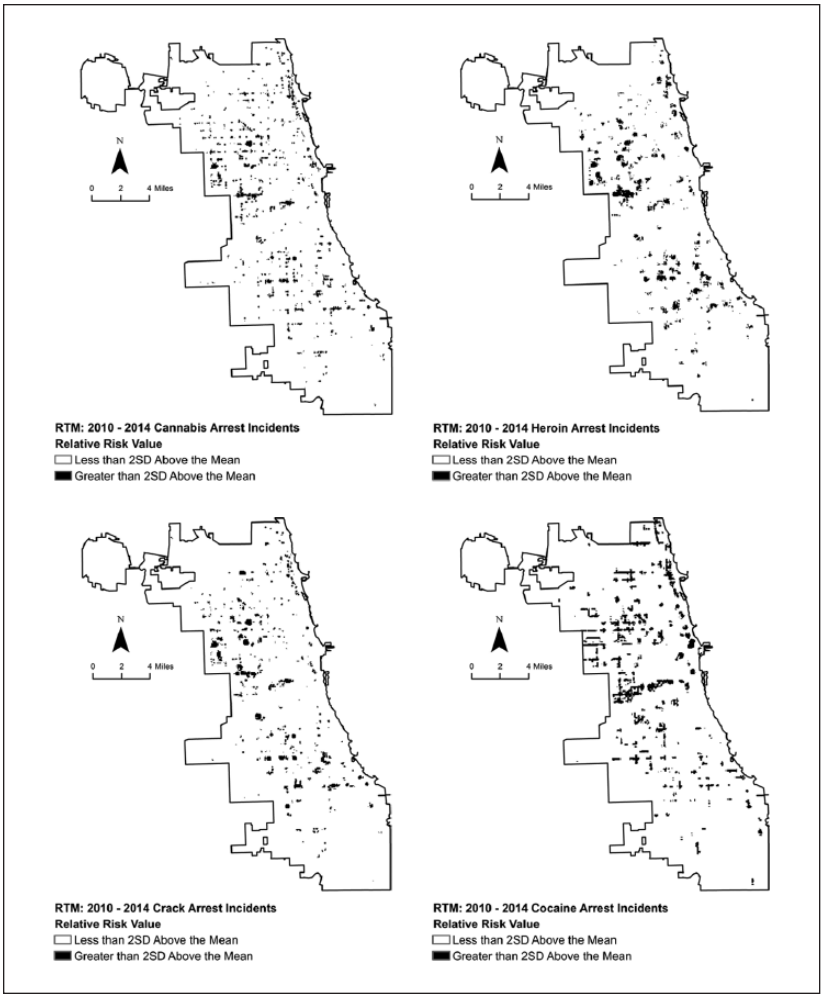

Figure 1. The spatial distribution of high-risk locations for cannabis, heroin, crack, and cocaine dealing in Chicago, Illinois from 2010 - 2014. High-risk drug dealing locations (i.e., areas shaded black) are defined as having a relative risk score (RRS) greater than two standard deviations above the mean.
Note. RTM = risk terrain models.

extent of influence was consistent for many factors across models, extending to one block for bus stops, two blocks for foreclosures, and three blocks for broken street lights, affordable housing, problem landlords, and schools.

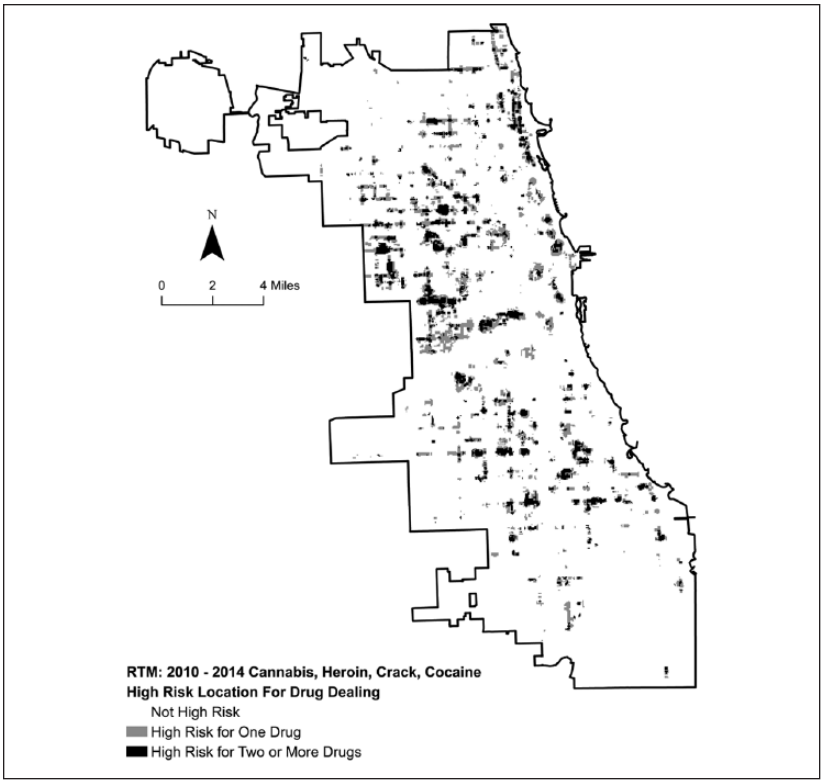

Figure 2. Spatial overlap (i.e., areas shaded black) and divergence (i.e., areas shaded gray) of the locations at high-risk for dealing cannabis, heroin, crack, and cocaine in Chicago, Illinois from 2010 - 2014.
Note. RTM = risk terrain models.

However, there were also a number of dissimilarities across models. The result, as Figure 2 shows, was several locations that were high risk for dealing one type of drug (i.e., areas shaded gray). Divergent spatial patterns in drug dealing locations were due to the unique set of risk factors, the way they influence their surroundings, and the extent of their influence. For example, parks and homeless shelters are risk factors unique to heroin dealing. In terms of operationalization, risk is a function of proximity to affordable housing for cannabis and crack dealing, but a function of density for heroin dealing. For cocaine dealing, risk is a function of being in areas with a high concentration of grocery stores, rather than being near them, as for other drugs. Finally, the spatial influence of risk factors also varies. Whereas the influence of filling

stations extends to three blocks for heroin and crack dealing, it is limited to one block for cannabis dealing. Across drug types, a number of similar variations in risk factors are observed.

Discussion

Theories of drug market location propose that drug dealing will occur at locations with certain environmental characteristics that are beneficial to the operation of an illicit market; places of ecological advantage (St. Jean, 2007). Two important dimensions of ecological advantage are customer accessibility and security from legal and physical threats (Eck, 1995). This study tested numerous place features that were likely to provide accessibility or security for drug dealing, and the results support prior evidence pointing to the importance of these two dimensions. In particular, grocery stores and foreclosures were risk factors for dealing across all types of drugs. Where the former can bolster accessibility by providing numerous potential customers via licit routine activities, the latter can provide increased security owing to being unattended and infrequently monitored structures. Overall, the findings suggest that accessibility and security are both key dimensions of ecological advantage for drug dealing.

Interestingly, many place features that could theoretically resolve accessibility and security concerns were unrelated to dealing for any type of drug. This is consistent with prior research (e.g., see Drawve, Thomas, & Walker, 2016; Irvin-Erickson, 2014; Kennedy, Caplan, Piza, & Buccine-Schraeder, 2015; Moreto et al., 2014). For example, Rengert et al. (2005) explained how taverns may not be related to drug markets due to increased guardianship from owners under threat of loss of liquor license and or to protect legitimate business. Indeed, guardianship and place management are important for controlling crime at places (Clarke & Eck, 2005). Some place features, such as public parking garages, may be better guarded due to constant monitoring by staff or CCTV (Piza, Caplan, & Kennedy, 2014), which might actually make locations near those features ecologically disadvantageous (St. Jean, 2007). Other features, such as homeless shelters, may be sufficiently managed in immediate proximal areas, which creates a buffer effect, whereby such features may increase the risk for drug dealing, but only for otherwise ecologically advantageous locations several blocks away (Rengert et al., 2005). Indeed, homeless shelters were risk factors for heroin markets, but their optimal spatial influence was three blocks. Finally, the influence of any particular type of place feature on drug dealing may vary among particular sections of a city, which might explain why highway access ramps were not associated with drug arrests despite their hypothesized importance in bolstering access.

In other words, only the most important highways will be advantageous, not all highways (Rengert et al., 2005).

Cannabis, heroin, crack, and cocaine dealing had many risk factors in common, and as a result, there was also substantial degree of geographic overlap in high-risk locations. This supports the idea that specific locations are highly attractive for drug dealing and can be shared among many drug dealers at the same time (Rengert, 1996). This is also consistent with the idea of agglomeration economies (Taniguchi et al., 2009). When drug dealers share locations, they benefit through enhanced protection from law enforcement, cost sharing, and improvements in customer search behavior (Bernasco & Jacques, 2015; Rengert, 1996; Taniguchi et al., 2009). Rengert (1996) discussed four types of drug distribution locations, one of which, the drug mart, occurs when numerous dealers locate in the same area, and through sheer number, are able to address a number of accessibility and security issues that dealers typically face.

However, there was some variation in risk factors for cannabis, heroin, crack, and cocaine dealing. Of particular importance is that the confluence of unique risk factors for each drug type can produce a number of qualitatively distinct high-risk locations for dealing (Kennedy et al., 2015). In other words, risk was higher within two blocks of foreclosures for all types of dealing, but it was higher for cannabis dealing at places within two blocks of foreclosures *and* within one block of a filling station; it was higher for heroin dealing within two blocks of foreclosures *and* within three blocks of a park; and it was higher for cocaine markets within two blocks of foreclosures *and* one block of a retail food establishment. Ultimately, and consistent with the notion of "market specialization" at places (Weisburd & Green, 1995, p. 714), there were several locations at high risk for dealing for only certain types of drugs. This finding may be a function of sellers of specific drugs establishing territory, searching for particular consumer populations, or seeking out particular environments in the face of unique risks.

Cocaine was perhaps the most salient outlier in this study, exhibiting few risk factors relative to cannabis, heroin, and crack. One explanation for this is that cocaine may be primarily sold through social networks within closed markets (Eck, 1995; Rengert, 1996). Indeed, there were few drug arrests for cocaine sales compared with cannabis, heroin, and crack. Closed markets are more difficult to police (May et al., 2000) and do not depend on the ecological advantages that are critical for the operation of open-air markets (Eck, 1995). This reasoning may explain why, for instance, risk is higher for cocaine dealing in areas with a dense concentration of grocery stores, compared with other types of drug dealing that are likely to occur in proximity to grocery stores. For example, it is possible that dealers and customers contact

one another through mobile phones to initiate a transaction and then meet at grocery store parking lots to conduct the transaction. In this scenario, it would behoove dealers and customers to meet where there are many grocery stores, rather than just a single store, so they can continually alter sales locations, but within the same familiar and convenient area, to avoid being detected. Other drugs sold in established street markets can reap the ecological advantages provided by a single grocery store that is also located near other advantageous features.

Open-air drug markets are harmful to participants and the community, but they are highly amenable to law enforcement (Harocopos & Hough, 2005). This study demonstrates how RTM can be used to produce actionable intelligence about drug dealing locations that could aid in better prioritization and allocation of resources for more effective law enforcement response. For example, places at high risk for drug dealing can be identified for directed patrol to reduce drug dealing, at least in the short term (Rosenbaum, 2006). By directing patrols to high-risk locations, law enforcement can create inconveniences that disrupt markets and reduce demand, particularly among occasional and ex-users, who are more likely to purchase drugs when they are easily accessible (May et al., 2000; Rengert, 1996). To be sure, a number of innovative strategies are available in modern day policing. However, directed patrol is well established and commonly utilized with the police profession, with a robust foundation of empirical support (e.g., Braga, Papachristos, & Hureau, 2012). It is likely to have some "staying power" within police practice. However, even as a temporary solution to crime problems, it can be harnessed in new ways that are more effective than are currently in use, and a number of innovations warrant discussion here. First, police can first get a sense of which forms of drug dealing are most amenable to directed patrol (e.g., here, cannabis, crack, and heroin dealing, but not cocaine dealing). Next, patrols can be directed toward specific forms of drug dealing (e.g., locations at high risk for heroin dealing or locations at high risk for heroin dealing) or can be directed toward places where many forms of dealing agglomerate (e.g., places at high risk for several forms of drug dealing) to disrupt multiple markets at once. Finally, police engaging in directed patrols can be informed about which features increase the risk of drug dealing, or certain types of drug dealing, at specific locations and then instructed to patrol more often near those risk factors and the areas in which they exert a criminogenic influence to maximize deterrence potential.

In addition, recent experimental (Ratcliffe, Taniguchi, Groff, & Wood, 2011) and quasi-experimental (Piza & O'Hara, 2014) research suggests the utility of foot patrol at high-risk places. While on foot patrol, officers can focus their attention on specific place features that they know to contribute to

elevated levels of risk at certain locations, for example, by checking the security of foreclosed properties, noticing broken street lights and reporting it to the appropriate agency to be repaired, or engaging business owners to learn of recent problems in the area or to educate them about what they can do to prevent drug dealing nearby. Compared with motorized patrol, foot patrol represents a more "surgical" technique because officers have the advantage of directly *interacting* with the surrounding physical environment in ways that can reduce the risk of drug dealing. Furthermore, because officers on foot patrol operate on a more micro level than officers in vehicles, direction as to which features they should focus on is all the more important for making the most of their patrol time.

Such activities may not only reduce community fear of crime and improve satisfaction with the police (e.g., see Kelling, 1981; Trojanowicz, 1982) but can also send a powerful message that drug dealing is not tolerated and that the police and community are working together to stop it. Indeed, the importance of police–community partnerships has long been recognized within the community policing literature (Greene, 2000). However, the point was further underlined in a recent task force assessment on police accountability in Chicago, the setting of the current study (Police Accountability Task Force, 2016).

To improve entrenched drug dealing locations in the long term, more comprehensive solutions are needed. In a systematic review of the literature, Mazerolle, Soole, and Rombouts (2007) determined that proactive, place-based strategies that utilized problem-oriented policing (Goldstein, 1990) and situational crime prevention (Clarke, 1980) proffered the most promising methods for policing drug markets. The idea is that law enforcement should orient their efforts toward disrupting the underlying dynamics of drug-prone locations themselves (Braga & Clarke, 2014). Incorporating such approaches within a broader risk-based policing strategy (e.g., see Caplan & Kennedy, 2015) has been shown to significantly reduce various types of crime in multiple jurisdictions (Caplan, Kennedy, & Piza, 2015). Such strategies could be applied to high-risk drug dealing locations and geared toward mitigating or otherwise removing ecological advantages to make them less appealing to drug dealers (Kennedy et al., 2015). For example, Hope (1994) described how high-activity drug dealing locations were addressed through a multitude of activities such as encouraging absentee landlords to take responsibility for their property, boarding up vacant properties, removing signs of physical disorder, and partnering with other municipal agencies to issue code violations. Baker and Wolfer (2003) discussed how drug problems at a park were mitigated by removing vegetation, repairing damaged fences, adding signage and CCTV, and improving lighting. Other responses might include re-directing the

flow of traffic on streets, razing buildings, or publicity campaigns in problem places (Rengert et al., 2005). There are two important considerations to keep in mind with these types of strategies (Goldstein, 1990). First, they should involve a kaleidoscope of multifaceted responses, based on thorough analysis, and tailored toward remedying, a specific problem. Second, they should utilize external partnerships with community members and organizations, business owners and other private entities, and other municipal agencies.

An important component of risk-based policing is that place-based metrics, such as reductions in risk of drug dealing locations, or the risk of particular features of those locations, can be utilized to measure success. This can provide a bridge to move beyond traditional person-based law enforcement strategies, which are likely to be ineffective (Mazerolle et al., 2007). As the results here show, the risk for drug dealing is highest at locations where the influence of risk factors converge. These locations are likely to be coveted because they are the most ecologically advantageous for the operation of an illicit market. Therefore, law enforcement cannot expect to remove a drug market by simply arresting people because other dealers will simply take their place (Rengert et al., 2005). Traditional arrest-based approaches ignore the ecological advantages that make drug dealing locations profitable in the first place. Moreover, person-based law enforcement strategies have greater potential for abuse of authority and corruption among officers, and mass arrests may overwhelm the criminal justice system (Rengert, 1996).

This study demonstrates how the environmental characteristics of locations can make them ripe for drug dealing. It also shows how these characteristics may vary depending on the type of drug that is being sold. However, further research is necessary to determine the generalizability of these findings across additional types of drugs and in different kinds of study settings. Several other limitations to the current study are important to note. First, this study did not include a temporal component, but research has shown drug-selling locations may be profitable at different times (Rengert, 1996). A second issue pertains to the causal ordering of risk factors and drug dealing. Specifically, the current data did not allow the authors to determine if certain risk factors made places ecologically advantageous which then subsequently invited drug dealers to conduct business, or if drug dealers exploited certain locations and then fundamentally changed the nature of the environment, making certain place features risk factors in the process. For example, it is unclear whether or not foreclosures attracted drug dealers because they offered a degree of security, or if drug dealing induced foreclosures by making the area unattractive by increasing crime and disorder. This issue applies to many other place features tested here, such as affordable housing, broken street lights, and homeless shelters and should be addressed by future research

with appropriate time series data. Third, though data were easily accessible, they were not necessarily provided with ample detail to disaggregate place features into more meaningful categories. For example, it would have been more interesting to examine certain types of packaged goods stores separately (e.g., small corner convenience stores vs. large warehouse corporate stores). Finally, this study was limited in scope, focusing solely on the physical features of places that make drug dealing more likely. Yet, theories of social ecology suggest the importance of broader social indicators, such as socioeconomic disadvantage and residential mobility (Sampson, Morenoff, & Gannon-Rowley, 2002). Studies that address these limitations would provide additional insight into how the immediate characteristics of environments and the larger structural conditions affect drug dealing and would allow for more effective drug policy.

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Notes

1. https://data.cityofchicago.org/
2. Data obtained from these latter two sources were collected as part of a larger study led by the Rutgers Center on Public Security (www.rutgerscps.org) and funded by the National Institute of Justice (Award 2012-IJ-CX-0038)
3. Infogroup Incorporated is a privately owned data and marketing services provider. Infogroup is available online at http://www.infogroup.com/
4. According to these studies, drug arrest data generally mirror other types of data (i.e., calls for service) and therefore provide a fairly reliable measure of drug markets.
5. Ideally, incidents involving the "manufacture" of drugs would not be included with "delivery" incidents as single outcome events. However, Chicago's Open Data Portal classifies these two types of incidents together (with the option of distinguishing "possession" incidents). Although possession incidents were removed, manufacture and delivery incidents were used as the outcome events for each drug type, respectively, which is a potential limitation of this study.
6. Drug arrest data included a variable indicating the location of the drug arrest (e.g., convenience store, gas station, restaurant, apartment etc.). However, drug arrests were considered to occur in public if the location was recorded as an alley, bridge, sidewalk, or street. Although other incidents may have occurred in

public despite their location record (e.g., drug arrests may have occurred outside in front of a convenience store), the data did not provide enough detail to distinguish those cases from others that took place inside private settings.

7. This rule did not apply to parks, highway access ramps, and 311 calls for broken street lights. Regarding parks and highway access ramps, these features are typically represented in a geographic information system as polygons and polylines, respectively. Because the Risk Terrain Modeling Diagnostics (RTMDx) Utility only accepts point features, park polygons and highway access ramp polylines were each converted to a representative set of points. Because several points are needed to represent these features, the density of features is not a meaningful operationalization. Therefore, parks and highway access ramps were tested as proximity only. However, 311 calls for broken street lights were tested as density only. As Caplan, Kennedy, and Piza (2013) explained, certain features are more or less "fleeting," rather than permanent features of the physical environment (p. 28). The concentration of such features is more meaningful representation of the way in which these features influence behavior.
8. Relative risk value (RRV) represents a risk factor's exponentiated coefficient.

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