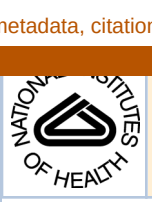

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Evaluating Medical Marijuana Dispensary Policies: Spatial Methods for the Study of Environmentally-Based Interventions

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Abstract

In 1996, California was the first state to pass a Compassionate Use Act allowing for the legal use of marijuana for medical purposes. Here we review several current policy and land use environmental interventions designed to limit problems related to the influx of medical marijuana dispensaries across California cities. Then we discuss the special challenges, solutions, and techniques used for studying the effects of these place-based policies. Finally, we present some of the advanced spatial analytic techniques that can be used to evaluate the effectiveness of environmental interventions, such as those related to reducing problems associated with the proliferation of medical marijuana dispensaries. Further, using data from a premise survey of all the dispensaries in Sacramento, this study will examine what characteristics and practices of these dispensaries are related to crime within varying distances from the dispensaries (e.g., 100, 250, 500, and 1000 feet). We find that some security measures, such as security cameras and having a door man outside, implemented by medical marijuana dispensary owners might be effective at reducing crime within the immediate vicinity of the dispensaries.

Keywords

environmental interventions; marijuana dispensaries; medical marijuana; Bayesian space-time models

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Environmental interventions are, at their core, designed to change the locations where social problems occur and reduce negative outcomes. Because these approaches are so inherently tied to the places where these problems happen, location must be explicitly included as part of the strategy for evaluating the effectiveness of such interventions. Thus using spatial methods for the study of environmental methods is integral for determining if such approaches work. This has become especially true for evaluating policies regulating the proliferation of medical marijuana dispensaries since some argue that they increase crime, youth access to marijuana, and recreational marijuana use (California Police Chief's Association, 2009). A variety of environmental approaches have been enacted by states and local jurisdictions in an attempt to regulate the supply and distribution of marijuana, including restrictions on density and zoning of dispensaries. These location-based approaches are designed to prevent negative social problems that are perceived to occur around these dispensaries. Thus understanding the effects of these regulatory approaches on these problems are tied closely to empirically studying those environments where these problems transpire. We will apply our discussion of these spatial analytic techniques to the perceived relationship between dispensaries and crime.

Background

In 1996, California was the first state to pass a Compassionate Use Act, which allowed the legal use of marijuana for medical purposes. Fifteen states and the District of Columbia have passed similar legislation in recent years (Leiderman & Devine, 2011). Marijuana distribution for medical use often occurs at dispensaries (or collectives) and is controversial due to perceptions that these dispensaries increase crime and other problems in the neighborhoods where they are located (California Police Chief's Association, 2009). Thus municipalities have implemented a variety of regulations to limit the problems perceived to occur in and around these medical marijuana dispensaries (California Police Chief's Association, 2009). These include environmental interventions limiting density of dispensaries based on population, land use ordinances, building codes and permits, and hours of operation. Despite regulating dispensaries through many of these environmental interventions, no empirical studies have examined how the characteristics of these dispensaries and their environmental contexts are related to increased crime. Another complicating factor is that while some states have legalized the use of marijuana, the classification has not changed at the federal level. Thus the use of marijuana for any purpose is deemed illegal by the federal government.

Further, despite the increasing number of states legalizing marijuana for medical purposes, there remains a dearth of research examining the effects of these policies on local communities. In California's case, regulating the dispensaries has been tasked to local jurisdictions. Throughout the state of California, cities and counties are struggling with developing ordinances to regulate dispensaries through land use polices or taxation through business permits. Yet, the lack of empirical research means that the effects of these policies on reducing problems thought to be associated with medical marijuana dispensaries (MMDs) are largely unknown.

In this paper we will first review several current policy and land use environmental interventions designed to limit problems related to the influx of medical marijuana dispensaries across various states and in California cities. We also will discuss the special challenges, solutions, and techniques used for studying the effects of these environmentally-based policies. Next, we will present advanced spatial analytic techniques available to evaluate the effectiveness of environmental interventions, specifically those related to reducing crime associated with the proliferation of medical marijuana dispensaries. The final section of this paper uses data from a premise survey of all dispensaries operating in Sacramento, California to examine what characteristics and security measures implemented by dispensaries are related to crime within varying distances from the dispensaries (e.g., 100, 250, 500, and 1000 feet). Thus, this survey of premises around each dispensary examines how the local context of these dispensaries may encourage or inhibit localized criminal activity.

Environmental Approaches used to Regulate Dispensaries

State-wide licensing of medical marijuana dispensaries and associated regulations exist in eight out of the seventeen states that allow marijuana for medical use. The other nine states either do not recognize distribution through dispensaries (e.g., Alaska) or defer to local jurisdictions for regulation (e.g., California) (National Organization for the Reform of Marijuana Laws, 2011). Table 1 and Table 2 detail place-based policies associated with these state-level regulations (Table 1) and local level regulations (Table 2) of medical marijuana dispensaries.

Most states defer to local entities to regulate the number of dispensaries allowed to operate in their county or region. Arizona is the only state that specifies density regulations, limiting

the number of dispensaries to less than 125 for the entire state. Local density controls tend to be conducted through limits per population after a period of moratoriums on new dispensaries. Moratoriums on new dispensary locations usually occur when concerns of MMD proliferation mount and are often a precursor to more strict regulations on density, location, and operations.

Distance buffers are designed to limit geographic availability of marijuana as well as reduce problems typically assumed to co-occur in proximity to dispensary locations, such as crime. The majority of states with licensing programs mandate distance buffers ranging from 300 feet to 1,000 feet between MMDs and places associated with children, such as schools. Local jurisdictions have imposed similar distance buffers around residential zones (Los Angeles Ordinance No. 181069, 2010; Phoenix Ordinance G-5573, 2010; Sacramento Ordinance 2010–038, 2010) and/or places where children and families frequent, such as parks, youth-oriented facilities, cinemas, and places of worship (La Paz County Ordinance No., 2011–02, 2010; Sacramento Ordinance 2010–038, 2010; The Lynn and Erin Compassionate Use Act, 2010). Buffers are also set around establishments with potentially high-risk clientele, such as other MMDs, alcohol outlets, and drug treatment facilities (Denver Council Bill No. 34, 2010; La Paz County Ordinance No., 2011–02, 2010; Los Angeles Ordinance No. 181069, 2010; Sacramento Ordinance 2010–038, 2010). Phoenix has the most conservative buffer, requiring 5,280 feet (~ a mile) between MMDs.

Most states indicate only vague site-specific requirements, such as a need for a “security plan” or evidence of “adequate security measures.” In fact, Colorado is the only state to specify any security measures outside of an alarm system. In addition, only Colorado and Vermont regulate hours of operation at a state level. In all cases, states defer authority to local jurisdictions to impose restrictions (or more severe restrictions) upon MMD security, hours, and other operations resulting in a variation of how environmental approaches are used. In the case study presented later, security measures used by dispensaries include the use of security cameras and doormen.

Where no state-wide regulations exist, local jurisdictions have utilized a variety of policy approaches. In Washington, Spokane ordered all existing MMDs to shut down (Cuniff, 2011) while Seattle imposed regulations limiting their proliferation (Seattle Ordinance No. 123661, 2011). California local jurisdictions have varied approaches ranging from place-based regulations to no active regulation (e.g. San Diego repealed regulations in July 2011; Kuhney, 2011) to explicit bans (e.g., Burbank; Kellam, 2011). Finally, pending Court cases and rulings in some states have both stymied the enforcement of existing regulations (e.g., Arizona, California) and placed pressure upon dispensaries to close (e.g., Michigan) (Arizona Department of Health Services, 2012; Hoeffel, 2011; White, 2011).

The variety of state and local regulatory efforts creates challenges for assessing the impact of these policies, especially when the effectiveness of some procedures being implemented (e.g., moratoriums) is not always known. Since these interventions are so tied to the locations where they are implemented understanding the effectiveness of specific procedures associated with regulating these dispensaries can provide clarity about what outcomes to expect from different environmental approaches.

Effectiveness of Environmental Approaches

Location restrictions, such as zoning codes and distance buffers, have long been used to segregate activities and control for negative externalities. More recently, zoning restrictions have been used to protect residential populations from secondary effects such as crime and increased availability of unfavorable or controversial products associated with businesses that sell alcohol, tobacco, firearms, fast food, and pornography (Ashe, Jernigan, Kline, &

Galaz, 2003; Holder, et al., 2000; Papayanis, 2000). In a multi-component community trials intervention, Holder et al. (2000) observed a decrease in high risk drinking and alcohol-related injuries when zoning regulations and distance buffers between alcohol outlets and public places, such as schools and parks, effectively limited alcohol access. However, a major critique of these practices is that policies such as these contribute to the marginalization and segregation of social space by keeping "unwanted" individuals and businesses out of more affluent residential communities (Papayanis, 2000).

Crime prevention through environmental design (CPTED) approaches target design and operational aspects of business through surveillance, access/control, and territoriality of place. The effectiveness of CPTED approaches is difficult to measure due to lack of controls and the multi-component nature of most interventions (Casteel & Peek-Asa, 2000; Cozens, Saville, & Hillier, 2005; Mair & Mair, 2003). Overall, multi-component intervention locations were associated with 30% to 84% reductions in robberies compared to non-intervention locations, with the highest reductions for those sites that used individualized security plans (Casteel & Peek-Asa, 2000; Mair & Mair, 2003). In fact, Loomis et al. (2002) found the odds of workplace homicide decreased with the presence of bright exterior lighting, security alarms, cash drop boxes, and the implementation of at least five environmental interventions. These environmental interventions ranged from placing barriers between employees and the public to installing video cameras and mirrors. Other single component interventions found to be effective include: employing a second clerk, locked entrances, installation of security hardware, and hiring guards (Casteel & Peek-Asa, 2000; Cozens, et al., 2005; Loomis, et al., 2002). Policies/ordinances regulating CPTED practices were also associated with a decrease in robberies post-intervention (Casteel & Peek-Asa, 2000). Casteel & Peek-Asa (2000) found in a review of the literature on CPTED that individualize security plans helped to effectively reduce crime. This requirement is popular among state-level regulations on MMDs. Additionally, since the majority of crimes occur between the late afternoon and early morning hours (Felson & Poulsen, 2003), limiting access by regulating dispensaries operating hours may reduce crime as well.

Although these approaches have not been studied explicitly with medical marijuana dispensaries, existing evidence suggests these approaches might reduce problems in areas where these dispensaries are located. However, studying the effects of environmental change often needs specialized spatial techniques that take into account their unique effects on place. Using spatial analysis methods provides robust statistical modeling of how places respond to environmental interventions to reduce social problems.

Analytic Methods for Studying Environmental Change of Medical Marijuana Dispensaries

Spatial Methods—By definition, environmental interventions are about changing environment or place characteristics. Thus, this issue of place must be adequately addressed when studying the effects of these interventions. Two important considerations in determining how best to evaluate these environmentally-based strategies is to think critically about how and why places may be connected to each other and then to find ways to model that relationship as part of the analytic strategy. Spatial methods include the use of measurement of problems across place, an assessment of the correlations that occur across space, and use of spatial analytic techniques, including spatial regression and Bayesian space-time models. In general, spatial regression models build on traditional regression techniques but with assessments and controls for the spatial structure of the data. These models are used when the unit of analysis is at the level of a geographic area and can be in the form of spatial error or spatial lag models. Spatial error models treat the spatial structure as part of the error term while spatial lag models assume that the spatial structure is a function of the dependent measure (Bailey & Gatrell, 1995).

The first consideration is to determine how place or location should be measured. This will depend, in part, on how the policy or intervention being implemented purports to change place. Limits to densities of MMDs will use some measure of density as the unit of analysis. Here, one will need to pay attention to whether density has been prescribed per some areal unit (e.g., zip code, city) such as in Washington D.C. or by population size (e.g., per 10,000 population) as is the case in Los Angeles. In absence of this information, decisions about how to determine the appropriate density unit must be made.

In the case example below, we look at violent crime events at varying distance buffers around the dispensaries. The purpose of these buffers is to determine whether or not implementation of security measures are related to lower numbers of violent crime at various distance thresholds. Understanding how these distance buffers are related to crime will provide information about how far-reaching across areas the effects of negative consequences or outcomes are or how the implementation of environmental prevention efforts may reduce those negative effects. For example, if crime or other problems are higher near dispensaries is this true at 200 feet? 500 feet? 1500 feet? Similarly if security measures are required by dispensaries to reduce problems, how local or far should these reductions in crime be seen? In essence buffer analyses allow for a fine grain assessment of the distance at which problems occur in relation to the place of interest. Empirical observations of these relationships need to be conducted so that environmental interventions are implemented using the best available evidence that will ensure their effectiveness.

Concerns about the location of places during statistical analysis arose because of spatial autocorrelation which posits that places located next to each other are likely to be similar to each other (Cliff & Ord, 1973, 1981). The presence of spatial autocorrelation can bias the tests of the coefficients resulting in Type I or Type II errors (Freisthler, Lery, Gruenewald, & Chow, 2006). Any application of these methods to studying environmental interventions across geographic areas must assess and control for spatial correlation found in the models. Cohen and colleagues (2006) implemented a procedure to adjust the standard errors due to correlations across space. After controlling for this spatial autocorrelation, these authors found that surrenders of alcohol licenses were related to lower gonorrhea rates (2006). They accounted for spatial autocorrelation by detecting levels of geographic clustering and adjusting tests of significance to include these assessments of spatial autocorrelation. To assess spatial autocorrelation, decisions must be made about how spatial areas are connected. This is usually done through the development of a connection matrix that provides information on which geographic areas are next to each other (a simple adjacency matrix is where areas sharing a boundary are denoted with a “1” and nonadjacent units with a “0”) or a distance matrix that provides the inverse distance from each geographic area to every other geographic area (Freisthler et al., 2006). The idea here is that areas closer to each other are weighted more heavily than those further away. These connection matrices are also used in the development of more sophisticated spatial statistical models, including spatial regression and Bayesian space-time models.

Gruenewald et al. (in press) take a slightly different approach by explicitly modeling the spatial structure using Bayesian conditionally autoregressive (CAR) space-time analyses in their study of the spread of methamphetamine problems across California. They found that in California when laws governing the sale of ephedrine or pseudoephedrine (a precursor chemical in the making of methamphetamine) were enacted rates of methamphetamine abuse and dependence decreased (Gruenewald, et al., in press). Using CAR procedures, the authors' model how changes occur over time and space in reaction to environmental changes related to reduced availability. Here time trend variables allow for the assessment of changes in legislation governing the distribution of products used in the manufacturing of methamphetamine. Although computationally intensive to implement, the benefits for

assessing the effective of environmental interventions are great. Use of these models can identify specific geographic areas that are more or less responsive to environmental interventions (Waller et al., 2007). Thus the use of these more sophisticated spatial methods represents both an advancement of the science and an increased opportunity to understand and document the effects of environmental change. However, these methods alone do not address all the issues that come with studying environmental change spatially.

Natural Experiments—The use of natural, quasi-experiments to study the effects of changes in crime and other related problems because of the introduction of medical marijuana dispensaries became possible recently as several California cities and many states enacted ordinances restricting the density and location of dispensaries. These policies and changes in practices have created an opportunity to estimate the effects of dispensaries on a variety of social problems—including crime. By 2010 the number of cannabis dispensaries almost tripled in both Los Angeles and Sacramento from their 2007 levels (186 to 545 in Los Angeles; 16 to 40 in Sacramento). Law enforcement officials cite concerns about increases in crime rates due to the rising number of dispensaries (California Police Chief's Association, 2009). Both the city of Los Angeles and Sacramento have passed legislation in 2010 that limited the density of dispensaries based on population and regulated the locations in which dispensaries could operate (e.g., cannot be within 1000 feet of schools) and mandated security measures at the dispensaries be increased in response to the rising number of MMDs. In the final section of this paper, we take advantage of the differential implementation of security measures in Sacramento and present a case study that examines how the presence or absence of different security measures may be related to violent crime around dispensaries.

Analyses of the effects of these policies can examine conditions before and after the policy was enacted. As such, studies would be longitudinal in nature and rely on the collection of readily available archival data, including police incidents of violent and property crimes and hospital discharge data related to cannabis abuse and dependence. As described above, this approach has been used previously to study extreme reduction in alcohol outlet densities due to civil unrest in Los Angeles County (Cohen et al., 2006) and policies designed to reduce the physical availability of methamphetamine in California (Gruenewald et al., in press) and provides valuable information on how to study how problems change when environmental approaches to reducing problems are enacted. Both studies also made adjustments to the analytic methods in order to assess and control for the geographic cluster that occurs when examining the effects of environmental interventions across areas.

Changes to regulations governing medical marijuana dispensaries often occur across entire cities or states. Finally, through the use of archival data (often collected by local agencies without the express intent of using them for research), evaluations of naturally occurring environmental interventions are often less expensive to complete than evaluations of individually-based interventions. Many of the archival data sources also include some location information that make them ideal to use with spatial analytic methods. By utilizing data collected by other entities on crime (police departments), health conditions (from hospital discharges), or a variety of other social problems, fewer resources are need to study potential effects of these interventions.

Challenges to Studying Environmental Change—The use of spatial models alone does not address some common problems that can arise when examining the effectiveness of environmental interventions. These issues arise when trying to determine the boundaries that define the intervention units, the fact that these spatial units of analysis are modifiable, and those boundaries in these areas are permeable meaning effects of the interventions can spillover into adjacent areas. With regards to intervention boundaries, environmental change

often occurs over an entire jurisdiction meaning that the "recipients" of such change are whole communities, cities, or states. Oftentimes, however, the jurisdictions at which interventions are implemented do not have discrete geographic boundaries (i.e., "neighborhoods"). When this occurs decisions must be made about the appropriate geographic level at which the changes are expected. Are the environmental strategies designed to change the structure of neighborhoods, such as policies designed to limit densities of various business establishments? If so, the unit of analysis for measurement may be "neighborhoods" which can be measured using a variety of administrative units (i.e., Census tracts) or locally defined boundaries.

Some environmental strategies are targeted at much smaller areas: individual neighborhood areas or specific business establishments. These require different assessments of the spatial relationships. For example, multivariate analyses at the dispensary level might need to take into account the distance of each dispensary from every other dispensaries, with those being close to each other have more weight (e.g., distance matrices see Freisthler, et al., 2006). Thus deciding the correct level at which to evaluate the effectiveness of environmental interventions is an important step to studying the effects of those changes. In the case study example described below, the security measures examined are only expected to be related to crime around the dispensary that has implemented those measures. We, then, examine how different distance thresholds may be related to lower violent crimes around medical marijuana dispensaries that employ a variety of different security measures.

Even once the geographic unit of analysis has been adequately defined, concerns can still exist about how the choice of one unit of analysis over another may differentially affect the results of an evaluation of an intervention. The modifiable areal unit problem (MAUP) occurs when studying problems at different areal units may result in different findings (Openshaw, 1984). With the case of medical marijuana dispensaries, it may be the case that security measures implemented by dispensaries may only affect crime locally. Thus studying this phenomenon at the level of a Census tract or postal zip code may obscure findings of effectiveness of these interventions at lower levels of geography.

However, the smaller the geographic unit of analysis, the greater the likelihood the effects of the intervention will spill over into adjacent areas. This occurs, in part, because these geographic boundaries are permeable and practices designed to reduce problems may be adopted by nearby business or localities adjacent to the intervention area. Two approaches can allow for a crude assessment of these spill over effects. First, distance buffers can be created that surround the intervention site which allows for the inclusion of changes in practices within a specified distance around the target area. The second is through the use of spatial lags. Spatial lags are assessments of characteristics of areas that share a boundary with the intervention site.

In the following case study, we attempt to examine how security measures are related to violent crime rates using different distance buffers. Here we attempt to address the issue of modifiable area unit problem by determining whether or not security measures have an effect on crime that is local or more distal to the dispensaries.

Sacramento: A Case Example

California was the first state to approve the use of cannabis for medical purposes in 1996 via Proposition 215. Essentially this legislation changed the Health and Safety Code so that cannabis was no longer classified as a Schedule I drug (i.e., illicit, highly addictive, and no medical purposes) to Schedule II (i.e., high potential for abuse but has accepted use as medical treatment) in the state. Although the first dispensaries began operating approximately at the same time, they were quickly raided by the Drug Enforcement Agency

and closed (Daley, 1997). Over time, more dispensaries were opened and federal enforcement decreased. Due to concerns of the rapid proliferation of dispensaries beginning in 2006, Sacramento declared a moratorium on new dispensary locations and required dispensaries to register with the city in July 2009. Not all dispensaries complied. Sacramento passed Measure C in November 2010 which allowed the city to levy substantial taxes (over $15,000 per year) specific to dispensaries.

Kepple and Freisthler (2012) found no relationship between densities of dispensaries and violent or property crimes in Sacramento. This study relied on routine activities theory which purports that crime occurs when the following three conditions are met: a motivated offender, a suitable target and a lack of guardianship (Cohen & Felson, 1979). This finding suggests that one of these conditions was not met in order for higher levels of crime to occur in areas with higher densities of dispensaries. Jacobson and colleagues (2011) observed that crime rates increased in areas surrounding dispensaries immediately after they closed. One possible explanation provided is that dispensaries provide adequate levels of security that help to deter crime in areas immediately surrounding them. However, present studies have not systematically evaluated the specific security measures implemented by dispensaries and associated crime incidents surrounding these locations. Given that the majority of policies require adequate security at dispensaries with some going so far as to specify the types of security features needed, we examined how the presence or absence of a variety of security measures may be related to crime at various distances from the dispensaries.

Methods—We conducted a premise survey at each dispensary in Sacramento between December 2010 and February 2011 using pretested protocols (Freisthler, Gruenewald, Treno, & Lee, 2003; Paschall et al., 2007). These surveys provided important information about the locations where these dispensaries are located and about their specific practices that may reduce problems associated with them.

Sampling and Data Collection Methods: A list of 51 medical marijuana dispensaries located within the city limits of Sacramento was compiled from listings in local newspapers, trade publications, and the official listing maintained by the city of Sacramento. Each location was visited one time to determine its status (e.g., open, closed, out of business). For those dispensaries that were open, the data collector recorded information about the hours of operation, type of business model (e.g., pharmacy, social club), exterior condition, characteristics of the immediate area, interior maintenance, and what security measures were present. If dispensaries were closed at the time of the visit, appearing to be out of business, or that could not be located, they received a follow up visit by the data collector to conduct the premise survey. Through this process it was determined that only 31 of the original list of 51 dispensaries were open and operating within the city limits of Sacramento. Five locations had either moved outside the city limits or were found to be a prior address of other dispensaries on the list. Fifteen dispensaries were no longer in business. All 31 dispensaries in business at the time of visit were successfully surveyed and their addresses geocoded. No purchases were made or samples accepted during the visit.

Measures

Violent crime: The dependent variable for this study is the number of violent crimes within 1000 feet of the medical marijuana dispensaries. Data on violent crimes for the year 2010 were obtained from the Sacramento Police Department website which archives all incidents of crime on an annual basis. Here, violent crime includes homicide, assaults, robbery, and aggravated assaults. Ninety-nine percent of all violent crimes were geocoded to the street address or intersection where the incident occurred. In order to provide a measure of extremely local versus more distal crime, we coded crime by distance from the dispensary.

Security measures: During the premise survey, information on visible security measures was recorded. These included the presence or absence of a doorman, a locked metal screen door, a pass through on the door, security cameras, and signs stating that a doctor's recommendation/prescription identification card were necessary for entry.

Data Analysis Procedures: Data were analyzed using t-tests comparing the average number of violent crimes for dispensaries that have each type of security measure versus those that did not. We analyze the relationship between violent crime and security measures utilized by dispensaries at 100, 250, 500, and 1000 feet buffers around the dispensaries. Given the small sample size and the exploratory nature of this analysis, we include p-values for both $p < .05$ and $p < .10$.

Results—Table 4 show the bivariate comparison of MMDs that employ various security strategies with those that do not within 100, 250, 500, and 1000 feet buffers of the dispensaries. Dispensaries with security cameras and signs requiring an identification prescription card had significantly lower levels of violence within 100 and 250 feet. Two other security measures showed trends toward significance but did not reach the $p < .05$ significance level. Having a door man outside was related to lower levels of crime at 250 and 100 feet, but neither relationship was statistically significant likely due to the small sample size. There was no relationship between having a pass through on the door and violent crime. Conversely, dispensaries with a screened metal door had a significantly higher average of violent crime than those dispensaries without a screened metal door within a 500 foot radius.

Discussion—The preliminary findings show that some security measures, such as security cameras, having a door man outside, and having signs requiring an identification prescription card, taken by medical marijuana dispensary owners might be effective at reducing crime within the immediate vicinity of the dispensaries. However, dispensaries with locked metal doors had higher crimes within 500 feet radius. This finding may be more indicative of the location of the dispensary than crime related to the dispensary itself. In other words, dispensaries located in high crime areas may already have locked metal doors on the building from previous tenants to ward against crime in this high crime area. These findings are limited by the small sample size and cross-sectional nature of the data in one location. Despite this, they point to some interesting, relatively inexpensive, measures that can be taken that might result in lower levels of crime within the immediate vicinity of medical marijuana dispensaries.

Implications for Evaluating Environmental Change Strategies—These findings suggest that some security measures might be more likely to reduce crime rates than others. It is noteworthy that certain environmental security measures were associated with lower levels of crime considering the limitations of a small, cross-sectional sample; these findings provide encouraging evidence that these security measures may be effective in reducing violent crime. Future studies capitalizing on the naturalistic studies utilizing the methods suggested in this paper can further contribute to our understanding of the long-term efficacy of these environmental strategy approaches.

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Table 1

State-Wide Medical Marijuana Dispensary Regulations

State	State Licensing Legislation	School Buffers	Density Controls	Security Measures	Hours of Operation	Operations
Arizona	Arizona Medical Marijuana Act (2010)	500 ft	1 per 10 pharmacies	Alarm System, "Adequate Security" to Prevent Theft		No On-site Consumption
Colorado	Colorado Medical Marijuana Code (2010)	1,000 ft		Alarm System, Cameras, Lighting, Safe for Storage of Cash/ Marijuana	7AM – 9PM	No On-site Consumption
Delaware	Delaware Medical Marijuana Act (2011)		Per jurisdiction	Alarm System, Security Plan		No Visible Cultivation
Maine	An Act to Amend the Maine Medical Marijuana Act (2010)	500 Ft	Per jurisdiction	"Appropriate Security Measures" to Prevent Unauthorized Entrance		
New Jersey	New Jersey Compassionate Use Medical Marijuana Act (2010)		Per jurisdiction	"Adequate Security"		
New Mexico	The Lynn and Erin Compassionate Use Act (2010)	300 ft		Alarm System, Security Plan		
Rhode Island	The Edward O. Hawkins and Thomas C. Slater Medical Marijuana Act (2009)	500 ft	Per jurisdiction	Alarm System, Security Measures to Prevent Unauthorized Entrance		No On-site Consumption
Vermont	An Act Relating to Registering Four Nonprofit Organizations to Dispense Marijuana for Symptom Relief (2011)	1,000 ft	Per jurisdiction	Alarm System, Security Plan to Prevent Unauthorized Entrance	By Appt Only	No On-site Consumption

Table 2

Medical Marijuana Dispensary Regulations by Local Jurisdictions

Policy for Local Jurisdiction	Zoning	Residential Buffers	School Buffers	MMD Buffers	Density Controls	Security Measures	Hours of Operation	Operations
La Paz County, AZ Ordinance No. 2011–02 (2011)	**P** Commercial*		500 ft	500 ft		Single Secured Entrance (SSE)	9AM–4PM	Sq Ft Limit, No Drive-Thru, No Seating, No Delivery
Phoenix, AZ Ordinance G-5573 (2010)	**P** Commercial**	1,000 ft	1,320 ft	5,280 ft				
Los Angeles, CA Ordinance No. 181069 (2010)	None Specified	Not Adjacent	1,000 ft	1,000 ft	Per Population; Cap at Moratorium	Cameras, Alarm, SSE, Outdoor Lights, Signage, Safe for Storage	10AM–8PM	No On-site Consumption; No visible cultivation
Sacramento, CA Ordinance 2009–033 (2009); Ordinances 2010–037 & 2010–038 (2010)	**P** Commercial* **SU** Commercial*** **SU** Industrial****	300 ft	600 ft	1,000 ft	Cap at Moratorium	Cameras, Alarm, SSE, Security Guard, Outdoor Lights, Signage, Safe for Storage	7AM–9PM	No On-site Consumption; No visible cultivation; Sq Ft limit
Denver, CO Council Bill No. 34 (2010)	No Residential		1,000 ft	1,000 ft		Cameras, Alarm, SSE, Security Guard	7AM–9PM	
Washington, DC Legalization of Marijuana for Medical Treatment Amendment (2010)	No Residential		300 ft		5–8 for City	Alarm, Outdoor Lights, Signage, Safe for Storage	Limits Indicated	No On-site Consumption
Ann Arbor, MI Ordinance No. ORD-10-37 (2010)	**P** Downtown; **P** Local and Campus Business Districts; **P** Limited, Light, and Heavy Industrial Districts; **P** Planned Unit Development Districts		1,000 ft			Cameras, Alarms, Safe for Storage	7AM–9PM	No On-site Consumption; Sq Ft Limit; No Drive-Thru

Policy for Local Jurisdiction	Zoning	Residential Buffers	School Buffers	MMD Buffers	Density Controls	Security Measures	Hours of Operation	Operations
Seattle, WA Ordinance No. 123661 (2011)	None Specified		1,000 ft					

P = Permitted, SU =Special Use Permit, CU = Conditional Use Permit,

*
C-2 “General Commercial,”

**
C-2 “Intermediate Commercial”,

***
C-4 “Heavy Commercial Zone”,

****
M-1, M-1(S), M-2, M-2(S) “Light” and “Heavy Industrial”

Table 3

Effectiveness of Policy Components

Policy Component	Example of Use in MMD Policies	Empirical Evidence of Implementation/Effectiveness
Density Controls	Limit number per population, per pharmacy, or introduce moratoriums	• No study of the effects of density controls for MMD on crime. • Alcohol outlet density and crime are positively related (Gorman, Speer, Gruenewald, & Labouvie, 2001; Gruenewald & Remer, 2006; Scribner, MacKinnon, & Dwyer, 1995). • New Jersey implemented policy to control density of alcohol outlets. On-premise outlets continued to be positively related to crime; off-premise outlets were not related to crime (Schwester, 2010).
Zoning & Distance Buffers		
Zoning Restrictions	No Residential; Commercial Districts Only	• No study on the effects of zoning restrictions for MMD on crime. • Zoning restrictions of business selling alcohol, pornography, and firearms used to protect residential populations from secondary effects, such as crime (Ashe, et al., 2003; Holder, et al., 2000; Papayanis, 2000). • A multi-component intervention that used zoning restrictions for alcohol outlets was associated with a decrease in high risk drinking and alcohol-related injuries (Holder, et al., 2000).
Distance Buffers	1,000 feet distance from school, child care facility, community center, park, or church	• No study on the effects of distance buffers for MMD on crime. • A multi-component intervention that used distance buffers for alcohol outlets was associated with a decrease in high risk drinking and alcohol-related injuries (Holder, et al., 2000).
Crime Prevention Through Environmental Design (CPTED)		
Security Measures	Individualized Security Plans Required; Alarm, Locked Doors, Security Guards	• No study on the effects of MMD security measures on crime. • Multi-component approaches were associated with higher reductions in robberies (Casteel & Peek-Asa, 2000). • Highest reductions for those sites that used individualized security plans (Casteel & Peek-Asa, 2000; Mair & Mair, 2003). • The odds of workplace homicide decreased with the presence of bright exterior lighting, security alarms, cash drop boxes, and the implementation of at least five environmental measures (e.g., barriers, video cameras) (Loomis, et al., 2002). • Single components found to be effective are: employing a second clerk, locked entrances, security hardware, and hiring guards (Casteel & Peek-Asa, 2000; Cozens, et al., 2005; Loomis, et al., 2002)
Hour of Operation	9AM–4PM, 10AM–8PM, 7AM–9PM	• Majority of crimes tend to occur between late afternoon to early morning hours (Felson & Poulsen, 2003).

Table 4

Bivariate Comparisons of Relationship of Violent Crime to Presence of Security Measures at Sacramento Medical Marijuana Dispensaries

		Violent Crime			
Security Measures	***n***	**100 Feet**	**250 Feet**	**500 Feet**	**1000 Feet**
Locked Metal Screen Door					
Present ($\bar{x}_1$, (SE))	17	0.24 (0.14)	1.00 (0.28)	4.88 (1.55)	13.6 (3.34)
Not Present ($\bar{x}_2$ (SE))	14	0.07 (0.07)	0.71 (0.24)	1.50 (0.51)	7.29 (1.91)
Difference ($\bar{x}_1 - \bar{x}_2$ (95% CI))	31	0.16 (−1.72, 0.50)	0.29 (−0.50, 1.07)	3.38 (−0.24, 7.01)†	6.36 (−1.99, 14.70)
Pass Through Door					
Present ($\bar{x}_1$, (SE))	7	0.00 (0.00)	0.57 (0.43)	4.14 (1.47)	9.71 (3.76)
Not Present ($\bar{x}_2$ (SE))	24	0.21 (0.10)	0.96 (0.21)	3.13 (1.12)	11.08 (2.49)
Difference ($\bar{x}_1 - \bar{x}_2$ (95% CI))	31	−0.21 (−0.61, 0.19)	−0.39 (−1.32, 0.55)	1.02 (−3.54, 5.58)	−1.37 (−11.69, 8.96)
Door Man Outside					
Present ($\bar{x}_1$, (SE))	4	0.00 (0.00)	0.00 (0.00)	0.75 (0.48)	7.00 (3.51)
Not Present ($\bar{x}_2$ (SE))	27	0.19 (0.09)	1.00 (0.21)	3.74 (1.04)	11.33 (2.33)
Difference ($\bar{x}_1 - \bar{x}_2$ (95% CI))	31	−0.19 (−0.69,0.32)	−1.00 (−2.11, 0.11)†	−2.99 (−8.59, 2.60)	−4.33 (−17.12, 8.46)
Security Cameras					
Present ($\bar{x}_1$, (SE))	4	0.07 (0.05)	0.70 (0.18)	3.37 (1.05)	10.74 (2.38)
Not Present ($\bar{x}_2$ (SE))	27	0.75 (0.48)	2.00 (0.71)	3.25 (0.85)	11.00 (2.04)
Difference ($\bar{x}_1 - \bar{x}_2$ (95% CI))	31	−0.68 (−1.11, −0.24)*	−1.30 (−2.37, −0.23)*	0.12 (−5.59, 5.83)	−0.26 (−13.15, 12.63)
Signs about ID Rx Card					
Present ($\bar{x}_1$, (SE))	20	0.05 (0.05)	0.50 (0.18)	2.25 (0.73)	9.25 (2.80)
Not Present ($\bar{x}_2$ (SE))	11	0.36 (0.20)	1.55 (0.34)	5.36 (2.17)	13.55 (2.87)
Difference ($\bar{x}_1 - \bar{x}_2$ (95% CI))	31	−0.31 (−0.65, 0.02)†	−1.05 (−1.77, −0.32)*	−3.11 (−6.94, 0.71)	−4.30 (−13.18, 4.59)

† $p < .10$,

* $p < .05$