Drug and Alcohol Dependence 154 (2015) 111–116

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

# The impacts of marijuana dispensary density and neighborhood ecology on marijuana abuse and dependence

Christina Mair[a,b,*], Bridget Freisthler[b,c], William R. Ponicki[b], Andrew Gaidus[b]

[a] University of Pittsburgh Graduate School of Public Health, Department of Behavioral and Community Health Sciences, 219 Parran Hall, 130 DeSoto Street, Pittsburgh, PA, 15261, USA
[b] Prevention Research Center, 180 Grand Ave., Ste. 1200, Oakland, CA, 94612, USA
[c] UCLA Luskin School of Public Affairs, Department of Social Welfare, 3250 Public Affairs Building, Box 951656, Los Angeles, CA, 90095, USA

ARTICLE INFO

*Article history:*
Received 29 September 2014
Received in revised form 8 June 2015
Accepted 12 June 2015
Available online 23 June 2015

*Keywords:*
Marijuana abuse
Marijuana dispensaries
Marijuana hospitalizations

ABSTRACT

*Background:* As an increasing number of states liberalize cannabis use and develop laws and local policies, it is essential to better understand the impacts of neighborhood ecology and marijuana dispensary density on marijuana use, abuse, and dependence. We investigated associations between marijuana abuse/dependence hospitalizations and community demographic and environmental conditions from 2001 to 2012 in California, as well as cross-sectional associations between local and adjacent marijuana dispensary densities and marijuana hospitalizations.
*Methods:* We analyzed panel population data relating hospitalizations coded for marijuana abuse or dependence and assigned to residential ZIP codes in California from 2001 through 2012 (20,219 space–time units) to ZIP code demographic and ecological characteristics. Bayesian space–time misalignment models were used to account for spatial variations in geographic unit definitions over time, while also accounting for spatial autocorrelation using conditional autoregressive priors. We also analyzed cross-sectional associations between marijuana abuse/dependence and the density of dispensaries in local and spatially adjacent ZIP codes in 2012.
*Results:* An additional one dispensary per square mile in a ZIP code was cross-sectionally associated with a 6.8% increase in the number of marijuana hospitalizations (95% credible interval 1.033, 1.105) with a marijuana abuse/dependence code. Other local characteristics, such as the median household income and age and racial/ethnic distributions, were associated with marijuana hospitalizations in cross-sectional and panel analyses.
*Conclusions:* Prevention and intervention programs for marijuana abuse and dependence may be particularly essential in areas of concentrated disadvantage. Policy makers may want to consider regulations that limit the density of dispensaries.



## 1. Introduction

The legal status and subsequent availability of marijuana for both medical and recreational use is rapidly changing in the United States. In 1996, California was the first state to legalize medical marijuana with the Compassionate Use Act, which allowed physicians to prescribe cannabis for medical purposes. Since then, 22 states and the District of Columbia have enacted similar laws. The vast majority of these laws allow marijuana to be sold through medical dispensaries. Despite the growing legal availability of marijuana for medical and recreational use, much remains unresolved about the relationships between marijuana use and related problems and the impacts of dispensaries on local communities (Gorman and Charles Huber, 2007; Lynne-Landsman et al., 2013).

Certain demographic groups are more likely to use marijuana for recreational and/or medical purposes. In California, more frequent marijuana users are more likely to be male, young adult, white, and have higher incomes (Freisthler and Gruenewald, 2014; Morrison et al., 2014). Medical marijuana users are also more likely to be male and white (O'Connell and Bou-Matar, 2007; Ogborne and Smart, 2000; Reiman, 2007; Swift et al., 2005; Ware et al., 2005), but are older than frequent users (mean around 40 years old) and have lower incomes (O'Connell and Bou-Matar, 2007; Ogborne

* Corresponding author at: University of Pittsburgh Graduate School of Public Health, Department of Behavioral and Community Health Sciences, 219 Parran Hall, 130 DeSoto Street, Pittsburgh, PA, 15261, USA. Tel.: +1 412 624 3613.
*E-mail addresses:* cmair@pitt.edu (C. Mair), freisthler@luskin.ucla.edu (B. Freisthler), bponicki@prev.org (W.R. Ponicki), agaidus@prev.org (A. Gaidus).

http://dx.doi.org/10.1016/j.drugalcdep.2015.06.019
0376-8716/

and Smart, 2000; Reiman, 2007; Swift et al., 2005; Ware et al., 2005). Rates of marijuana abuse and dependence may be higher in areas with disproportionately greater numbers of these population subgroups, making them potential targets of prevention efforts to reduce costs related to marijuana abuse and dependence hospitalizations.

Some studies suggest that legalizing medical marijuana appears to be related to higher levels of use for adults and adolescents (Cerda et al., 2012; Harper et al., 2012; Wall et al., 2011), although states that legalize marijuana had higher rates of marijuana use before legalization—suggesting that norms around use of marijuana may be more lax in those states (Wall et al., 2011). However, these findings are not universal as other studies have found no difference in marijuana use among adolescents after enactment of medical marijuana laws (Khatapoush and Hallfors, 2004; Lynne-Landsman et al., 2013; Choo et al., 2014). No differences have been found in rates of marijuana abuse and dependence among marijuana users before and after enacting legislation in states that have liberalized marijuana policies in recent years (Cerda et al., 2012). Allowing medical marijuana to be distributed through dispensaries increases the likelihood of using marijuana in the past year and using marijuana more frequently (Freisthler and Gruenewald, 2014). Past-month marijuana use is higher in states that allow distribution of medical marijuana through store-front dispensaries (Pacula et al., 2013).

Very few studies have examined where dispensaries are located. Store-front dispensaries in Denver, Colorado tend to be located in neighborhoods with higher crime rates and a higher proportion of retail jobs (Boggess et al., 2014). In California, dispensaries were located in Census block groups with higher levels of marijuana use, lower median household incomes, higher percentages of male residents, and lower percentages of Asian-American residents and residents aged 30–39 years (Morrison et al., 2014). Thus there is limited information that areas with some disadvantage (i.e., lower income, higher crime) have higher densities of dispensaries; however, how disadvantage and dispensary density are related to overall rates of marijuana abuse and dependence is unknown.

When considering the impacts of marijuana dispensaries on local use and abuse, about which little is known, the literature on alcohol outlets is potentially useful. Greater densities of alcohol outlets, another source of a potentially addictive substance, have been linked to a range of health consequences, including incidents of crime and violent assaults (Gorman et al., 2005; Lipton and Gruenewald, 2002; Livingston, 2008), drinking and driving (Ponicki et al., 2013), intimate partner violence (Cunradi et al., 2012), and other alcohol-related problems (Campbell et al., 2009; Freisthler et al., 2007). Alcohol outlets may increase availability, or areas of high alcohol outlet density may be characterized by other conditions which produce problems (e.g., low social capital, high deprivation) and density of outlets may be correlated with these conditions. Similar to the role of alcohol outlets in communities, marijuana dispensaries may increase local availability and subsequent use of marijuana and/or may be more likely to be located in socially disorganized neighborhoods.

There are several reasons to examine the impacts of medical marijuana dispensaries on local use using population-based geographic assessments. These methods allow us to address the spatial dependence of contiguous geographic units, without which there may be substantive bias in statistical tests of dispensary and other environmental effects. Furthermore, because dispensaries within an area may serve both local residents and customers from nearby areas, and many areas have no dispensaries of their own, the spatial scale of dispensary effects may be larger than any single unit. Models that measure impacts only within local areas will therefore miss effects on marijuana use in neighboring areas, understating effects. These methods allow us to examine spatial spillover effects.

It is important for us to better understand the impacts of neighborhood ecology and marijuana dispensary density on use and abuse in California as an increasing number of states follow in California's footsteps and liberalize cannabis policies. Determining in what ways marijuana dispensaries function in roles similar to alcohol outlets and in what ways they differ is essential as, other states and communities develop laws and local policies such as zoning restrictions and limiting the number of dispensary permits. The purpose of this analysis is to first examine whether hospitalizations for marijuana abuse and dependence are related to community demographic and environmental conditions, and then to investigate cross-sectional associations between marijuana dispensary densities and hospitalizations in California.

## 2. Material and methods

### 2.1. Data sources and variables

Annual data, including hospital discharges and Census-based registries, were aggregated over a 12-year period (2001 through 2012) across ZIP code polygon areas (ESRI, 2012) of California, for a total of 20,219 space–time units. Locations of marijuana dispensaries as of early 2012 were geocoded and aggregated to 1702 statewide ZIP codes as defined in 2012. These data were used to conduct two population-level Bayesian analyses: (1) A space–time analysis of associations between marijuana abuse and dependence hospitalizations and ZIP code demographic and other characteristics, and (2) a cross-sectional analysis of associations between marijuana hospitalizations and marijuana dispensary densities.

*2.1.1. Marijuana abuse and dependence hospitalizations.* The primary outcome measure was the annual number of marijuana abuse or dependence hospitalizations per ZIP code, obtained from the California Office of Statewide Health Planning and Development patient discharge data. These records provide information on all discharges that result in at least one overnight hospital stay. We included discharges that had either a primary or secondary ICD-9 diagnostic code of 304.3 (cannabis dependence) or 305.2 (cannabis abuse). The number of such cases per year that required hospitalization with at least one overnight stay increased over the study period, from 17,469 in 2001 to 68,408 in 2012. The vast majority (>85%) of cannabis discharges were coded as abuse rather than dependence. In only 0.8% of cases was cannabis dependence/abuse the primary diagnosis; in the other 99.2% of cases the diagnosis was secondary to hospital discharge for some other medical or injury condition. The percent of primary diagnoses decreased over the study period, from 2.2% ($n = 427$) in 2001 to 0.4% ($n = 294$) in 2012. Each hospital discharge was linked to the ZIP code of the patient. 97.3% of all discharges included five-digit patient ZIP codes—the remaining were homeless, lived in another state, were missing/unknown, or only provided ZIP codes masked to 3 digits due to small population sizes within their five-digit ZIP code. These discharges were dropped from analyses.

*2.1.2. Marijuana dispensary density.* Locations of marijuana dispensaries were obtained from six different websites listing the information for these businesses in March–April, 2012. The six websites were chosen by conducting a comprehensive search of such databases available on the web and by asking dispensary owners where they advertise their services. These websites provide up-to-date information on locations of dispensaries, ensuring that we obtained information for newly opened dispensaries. Each dispensary was geocoded to its address and spatially joined to ZIP code polygons for the year 2012 (ESRI, 2012). Overall marijuana density estimates used in models were calculated as the number of dispensaries per square mile within each ZIP code. Dispensary