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Research paper

Spatial accessibility of drug treatment facilities and the effects on locus of control, drug use, and service use among heroin-injecting Mexican American men☆

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ABSTRACT

Background: This study explores the spatial accessibility of outpatient drug treatment facilities and the potential relationship with drug use-related outcomes among Mexican American heroin users.
Methods: Secondary data on 219 current and former heroin-injecting Mexican American men aged 45 and older were drawn from a research study in Houston, Texas. We used geographic information systems (GIS) to derive two spatial accessibility measures: distance from one's place of residence to the closest drug treatment facility (in minutes); and the number of facilities within a 10-minute driving distance from one's place of residence. Exploratory logistic regression analyses examined the association between the spatial accessibility of drug treatment facilities and several drug use-related outcomes: internal locus of control (LOC); perceived chances and worries of injecting in the next six months; treatment utilization; and location of last heroin purchase.
Results: Participants with greater spatial access to treatment programs were more likely to report a higher chance of injecting in the near future. However, while current heroin users were more worried about injecting in the next six months, greater spatial access to treatment programs seemed to have a buffering effect. Finally, those who lived closer to a treatment programs were more likely to have last purchased heroin inside the neighborhood versus outside the neighborhood. Spatial accessibility was not associated with internal LOC or treatment utilization.
Conclusion: The findings showed that the presence of outpatient treatment facilities—particularly services in Spanish—may influence perceived risk of future heroin use and purchasing behaviors among Mexican American men. Implications for future spatially-informed drug use research and the planning of culturally and linguistically responsive drug treatment programs are discussed.

Introduction

Racial and ethnic minority groups—especially Hispanics—continue to face significant disparities in access to drug use treatment and other related services. Compared to non-Hispanic Whites, Hispanics tend to utilize fewer services, be less satisfied with the treatment they do receive, be more likely to prematurely terminate treatment, and exhibit poorer treatment outcomes (Alegria et al., 2006; Alvarez, Jason, Olson, Ferrari, & Davis, 2007; Hser, Huang, Teruya, & Anglin, 2004; Substance Abuse and Mental Health Services Administration, 2009a). While access to care has been generally studied based on wait time to enter treatment or as a service barrier to care, limited research has explored the geographic accessibility of treatment for Hispanic communities with great need for services (Guerrero, Kao, & Perron, 2013; Guerrero, Pan, Curtis, & Lizano, 2011).

The environmental context of illicit drug use is a complex phenomenon that requires an ecological or multilevel perspective (Galea, Nandi, & Vlahov, 2004). With the advent of increasingly accessible Geographic Information Systems (GIS) and other technologies, researchers have a broad range of spatial tools to analyze

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individual health and behavior in the context of their surrounding environments (Borrell, 2011). The influence of geography and other environmental factors on drug use, addiction, and treatment is still a relatively new, but emerging, field of inquiry (McLafferty, 2008). As recently as 2006, the Association of American Geographers and the National Institute on Drug Abuse (NIDA) held a joint symposium to explore the linkages between geography and drug addiction. The report coming out of this symposium recommended several key areas for future research, including "the locational analyses of drug addiction treatment and service delivery facilities" and "the use of Geographic Information Systems to better understand and respond to drug addiction" (Thomas, Richardson, & Cheung, 2008, p. vi).

Guided by these recommendations, we conducted an exploratory study to look at the spatial accessibility of outpatient drug treatment facilities and its potential relationship with internal locus of control, drug use, and treatment utilization among Mexican American current and former heroin users. The term "spatial accessibility" refers to the aspect of access that focuses on the geographic location of services (Guagliardo, 2004; Higgs, 2005, 2009). Two broad research questions guided this exploratory study: (1) What is the impact of spatial accessibility on drug addiction and treatment utilization among this population? and (2) Does spatial accessibility have a differential impact on current users, compared to former users and those currently in methadone treatment? To address these questions, this study used secondary data from a study of Mexican American current and former heroin users living in Houston, Texas. Findings from this exploratory study could inform drug policy in the funding and design of drug treatment programs in the community.

Spatial accessibility, drug use, and treatment utilization

Access to services is a multidimensional issue, reflecting the degree of "fit" between individuals and the service delivery system (Penchansky & Thomas, 1981). Spatial accessibility focuses on the geographic location of services and its potential effects on an individual's ability or willingness to utilize services (Guagliardo, 2004; Higgs, 2005, 2009). Spatial access is based on the concept of distance decay, which assumes that access or utilization decreases as the distance from the service increases, and is commonly operationalized as distance to/from a service or the quantity or density of services within a certain area. Previous research on spatial accessibility has largely focused on the issue of "potential" accessibility (or the availability of services for individuals that might be in need), as opposed to "realized" accessibility (or the actual utilization of services by individuals) (Higgs, 2009). Despite increased attention, the potential relationship between the spatial organization of services, utilization, and outcomes is relatively unexplored.

There is growing evidence regarding the spatial nature of drug treatment facilities (Perron, Gillespie, Alexander-Eitzman, & Delva, 2010), including the relationship between drug treatment facilities and minority communities (Guerrero et al., 2013). However, specific research on the spatial accessibility to drug treatment facilities and its effects on drug addiction and treatment utilization are limited. For example, Beardsley, Wish, Fitzelle, O'Grady, and Arria (2003) found that patients who traveled less than one mile to participate in substance abuse treatment programs in Baltimore, Maryland, USA were more likely to complete the program than those who traveled more than one mile. They also found that participants who lived more than four miles away from a program had shorter lengths of stay in treatment. Similarly, Fortney, Booth, Blow, Bunn, and Cook (1995) found that US veterans were less likely to participate in aftercare treatment (for alcoholism) if they lived further away (in miles) from the treatment program.

In contrast, the spatial accessibility of drug treatment programs may also be associated with poorer outcomes, such as increased drug use and decreased treatment adherence. For example, Archibald (2008) found that regions with greater density of services providers were associate with greater prevalence of substance abuse while another study by Whetten et al. (2006) showed that among HIV-positive persons, greater distance from a clinic was associated with higher participation in substance abuse and mental health programs (although not with retention and engagement). Finally, Stahler et al. (2008) found that a high density of 12-step, self-help groups (Narcotics Anonymous and/or Alcoholics Anonymous) was associated with a decreased likelihood of patients diagnosed with comorbid mental health and substance abuse disorders in continuing treatment.

Even less research exists with respect to the geography of treatment programs and its impact on minority populations, specifically Hispanics. Recent studies (Guerrero et al., 2011, 2013) have explored the use of GIS as a tool to identify specific Hispanic communities with less access to Spanish-serving treatment facilities in Los Angeles County, California, United States. For example, Guerrero and colleagues (Guerrero et al., 2013) used spatial autocorrelation analysis to identify five "hot spots" or communities, which had high concentrations of Hispanics (74–86%) and were significantly farther from Spanish-serving facilities than the rest of the county.

Conceptual framework

Bronfenbrenner's *Ecological Systems Theory* places individuals in the context of their surrounding environment, in which the interactions between multiple systems can influence individual health or well-being, as well as behaviors (Bronfenbrenner, 1974, 1979). The accessibility of services is not only a function of individual characteristics; the capacity or willingness to utilize services is often influenced by one's environment. In the drug use context, a framework proposed by Jacobson (2004) emphasizes the importance of considering ecological factors in addition to personal characteristics when studying treatment outcomes. He suggests that neighborhood drug availability and community resources are important factors in treatment outcomes and relapse, and that neighborhood disadvantage can influence individual attitudes toward treatment through perceptions of reduced personal efficacy. In addition, the neighborhood in which a treatment facility is located may have an influence on the facility's clients; however, this influence can be either positive or negative. Finally, the distance and related travel burden from home to treatment are components of Jacobson's framework for place's role in treatment attrition.

One potential mechanism could be the impact of neighborhood characteristics (e.g. the lack of resources) on an individual's drug-related locus of control (LOC), which focuses on whether an individual believes that outcomes in life are related to his or her "own behavior or attributes versus the degree to which he feels the reward is controlled by forces outside of himself and may occur independently of his own actions" (Rotter, 1966, p. 1). Individuals with a more internal LOC orientation believe in their own personal agency and those with a more external LOC orientation feel more powerlessness over their lives. In general, higher internal LOC is associated with more positive outcomes for drug use and misuse (De Moja, 1997; Hall, 2001; Haynes & Ayliffe, 1991; Murphy & Bentall, 1992; Oswald, Walker, Krajewski, & Reilly, 1994). As it relates to the spatial accessibility of drug treatment facilities, the lack of resources and services in one's neighborhood may be related to one's perceptions of control or efficacy (Boardman & Robert, 2000; Christie-Mizell & Erickson, 2007; Ross, Mirowsky, & Pribesh, 2001).

Methods

Study location

Houston, Texas is the fourth most populous city and third most populous county (Harris County) in the United States. The Houston metropolitan area has a population of approximately 5.8 million people (United States Census Bureau Population Division, 2010). Approximately half of the population in Houston and Harris County is Hispanic. Moreover, 73% of Hispanics in Houston and Harris County are of Mexican/Mexican American heritage (City of Houston Planning and Development Department, 2012). Recruitment for the current study focused on Southeast and North Houston, predominantly Mexican American areas with high rates of poverty and psychosocial strife. Both areas have high underclass characteristics, including the highest concentration of poverty (over 40%) in the city of Houston (City of Houston Planning and Development Department, 2004) and high rates of high school dropout, male unemployment, households receiving public assistance, and female-headed households (Valdez, Kaplan, & Curtis, 2007). These Mexican American communities tend to be socially isolated enclaves highly protective of its members and closed to individuals from other communities (Valdez, Neaigus, & Kaplan, 2008).

Data and sample

This study utilized data drawn from a National Institute on Drug Abuse study that examined health consequences of long-term injection heroin use in aging Mexican American men (Project *CHIVA*), conducted by the University of Houston's Center for Drug and Social Policy Research (CDSPR). The word "chiva" is an informal or slang term for heroin in the Mexican American community. A field-intensive outreach methodology, executed by trained outreach specialists who were familiar with the target communities, was employed to recruit a total of 227 Mexican American males aged 45 and older, who had injected heroin for at least 3 years during their lifetime. During the initial screening, individuals were categorized into three groups: former injectors not in treatment, former injectors enrolled in a methadone maintenance treatment program at the time of the interview, and current injectors. Semi-structured interviews were administered to the entire sample and in-depth follow-up ethnographic interviews were conducted with a subset of the sample. For this study, we utilized the quantitative data from the semi-structured interviews with the full sample. The study is further described in Torres, Kaplan, and Valdez (2011). The study protocol was approved by the University of Houston's Institutional Review Board (IRB).

The analytic sample for this paper included 219 participants (out of the 227), who provided sufficient information (e.g. street address or cross streets) to allow us to geocode and map their approximate home residence at the time of the interview (Fig. 1). While recruitment of the sample was focused in Southeast and North Houston, as Fig. 1 shows, many participants lived in other parts of the city and Harris County.

This study utilized two additional spatial data sources. First, information regarding *outpatient substance abuse treatment facilities* was obtained from the Substance Abuse and Mental Health Services Administration's (SAMHSA) Behavioral Health Treatment Services Locator web tool (http://findtreatment.samhsa.gov/). Based on where the participants lived, we included facilities located in the greater Houston area, particularly, Harris, Fort Bend, Brazoria, Montgomery, and Liberty counties. Locations of a total number of 106 facilities—including 31 facilities providing services in Spanish—were geocoded (Fig. 2). Second, a *street network* is a special type of spatial data that includes streets, highways, and freeways (drawn as line features), but also includes key attributes associated with those features, e.g. speed limits, one-way streets, dead ends, etc. Using Esri's StreetMap data (2006), spatial network analysis was conducted to create the spatial accessibility measures discussed below.

Measures

Drug use-related outcomes

Building on Jacobson's (2004) framework, this study focused on several outcomes related to drug use and treatment use. The participants' injection drug-related *locus of control* (LOC) was based on a series of six yes/no questions created specifically for this study: It is my own behavior, which determines whether I will inject drugs in the next 6 months; No matter what I do, if I'm going to inject drugs in the next 6 months, I will inject drugs in the next 6 months; I'm in control of whether or not I will inject drugs in the next 6 months; If I take the right actions, I can avoid injecting drugs in the next 6 months; I can change my drug use behaviors so that I do not inject drugs in the next 6 months; and No matter what I do, I am not likely to inject drugs in the next 6 months. The "no" responses were coded as 0 and the "yes" responses were coded as 1 (question 2 was reverse coded). We then computed a summative score ranging from 0 to 6 and dichotomized the sample into individuals with internal LOC (score of 4 or higher) and those with external LOC (score less than 4).

Since this was a cross-sectional study, we relied on participants' self-reports in order to assess for the risk of future drug use. The participants' perceptions of the *potential of injecting heroin in the future* were measured by two 5-point Likert questions: the *chances* of injecting in the next six months; and how *worried* they were about injecting in the next six months. Based on the distribution of responses, the chances measure was dichotomized into "very high chance" versus "medium/low/very low/no chance" groups while the worried measure was dichotomized into "extremely/quite worried" versus "somewhat/only a little/not at all worried" groups.

Treatment use was represented by two measures: (1) whether the participant ever sought treatment (yes vs. no) and (2) whether the participant ever received treatment (yes vs. no). Finally, the *location of last heroin purchase* was a dichotomous measure, based on whether the participants made their last heroin purchase inside or outside the neighborhood.

Spatial accessibility of treatment facilities

Spatial network analyses, using Esri's Network Analyst (2011b) were used to derive two measures to operationalize the spatial accessibility of substance abuse treatment facilities: (1) *distance to the closest facility* (in minutes) and (2) *number of facilities within a 10-minute driving distance* (using any road combination). The closest facility tool was used to create the first measure. Participants who lived closer to a facility were considered to have greater spatial access to treatment than participants who live farther from a facility. For the second measure, the service area tool was used to compute a 10-minute "service area" for each participant—or the area representing at most a 10 minute drive from one's home, driving in any direction and combination of roads. Once created, the number of facilities within each participant's service area was then counted. Both measures were calculated for all facilities and facilities also providing services in Spanish (to serve as a proxy for the provision of culturally competent services). Participants who lived in areas with more facilities were considered to have greater spatial access to treatment.

The decision to use a 10-minute threshold was based on previous research looking at spatial accessibility from the health services research literature (Langford & Higgs, 2006), as well as research focused on food deserts (Jiao, Moudon,

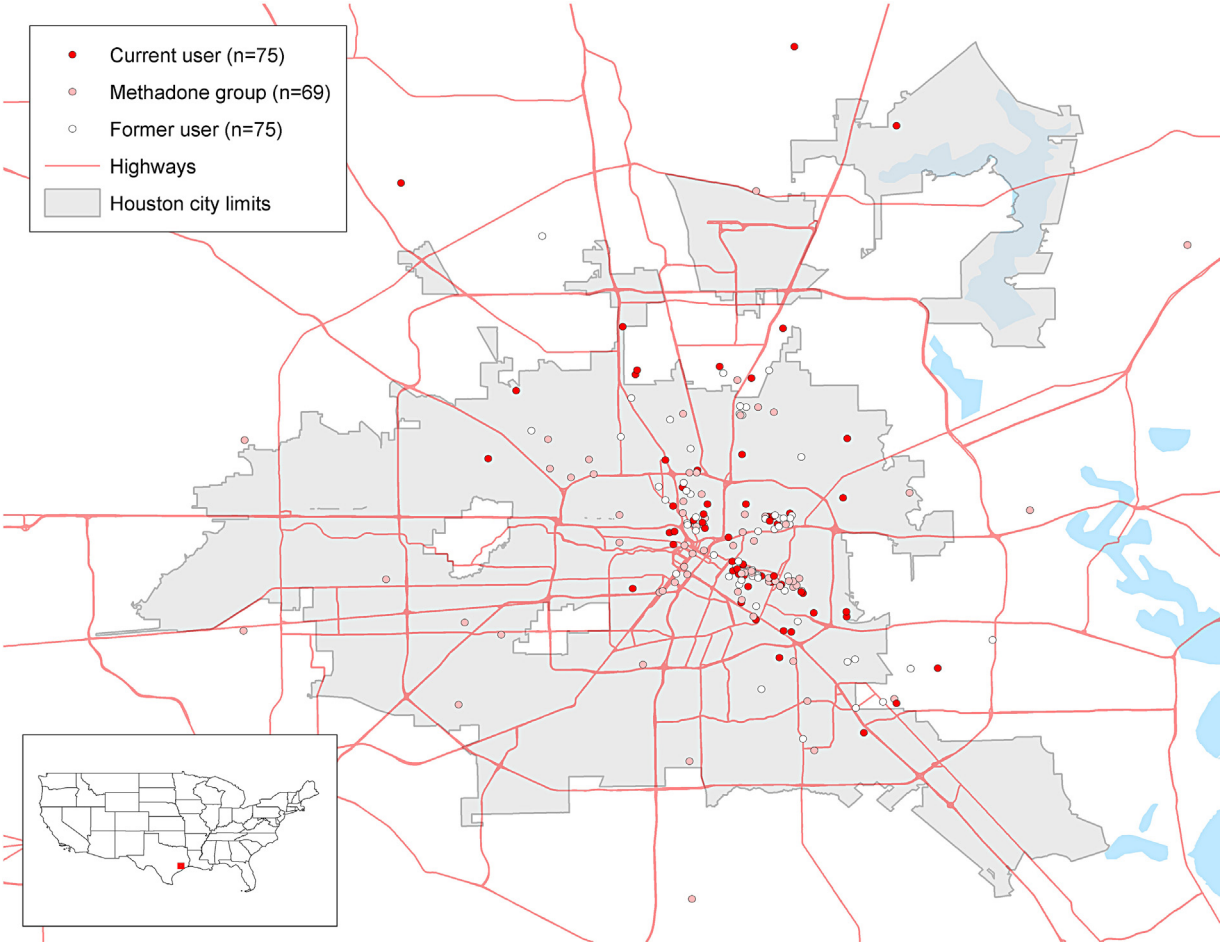

Fig. 1. Study participants.
Data sources: ESRI Data & Maps and StreetMap USA 2006; United States Census Bureau.

Ulmer, Hurvitz, & Drewnowski, 2012). In preparation, we also tested service areas with various thresholds (e.g. 5 minute, 15 minute, and 30 minute) and overlaid these layers with the city's "super neighborhoods," i.e. geographic areas designated by the city of Houston for local planning and governance (http://www.houstontx.gov/superneighborhoods/index.html). Based on this process, we determined in most cases, a 10-minute driving radius resulted in adequate coverage of the participant's home super neighborhood as well as the adjacent super neighborhoods.

Control measures

Several variables were also included in the multivariate models as controls, including: drug user group (former, methadone, and current); the participant's age at the time of the interview (continuous); the age at which the participant reported first injecting heroin (continuous); educational attainment (less than high school vs. high school graduate or equivalent); fulltime employment status (yes or no); and marital status (married vs. not married).

Analysis

The ArcGIS 10.0 software (Esri, 2011a) was used to manage the spatial data, geocode the participants and facilities, and construct the spatial accessibility measures. Once the spatial accessibility measures were created, bivariate and logistic regression analyses were then used to explore and test the relationships between spatial accessibility and the drug use-related outcomes. Using Stata 11.2 (StataCorp, 2009), separate analyses were conducted for the full sample ($N = 219$), with a particular interest on the current user group ($n = 75$).

Results

Descriptives

As shown in Table 1, the current users in our sample tended to be younger and less educated than the methadone and former user groups. In particular, only about half of current users (52%) had graduated from high school, compared to 68% of the respondents in both methadone and former user groups. Higher proportions of the respondents in our methadone group were employed fulltime and married compared to the other two groups. Most notably, the average age at which one first injected heroin differed significantly among the three groups, with the current users in our sample starting at an older age than both the methadone and former user groups (20.2 years vs. 17.7 and 18.6, respectively).

With regards to the drug-related outcomes, current users were significantly less likely to exhibit internal LOC, compared to the other two groups. Less than half of the current user group had a LOC score of 4 or higher, compared to 96% of the former users and 84% of the methadone group. Interestingly, former users were the most likely to report a "very high" chance of injecting in the future (45%), followed by current users (35%). The methadone group was the least likely (20%) to report a "very high" chance of injecting in the future. A significantly greater percentage of current users (42%)

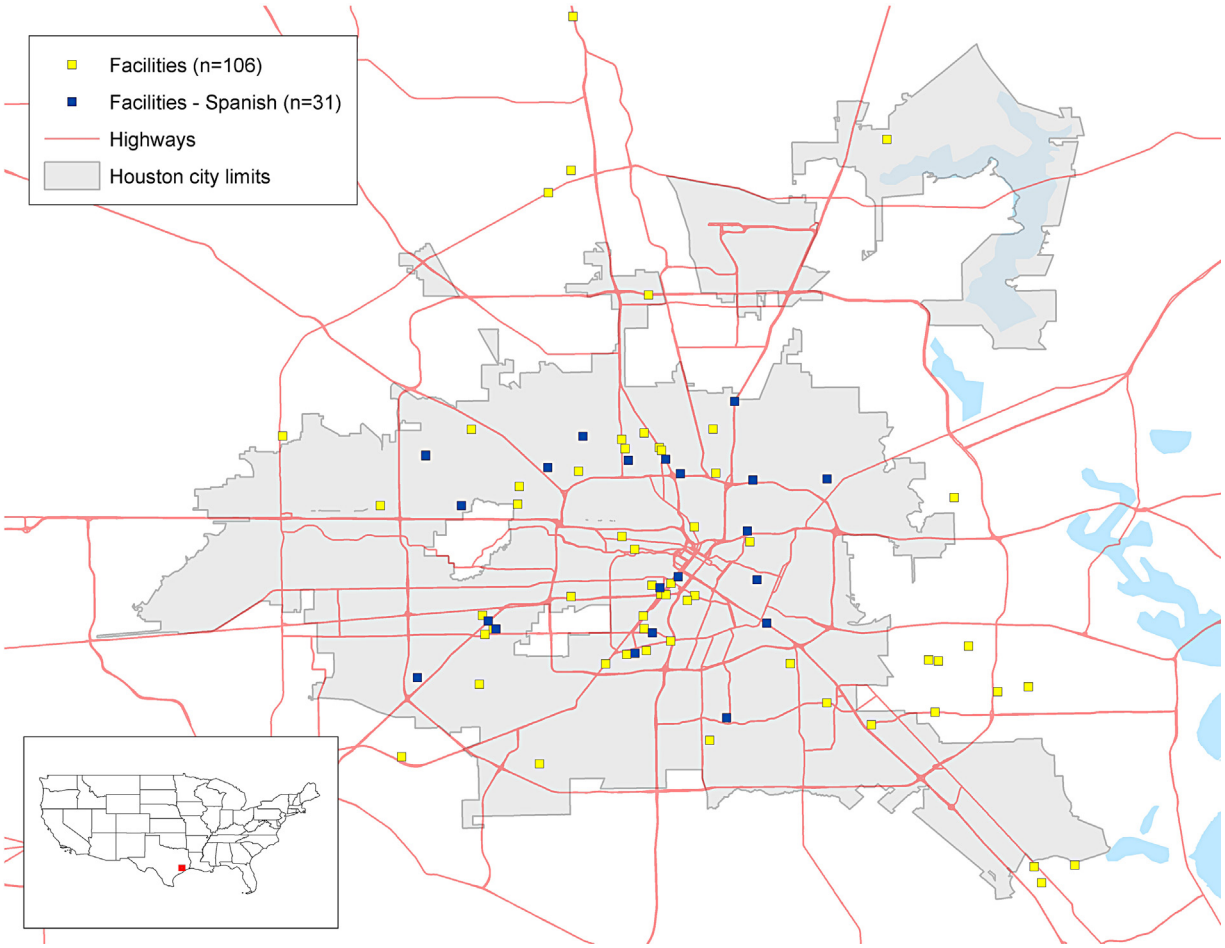

Fig. 2. Outpatient substance abuse treatment facilities in the Greater Houston area.
Data sources: ESRI Data & Maps and StreetMap USA 2006; Substance Abuse and Mental Health Services Administration; United States Census Bureau.

were "extremely" or "quite" worried about injecting in the future, compared to only 19% of the methadone group and 4% of former users.

Finally, the descriptive statistics suggested that the current user group may have less spatial access to drug treatment services, compared to the former user and methadone groups. For example, the mean distance to the closest facility was slightly greater for the current user group than the other two groups, particularly for the facilities with Spanish language services (5.1 minutes vs. 4.1 minutes and 4.7 minutes, respectively). Current users also tended to live near fewer facilities, averaging 16.1 facilities within a 10-minute drive compared to an average of 17.2 facilities for both the current user and methadone groups.

Association between spatial accessibility and drug use

For the full sample, the bivariate analysis showed that participants with greater spatial access to facilities perceived their chances of injecting in the future to be greater (Table 2). For example, participants who reported a "very high" chance of injecting lived an average of 3.7 minutes away from the closest facility with Spanish-language services while those who reported "medium" to "no" chances lived significantly farther at 5.1 minutes. This pattern was also found with regard to the relative density of facilities. Participants who reported a "very high" chance of injecting tended to live near more facilities than participants who reported lower chances: 18.6 vs. 15.9 facilities, respectively. This was also the case with regard to facilities that provided Spanish language services. In contrast, participants who reported that they were "extremely" or "quite" worried about injecting in the future on average, lived farther from a Spanish-serving facility than those who were less worried (5.6 vs. 4.3, respectively).

For the current users, we found similar patterns, but the relationship between spatial accessibility and being worried about injecting in the future was more apparent. In general, participants who reported to be less worried about injecting in the future, on average, lived closer to a facility (particularly, those providing Spanish language services) and lived in an area with more facilities. For example, "extremely" or "quite" worried individuals lived an average of 6.5 minutes away from the closest Spanish-language facility, compared to just 4.0 minutes for less worried individuals.

Another finding emerging from the bivariate analysis was the relationship between spatial accessibility to treatment facilities and the location of the participants' last heroin purchase. As shown in Table 2, participants who last purchased heroin in the neighborhood tended to live closer to a Spanish-serving facility. Similarly, current users who made their last purchase of heroin in the neighborhood tended to live closer to a facility than those who last purchased heroin outside the neighborhood (Table 3).

Regression analysis

Next, we used logistic regression models to further explore the relationship between spatial accessibility and the drug-related

Table 1
Description of sample.

	Current users ($n = 75$)	Methadone treatment ($n = 69$)	Former users ($n = 75$)	Total ($n = 219$)
Sociodemographic characteristics				
Mean age (SD)***	53.6 (7.2)	56.2 (9.6)	56.0 (7.9)	55.2 (8.4)
Mean age first injected heroin (SD)	20.2 (6.8)	18.6 (6.1)	17.7 (4.7)	18.9 (6.0)
High school graduate or equivalent (%)	52.0	68.0	68.1	62.6
Employed fulltime (%)	12.0	12.0	15.9	13.2
Married (%)	21.3	17.3	30.4	22.8
Drug-related outcomes				
Internal LOC (score of 4 or higher)***	49.3	84.0	95.9	76.7
Injecting in the next 6 months?				
Very high chance**	35.2	20.0	45.2	33.3
Extremely or quite worried***	42.2	18.7	4.1	21.5
Treatment use				
Ever sought treatment (%)	67.4	na	65.8	67.4
Ever received treatment (%)	71.8	na	67.1	69.4
Last purchased heroin inside the neighborhood	62.0	64.0	74.0	66.7
Spatial accessibility (mean/SD)				
Mean driving time (minutes) to closest facility (SD)				
All facilities	3.4 (2.5)	3.3 (4.0)	2.7 (1.8)	3.1 (2.9)
Facilities w/Spanish language services	5.1 (5.0)	4.7 (5.2)	4.1 (3.3)	4.6 (4.6)
Mean number facilities within 10-minute drive (SD)				
All facilities	16.1 (9.0)	17.2 (9.8)	17.2 (8.5)	16.8 (9.1)
Facilities w/Spanish language services	5.7 (3.1)	5.8 (3.1)	6.1 (2.9)	5.9 (3.0)

Notes: LOC = locus of control; SD = standard deviation.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 2
Spatial accessibility and drug use-related outcomes among current and former Mexican American heroin users (bivariate analysis, full sample $N = 219$).

Outcomes	Driving time to closest facility Mean minutes (SD)		Number of facilities within 10-minute drive Mean (SD)	
	All facilities	Spanish-serving facilities	All facilities	Spanish-serving facilities
Locus of control				
Internal LOC	3.0 (2.6)	4.5 (4.2)	17.0 (9.2)	5.9 (3.0)
External LOC	3.6 (3.7)	5.1 (5.6)	16.3 (8.9)	5.7 (3.2)
Chances of injecting in next 6 months?				
Very high chance	2.8 (2.1)	3.7 (3.8)**	18.6 (8.8)**	6.6 (2.7)**
Medium/low/very low/no chance	3.3 (3.2)	5.1 (4.8)	15.9 (9.1)	5.5 (3.1)
Worried about injecting in next 6 months?				
Extremely/quite worried	3.6 (4.1)	5.6 (7.0)*	16.7 (10.0)	5.7 (3.3)
Somewhat/a little/not worried	3.0 (2.5)	4.3 (3.6)	16.9 (8.8)	5.9 (3.0)
Treatment use				
Ever sought treatment	3.2 (3.1)	4.7 (4.9)	16.8 (9.2)	5.9 (3.0)
Never sought treatment	2.7 (1.8)	4.1 (2.9)	16.8 (8.7)	6.0 (3.1)
Ever received treatment	3.2 (3.1)	4.7 (4.9)	17.1 (9.3))	5.9 (3.0)
Never received treatment	2.9 (1.8)	4.2 (3.0)	15.8 (8.3)	5.7 (3.0)
Last purchased heroin				
Inside the neighborhood	3.0 (2.9)	4.3 (4.1)*	16.9 (8.5)	6.0 (2.8)
Outside the neighborhood	3.4 (2.9)	5.3 (5.3)	16.8 (10.3)	5.6 (3.3)

Notes: SD = standard deviation.
* $p < 0.10$.
** $p < 0.05$.

outcomes, controlling for other potential factors (i.e., age, educational attainment, etc.). Due to the exploratory nature of this study, we will only report the significant results related to the spatial accessibility measures. The full regression tables are available upon request.

As shown in Table 4, spatial accessibility seemed to have a negative impact on the perceived chances and worries of injecting in the future and whether an individual last purchased heroin inside the neighborhood. For example, participants living with a higher number of facilities within a 10-minute driving distance were more likely to report a very high chance of injecting (OR = 1.04, $p < 0.05$); this pattern was also found with the number of facilities providing Spanish services (OR = 1.15, $p < 0.01$). Living closer to a treatment facility providing Spanish language services had a similar effect: greater distances were associated with lower self-reported chances on injecting in the future (OR = 0.90; $p < 0.01$). The number of facilities within a 10-minute driving distance also seemed to reduce the likelihood of one making their last heroin purchase inside the neighborhood (OR = 0.95, $p < 0.10$; OR = 0.84, $p < 0.10$ for the number of Spanish-serving facilities).

Table 3
Spatial accessibility and drug use-related outcomes among current Mexican American heroin users (bivariate analysis, $n = 71$).

Outcomes	Driving time to closest facility Mean minutes (SD)		Number of facilities within 10-minute drive Mean (SD)	
	All facilities	Spanish-serving facilities	All facilities	Spanish-serving facilities
Locus of control				
Internal LOC	3.5 (2.6)	5.3 (5.2)	15.3 (9.0)	5.7 (3.0)
External LOC	3.3 (2.4)	4.9 (4.8)	16.8 (9.0)	5.8 (3.3)
Chances of injecting in next 6 months?				
Very high chance	3.4 (2.7)	4.4 (5.2)	18.2 (9.0)[a]	6.5 (2.9)[b]
Medium/low/very low/no chance	3.4 (2.4)	5.4 (4.9)	14.9 (8.8)	5.3 (3.2)
Worried about injecting in next 6 months?				
Extremely/quite worried	3.8 (3.1)	6.5 (7.0)**	13.5 (9.1)**	4.9 (3.4)**
Somewhat/a little/not worried	3.2 (1.9)	4.0 (2.2)	18.0 (8.4)	6.4 (2.8)
Treatment use				
Ever sought treatment	3.6 (2.7)	5.4 (5.6)	16.3 (9.4)	5.8 (3.3)
Never sought treatment	3.0 (2.1)	4.4 (3.3)	15.5 (8.0)	5.6 (2.8)
Ever received treatment	3.5 (2.7)	5.2 (5.5)	16.7 (9.4)	5.9 (3.3)
Never received treatment	3.3 (2.1)	4.6 (3.4)	14.6 (7.6)	5.4 (2.8)
Last purchased heroin				
Inside the neighborhood	3.0 (1.8)*	3.9 (7.2)**	16.8 (8.2)	6.2 (2.9)
Outside the neighborhood	4.1 (3.3)	6.9 (2.3)	14.9 (10.1)	5.1 (3.4)

Notes: SD = standard deviation.
[a] $p = 0.14$.
[b] $p = 0.12$.
* $p < 0.10$.
** $p < 0.05$.

Table 4
Logistic regression results: effects of spatial accessibility of drug treatment facilities on drug-abuse related outcomes.

	OR	(95% CI)	OR	95% CI	OR	95% CI
Model 1: Odds of reporting "very high" chances of injecting in the next six months						
Group (ref = former users)						
Methadone group	0.32	(0.15, 0.70)	0.35	(0.16, 0.75)	0.35	(0.16, 0.74)
Current users	0.72	(0.35, 1.48)	0.74	(0.36, 1.52)	0.77	(0.37, 1.57)
Number of facilities with 10 minutes	**1.04**	**(1.01, 1.08)**	–	–	–	–
Number of Spanish-serving facilities within 10 minutes	–	–	**1.15**	**(1.04, 1.28)**	–	–
Distance to closest facilities (in minutes)	–	–	–	–	**0.90**	**(0.81, 0.98)**
Model 2: Odds of being "extremely" or quite" worried about injecting in the next six months						
Group (ref = former users)						
Methadone group	16.31	(0.17, 1590.18)	–	–	–	–
Current users	507.14	(6.16, 41,771.64)	–	–	–	–
Number of facilities within 10 minutes	1.13	(0.95, 1.33)	–	–	–	–
X Methadone group	0.95	(0.79, 1.14)	–	–	–	–
X Current user group	**0.83**	**(0.70, 1.00)**	–	–	–	–
Model 3: Odds of last purchasing heroin inside the neighborhood						
Group (ref = former users)						
Methadone group	0.17	(0.03, 0.87)	0.11	(0.02, 0.66)	0.87	(0.28, 2.75)
Current users	0.11	(0.02, 0.59)	0.08	(0.01, 0.51)	1.72	(0.47, 6.24)
Number of facilities with 10 minutes	**0.95**	**(0.89, 1.01)**	–	–	–	–
X Methadone group	1.06	(0.98, 1.15)	–	–	–	–
X Current User group	**1.09**	**(1.00, 1.18)**	–	–	–	–
Number of Spanish-serving facilities with 10 minutes	–	–	**0.84**	**(0.69, 1.03)**	–	–
X Methadone group	–	–	1.27	(0.98, 1.65)	–	–
X Current user group	–	–	**1.32**	**(1.02, 1.71)**	–	–
Distance to closest Spanish-serving facility	–	–	–	–	1.15	(0.92, 1.43)
X Methadone group	–	–	–	–	0.86	(0.68, 1.09)
X Current user group	–	–	–	–	**0.74**	**(0.57, 0.97)**

Notes: OR = odds ratios; 95% CI = 95% confidence intervals. Distance to closet facility reported in minutes. All models included the following control variables: age at time of interview; age at which first injected heroin; educational attainment; employment status; and marital status.

We also included interaction terms (group membership x spatial accessibility measures) in the regression models to explore the potential moderating effects of spatial accessibility on the drug use-related outcomes. Two key findings emerged from these analyses. First, although current users were significantly more likely to be extremely or quite worried about injecting in the future, increased spatial accessibility to treatment facilities seemed to have a buffering effect. In other words, the results showed the interaction between current user status and greater number of nearby facilities was associated with a reduced likelihood of being extremely or quite worried about injecting in the near future (OR = 0.83, $p < 0.05$). Second, current users with greater spatial accessibility to treatment facilities were more likely to make their last heroin purchase inside the neighborhood; significant results were found with the interaction between current users and two of the spatial accessibility measures—number of Spanish-serving facilities

(OR = 1.32, $p < 0.05$) and distance to the closest Spanish-serving facility (OR = 0.74, $p < 0.05$). Marginal significance was found with the interaction between current users and the number of facilities (OR = 1.09, $p < 0.10$).

Discussion

The primary goal of this study was to explore the potential role of spatial accessibility of drug treatment facilities in the drug use and treatment utilization behaviors of former and current Mexican American heroin injectors. Due to the limited research thus far, we conceptualized this as an exploratory study, one that we hope will contribute to our understanding of the geography of drug treatment facilities and drug use desire among Hispanics with history of injecting illicit drugs. Data from the CHIVA study provided a unique opportunity to look at an understudied population in a large metropolitan city in the United States.

The results suggest that the spatial accessibility of treatment facilities may be related to one's concerns of injecting in the future. However, the direction of this impact is not entirely clear. On the one hand, we found that increased spatial accessibility was associated with decreased *worries* about injecting in the future, particularly among current users. On the other hand, the results also suggest that individuals reporting a very high *chance* of injecting in the future tended to live closer to a facility, as well as in areas with a greater number of facilities. The latter finding seems consistent with previous literature that showed that drug use tended to increase the closer one lived near a clinic or treatment program (Archibald, 2008; Latkin, Glass, & Duncan, 1998). Although the directionality of this relationship is not clear, it is likely that clinics providing drug treatment services open where the need is, i.e. in communities with high rates of drug use. It is also possible that participants in the study do not perceive the existing clinics and the services they offer as being culturally relevant. However, the former finding suggests that the proximity of drug treatment programs may play an important role in fostering a change in one's perception and potentially, one's behaviors.

We also found that the spatial accessibility of treatment facilities was associated with the increased likelihood of purchasing heroin inside the neighborhood, compared to outside the neighborhood. This was the case for the sample as a whole, but particularly for current users. These findings seem to highlight the challenges facing drug treatment programs—which strive to be located near the target populations they serve, but as a consequence, are situated in neighborhoods whose socio demographic factors may promote or sustain drug use behaviors. Jacobson (2006) found that treatment facilities were more likely to be located in areas with higher levels of "disadvantage," including drug activity. Therefore, individuals living near treatment facilities may simply be exposed to the neighborhood's stressors and environmental cues.

Our study did not find any significant relationships between the spatial accessibility of facilities and treatment utilization, as one might expect. Neither living closer to a facility nor in an area with more facilities impacted the likelihood of ever having sought or received treatment among our participants. Previous research has shown that the average distance traveled by patients to Opioid treatment programs was 15 miles, sometimes requiring travel across state borders (Rosenblum et al., 2011). It is possible that many of our participants did not seek services at a nearby facility. One potential explanation may involve the stigma associated with having a drug addiction or seeking drug treatment. The literature suggests that individuals with a drug use problem may be hesitant to use local or neighborhood services due to the stigma associated with drug use or fear of seeing someone s/he knows (Ahern, Stuber, & Galea, 2007). The potential effects of stigma on treatment utilization and preferences may be even more dramatic for Hispanic and other minority populations, which tend to be geographically concentrated in ethnic neighborhoods and abide by traditional social roles (Portes & Rumbaut, 1996; Wen, Lauderdale, & Kandula, 2009). In the CHIVA study, our qualitative data suggested that participants who were in methadone maintenance (MM) treatment purposely found MM centers outside of their neighborhoods due to drug treatment and cultural stigmas. Drug treatment stigma focuses on the tenants of traditional addictions mindset that you cannot use one drug (methadone) to stop using another (heroin). In addition, the cultural value of Machismo or traditional masculinity holds that MM is a "weak method" to quit drug use, versus the more "macho method" of quitting "cold turkey" (without any treatment). These influences converge and create dissonance in users, which may explain decisions related to the distance and locations to seek treatment.

Another potential explanation may be the impact of other environmental factors, such as crime. For example, Mennis, Stahler, and Barron (2012) showed that patients living in a high crime neighborhood were less likely to continue their treatment. Jacobson (2004) also identified other potential environmental factors that might impact treatment utilization, such as drug availability, neighborhood disadvantage (e.g. poverty), and the availability of other community resources. The CHIVA participants are enmeshed in the drug scene and surrounded by contextual drug cues and influences; these contextual cues have been implicated as precursors to relapse and maintenance of drug use.

This study had several key limitations. The analysis was based on cross-sectional data, so the reader should be cautious in making any causal inferences. Because we were using secondary data, we were bounded by the questions and measures in the initial study. Most notably, it is important to note that the original study was not designed with the intent to look at spatially-oriented research questions. Because the original study utilized specific recruitment strategies to reach a "hidden" population, over half of our participants lived in two neighborhoods in the Houston area. As a consequence, there may not have been sufficient spatial variation where the participants lived in relationship to where drug treatment facilities were located. Another potential limitation was our focus on outpatient treatment facilities. While these facilities offer services to more than 75% of all clients requesting treatment (Substance Abuse and Mental Health Services Administration, 2009b), it would be important to determine the location of various types of treatment facilities, such as methadone, self-help, hospital and residential programs in future research.

Despite these limitations, this study highlights the critical need for further research on the geography of drug treatment facilities. Most notably, the drug use research literature, as it relates to the topic of spatial accessibility, has largely relied on administrative geographic units, such as states, counties, and zip codes (e.g. Archibald, 2008; Beardsley et al., 2003; Fortney et al., 1995; Jacobson, 2006; Perron et al., 2010; Whetten et al., 2006). More recently used geographies include census tracts, which are U.S. Census Bureau-designated geographies that average around 4000 persons and provide greater geographic specificity (e.g. Guerrero et al., 2011, 2013). Drug use research has certainly benefitted from the use of administrative geographic measures to identify hotspots and inform health care policy interventions and significant insights have been gathered using the use of these geographic units. However, while such units (e.g. census tracts) are standardized systems for understanding geography and offer a comparative framework and common language, these measures are not resident-centered or necessarily descriptive of their subjective reality (Matthews, 2008, 2011; Stahler et al., 2008). Moreover, since administrative boundaries are arbitrarily drawn and also permeable, individuals

are not limited to the services within certain geographies, but instead, often travel across these lines in order to access services or other resources. As mentioned before, evidence has shown that many individuals may travel long distances and sometimes across state boundaries to seek drug treatment services (Rosenblum et al., 2011).

Our spatial accessibility measure for the number of facilities within a 10-minute driving distance was derived by first computing a "service area" around each participant's home residence. The use of service areas is one approach to measuring individuals' "activity spaces", or visual representations of their movements as they engage in day-to-day activities (Sherman, Spencer, Preisser, Gesler, & Arcury, 2005). According to Sherman et al., an activity space serves as "a measure of individual spatial behavior that theoretically accounts for . . . individual and environmental differences and offers an alternative approach to studying geographic accessibility." In the research on drug use, this activity spaces approach has been largely used in studies with urban adolescents (Mason, Cheung, & Walker, 2004; Mason & Korpela, 2008; Mason et al., 2009); future research could extend this approach to the adult population. Finally, going beyond current practices, the use of GIS in drug use research should be expanded with other technologies. Specifically, on a micro level, GIS technologies—combined with other data collection strategies such as ecological momentary assessment or EMA (Shiffman, 2009)—could be used to assess drug availability and proximity to environmental factors that trigger craving and/or relapse. As NIDA seeks to expand its understanding of the geographic dimensions of drug use, the findings and methodologies employed in this study can also inform future studies in urban areas around the world reporting high use of illicit drugs, as well as drug related criminal activity.

Finally, the findings point to several key implications for drug policy in the planning and design of drug treatment programs—particularly those targeting minorities in the localities at greater risk of illicit drug use, or in need for targeted culturally and linguistically responsive care. The mixed results suggest that drug treatment facilities can serve as a catalyst for positive perceptions and engagement, but at the same time, can also be a negative influence, unknowingly or unwittingly promoting and enabling continual drug use behaviors. As Tempalski (2008) argues, "Stigmatization associated with drug use. . .often becomes embodied in the location of services used and frequented by clients. . .This transfers stigma from persons to services and often the places where those services are located" (p. 328). In locating and designing drug treatment programs, planners should seek to promote what Jacobson (2004) refers to as "restorative qualities" of the facility itself and its surroundings. As such, programs must not see themselves as just treating an "identified patient", but contributing to health promotion for the entire community. As community involvement among administrators and staff working in drug treatment programs is associated with high access to care for ethnic minority clients (Guerrero, 2013), drug policy should promote higher interaction between treatment programs and their surrounding environment to support all aspects of their clients' recovery efforts. The design and development of treatment centers that respect the cultural norms and values of community residents and clients will go far to decrease stigma and increase health among ethnic minority communities.

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Conflict of interest statement

None declared.

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