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Patterns of Drug Use, Risky Behavior, and Health Status Among Persons Who Inject Drugs Living in San Diego, California: A Latent Class Analysis

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Abstract

Background—Among persons who inject drugs (PWID), polydrug use (the practice of mixing multiple drugs/alcohol sequentially or simultaneously) increases risk for HIV transmission and unintentional overdose deaths. Research has shown local drug markets influence drug use practices. However, little is known about the impact of drug mixing in markets dominated by black tar heroin and methamphetamine, such as the western United States.

Methods—Data were collected through an ongoing longitudinal study examining drug use, risk behavior, and health status among PWID. Latent class analysis (LCA) was used to identify patterns of substance use (heroin, methamphetamine, prescription drugs, alcohol, and marijuana) via multiple administration routes (injecting, smoking, and swallowing). Logistic regression was used to identify behaviors and health indicators associated with drug use class.

Results—The sample included 511 mostly white (51.5%) males (73.8%), with mean age of 43.5 years. Two distinct classes of drug users predominated: methamphetamine by multiple routes (51%) and heroin by injection (49%). In multivariable logistic regression, class membership was associated with age, race, and housing status. PWID who were HIV-seropositive and reported prior sexually transmitted infections had increased odds of belonging to the methamphetamine

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Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

class. Those who were HCV positive and reported previous opioid overdose had an increased odds of being in the primarily heroin injection class (all *P*-values < .05).

Conclusion—Risk behaviors and health outcomes differed between PWID who primarily inject heroin vs. those who use methamphetamine. The findings suggest that in a region where PWID mainly use black tar heroin or methamphetamine, interventions tailored to sub-populations of PWID could improve effectiveness.

Keywords

persons who inject drugs; polydrug use; latent class analysis; tailored interventions; San Diego; California

INTRODUCTION

Research has found individual factors (e.g., gender, race, age, depression, homelessness, desire for subjective effects of drugs, etc.) (Harrell, Mancha, Petras, Trenz, & Latimer, 2012; Hunt, Evans, Moloney, & Bailey, 2009; Kuramoto, Bohnert, & Latkin, 2011; Patra, Fischer, Maksimowska, & Rehm, 2009) and environmental factors (e.g., local drug markets, syringe access) impact drug use practices (Ciccarone, 2009; Ciccarone & Bourgois, 2003a). Among persons who inject drugs (PWID), polydrug use, the practice of administering multiple drugs either sequentially or simultaneously, may increase risk for HIV (Kuramoto, Bohnert, & Latkin, 2011) and drug-related overdose deaths (Coffin et al., 2003; Ochoa et al., 2005; Seal et al., 2001). While considerable variation in polydrug use has been documented (Kuramoto, Bohnert, & Latkin, 2011; Lakenau & Clatts, 2005; Monga et al., 2007; Wu et al., 2011), many studies of polydrug use among PWID have been conducted in the northeastern United States, where cocaine and white powder heroin are common (Rosenblum, Unick, & Ciccarone, 2014). Thus, less is known about polydrug use in markets dominated by methamphetamine and black tar heroin, such as those occurring in the western United States, which may have important implications for infectious disease and overdose prevention (Brouwer et al., 2006; Ciccarone, 2009; Garfein et al., 2004; Shukla, Crump, & Chrisco, 2012).

Compared to the white powder heroin that is more typical in the eastern United States (Rosenblum et al., 2013), the black tar heroin available in the western United States possesses some properties that may affect the likelihood that HIV is transmitted (Ciccarone, 2009; Ciccarone & Bourgois, 2003b). Black tar heroin is gummy and leaves more contaminants in the syringe. In order to unclog their syringes, some PWID may rinse their syringes more aggressively which could lower the amount of residual blood (Ciccarone, 2009). Heating practices used to dissolve black tar heroin may also destroy HIV-infected cells, thereby decreasing the likelihood of transmission via injection paraphernalia (Ciccarone, 2009). However, because small quantities of black tar heroin are most easily divided and shared in liquid form, syringe-mediated drug-sharing (backloading) may increase risk of blood borne virus transmission in settings dominated by black tar heroin (Jose et al., 1993; Koester, Glanz, & Barón, 2005).

Few studies describe substance use and related health outcomes among PWID in San Diego, California, and no studies to date have described polydrug use or its influence on risk behaviors and health outcomes among PWID in this context. In the current study we employ a latent class analysis (LCA) approach to examine patterns of polydrug use among PWID. Commonly employed statistical methods for analyzing polydrug use dichotomize data (any vs. no use of a given or multiple drugs), whereas LCA uses conditional probabilities to infer classes from response patterns on observed variables (Gibson, 1959; Hagenaars & McCutcheon, 2002; McCuthcheon, 1987). The primary goal of LCA is to maximize *homogeneity* within groups (i.e., profiles of individuals within a class should be similar) and maximize *heterogeneity* between classes (i.e., profiles of individuals across classes should be distinct). Thus, LCA helps to reduce a constellation of observed variables into a smaller set of distinct groups or classes. Class membership may then be analyzed in terms of its associations with other variables of interest (e.g., HIV risk behaviors, health outcomes). This approach has largely shown that the use of multiple substances is associated with poorer health outcomes (Green et al., 2010; Harrell, Mancha, Petras, Trenz, & Latimer, 2012; Lakenau & Clatts, 2005; Patra, Fischer, Maksimowska, & Rehm, 2009; Trenz et al., 2013).

The objective of the current study was to examine habitual drug use (defined as weekly or more frequent use) among PWID with an interest in identifying distinct patterns of heroin and methamphetamine mixing that may be occurring in San Diego. First, we created latent classes of habitual drug use using the five most prevalent substances (i.e., heroin, methamphetamine, prescription drugs, alcohol, and marijuana) by various routes of administration (i.e., snorting, swallowing, injecting, smoking). Second, we examined whether drug use class was associated with differences in sexual behavior, injection practices and infectious disease prevalence.

METHODS

Sample

Data for this study were taken from an ongoing longitudinal cohort study of PWID (hereafter the STAHR-II study) in San Diego, California. To be eligible for STAHR-II individuals were (1) ≥18 years of age who (2) injected drugs within the past 30 days, (3) reported they intend to reside in San Diego County for years, (4) were willing to provide contact information to maintain contact with study staff, and (5) have their blood drawn for serological testing for HIV and HCV. All participants enrolled between June 2012 and September 2013 were eligible for this analysis (N = 511).

Participants were recruited using targeted advertising, street outreach, and word-of-mouth referrals in areas with a high prevalence of drug use. Recruitment and study procedures took place at a storefront office and on a mobile unit that parked in multiple locations throughout the county to increase representativeness of the sample. A bilingual (Spanish-English) outreach worker provided PWID with information about the study, and facilitated appointments for prospective participants.

Measures

Surveys were conducted using computer assisted personal interviewing (CAPI) technology. Trained interviewers read questions to participants in Spanish or English and entered responses on a laptop computer. Baseline interviews elicited socio-demographic information (i.e., participant age, sex, educational attainment), substance use history (i.e., age of initiation, past 6 months use of specific drugs including heroin, crack/cocaine, methamphetamine, prescription drugs, marijuana) by route of administration (i.e., snorting, smoking, swallowing, or injection), syringe and injection equipment sharing behaviors, sexual behaviors (i.e., number of steady and casual sexual partners, condom use, sex in exchange for drugs or money), contextual factors (i.e., locations of drug use, use of syringe exchange program, drug treatment, and criminal history), and health status (HIV and HCV seropositivity). All behavioral questions referred to the 6-months prior to completing the baseline interview. After the interview, participants received counseling and serological testing for HIV and HCV to determine baseline prevalence of these infections. All participants were offered referrals for drug treatment and were compensated USD $25 for the baseline interview. Individuals screening positive for HIV or HCV infection were provided with information and offered assistance to seek medical follow-up for further evaluation and treatment.

Statistical Methods

We approached the analysis in two steps. First, we used LCA to identify latent classes of weekly polydrug use, based on patterns of drug type and route of administration. Second, we used logistic regression to identify demographic characteristics, HIV risk behaviors, and health outcomes that were associated with class membership. In this case, we used a combination of drug type (heroin, methamphetamine, prescription drugs, alcohol, and marijuana) and route of administration (injection, smoking, and swallowing) to define drug use profiles. In order to identify classes based on habitual (vs. episodic) use, we recoded each drug by specific route of administration into a binary variable (1 = used weekly or more frequently, 0 = used less than weekly or never). For example, heroin-injected, heroin-snorted, heroin-smoked were three separate variables coded as “used weekly or more” versus “less than weekly/never.” We then reviewed the distribution of drugs and selected drugs reported by at least 15% of the entire sample for inclusion in the LCA. Based on this standard, seven drug/administration-route combinations were included in the LCA: heroin injection, methamphetamine injection, methamphetamine smoking, methamphetamine snorting, prescription drug swallowing, binge drinking, and marijuana smoking. The prevalence of each drug assessed for inclusion in the model is depicted in appendix 1. Drugs not meeting inclusion criteria included: heroin smoke or snort; cocaine smoke, snort, or injection; simultaneous heroin & cocaine injection; simultaneous methamphetamine & cocaine injection; simultaneous methamphetamine & heroin injection; ketamine injection; oxycontin swallow, snort or injection; and prescription drug smoke, snort or injection.

We then examined models with between 2 and 5 classes. Fit statistics for each model are illustrated in Table 1. Smaller values of Akaike information criteria (AIC) and Bayesian information criteria (BIC) and higher values of entropy indicate better fit. A non-significant bootstrap likelihood-ratio test (LRT) *P*-value indicates that more classes does not improve

the analysis (Gibson, 1959; Hagenaars & McCutcheon, 2002; McCuthcheon, 1987). Thus, we selected a two-class solution based on the goodness-of-fit indices.

After selecting the best fitting model, we used logistic regression to assess factors associated with class membership. Bivariate analyses were first conducted to determine demographic, behavioral, or health status indicators associated with class membership. Factors associated with class membership at the $P < .20$ level in bivariate analyses were considered for inclusion into a logistic regression model, using a manual backward stepwise approach. Variables achieving significance at the $P < .05$ level were retained in the final model. Models were checked for meaningful interactions and none were found to be statistically significant. Variables that produced a 10% or greater change between the crude and adjusted odds ratios were considered confounders and were retained in the final model regardless of their significance. All analyses were performed using SAS PROC LCA (Lanza, Dziak, Huang, Wagner, & Collins, 2012).

RESULTS

Sample Description

The study included 511 PWID enrolled in the STAHR-II cohort between June 2013 and September 2013. The majority were white (51.5%), male (73.8%), and had a mean age of 43.5 years (range 18–70; SD = 11.7). Overall, HIV seroprevalance was 8.8% and HCV seroprevalence was 67.2%. Nearly half of the sample (42.1%) reported ever overdosing on heroin or another opioid in the past 6 months. Other socio-demographic characteristics, HIV risk behaviors, health services utilization, and health outcomes are displayed in Table 2.

Determination of Class Membership

Table 3 depicts the conditional probability that respondents in each class indicated weekly or more frequent heroin injecting, methamphetamine injecting, methamphetamine smoking, methamphetamine snorting, prescription drug swallowing, binge drinking, and marijuana smoking. Both classes were predominated by a single drug (heroin or methamphetamine), however, both groups reported polydrug use. Class 1, representing 51% of the sample, is characterized by methamphetamine use with multiple routes of administration. For class 1 the conditional probability of methamphetamine smoking, snorting, and injecting were 71.6%, 34.1%, 81.2%, respectively. Class 2, representing 49% of the sample, is characterized by heroin injection (conditional probability of heroin injection = 82.5%). Conditional probabilities for the use of prescription drugs and binge drinking were similar in both classes (15.3% vs. 18.8%, and 21.9% vs. 19.8%, respectively). However, class 1 members had a higher conditional probability of marijuana use (48.6% vs. 25.4%, respectively).

Bivariate Analysis of Factors Associated With Class Membership

Results of the bivariate logistic regressions comparing the odds of being in Class 2 (mostly heroin injection) vs. Class 1 (mostly multi-modal methamphetamine) are displayed in Table 2. Differences by class were observed for gender ($P = .19$), race/ethnicity ($P = .03$), and homelessness ($P \leq .001$). Individuals in both classes reported high-risk injection behaviors

(see Table 2); however, those in the heroin class reported fewer injection partners ($P = .01$), had lower odds of using synthetic drugs ($P = .05$), and lower odds of ever engaging in commercial sex ($P = .03$) than those in the methamphetamine class. Primarily heroin users were also more likely to consistently use condoms with casual partners ($P = .05$), have lower odds of hospitalization in the past 6 months ($P = .05$), and were more likely to have accessed drug treatment during their life ($P = .12$). Individuals in the primarily heroin using class were less likely to test HIV-positive ($P < .001$) or report STI history ($P < .001$), but were more likely to test HCV antibody-positive ($P < .001$) and overdose on heroin or other opioids ($P < .001$).

Multivariable Analysis of Factors Associated With Class Membership

In the final multivariable model (Table 4), each 10-year increase in age was associated with a decreased odds of membership in the primarily heroin class; (adjusted odds ratio [AOR] = 0.79, 95% CI = 0.65, 0.96). Compared to Whites, Hispanics, and Blacks had 1.84 (95% CI = 1.14, 3.01) and 3.23 (95% CI = 1.53, 6.84) times greater odds of belonging to the primarily heroin injecting class. Those who were homeless (AOR = 0.42, 95% CI = 0.27, 0.65), tested HIV-seropositive (AOR = 0.17, 95% CI = 0.07, 0.44), and reported previously being diagnosed with an STI (AOR = 0.59, 95% CI = 0.38, 0.91) had decreased odds of being primarily heroin injectors. Those who tested HCV-seropositive (AOR = 2.25, 95% CI = 1.37, 3.72) or overdosed on heroin or other opioids in their lifetime (AOR = 1.89, 95% CI = 1.23, 2.89) had greater odds of being primarily heroin injectors.

DISCUSSION

Composition of Drug Use Classes

This is the first study to our knowledge that used LCA to classify PWID in a drug market dominated by black tar heroin and methamphetamine and to identify individual factors associated with membership. We identified two distinct classes of drug use among PWID in San Diego, California; (1) primarily methamphetamine users with multiple routes of administration and (2) primarily heroin injectors. Membership in the primarily heroin injecting class was associated with being Black or Hispanic, HCV seropositive, and having ever experienced an opioid overdose. PWID in the multi-route methamphetamine class were more likely to be older, homeless, test HIV seropositive, report a previous STI diagnosis, and sharing injection paraphernalia.

Though the classes were characterized by use of single drugs, polydrug use within the previous 6 months was common in both classes. Generally, the prevalence of cocaine use was low; less than 16% of participants reported cocaine use at baseline and no single route of administration was greater than 5%. Further, polydrug use in this sample was dominated by sequential polydrug use characterized by the use of multiple substances over time. In fact, simultaneous drug use (i.e., “speedballs,” in which cocaine and heroin are mixed at the time of administration) was uncommon; no form of simultaneous use met the inclusion criteria for our LCA. As a result, the composition of our drug use classes among PWID is distinct from those found in other settings where cocaine use is more prevalent (Harrell, Mancha, Petras, Trenz, & Latimer, 2012; Kuramoto, Bohnert, & Latkin, 2011; Monga et al.,

2007). This finding supports our hypothesis that polydrug classes in San Diego's drug market can be characterized as different from those reported elsewhere (Garfein et al., 2004).

Prevalent Health Behaviors and Outcomes by Polydrug Classes

The two drug use classes were associated with different health consequences. PWID who tested HIV positive were significantly less likely to belong to class 2, the primarily heroin injecting class, which might be explained by the properties of black tar heroin. To inject black tar heroin, PWID may have to rinse previously used injection paraphernalia aggressively in order to remove contaminants that may clog syringes, and black tar heroin is typically heated to enhance drug solubility. These practices may reduce the likelihood of HIV infection by either decreasing the amount of blood remaining in syringes or simply killing the virus (Ciccarone, 2009; Ciccarone & Bourgois, 2003a). Conversely, HCV is less sensitive and has a much higher concentration in blood than HIV; thus, HCV may survive longer than HIV under similar conditions (Abdala, Reyes, Carney, & Heimer, 2000; Doerrbecker et al., 2013; Doerrbecker et al., 2011). In addition, we may be detecting a network effect in which the prevalence of HCV infection is higher among heroin users than methamphetamine users, so only those meth users who share with heroin users are likely to become infected with HCV (Garfein et al., 2012). Future studies that include social network data will help tease apart these potential influences on blood borne virus transmission.

Because heroin use is associated with decreased libido and sexual activity (Mirin, Meyer, Mendelson, & Ellingboe, 1980), it is possible that the heroin class experienced fewer sex-related HIV risks compared to methamphetamine. Studies suggest that sexual transmission is a significant contributor to HIV prevalence among PWID populations (Kral et al., 2001; Strathdee et al., 2001). The association between drug use and sexual risk behavior is known to be particularly important among men who have sex with men (MSM) (Colfax & Shoptaw, 2005). In this analysis, MSM comprise a slightly larger, but not statistically different, proportion of the methamphetamine class. Subsequent analysis will explore whether drug use classes and associated risk behaviors are similar when only MSM are included.

While our analysis identified two classes, one predominated by methamphetamine use and one predominated by heroin use, it is important to keep in mind that members of both classes reported using multiple substances. So, while those reporting lifetime overdose were more likely to belong to the primarily heroin group, nearly 1/3 of PWID in the methamphetamine group also reported lifetime opioid overdose. This finding suggests that overdose education and naloxone distribution programs should be offered to anyone reporting opioid use, even if opioids are not their primary drug of abuse (Sporer & Kral, 2007).

STUDY'S LIMITATIONS

Despite their strengths, our findings must be interpreted within the limitations of our data. First, we utilized cross-sectional data from the baseline interview of the STAHR-II study. Thus, we are unable to establish casual relationships between class membership and adverse health behaviors or health status. Furthermore, since class membership, risk behaviors and

health status may change over time, future analysis using longitudinal data to model whether class membership is stable and whether/how transitions between classes impact incident cases of infectious disease or experiences of overdose. We used a more conservative multistep approach for our LCA by running the indicators first and then adding the covariates/predictors after class membership had already been determined. Future studies might correct for the uncertainty around class membership by simultaneously estimating the classes with the covariates predicting the latent categorical variable (Vermunt, 2010). However, we believe our approach is more in line with applied research; we are classifying participants into groups for the latent categorical variable and then the groups are treated as discrete entities in the logistic regression analyses. To reduce potential bias associated with the probability of belonging to a particular polydrug class, only drugs with a prevalence of 15% weekly use or more were included in this analysis. We used this stringent criterion to reduce misclassification bias. However, that limits our findings to habitual or high frequency users. Individuals engaging in less frequent or binge behaviors may have different risk for infectious disease and may be missing from our sample. Further, there was overlap in drug use behaviors across classes. While the classes may not be perfectly delineated (entropy value of 0.77 indicates less than ideal classification quality), we believe when taken together, the two-class solution we present is well-suited for our data and within other published cut-offs (Ramaswamy, DeSarbo, Reibstein, & Robinson, 1993). Future work should measure overdose related to other drugs, especially methamphetamine given the high rate of use in this setting. Our reliance on used standard epidemiological recall-based survey methods may introduce bias into the data. Given the constantly evolving nature of drug use practices and related HIV risk behaviors assessment tools with greater specificity are needed to more fully understand the link between drug use, health behaviors, and health outcomes.

CONCLUSION

Identification of specific sub-populations of drug users has important implications for infectious disease and overdose prevention. This paper explored polydrug use among PWID in a drug market characterized predominately by black tar heroin and methamphetamine. In our analyses, class membership was associated with different socio-demographic and behavioral factors, as well as health outcomes. This information can help health educators and treatment providers tailor health promotion interventions for the specific risk behaviors relevant for each class. Treating each drug in isolation (i.e., entering each drug into a model separately) may fail to capture salient features of drug mixing that impact PWID's health outcomes. Future work will build on these analyses, assessing particular harm reduction needs (i.e., education, access to public health services, skills building activities to improve self-efficacy related to safe injection, condom use, or overdose prevention) in order to develop class-specific interventions.

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GLOSSARY

LCA	Latent class analysis
PWID	Persons who inject drugs

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Biographies

Dr. Roth, PhD, MPH, worked in a variety of community-based organizations prior to embarking on her graduate training. Across these positions, she worked to link individuals to sexually transmitted infection (STI) and HIV testing, medical care, and social services to decrease their likelihood of acquiring/transmitting communicable diseases. In September 2014, she joins the Department of Community Health and Prevention at Drexel University as Assistant Professor. In Philadelphia, she will utilize a community-engaged research approach to design and evaluate intervention studies for STIs, HIV, and drug abuse-related disparities.

Mr. Armenta, PhD(c), MPH, MA., is an epidemiologist who studies infectious disease transmission dynamics and novel methods in which persons who inject drugs distribute and inject drugs. His curent research interests include to understand emerging behaviors, how they affect disease incidence and prevalence and to develop intervention strategies to help curb the spread of disease.

Karla Wagner, Ph.D., is an Assistant Professor in the School of Community Health Sciences at the University of Nevada, Reno. She conducts mixed methods behavioral research that focuses on the prevention of negative health outcomes associated with injection drug use, especially HIV, viral hepatitis, and fatal overdose. She has worked with syringe exchange programs in New York and Los Angeles, and is involved in the development and evaluation of overdose prevention/naloxone distribution programs. Her current projects investigate the social network factors associated with HIV risk behavior among female sex workers and their drug-using male partners in Tijuana, Mexico. She earned a Master's degree in Anthropology from Northern Arizona University, and a Ph.D. in Preventive Medicine (Health Behavior Research) from the University of Southern California Keck School of Medicine.

Scott C. Roesch, Ph.D., is a professor of psychology at SDSU, where he teaches multivariate statistics at the graduate level. In addition to authoring over 100 publications, he is currently serving as an Associate Editor for *Implementation Science*, and has served as an Associate Editor for the journal of *Health Psychology*. His primary research interest is the application of novel statistical methodology (e.g., latent variable methods) to physical and mental health data.

Ricky N. Bluthenthal, Ph.D., is a Professor in the Department of Preventive Medicine and the Institute for Prevention Research at the Keck School of Medicine, University of Southern California. His current research interests include health disparities related to substance users, sexual minorities, and infectious diseases, such as HIV, hepatitis C virus,

and STIs. Current studies include research on injection initiation and prevention, family-based health promotion for Latino families, and racial and ethnic differences in HIV risk and substance use among gay men. He received his doctoral degree in sociology from the University of California, Berkeley in 1998.

Mrs. Cuevas-Mota, MPH, has almost 10 years of research experience ranging from Dating Violence, Tuberculosis (TB), Physical Activity, Smoking, HIV, Hepatitis C, Injection Drug Use among high risk populations in local and binational settings. She is fluently bilingual in English and Spanish and has experience in qualitative and quantitative data collection. Her current interests include continuing to work in benefit of underserved communities, to reduce health inequities and promote healthy communities in the U.S.-México border region.

Richard S. Garfein, PhD, MPH, is a Professor in the Division of Global Public Health, Department of Medicine at UCSD. His current research interests include identifying risk factors for and developing interventions to prevent infectious diseases associated with substance abuse. Dr. Garfein has recently expanded the scope of his research to include describing tuberculosis among vulnerable populations, evaluating molecular assays for rapid detection of drug resistant TB, and developing mobile phone based interventions for improving patient adherence to anti-TB treatment. His international research and consulting activities have included Mexico, Russia, Thailand, Taiwan, Okinawa, Puerto Rico, Malawi, Sierra Leone, and Kyrgyzstan.

APPENDIX

TABLE A1

Prevalence of weekly or more frequent drugs used by PWID in the San Diego STAHR-II Cohort, 6 months[a]

Variable	All subjects (*n* = 505)	Class 1 Methamphetamine, multi-routes of administration (*n* = 232)	Class 2 Heroin, primarily injection (*n* = 273)	*P*-value
Heroin smoke (*n* = 480)	46 (9.6%)	17 (7.5%)	29 (11.5%)	.18
Heroin snort (*n* = 463)	27 (5.8%)	8 (3.7%)	19 (7.7%)	.95
Heroin injection (*n* = 482)	269 (55.8%)	61 (26.5%)	208 (82.5%)	<.001
Cocaine smoke (*n* = 472)	17 (3.6%)	9 (4.1%)	8 (3.2%)	.51
Cocaine snort (*n* = 484)	9 (1.9%)	4 (1.8%)	5 (1.9%)	.20
Cocaine injection (*n* = 487)	20 (4.1%)	9 (3.9%)	11 (4.2%)	.76
Methamphetamine smoke (*n* = 480)	194 (40.4%)	167 (73.9%)	27 (10.6%)	<.001
Methamphetamine snort (*n* = 457)	78 (17.1%)	76 (34.4%)	2 (0.8%)	<.001
Methamphetamine injection (*n* = 486)	193 (39.7%)	193 (85.0%)	0 (0.0%)	<.001
Simultaneous heroin & cocaine injection (*n* = 264)	27 (10.2%)	8 (8.3%)	19 (11.3%)	.77
Simultaneous methamphetamine & cocaine injection (*n* = 75)	3 (4.0%)	3 (6.0%)	0 (0.0%)	.19
Simultaneous methamphetamine & heroin injection (*n* = 459)	31 (6.8%)	28 (12.2%)	3 (1.3%)	<.001
Ketamine injection (*n* = 38)	2 (5.3%)	0 (0.0%)	2 (11.1%)	.15
Oxycontin swallow (*n* = 500)	22 (4.4%)	11 (4.7%)	11 (4.1%)	.47
Oxycontin snort (*n* = 438)	2 (0.5%)	2 (1.0%)	0 (0.0%)	.77
Oxycontin injection (*n* = 108)	5 (4.6%)	4 (7.8%)	1 (1.8%)	.91
Prescription drug swallow (*n* = 503)	86 (17.1%)	35 (15.1%)	51 (18.8%)	.46
Prescription drug smoke (*n* = 309)	1 (0.3%)	0 (0.0%)	1 (0.6%)	.20
Prescription drug snort (*n* = 346)	4 (1.2%)	2 (1.3%)	2 (1.1%)	.42
Prescription drug injection (*n* = 499)	6 (1.2%)	3 (1.3%)	3 (1.1%)	.56
Marijuana smoke (*n* = 456)	169 (37.1%)	104 (48.1%)	65 (27.1%)	<.001
Binge drink (*n* = 503)	107 (21.3%)	54 (23.4%)	53 (19.5%)	.03

[a]Route of administration was ascertained only when participants indicated use of a particular drug.

TABLE 1

Fit statistics of the latent class models among persons who inject drugs, San Diego, CA (n = 511)

Log likelihood	AIC	BIC	Entropy	Bootstrap LRT *P*-value*
2 class –1829.21	171.86	235.41	0.77	–
3 class –1810.80	151.04	248.50	0.71	.09
4 class –1802.62	150.69	282.02	0.71	.27
5 class –1795.74	152.92	318.14	0.69	.63

*Bootstrap LRT ran for 2,000 iterations.

Subst Use Misuse. Author manuscript; available in PMC 2015 March 11.

TABLE 2

Bivariate analysis of drug use class by socio-demographic characteristics, HIV risk behaviors, health services utilization, and health outcomes among persons who inject drugs, San Diego, CA

	All subjects (*N* = 505) N (%)	Class 1 Methamphetamine, Multi-routes of administration (*N* = 232) N (%)	Class 2 Heroin, Primarily injection (*N* = 273) N (%)	Odds Ratio**	95% Confidence interval	*P*-value
Socio-demographic characteristics						
Male (*n* = 504)	372 (73.8%)	177 (76.6%)	195 (71.4%)	**0.76**	**0.51,1.14**	**0.19**
Mean age (SD)	43.5 (11.73)	43.78 (10.7)	43.17 (12.6)	1.00	0.99, 1.02	0.56
Race/Ethnicity						
White	260 (51.5%)	137 (59.1%)	123 (45.1%)	—	—	—
Hispanic	151 (29.9%)	55 (23.7%)	96 (35.2%)	**1.94**	**1.29,2.93**	**<0.01**
Black	46 (9.1%)	16 (6.9%)	30 (11.0%)	**2.09**	**1.09,4.02**	**0.03**
Other	48 (9.5%)	24 (10.3%)	24 (8.8%)	1.14	0.60, 2.06	0.73
Educational Attainment						
<High School	173 (34.3%)	82 (35.3%)	91 (33.3%)	—	—	—
High school or equivalent	148 (29.3%)	66 (28.4%)	82 (30.0%)	1.12	0.72, 1.74	0.61
>High School	184 (36.4%)	84 (36.2%)	100 (36.6%)	1.07	0.71, 1.63	0.74
Income < $10,000 (n = 503)	348 (69.2%)	156 (67.5%)	192 (70.6%)	1.15	0.79, 1.70	0.46
Homeless, past 6 months	316 (62.6%)	165 (71.1%)	151 (55.3%)	**0.50**	**0.35,0.73**	**<0.001**
Mean years injecting drugs (SD)	21.18 (13.43)	20.56 (12.94)	21.70 (13.84)	1.01	0.99, 1.02	0.34
Ever used synthetic drugs (*n* = 503)	160 (31.8%)	84 (36.2%)	76 (28.0%)	**0.69**	**0.47,1.00**	**0.05**
HIV risk behaviors						
Ever injected drugs in Mexico (*n* = 463)	180 (38.9%)	77 (35.8%)	103 (41.5%)	**1.27**	**0.87,1.85**	**0.20**
Shared injection paraphernalia, past 6 months (*n* = 478)	346 (72.4%)	156 (70.3%)	190 (74.2%)	0.82	0.55, 1.23	0.33
Shared syringe past 6 months	251 (59.8%)	114 (56.2%)	137 (63.1%)	**1.34**	**0.90,1.98**	**0.15**
Used a syringe to divide drugs, past 6 months	238 (64.9%)	112 (64.0%)	126 (65.6%)	1.07	0.70, 1.65	0.74
No. of injection partners, past 6 months (*n* = 502)						
Mean (sd)	2.18 (2.48)	2.50 (2.90)	1.91 (2.03)	**0.90**	**0.82,0.98**	**0.01**
Median	2.00	2.00	1.00			
IQR	1.00	2.00	1.00			

	All subjects (*N* = 505) N (%)	Class 1 Methamphetamine, Multi-routes of administration (*N* = 232) N (%)	Class 2 Heroin, Primarily injection (*N* = 273) N (%)	Odds Ratio**	95% Confidence interval	*P*-value
No. of casual partners, past 6 months (*n* = 500)						
Mean (sd)	5.16 (18.15)	5.53 (16.38)	4.84 (19.56)	1.0	0.99, 1.01	0.67
Median	0.00	1.00	0.00			
IQR	2.00	3.00	1.00			
Consistent condom use with casual partners, past 6 months (*n* = 196)	39 (19.9%)	18 (15.3%)	21 (26.9%)	**2.05**	**1.01**,**4.16**	**0.05**
Ever exchanged sex for drugs or money (*n* = 501)	151 (30.1%)	80 (34.9%)	71 (26.1%)	**0.66**	**0.45**,**0.97**	**0.03**
Health services utilization						
Used syringe exchange program, past 6 months	197 (39.0%)	93 (40.1%)	104 (38.1%)	0.92	0.64, 1.32	0.65
≥1 Hospitalization, past 6 months (*n* = 502)	51 (22.2%)	42 (15.4%)	93 (18.5%)	**0.64**	**0.41**,**1.01**	**0.05**
≥1 Emergency Room visit, past 6 months (*n* = 502)	82 (35.7%)	86 (31.6%)	168 (33.5%)	0.84	0.57, 1.21	0.34
Lifetime drug treatment (n = 503)	396 (78.7%)	174 (75.7%)	222 (81.3%)	**1.40**	**0.91**,**2.15**	**0.12**
Health outcomes						
HIV Seropositive (*n* = 464)	41 (8.8%)	35 (16.5%)	6 (2.4%)	**0.12**	**0.05**, **0.30**	<**0.001**
Hepatitis C virus Seropositive (*n* = 464)	312 (67.2%)	125 (59.0%)	187 (74.2%)	**2.00**	**1.35**, **2.97**	<**0.001**
Ever diagnosed with STI (self-report)(*n* = 501)	206 (41.1%)	117 (50.9%)	89 (32.8%)	**0.47**	**0.33**, **0.68**	<**0.001**
Ever overdosed† (*n* = 504)	212 (42.1%)	74 (32.0%)	138 (50.5%)	**2.17**	**1.51**, **3.12**	<**0.001**
No. of lifetime overdoses† (*n* = 504)						
Mean (sd)	2.22 (6.51)	1.87 (7.32)	2.52 (5.74)	1.02	0.10, 1.05	0.28
Median	0.00	.00	1.00			

*Referent group = Class 1

‡For males only.

†Overdosed on heroin, morphine, methadone, or oxycontin.

TABLE 3

Latent class marginal and conditional probabilities for drug usage[†] among persons who inject drugs, San Diego, CA (n = 511)

Variable[*]	Class 1 51% (SE = 0.03)	Class 2 49% (SE = 0.03)
Mean posterior probabilities (SD)	0.96 (0.09)	0.91 (0.13)
Heroin injecting	28.8%	82.5%
Methamphetamine smoking	71.6%	10.8%
Methamphetamine snorting	34.1%	1.1%
Methamphetamine injecting	81.2%	0.7%
Prescription drug swallowing	15.3%	18.8%
Binge drinking (≥5 drinks in one sitting)	21.9%	19.8%
Marijuana smoking	48.6%	25.4%

[*] All drugs included in the latent class analysis (LCA) were 15% prevalent in the last 6-months. Variables were dichotomized (weekly or more frequent use vs. less frequent) for LCA.

[†] Drugs with less than 15% prevalence in the last 6 months did not meet the inclusion criteria for the LCA. All rates of use by class are displayed in Appendix 1.

TABLE 4

Multivariable analysis of factors associated with class membership among persons who inject drugs, San Diego, CA (n = 431)

	Adjusted odds ratio*	95% Confidence interval	*P*-value
Race/Ethnicity			<.**01**
White	–	–	
Black	3.23	1.53, 6.84	
Hispanic	1.84	1.14, 3.01	
Other	1.29	0.66, 2.55	
Hepatitis C Virus Seropositive	2.25	1.37, 3.72	<.**01**
Ever overdosed†	1.89	1.23, 2.89	<.**001**
Age (per 10 year increase)	0.79	0.65, 0.96	.**01**
Ever diagnosed with STI (self-report)	0.59	0.38, 0.91	.**02**
Homeless, past 6 months	0.42	0.27, 0.65	<.**001**
Tested HIV Seropositive	0.17	0.07, 0.44	<.**001**

*Referent group = Class 1, primarily methamphetamine users with multi-routes of administration. Class 2, primarily heroin injectors.

†Overdosed on heroin, morphine, methadone, or oxycontin.