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Rural and urban comparisons of polysubstance use profiles and associated injection behaviors among people who inject drugs in Puerto Rico

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Abstract

Introduction—In contrast to urban populations, little is known about polysubstance use among rural people who inject drugs (PWID), particularly in Puerto Rico where injection drug use and related health consequences are prevalent. The aim of the study is to compare injection and non-injection substance use profiles among separate urban and rural samples of Puerto Rican PWID.

Material and Methods—Data for the urban sample come from 455 PWID who participated in the CDC's National HIV Behavioral Surveillance survey of injection drug use in San Juan. The data for the rural sample come from 315 PWID residing in four rural cities approximately 40-miles from San Juan. Latent class analysis was used to derive separate urban and rural profiles of weekly injection and non-injection substance use. Injection behaviors were examined as possible correlates of latent class membership.

Results—Five latent classes were identified in the urban sample, and three latent classes were identified in the rural sample. Classes were similar across samples; however, key differences emerged. Both samples had classes of primary heroin injectors, primary speedball injectors, and cocaine-heroin injectors. The urban sample had one high polysubstance class. Polysubstance use profiles that shared similar characteristics between samples also shared similar injection patterns, with some variation.

Discussion—Variations in substance patterns and associated health risks are likely shaped by social and geographic boundaries.

Conclusions—Understanding variations in substance use patterns across rural and urban locales may improve surveillance efforts and tailor desistance and harm reduction efforts at the state and local levels.

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Keywords

Polysubstance use; rural; injection drugs; Hispanic; latent class analysis

1. Introduction

Patterns of substance use and related health risks differ considerably across substances and geographic locations (Colon et al., 2001; Deren et al., 2003). This is particularly evident among Puerto Ricans, who despite lower overall rates of lifetime illicit substance use (Canino, 2007), display higher rates of substance use-related health consequences such as HIV and hepatitis C (HCV; Mino et al., 2011). Comparative research in the San Juan metropolitan area and New York City shows that people who inject drugs (PWID) in San Juan use injection drugs more often and engage in riskier injection behaviors compared to Puerto Ricans on the mainland (Colon et al., 2001). Within Puerto Rico, internal differences in use patterns, overdose risk, and service need—especially urban/rural differences—are not well known, while the growth in injection opioid use in rural communities elsewhere in the U.S. suggests a need for research in rural areas (Dombrowski et al., 2016). This study uses latent class analysis (LCA) to examine weekly injection and non-injection polysubstance use profiles across comparable rural and urban samples of active PWID in Puerto Rico to determine how and when rural and urban substance use and injection risk differ.

Polysubstance use is understood as the consumption of two or more substances during a specified time period, including simultaneous use of multiple substances in a single occasion or concurrent use of multiple substances on separate occasions within a short period of time (Ives and Ghelani, 2006). In general, polysubstance use among PWID has been associated with distinct physical and mental health comorbidities (Betts et al., 2016; Patra et al., 2009), increased injection and sexual risk behaviors (Harrell et al., 2012; Meacham et al., 2015), and poorer treatment outcomes (Dutra et al., 2008). These factors may explain higher risks of overdose and HIV and HCV infection among polysubstance using PWID when compared to PWID who use a limited range of substances (Harrell et al., 2012; Keen et al., 2014).

Simultaneous use of heroin and cocaine (i.e., speedball) is highly prevalent among Puerto Rican PWID (Colon et al., 2001). Compared to U.S. born Hispanics, Puerto Rican born Hispanics are more likely to use injection heroin and speedball and less likely to inject amphetamines (Freeman et al., 1999). Compared to Puerto Rican PWID in New York City, those in San Juan are more likely to use injection heroin, cocaine, and speedball and less likely to use non-injection substances such marijuana, alcohol, and non-injectable heroin and cocaine (Colon et al., 2001). Despite these findings, surprisingly little is known about *concurrent* polysubstance use profiles among Puerto Rican PWID. Qualitative research in urban Puerto Rico suggests that marijuana, alcohol, and benzodiazepines are often used simultaneously with injection heroin and/or cocaine to enhance or attenuate the effects (Finlinson et al., 2006; Porter, 1999), but rigorous statistical treatments are few.

Understanding distinct classes of polysubstance use has important implications for those situations where select patterns of substance use and routes of administration are associated with distinct health consequences (Harrell et al., 2012). Polysubstance use among Puerto

Rican PWID has been associated with increased injection risk behavior compared to use of primarily one injection substance (Hautala et al., 2017). Others suggest that the use of alcohol with injection drugs also increases injection risk behavior (Matos et al., 2004; Welch-Lazoritz et al., 2017). Despite suspected risks, the association between various substance use combinations and injection risk behaviors among PWID is not well understood, particularly in Puerto Rico, and particularly for rural users. Prior research among rural non-Hispanic populations in the U.S. suggests important differences in types of substances used (Gfroerer et al., 2007), patterns and emergence of substance use disorders (Brooks et al., 2017), and routes of administration (Young et al., 2010). Because rural communities in Puerto Rico have limited access to safe injection resources compared to their counterparts in urban San Juan (Des Jarlais et al., 2013; Welch-Lazoritz et al., 2017), the association between substance use patterns and injection-related behavior may vary considerably across rural and urban distinctions, with important implications for tailoring treatment and harm reduction services.

To address these gaps in the literature, the first aim of this study is to use LCA to compare weekly polysubstance use profiles within and between separate rural and urban samples of active PWID in Puerto Rico. LCA is a statistical method which aims to identify latent subgroups of individuals who share similar profiles on a set of observed variables (Collins and Lanza, 2013), and has recently been used to characterize polysubstance use among PWID outside of Puerto Rico (Betts et al., 2016; Hopfer et al., 2014; Meacham et al., 2015; Roth et al., 2015). LCA, however, has not been used previously to compare urban and rural PWID. Thus, the second aim of this study is to examine injection related outcomes associated with polysubstance use within and between comparable urban and rural samples. Understanding these differences may help improve surveillance efforts and tailor cost-effective interventions.

2. Material and Methods

2.1 Sample

The urban sample consists of the 455 PWID residing in the San Juan metropolitan area who participated in the CDC's National HIV Behavioral Surveillance (NHBS) survey of injection drug use (IDU) Round 3 in 2012 (Centers for Disease Control and Prevention, 2012). The rural sample consists of 315 PWID residing in four rural towns in central Puerto Rico, about 40-miles from San Juan. Interviews were completed between April-June 2015. The sampling technique and questionnaire for the rural sample were adapted from the CDC NHBS IDU 3 study to generate a comparison to the urban data. Persons were eligible if they injected drugs in the past 12 months and were age 18 years or older, able to complete the survey in either English or Spanish, and able to provide informed consent. Drug injection in the past 12 months was confirmed by observing physical evidence of recent injection (e.g., track marks) and by assessing knowledge of injection practices.

Recruitment for both samples was managed using respondent driven sampling (RDS; (Heckathorn, 1997; 2002). An initial set of respondents, referred to as “seeds” (13 seeds in urban sample; 8 seeds in rural sample—two in each town), were recruited and given three referral coupons that they could give to other PWID who had not previously participated in

the study. Eligible participants referred by the seeds comprise the first wave of the sample, and are given three referral coupons to recruit the next wave, and so on. In both studies, participants were compensated with $25 for the interview and $10 for each referral. Written, informed consent was obtained by all study participants in both samples. The study received IRB approval through the [removed for blind review] and [removed for blind review].

2.2 Measures

2.2.1 Substance Use—In trained interviewer administered questionnaires, respondents were asked about frequency of use on a wide array of injection and non-injection substances. Consistent with prior research (Harrell et al., 2012; Monga et al., 2007), we restricted the selection of both injection and non-injection drugs to those in which at least 20% of the sample reported using in the past month. Both samples resulted in the selection of the same seven substances. For injection drug use, heroin, cocaine, and speedball use were included. For non-injection drug use, binge drinking (five or more drinks on a single occasion for men and four or more drinks on a single occasion for women), marijuana, benzodiazepine, and crack cocaine use were included. Respondents were asked how often they used each substance in the past 12 months. Response options ranged from (0) never to (9) four or more times per day. To differentiate between habitual use rather than episodic use (Roth et al., 2015), we dichotomized each item into (0) less than weekly use and (1) weekly or more use.

2.2.2 Injection Behavior—Four injection-related variables were examined as potential correlates of latent class membership. Respondents were asked how many people they used a needle with after someone already injected with it in the past 12 months; how many people they used the same cooker, cotton, or water with after someone had already used it in the past 12 months; and, how many people they used drugs with that had been divided with a syringe that has already been used in the past 12 months (i.e., backloading). Because of heavy skew, response options for these three questions were dichotomized into (0) zero partners and (1) one or more partners. Respondents were also asked whether they had received new sterile needles for free, not including those given to them by a friend, relative, or sex partners in the past 12 months (e.g., from a needle exchange program). Response options were (0) no and (1) yes.

2.3 Analytic Strategy

LCA was used to examine profiles of polysubstance use for the urban and rural samples separately in Mplus version 7.4 (Muthen and Muthen, 1998-2016). Full-information maximum likelihood was used to account for missing data on the substance use indicators. LCA aims to uncover unobserved heterogeneity in the data which represents subgroups of individuals who share similar profiles on a set of observed characteristics. Because class enumeration must be inferred from the data, three information criteria measures (Akaike information criteria – AIC, Akaike, 1987; Bayesian information criteria—BIC, Schwarz, 1978; and the sample-adjusted BIC—A-BIC) and two likelihood ratio tests (Lo-Mendall-Rubin likelihood ratio test—LMR-LRT, Lo et al., 2001; and bootstrap likelihood ratio test—BLRT, McLachlan and Peel, 2000) were compared across successive models. Lower values on the information criteria suggest better model fit, and significant values on the likelihood ratio tests suggests that a k-class model fits the data better than a k-1 class model. Multiple

random start values were examined to ensure proper model identification, and the tenability of the local independence assumption was assessed by examining the standardized bivariate residuals (Magidson and Vermunt, 2011). Injection related behaviors were examined as possible outcomes of latent class membership using the *auxiliary (DCAT)* command in Mplus to examine probabilities of the four injection behavior variables across latent class groups. This approach takes into account latent class assignment uncertainty, and simulation studies suggest that this model-based approach produces less bias than the classify-and-analyze and pseudo-class draw methods (Lanza et al., 2013).

3. Results

3.1 Descriptive Statistics

Table 1 presents sample demographics, substance use prevalence, and injection-related behaviors. Both samples were comprised of similar demographic and injection profiles (e.g., mostly male, average age of early 40s, low educational attainment, mostly single), with the exception of past year homelessness, which was nearly twice as prevalent in the urban sample. Prevalence of non-injection substance use was similar across both samples for binge drinking; however, the rural sample had a slightly higher percentage of people who regularly used marijuana and benzodiazepines, and the urban sample had a slightly higher percentage of people who regularly use crack cocaine. Prevalence of weekly or greater injection drug use was similar across both samples for cocaine, heroin, and speedball. Additional demographic, substance use, injection risk, and RDS descriptive comparisons can be found in Thrash et al. (2017).

3.2 LCA Model Selection and Within Sample Description

For the rural sample, up to six classes were examined (see Table 2). The AIC and A-BIC values favored a four-class model. One of the classes, however, contained only five individuals and was not considered. When two- and three-class solutions were considered, the AIC and A-BIC values were lowest in the three-class model, and the BLRT further suggested that a three-class model fits the data better than the two-class model. As a result, a three-class model was selected for the rural sample with high class separation and classification accuracy (entropy = .73; average posterior probability range = .77 - .90).

Table 3 presents the unconditional and conditional class probabilities for each substance. The first class (Rural Class 1: 7%) had high probabilities of weekly heroin injection and moderate probabilities of binge drinking, marijuana, and benzodiazepine use. Probabilities on all other substances were low. The second class (Rural Class 2: 26%) had high probabilities of weekly cocaine, heroin, and speedball injection, and moderate probabilities of weekly marijuana and benzodiazepine use. Probabilities on all other substances were low. The third group (Rural Class 3: 67%) had high probabilities of weekly speedball injection, and low probabilities of using all other substances.

For the urban sample, up to six classes were examined (see Table 2). The AIC and A-BIC values were lowest in the five-class model. The BLRT further provided support that a five-class solution fits the data better than a four-class solution. The five-class solution had high

class separation and classification accuracy (entropy = .78; average posterior probability range = .77 - .94).

Table 3 presents the unconditional and conditional class probabilities for use of each substance in the urban sample. The first class (Urban Class 1: 6%) had high probabilities of weekly use on all seven substances examined. The second class (Urban Class 2: 10%) had high probabilities of weekly speedball injection and marijuana use, and moderate probabilities of weekly binge drinking and benzodiazepine use. The third class (Urban Class 3: 42%) had high probabilities of weekly speedball use and low probabilities on all other substances. The fourth class (Urban Class 4: 21%) had high probabilities of weekly cocaine, heroin, and speedball injection, and moderate probabilities of weekly binge drinking. Probabilities of all other substances were low. The fifth class (Urban Class 5: 21%) had high probabilities of weekly heroin use and low probabilities of other substance use.

3.3 Between Sample Comparisons of Polysubstance Use Profiles

Plots of conditional probabilities were grouped together based on key similarities across both samples to provide between-sample polysubstance use comparisons (see Figure 1). In both samples, each class was primarily characterized by the type of injection drug. The largest classes in both samples (Rural Class 3 and Urban Class 3) were characterized by regular speedball injection and low probabilities on all other substances examined. A somewhat similar group in the urban sample (Urban Class 2) was distinguished by moderate probabilities of weekly binge drinking and benzodiazepine use, and a high probability of weekly marijuana use (similar to Rural Class 1). In addition to the primary speedball injector classes, both samples revealed classes of respondents who were primarily heroin injectors (Rural Class 1 and Urban Class 5; see bottom left portion of Figure 1). The rural class, however, was smaller in proportion and had moderate probabilities of weekly marijuana and benzodiazepine use compared to the urban class. Both samples also had at least one group that had high probabilities of weekly cocaine, heroin, and speedball injection (Rural Class 2 and Urban Class 4). The urban sample revealed one unique class (Urban Class 1) comprised of respondents with relatively high probabilities of weekly use on all substances examined. This class shared similar injection patterns with Rural Class 2 and Urban Class 4, and shared similar non-injection patterns with Urban Class 2. However, this is the only class across either sample with high probabilities of weekly crack cocaine use.

3.4 Within Sample Injection Profiles across LCA Subgroups

Table 4 displays the injection risk profiles within the LCA subgroups. For the rural sample, probabilities for shared syringe use and shared cooking equipment were significantly lower in the Rural Class 1 (heroin injectors) compared to the other two rural classes. Conversely, Rural Class 1 (heroin injectors) was significantly less likely to obtain sterile needles from a service agency than rural class 2 (cocaine and heroin injectors), but not Rural Class 3 (speedball injectors). Backloading was not a significant correlate of polysubstance use patterns in the rural sample.

In the urban sample, Urban Class 1 (high injection and non-injection polysubstance use) had significantly higher probabilities of shared syringe use, shared cooking equipment, and

backloading than the other urban polysubstance use classes. For shared syringe use, Urban Class 4 (cocaine and heroin injectors) had significantly higher probabilities than Urban Classes 3 (speedball injectors) and 5 (heroin injectors). No other contrasts were significant. For shared cooking equipment, Urban Class 2 (speedball injectors) had higher probabilities than Urban Classes 3 (speedball injectors) and 5 (heroin injectors), but not Urban Class 4 (cocaine and heroin injectors). Urban Class 5 (heroin injectors) had significantly lower probability than Urban Class 4 (cocaine and heroin injectors). No other contrasts were significant. For backloading, Urban Classes 2 (speedball injectors) and 4 (cocaine and heroin injectors) had higher probabilities than UrbanClass 5 (heroin injectors). In addition, Urban Class 4 (cocaine and heroin injectors) had higher probabilities of backloading than Urban Class 3 (speedball injectors). No other contrasts were significant. There were no significant differences for obtaining sterile needles from a service agency such as a needle exchange program.

3.5 Between Sample Comparisons of Injection Risk Profiles

Because they share common metrics, probabilities of shared syringe use, cooker use, backloading, and obtaining sterile needles from a service agency were plotted across latent classes that share similar polysubstance use profiles to allow cross-class comparisons of associated risk behaviors (see Figure 2). Here we see that similar polysubstance use latent classes across the rural/urban samples also share similar injection risk patterns. For the three classes of primarily speedball injectors (Rural Class 3, Urban Class 2, and Urban Class 3), risk patterns look relatively similar, with the slight exception of the class characterized by moderate non-injection polysubstance use (Urban Class 2) which had higher probabilities of shared cooker equipment use and backloading. For the heroin injector classes (Rural Class 1 and Urban Class 5), probabilities were also quite similar except for obtaining sterile needles, which was higher in the urban sample. For the cocaine and heroin injector classes (Rural Class 2 and Urban Class 4), risk behavior probabilities were again nearly identical. Lastly, for the high injection and non-injection polysubstance use class (Urban Class 1), the probabilities of all four outcomes are among the highest compared to all the other classes.

4. Discussion

The first aim of the study was to compare weekly polysubstance use profiles within and between separate rural and urban samples of PWID in Puerto Rico. A three-class solution was identified in the rural sample, and a five-class solution was identified in the urban sample, patterns similar to those found in prior LCA research with PWID (Betts et al., 2016; Harrell et al., 2012; Kuramoto et al., 2011; Meacham et al., 2015; Monga et al., 2007; Roy et al., 2013; Trenz et al., 2013). These patterns across diverse populations of PWID suggests that polysubstance use is normative (rather than restricted to a small subset) within the PWID population—and may reflect a common liability for polysubstance use among heavy substance users everywhere (Vanyukov et al., 2003). However, economic, political, and geographic structures are also known to generate differences in use patterns and related injection risks across locales (Singer, 1999).

Our results show important similarities and differences in polysubstance use between distinct urban and rural areas—supporting both normative and spatial-cultural arguments. We feel this is true despite the fact that the rural sample was comprised of PWID residing 40 miles outside of San Juan. The mountainous terrain and low mobility of rural users produced considerable geographic isolation, implying that similarities in polysubstance use profiles may not be reduced to a function of close proximity or overlapping drug markets. The urban sample had a more diverse array of polysubstance use profiles, whereas nearly all of the rural sample fit into two classes. Potential sources for this difference include greater demographic and cultural homogeneity in rural communities (Brooks et al., 2017), and rural social networks that tend to be more dense, family-centered, and interdependent compared to urban communities (Dew et al., 2007).

The second aim of this study was to examine injection related outcomes associated with polysubstance use profiles. Importantly, we found widespread evidence that similar polysubstance use classes across the samples shared similar injection risk profiles. Within samples, however, we found that latent classes with a higher number of substance use combinations have higher probabilities of risky injection behavior than classes characterized by fewer substances. The rural and urban classes characterized by primarily heroin injectors had the lowest probability of risky injection behavior, echoing results from PWID in Baltimore (Kuramoto et al., 2011) and San Diego (Roth et al., 2015). Conversely, the urban class that was characterized by high injection and non-injection polysubstance use had the highest probabilities of risky injection behavior, findings supportive of research among various samples of PWID (Harrell et al., 2012). The other latent classes with evidence of polysubstance use (cocaine and heroin injectors, speedball injectors) had moderate probabilities of risky injection behavior, higher than heroin injectors but lower than the class containing high polysubstance use. The association between moderate and high polysubstance use with risky behaviors is likely related to frequent injection speedball use, which has been associated with increased injection frequency (Colon et al., 2001b) and joint drug purchasing in Puerto Rico (Colón et al., 2001a). Ethnographic reports from Puerto Rico suggest that PWID who pool money to purchase heroin and cocaine to prepare speedballs are likely to use a single needle to divide the mixture into smaller quantities (e.g., backloading; Abadie et al., 2016).

Understanding differences between urban and rural use patterns and associated injection behaviors is important when seeking to counter overdose risk. Despite similarities in polysubstance use and injection risk profiles across the rural and urban samples, small to moderate differences in polysubstance use patterns can have important implications for overdose prevention. Where injection use of heroin (alone or in combination with cocaine) is common, the risk for opioid overdose increases with co-use of other substances, especially central nervous system depressants such as alcohol and benzodiazepines (Darke, 2014). Based on our results, approximately one third of respondents in both samples are at high risk for overdose because of regular use of some form of injection heroin along with moderate alcohol and/or benzodiazepine use (Rural Classes 1 and 2, and Urban Classes 1, 2, and 4).

In both samples, the largest group was characterized by weekly use of injection speedball and low probabilities of other substance use (Rural Class 3 and Urban Class 3). This too

represents unique overdose risks. Injection speedball use has been shown to moderately increase the odds of overdose death, perhaps because it is associated with increased injection quantity and frequency (Colon et al., 2001) and treatment noncompliance (Merraro et al., 2005), both of which are conducive to overdose risk (Darke, 2014). The only class across both samples with low potential overdose risk compared to other profiles is Urban Class 5, defined by high probabilities of weekly or greater injection heroin use and low probabilities on all other substances examined. Primarily heroin injector classes in both samples have the longest injection duration averages (results available upon request), and stable use patterns that likely increase tolerance which may provide a slight protective effect against overdose risk (Galea et al., 2006).

Although the risk for overdose is high in both samples, the lack of treatment and harm reduction services in rural Puerto Rico likely creates structural barriers that increase odds for overdose and other health risks in those areas (Des Jarlais et al., 2013). Indeed, a key difference to emerge across the rural and urban samples was obtaining sterile needles from a service agency. This was far more common in the urban sample, and not surprising, recent research shows that urban Puerto Rican PWID are more likely to access needle exchange programs than their rural counterparts (Welch-Lazoritz et al., 2017).

Addressing substantial unmet substance use and HIV treatment needs in Puerto Rico, with a particular focus on rural outreach, can reduce health risks conducive to mortality among Puerto Rican PWID. Different strategies may be required to address different drug use patterns, however. The results shown here argue for overdose prevention strategies that go beyond one-size-fits-all naloxone distribution. Use patterns and the specific challenges of service delivery in rural areas require specific attention. On the positive side, fewer distinct use classes found in rural areas may simplify outreach and allow for more concentrated prevention efforts.

4.1 Limitations

Several limitations may affect the interpretation of the findings. First, the data are cross-sectional and temporal ordering cannot be established between polysubstance use profiles and injection correlates. Longitudinal data and/or qualitative research may give better insight into the potential developmental processes underlying polysubstance use across rural and urban communities. Second, the two samples may not be generalizable to all of Puerto Rico. Given their hard-to-reach nature, generating a representative sample of active PWID is difficult. RDS is a common sampling technique with known qualities, which improves upon convenience sampling techniques to give more accurate population estimates. Despite the strengths of RDS, the samples may not be generalizable to all PWID within the two areas sampled, or Puerto Rican PWID residing outside of the expansive San Juan metropolitan area.

5. Conclusions

Injection drug use and its consequences are highly prevalent in Puerto Rico (Mino et al., 2011). This study extends research on Puerto Rican PWID by examining latent subgroups of injection and non-injection substance use patterns across rural and urban distinctions.

Variations in substance use patterns across rural and urban communities suggests the need for more inclusive surveillance efforts, which can be used to understand various combinatorial patterns of substance use and related risks to adapt limited programming resources at the local, state, and national levels. The existence of unique polysubstance use classes and their distinct injection profiles support the general need for treatment modalities aimed at desistance and harm reduction to be tailored to particular patterns of substance use and population density.

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Highlights

- Polysubstance use profiles vary across rural and urban communities in Puerto Rico
- Some form of injection heroin was used by nearly all participants in both samples
- Similar polysubstance use profiles also share similar injection behavior correlates

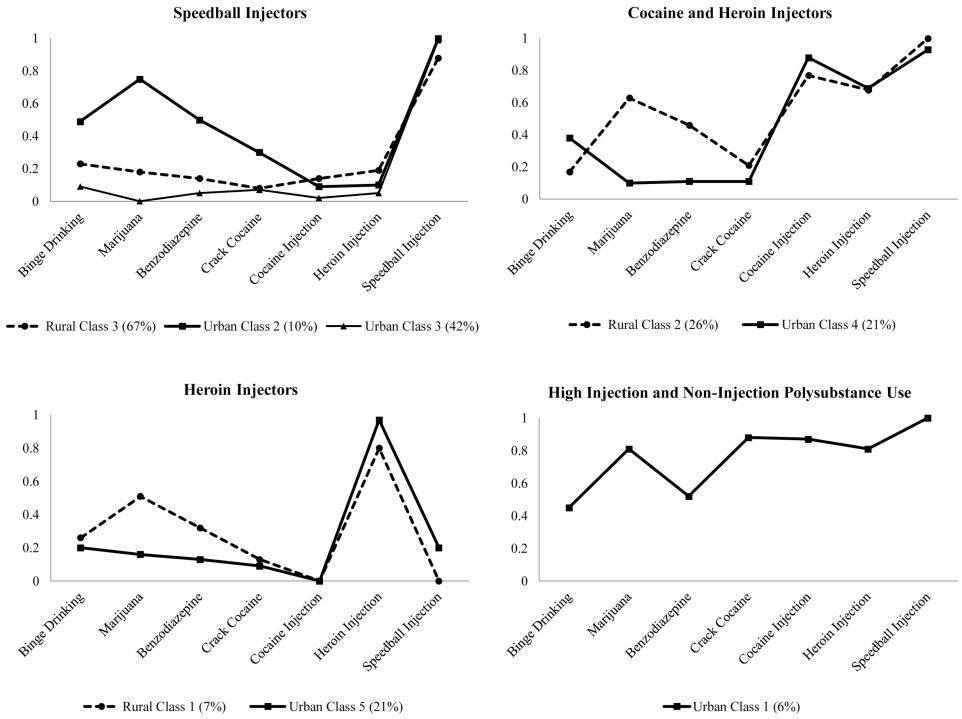

Figure 1.

Latent class analysis profiles of weekly non-injection (i.e., binge drinking, marijuana, benzodiazepine, and crack cocaine) and injection (i.e., cocaine, heroin, and speedball) substances grouped by similarities across rural (dashed lines) and urban (solid lines) samples. The Y-axis represents the probability of weekly or greater use of a particular substance within each class.

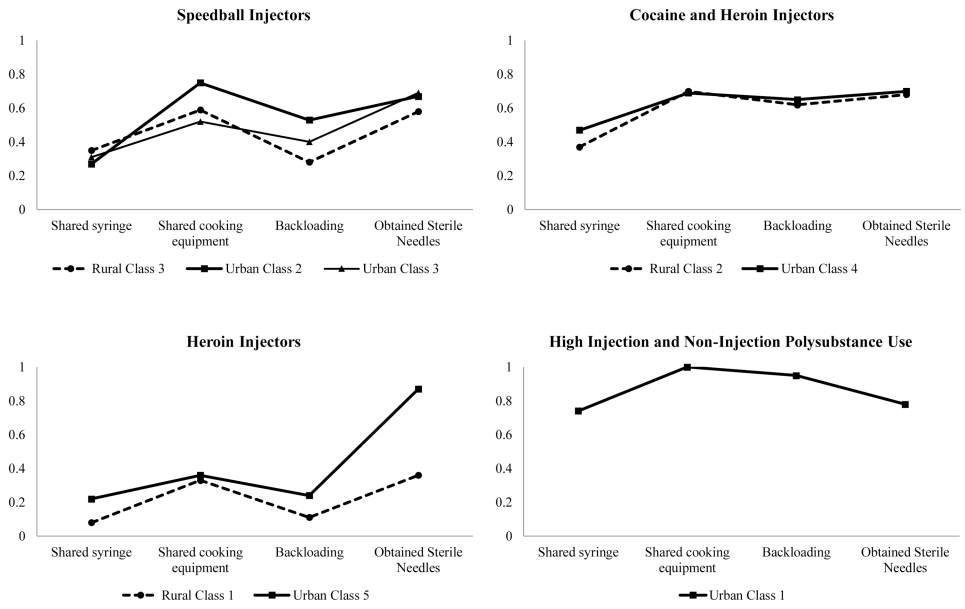

Figure 2.

Predicted probabilities of past year injection behavior grouped by similarities in latent substance use profiles across rural (dashed lines) and urban (solid lines) samples. The Y-axis represents the predicted probability of endorsing each item in the past 12 months.

Table 1
Descriptive Statistics across Rural and Urban Samples

	Rural (*N* = 315)	Urban (*N* = 455)
	% or Mean	% or Mean
Demographics:		
Age (Mean)	41.8	40.7
Male	90.8%	82.5%
Past Year Homelessness	38.5%	78.2%
Marital Status		
Single	47.0%	61.8%
Married/Cohabiting	22.2%	17.4%
Divorced/Separated/Widowed	30.8%	20.9%
≥ High School Diploma	47.6%	45.5%
Years injecting drugs (Mean)	19.9	20.1
Substance Use (Weekly vs. Less Than Weekly Use):		
Non-Injection:		
Binge Drinking	21.6%	24.6%
Marijuana	32.2%	19.8%
Benzodiazepine	23.2%	16.5%
Crack Cocaine	11.5%	16.3%
Injection:		
Cocaine	29.3%	26.4%
Heroin	35.6%	39.1%
Speedball	85.0%	90.3%
Injection Characteristics:		
Shared used syringe in past year	33.7%	37.2%
Shared used cooker, cotton, or water in past year	60.0%	60.6%
Backloading in past year	34.2%	50.0%
Obtained sterile needle from service agency in past year	58.7%	71.4%

Table 2

Latent Class Analysis Model Selection

	AIC	BIC	SA-BIC	LMR-LRT	BLRT	Entropy	LL
Rural Sample							
1	2347.93	2374.20	2352.00				-1166.97
2	2291.77	2348.06	2300.48	70.63*	72.17*	0.82	-1130.89
3	2285.37	2371.68	2298.73	21.92	22.40*	0.73	-1119.69
4	2278.97	2395.30	2296.98	21.92*	22.39*	0.79	-1108.49
5	2278.80	2425.15	2301.45	15.83	16.17	0.78	-1100.40
6	*unidentified*						
Urban Sample							
1	3205.10	3233.94	3211.72				-1595.55
2	3077.11	3138.92	3091.31	141.10*	143.99*	0.65	-1523.56
3	2994.02	3088.78	3015.79	97.11*	99.09*	0.75	-1474.01
4	2974.17	3101.90	3003.52	35.13*	35.85*	0.79	-1456.09
5	2962.33	3123.02	2999.25	27.29	27.84*	0.78	-1442.16
6	2963.36	3157.02	3007.85	14.67	14.97	0.87	-1434.68

* $p < .05$

Note: AIC – Akaike Information Criteria; BIC – Bayesian Information Criteria; SA-BIC – Sample Adjusted BIC; LMR-LRT – Lo-Mendell-Rubin Likelihood Ratio Test; BLRT – Bootstrap Likelihood Ratio Test; LL – Log Likelihood

Table 3

Latent Class Analysis Probabilities across Rural and Urban Samples

	Rural (N = 315)			Urban (N = 455)				
	Rural Class 1	*Rural Class 2*	*Rural Class 3*	*Urban Class 1*	*Urban Class 2*	*Urban Class 3*	*Urban Class 4*	*Urban Class 5*
Proportion:	.07	.26	.67	.06	.10	.42	.21	.21
Non-Injection:								
Binge Drinking	.26	.17	.23	.45	.49	.09	.38	.20
Marijuana	.51	.63	.18	.81	.75	.00	.10	.16
Benzodiazepine	.32	.46	.14	.52	.50	.05	.11	.13
Crack Cocaine	.13	.21	.08	.88	.30	.07	.11	.09
Injection:								
Cocaine	.00	.77	.14	.87	.09	.02	.88	.00
Heroin	.80	.68	.19	.81	.10	.05	.69	.97
Speedball	.00	1.00	.88	1.00	1.00	.99	.93	.20

Table 4

Within-Sample Injection Behavior Probabilities across Latent Classes

	Rural (N = 315)			Urban (N = 455)				
	Rural Class 1	***Rural Class 2***	***Rural Class 3***	***Urban Class 1***	***Urban Class 2***	***Urban Class 3***	***Urban Class 4***	***Urban Class 5***
Shared syringe $^{+}$	$.08_{a}$	$.37_{b}$	$.35_{b}$	$.74_{a}$	$.27_{bc}$	$.31_{b}$	$.47_{c}$	$.22_{b}$
Shared cooking equipment $^{+}$	$.33_{a}$	$.70_{b}$	$.59_{b}$	1.00_{a}	$.75_{b}$	$.52_{cd}$	$.69_{bc}$	$.36_{d}$
Backloading $^{\#}$	$.11_{a}$	$.62_{a}$	$.28_{a}$	$.95_{a}$	$.53_{bc}$	$.40_{bd}$	$.65_{c}$	$.24_{d}$
Obtained Sterile Needles *	$.36_{a}$	$.68_{b}$	$.58_{ab}$	$.78_{a}$	$.67_{a}$	$.69_{a}$	$.70_{a}$	$.87_{a}$

* significant in rural sample only

$^{\#}$ significant in urban sample only

$^{+}$ significant in both samples

Note: Probabilities or means within each sample that do not share a subscript are significantly different from one another ($p < .05$)