Injection-related risk behavior and engagement in outreach, intervention and prevention services across 20 U.S. cities

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Abstract

Background. Monitoring the effects of HIV prevention efforts on risk behaviors among persons who inject drugs (PWID) is key to informing prevention programs and policy.

Methods. Using data from the 2012 National HIV Behavioral Surveillance interviews with PWID across 20 U.S. cities (n = 10,171), we conducted latent class analysis (LCA) to identify injection risk classes and assess the relationship between engagement in prevention services and injection-related risk behavior. We conducted stratified analyses to examine the consistency of these associations across different geographical regions.

Results. The LCA identified six distinct classes of injection-related risk behavior. The class structure was consistent across regions of the U.S., but the distribution of risk classes varied significantly across regions. With covariate adjustment, the South had the most high-risk behavior (21%), and the Midwest had the least (6%). Participation in syringe access services and other prevention services was the lowest in the South. Syringe access was associated with a significantly lower likelihood of membership in the highest risk class in all regions except the Midwest. Participation in individual or group intervention with a practical skills component was associated with less risky injection behavior in all regions except the Northeast. Interventions that featured only safer injection information and discussion had no relationship with risk class.

Conclusions. Our findings support evidence of the effectiveness of syringe service programs and safer injection skills training in reducing high-risk injection behavior and underscores the need to improve access to these prevention interventions in the South of the U.S.

Key words: injection drug use, HIV risk behavior, HIV prevention

1. Introduction

Of the estimated 16 million persons who inject drugs (PWID) worldwide, 1.3 million reside in the United States (U.S.).[1] Injection drug use is a major risk factor for acquiring HIV and hepatitis C virus (HCV) infections through syringe and other paraphernalia sharing.[2] Although lifetime PWID comprise an estimated 2.6% of the U.S. population aged 13 years or older, they account for 22% of all persons living with HIV infection[3] and about 70% of the estimated 30,000 new HCV infections per year.[4,5] Prevention of these infections among PWID is critical to reduce ongoing transmission, morbidity, and mortality. Moreover, given the wide geographic variability in HIV[4] and HCV[6] in U.S. regions, it is imperative to identify groups at heightened risk and to inform targeted interventions. Specifically, the estimated number of HIV diagnoses attributed to injection drug use is highest in the South compared to other regions,[7] yet this region continues to have the highest numbers of people without health insurance and other social and policy factors that may limit access to much-needed health and prevention services.[8,9] Understanding regional differences in risk behaviors and access to prevention services among PWID is key to meeting the goals of the U.S. National HIV/AIDS Strategy[10] to strengthen HIV prevention efforts in communities where HIV is most heavily concentrated and to expand a combination of effective, evidence-based, and scalable approaches.

To effectively respond to HIV and HCV among PWID, a comprehensive, multi-level prevention strategy is needed that includes access to sterile injection equipment, substance use disorder treatment and medication-assisted treatment (MAT), HIV and HCV testing and counseling, and sexual and injection risk-reduction.[11,12] In addition, identifying specific sub-groups of PWID with distinct patterns of high-risk behaviors will inform targeting of HIV/HCV prevention interventions.

Latent class analysis (LCA) is a method for empirically identifying distinct patterns or subtypes, based on a set of observed categorical variables.[13,14] LCA has been applied in public health research to identify subgroups, or "classes," defined by distinct response patterns of risk behaviors. Further analysis can be conducted to identify correlates or predictors of these classes. LCA has been used to evaluate patterns of substance use,[15,16] sexual behavior,[17,18] injection risk behavior,[18,19] and other behaviors. In this study, we used LCA to identify distinct patterns of injection-related risk behavior in a large, multi-site sample of PWID, and to examine how participation in prevention and intervention programs was related to risk behavior. Additionally, we examined these relationships by geographic region due to regional differences in public health policy and the availability of prevention services.

2. Methods

2.1. Sampling Method

We used data from the 2012 National HIV Behavioral Surveillance (NHBS) surveys of PWID in 20 U.S. cities (n=10,171). Methods for NHBS among PWID are described in detail elsewhere.[20] Briefly, NHBS was conducted in 20 large U.S. cities within metropolitan statistical areas with >500,000 residents. NHBS was approved by institutional review boards at each of the participating sites. No personally identifying information was collected during enrollment, interview, or HIV testing.

Participants were recruited using respondent-driven sampling (RDS).[20,21] Eligible seeds (i.e., initial recruits identified during the formative research phase)[22] recruited up to five PWID to complete the survey, who in turn recruited others. Guidance for recruiting initial seeds was provided to all NHBS cities to ensure standardization. The recruitment process was tracked using a coded coupon system, and continued until the sample size was reached or the sampling period

ended. The RDS sampling period ranged between 2 and 5 months. Participants who agreed to recruit others received an incentive of $10 for each recruit who completed the interview. Persons were eligible to participate and recruit if they injected drugs in the past 12 months and were aged ≥18 years, current residents of the city, 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.

2.2. Data Collection

Trained interviewers obtained informed consent and conducted face-to-face interviews, which took approximately 40 minutes and consisted of questions about participants' demographic characteristics, HIV testing history, sexual and drug-use behaviors, and use of HIV prevention/intervention services and programs. All participants were offered an anonymous HIV test and, for those who consented, testing was performed by collecting blood or oral specimens for either rapid testing in the field or laboratory-based testing. A nonreactive rapid or laboratory-based screening test result was considered HIV-negative; a reactive test result was considered HIV-positive if confirmed by Western blot or indirect immunofluorescence assay. Incentive amounts were determined locally and were in line with similar study types and designs and commensurate with the amount of time required of participants. Participants received $20–$30 for the interview, and an additional $10–$25 for HIV testing.

2.3. Measures

2.3.1. Sociodemographic, Drug Use, Health Status, and Network Variables. Sociodemographic measures included region, gender, age, race/ethnicity, self-reported sexual orientation, and homelessness (past year and current). Other variables included self-reported HIV and HCV

status, types of drugs injected in the past 12 months, male-male sex, and participation in substance use treatment. Network size was assessed by asking how many people the participant knew that injected drugs and whom they had seen within the past 30 days.

2.3.2. Injection Risk Behaviors. Injection risk behaviors were measured using responses to five questions, including two questions about receptive syringe sharing and three questions about sharing of other equipment. Participants were asked “In the past 12 months, with how many people did you use a needle after they injected with it?” Responses were recoded into three categories: 0, 1, and >1. Frequency of receptive syringe sharing was assessed by asking, “In the past 12 months, how often did you use needles that someone else had already injected with?” Responses were on a 5-point Likert scale (never, rarely, about half the time, most of the time, always). Similar items measured the frequency of using shared cookers, cotton filters, and rinse water. Responses on these items were recoded into three categories: never, rarely, and about half the time or more.

2.3.3. Prevention and Intervention Participation. In two separate questions, participants were asked if they had obtained needles from a needle exchange program in the past 12 months, and if they had received free sterile needles from any source in the past 12 months. These items were combined to form a measure of participation in syringe access services. Participation in intervention programs was measured with the following questions: 1) “In the past 12 months, have you had a one-on-one conversation with an outreach worker, counselor, or prevention program worker about ways to prevent HIV? Don’t count the times when you had a conversation as part of an HIV test;” 2) “During those one-on-one conversation(s), did you: Discuss safe drug-injecting practices? Practice how to prepare for safe injections?” 3) “In the past 12 months, not including discussions with friends, have you been a participant in any organized session(s)

involving a small group of people to discuss ways to prevent HIV?" 4) "During these organized group session(s), did you: Discuss safe drug-injecting practices? Practice how to prepare for safe injections?" Based on these items, we created four variables as indicators of 1) individual didactic intervention (discussed safe injecting practices one-on-one), 2) individual practical skills intervention (practiced preparing for safe injection one-on-one), 3) group didactic intervention (discussed safe injecting practices in a group), 4) group practical skills intervention (practiced how to prepare for safe injections in a group). Practical skills interventions always included discussion.

2.4. Data Analysis

2.4.1: Regional Comparisons. We compared the proportions of respondents reporting prevention/intervention participation among regions by computing corrected chi-square statistics using -*svy*- command in Stata (v. 13).[23]

2.4.2: RDS Analysis. Weighting of RDS samples is used to adjust for oversampling of individuals with larger networks (i.e. higher probability of selection), and for differential recruitment.[24,25] We computed individualized (dual component) RDS weights[25] for the five dependent variables using the -*rds*- command in Stata.[26] The weights were highly correlated (r=0.99), and we used the average of the five weights as sampling weights in the latent class analysis described below.

2.4.3. Latent Class Analysis. We conducted a latent class analysis (LCA) in Mplus (version 7)[27] using the five measures of injection risk behavior, with complex sampling specifications including strata (20 MSAs), cluster (181 RDS chains), and sampling weights. LCA is a method for building a measurement model, similar in some ways to latent factor analysis, but the latent variable is categorical rather than continuous. The number of classes was decided based on

Bayes Information Criterion (BIC) and examination of bivariate residuals. Next, we tested whether the measurement model was equivalent (invariant) across regions. If the class structure varied across regions, then we would conduct analyses separately for those regions that differed. We tested measurement invariance by including direct effects of region dummy variables on latent class indicator variables,[28,29] setting all equal to zero, and requesting modification indices. The modification index is the expected change in chi-square if the parameter is not constrained to be zero. Considering the sample size and the number of parameters in the model (i.e. 10 thresholds per class), we set a significance cutoff of $p<0.001$ (corresponding chi-square value 10.83). For each modification index above the cutoff we tested the effect of freeing that parameter on the model fit with a Wald test, and inspected the item probabilities.

2.4.4. Latent Class Regression Models. After establishing the measurement model, we looked at correlates of latent class using latent class regression analyses, simultaneously estimating class membership and a multinomial logistic regression of the categorical latent variable on covariates (one-step analysis).[30,31] Covariates included in the first latent class regression model were demographics (region, age, gender, race/ethnicity), sexual orientation, male-male sex (for males only), homelessness, self-reported HIV and HCV infection status, injection network size, types of drugs injected in the past 12 months, and substance use treatment. Significant predictors ($p<0.05$) were retained in the model. Individuals who identified as transgender (n=51) were excluded in the final model as sexual behavior data (i.e. male-male sex) were not collected for this group. Next, in separate models adjusting for significant covariates identified in the first analysis, we examined 1) participation in syringe access services, and 2) participation in individual and group interventions with or without practical skills training. For each model we computed Wald tests for the overall multinomial effect, and then conducted a region-stratified

analysis and computed a Wald test of equality of coefficients to test whether associations were consistent across regions. Wald tests were computed on the effects of individual and group interventions separately and in combination. Covariate associations were held equal across regions in the stratified models.

3. Results

3.1. Sample. The distribution of the sample by region, demographic characteristics, and intervention participation is shown in Table 1. The South and Midwest samples were predominantly black and older (aged >50 years), while the Northeast and West samples included greater proportions of white and younger (<50 years) PWID. The San Juan sample included the greatest number of PWID under <50 years. The percentage of men reporting male-male sex in the Midwest sample was less than 6% compared to 16-25% in other mainland regions, and 34% in San Juan. The types of substances injected also varied considerably by region, with heroin dominating in the Midwest, speedball (i.e., heroin and cocaine injected together) in San Juan, and methamphetamine injection being rare except in the West. In addition, the median injection network size was smallest in the Midwest (15 persons), compared to other mainland regions (19-26 persons), and San Juan (50 persons).

Over half (57%) of participants reported getting needles from a syringe services program (SSP). SSP use varied significantly across region (corrected chi-square = 12.07, $p<0.001$); participants in the South were least likely to use a SSP. Intervention participation was similar across regions, with only slight variation in reported participation in practical skills interventions (corrected chi-square = 3.15, $p<0.05$). Overall, receptive syringe sharing was reported by 33% of participants, while larger proportions reported sharing cookers (55%), and cottons and rinse water (46%).

3.2. Latent Class Analysis. The sample for the latent class analysis included 10,170 PWID who completed the survey and responded to questions about injection risk behavior. (One person was excluded for missing data on all injection risk items.) The BIC indicated that a six class solution had the best fit. The test of measurement invariance across region found only one Wald test was significant (Wald = 17.60, $p<0.001$), therefore we concluded that the latent class structure was invariant across regions.

Table 2 reports on the risk behavior profiles of six classes identified in the analysis with 1 being the lowest risk class and 6 the highest risk class: **1) low risk** with very low probability of any risk behavior; **2) low equipmen**t with low frequency non-syringe equipment sharing; **3) high equipment** with high frequency non-syringe equipment sharing; **4) syringe** which includes low frequency syringe sharing with low probability of other equipment sharing; **5) moderate risk** syringe sharing with low frequency equipment sharing; and **6) high risk** syringe sharing with high frequency other equipment sharing. Figure 1 reports on adjusted regional prevalence estimates and shows that, after adjusting for age, gender, and race/ethnicity, the Midwest region had the lowest prevalence of high-risk behavior, while the highest prevalence was observed in the South.

3.3. Covariate Analysis. We now describe the results of multinomial regression analyses of risk class on selected variables; low-risk class (class 1) was used as the reference category in these models (see Table S1, online supplement). High-risk (class 6) injection behavior was less likely among black participants than non-Hispanic white participants and more likely among women, especially women who identified as bisexual. Also, those who were under 40 (vs. 50+), homeless in the past 12 months, or reported male-male sex but did not identify as gay had higher ($p < 0.01$) relative odds of high-risk behavior class. Speedball and methamphetamine injection, daily

injection, and larger network size also were associated with high-risk class membership. Participants who self-reported HIV infection were somewhat less likely to be in the high-risk class ($p = 0.016$), while those who reported HCV infection were more likely to be in one of the 3 classes that include syringe-sharing. Substance use disorder treatment had no significant association ($p>0.05$) with class membership and was dropped from the model. Membership in the syringe class was associated with methamphetamine injection and white race/ethnicity. In these adjusted models, participants in the South were more likely than those in other regions to belong to the high-risk class and the high equipment sharing class. Adjusted high-risk class odds for San Juan and the West and Midwest were not significantly different from those in the Northeast.

3.4. Syringe Service Program Participation. Table 3 reports the effects of SSP participation on the probability of injection risk class membership by region, with the Wald test of the overall multinomial effect, and odds ratios and 95% confidence intervals for each contrast. Overall, participants who reported SSP use had significantly lower odds of being in any syringe-sharing class (high-risk, moderate risk, or syringe) vs. low-risk class membership. However, the effect was not uniform across regions (test of equality of coefficients between regions, Wald[20]=33.86, $p=0.02$). The effect was significant in all regions except the Midwest, with high-risk vs. low-risk odds ratios ranging from 0.58 in the South to 0.32 in San Juan. Syringe program access did not have a consistent significant relationship with being in low or high equipment sharing classes vs. low-risk class membership, although the overall effect indicated higher odds of low equipment sharing ($p = 0.048$).

3.5. Intervention Participation. Across all regions, there was a significant effect of participating in individual interventions with skills training (Wald[5]=17.15, $p=0.004$, see Table S2, online

supplement). Individual skills training was associated with a significantly lower likelihood of high-risk class membership (vs. low-risk, OR=0.49, 95 CI 0.34-0.71). The overall effect of group intervention with skills training was not significant (Wald[5]=7.99, p=0.16), although it was associated with a lower likelihood of high equipment sharing behavior (vs. low-risk, OR=0.57, 95% CI 0.33-0.99). Interventions that included only information and discussion had no significant relationship with risk class membership.

Table 4 shows the effects of intervention participation on injection class membership by region. Again, the relationships were not uniform across regions (for individual skills-based intervention, Wald[20]=57.10, p<0.0001; for group intervention, Wald[19]=47.50, p=0.0003). Individual skills-based intervention showed significant effects in the Midwest, West, and San Juan, with exposed individuals having a relatively lower likelihood of high-risk compared to low-risk class membership. In the South, the overall test was not significant, although individual skills-based intervention was associated with lower odds of high-risk class membership. Group skills-based intervention showed significant effects in the West and San Juan. In the West region, group skills intervention participants had a relatively lower likelihood of high-risk or high equipment sharing class compared to low-risk membership. In San Juan, group skills intervention participation was associated with a greater likelihood of low-risk behavior compared to all other classes. The combined effect of individual and/or group skills-based intervention was significant in all regions except the Northeast.

4. Discussion

Latent class analysis identified six distinct classes of injection risk behavior among PWID. Adjusting for age, gender, and race/ethnicity, high-risk class membership was more prevalent in the South, while low-risk class was more prevalent in the Midwest region. Some of

the variance in risk class prevalence between regions was attributable to differences in population characteristics such as prevalence of male-male sex, type of drug injected, and network size. Some of the differences in proportions of high-risk and low-risk class membership between regions were lessened after adjusting for these additional variables. However, covariate adjustment only heightened the risk discrepancy between the South and other regions, indicating that elevated high-risk behavior in this region is not explained by these known factors. Moreover, use of SSPs (38%) was lowest in the South compared to other regions (52%-85%), indicating the need for more targeted interventions in this region. These findings are consistent with data reported from a survey of SSPs conducted in 2013,[32] and the legal status of needle exchange in these states.[9,33] As of 2012 there were no legal provisions for SSPs in Texas, Louisiana, Florida, or Georgia. Interventions in this region should also address the specific needs of the predominantly older, African American population who primarily inject heroin (Table 1). Minority PWID may be especially vulnerable where the legality of syringe possession is unclear or laws are enforced unequally.[33]

In multinomial regressions on latent class, SSP participation was significantly associated overall with lower odds of all syringe-sharing classes (high-risk, moderate-risk, and syringe only). Region-specific effects were significant for high-risk class membership in all except the Midwest region, where high-risk behavior was already least prevalent. There were no consistent significant associations between SSP participation and the probabilities of non-syringe equipment sharing classes. Sharing non-syringe equipment, such as cookers, has been previously shown to be an important risk factor for HCV transmission.[34-36] However, it is likely that PWID are less aware of the risks associated with non-syringe equipment sharing, and social norms against equipment sharing are less prevalent than those against syringe sharing.[37,38]

Interventions, particularly those directed toward reducing HCV transmission, should address the low adherence to harm reduction practices among these classes.

Participation in intervention programs that included a skills training component was also associated with less risky behavior in all regions except the Northeast. However, the effects in the South reached significance only when individual and group intervention effects were combined. Participation in interventions consisting of discussion only had no effect on risk class. In a similar vein, a meta-analysis of 37 randomized controlled trials[39] found that interventions were more likely to reduce injection drug use if they included an interpersonal skills training component for safer injection. However, another review and meta-analysis[40] found little evidence of any added benefit of multi-session psychosocial interventions compared to standard educational interventions for reducing injection risk behaviors. The lack of intervention effects in the Northeast and the relatively weak effects in the South compared to the strong effects in the West and in San Juan warrant further investigation. In addition, research is needed on whether interventions are effective with high-risk versus low-risk participants.[19]

Limitations.

There are some limitations of the NHBS sample. NHBS recruitment is conducted in cities with high AIDS burden, thus our findings may not reflect risk behavior patterns in lower prevalence areas. Furthermore, young suburban PWID may be underrepresented because they tend to have smaller, more isolated networks,[41,42] thus our findings may not be representative of all PWID in the areas where NHBS recruited. Although RDS weights were used to adjust for oversampling of PWID with larger networks, future surveys should include enhanced efforts to recruit younger PWID.

For consistency with other reports based on NHBS data, we grouped cities into standard

regions. Consequently, there may be differences between cities that are not detected in this analysis. Some regional differences might be related to data not collected in the 2012 cycle of NHBS. For example, the substance use treatment question did not ascertain type of treatment program (i.e., behavior/education counseling, MAT). Given that several recent reviews have highlighted significant differences in treatment type effectiveness in reducing HIV and HCV risk behaviors,[43,44] regional differences that might exist in the NHBS sample were not found. Furthermore, this analysis is based on cross-sectional data; intervention participation and risk behavior were both assessed for the past 12 months. Associations between intervention participation and risk behavior are not necessarily causal.

Conclusions.

Latent class analysis can be used to identify distinct classes of injection risk behavior, providing a more nuanced and useful measure of behavior than unidimensional measures. The results of this analysis suggest that increasing access to sterile syringes should be a priority in the South, where risky injection practices are prevalent, syringe access is low, and HIV diagnosis rates are the highest in the country.[45] More attention should also be given to providing skills-based rather than didactic interventions for reducing injection risk behavior.

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Disclaimer

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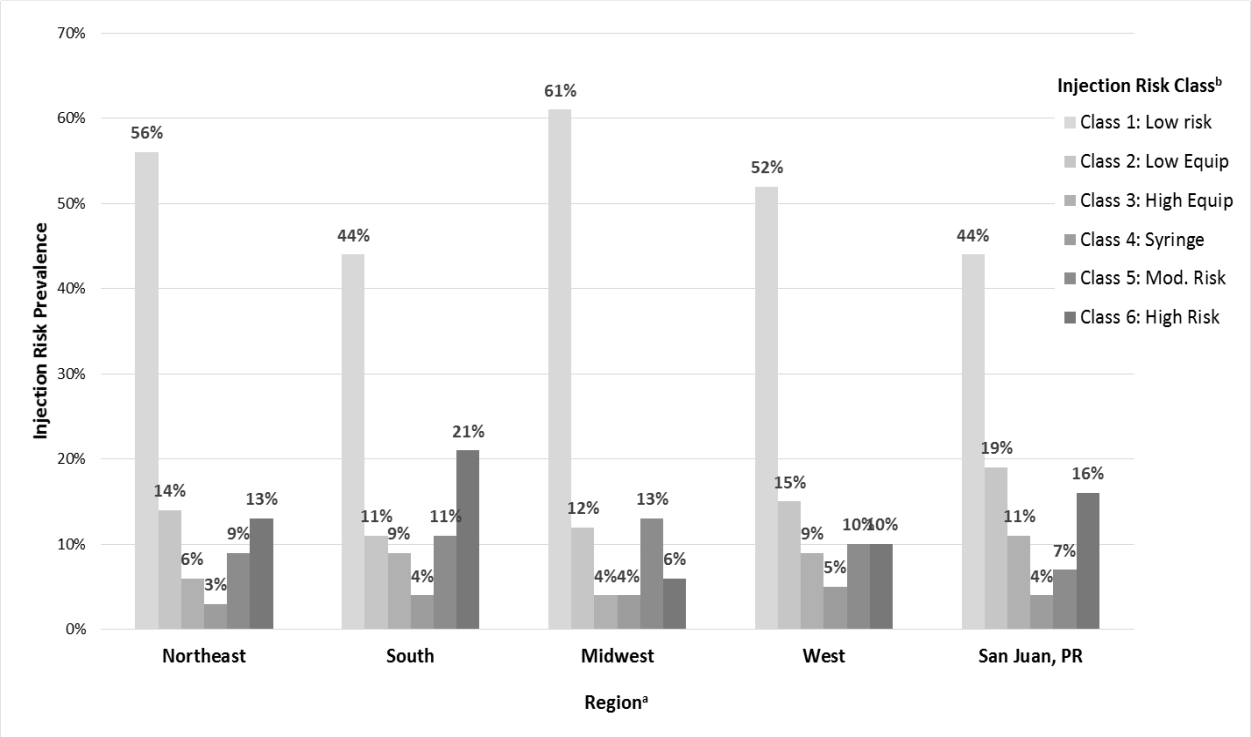
Figure 1. Regional adjusted estimates of risk class prevalence (n = 10,152)



[a]Northeast: Boston, Nassau, New York City, Newark, Philadelphia; South: Atlanta, Baltimore, Dallas, Houston, Miami, New Orleans, Washington (D.C.); Midwest: Chicago, Detroit; West: Denver, Los Angeles, San Diego, San Francisco, Seattle
[b]Injection Risk Classes are **1: Low Risk**: very low probability of any risk behavior (reference category); **2: Low Equip**: low frequency non-syringe equipment sharing; **3: High Equip**: high frequency non-syringe equipment sharing; **4: Syringe**: syringe sharing with low probability of other equipment sharing; **5: Moderate risk**: low frequency syringe and other equipment sharing; **6: High risk**: syringe sharing with high frequency other equipment sharing.
†Adjusted for gender, age, and race/ethnicity
Note: 18 cases missing on covariates.