**Latent classes of sexual risk behavior and engagement in outreach, intervention and prevention services among women who inject drugs across 20 U.S. cities**

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Running head: Sexual risk and intervention among WWID

**Abstract**

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

*Methods.* Data for this study came from the 2012 National HIV Behavioral Surveillance interviews with PWID across 20 U.S. cities. The present analyses include those who identified as female, ever had sex with a man, and were at risk for HIV infection (did not report a previous positive HIV test result) (n = 2,624). We conducted latent class analysis (LCA) to identify sexual risk classes, and modeled associations with engagement in HIV prevention services and HIV test results.

*Results.* We identified six classes of sexual risk behavior: 1) low risk, 2) monogamous, 3) casual partner, 4) multiple partner, 5) exchange sex, and 6) exchange plus main partner. The class distribution was similar across the mainland regions. Bisexual orientation and homelessness were significant predictors of higher risk class. HIV prevalence and participation in behavioral interventions did not vary significantly by risk class, while obtaining and using free condoms did. Independent of risk class, women in cities in the South were significantly less likely to use free condoms, and HIV prevalence was higher among non-Hispanic black women and women aged 40-49.

*Conclusions.* Bisexual orientation and homelessness were predictors of higher risk. Condom distribution programs reached fewer women in cities in the South. Race and age disparities in HIV-positive rates persisted after adjusting for sexual risk class.

**Key words**: injection drug use, women, HIV risk behavior

**1. Introduction**

There are an estimated 16 million persons who inject drugs (PWID) globally, of whom an estimated 1.3 million are in the United States (U.S.).1 While there are no global population size estimates of the number of women who inject drugs (WWID), the proportion of women among populations of PWID ranges from 10–30% and is increasing.2 In the U.S., 2015 National HIV Behavioral Surveillance (NHBS) data show that 34% of recently initiated PWID (first injected between 2010 and 2015) were women.3 WWID have substantially different needs and face higher risks for HIV, hepatitis B (HBV), and hepatitis C (HCV) infections than men who inject drugs.2,4-16 However, the literature rarely distinguishes between men and women when discussing prevalence, needs, risks and outcomes of injection drug use. This has led to a possible underrepresentation of the specific issues that WWID face and a gap in appropriate interventions and policy development.4,17

Higher rates of HIV among WWID compared with men are often attributed to dual risk from unsafe injection practices and condomless sex.9,16,18-20 Dependence on partners for drugs, housing, or financial stability may increase women’s vulnerability and decrease their ability to negotiate safer sex.21,22 Moreover, sex work is common among WWID,4,23 and WWID sex workers are more likely to share syringes and other injection paraphernalia,24,25 have condomless sex with their clients as well as their intimate partners,26,27 experience compounded stigma from both drug use and sex work,28 and have higher rates of STIs.6,26 Yet, access to prevention services may be limited by a number of factors2 such as high levels of stigma, norms related to syringe acquisition and sharing,7 intimate partner violence,13,22,26,29-31 neighborhood violence and policing,32 and perceived risk of arrest and incarceration.33,34 Harm reduction programs may appear male-focused and unfriendly to women, and women may rely on their male partners to access services such as syringe services programs (SSPs).15,20,21,35

In a previous analysis we examined latent classes of injection risk in a large, multi-site sample of PWID.36 In that study we found that women, and especially bisexual women, had a greater likelihood than men of being in the high-risk syringe and equipment sharing classes. To improve our understanding of sexual risk in the highly vulnerable population of WWID at risk of HIV acquisition, we used latent class analysis (LCA)37-42 to identify distinct patterns of sexual risk behavior among WWID in this same sample. We examined how participation in prevention and intervention programs was related to risk-behavior class, and we tested differences in HIV-positive test rates. 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 CDC’s 2012 National HIV Behavioral Surveillance (NHBS)43 among PWID in 20 U.S. cities. Methods for NHBS among PWID are described in detail elsewhere.44-46 Briefly, In 2012, NHBS was conducted in 20 large U.S. cities within metropolitan statistical areas with >500,000 residents. NHBS data collection was approved by institutional review boards at each of the participating sites.

Participants were recruited using respondent-driven sampling (RDS).44,47 Eligible seeds recruited up to five PWID to complete the anonymous survey, who in turn recruited others. The recruitment process was tracked using a coded coupon system, and continued until the sample size was reached or the sampling period ended. Participants 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 included questions about 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. For those who consented, HIV testing was performed by collecting blood or oral specimens for 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 ranged from $20–$30 for the interview, and an additional $10–$25 for HIV testing.

2.3. Measures

*2.3.1. Sociodemographic and Health Status Variables.* Sociodemographic measures included gender, age, race/ethnicity, self-reported sexual orientation, and past-year homelessness. Other variables included self-reported HIV testing and status, and STI diagnoses in the past 12 months. For participants who consented to HIV testing, HIV test results are available.

*2.3.2. Sexual Risk Behavior.* Participants answered a series of questions about their sexual behavior in the past 12 months. Measures used in this analysis include: 1) number of sex partners (none, one, multiple); 2) condomless vaginal sex with a main partner (yes/no); 3) condomless anal sex with a main partner (yes/no); 4) condomless vaginal or anal sex with casual partners (none, one, multiple); 5) first-time partners (none, one, multiple); 6) partners from whom participant received money or goods in exchange for sex (none, one, multiple).

*2.3.3. Prevention and Intervention Participation.* The questions used to assess prevention and intervention participation are presented in Table S1 (Supplemental Digital Content). Participants were asked if they had obtained free condoms in the past 12 months, and if so, had they used them. A series of questions assessed one-on-one and group intervention participation in the past 12 months. Based on these items, we created indicators for any intervention participation, any one-on-one intervention, any group intervention, and any intervention that included practicing risk-reduction skills.

2.4. Data Analysis

For the purposes of this analysis, we included women who were potentially at risk of acquiring HIV infection through heterosexual activity. Of the 2,880 women in the sample, n=68 were excluded for never having sex with a man, and n=188 were excluded for reporting a previous positive HIV test result, leaving a sample of 2,624 for this analysis.

*2.4.1: Regional Comparisons*. Cities were categorized into Northeast, South, Midwest and West regions based on the U.S. Census Bureau definition48; San Juan, Puerto Rico was assessed separately. We compared the proportions of respondents reporting prevention/intervention participation among the four U.S. regions and San Juan, P.R. by computing corrected chi-square statistics using -*svy*- command in Stata (v. 13).

*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.49,50 We computed individualized (dual component) RDS weights50 for the five dependent variables using the -*rds*- command in Stata.51 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 (v. 7)52 using six measures of sexual risk behavior, with complex sampling specifications including strata (20 MSAs), cluster (141 RDS chains), and sampling weights. 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 by including direct effects of region dummy variables on latent class indicator variables,53,54 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 examined 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).55-57 Covariates included in the latent class regression model were demographics (region, age, race/ethnicity), sexual orientation, poverty, and homelessness. Predictors with p-value <0.05 were retained in the model.

Next, in separate models adjusting for covariates, we examined associations between latent classes and outcomes of obtaining free condoms, using free condoms, intervention participation, and positive HIV test result. We examined the one-step model for changes in latent class structure that would indicate the necessity for a 3-step approach. Due to the model complexity, automatic 3-step procedures were not available, so a manual approach was required.58,59 The 3-step approach for distal outcomes comprises 1) fitting the latent class model without the outcome, 2) computing the classification uncertainty rate for the most likely class, and 3) estimating the model with the distal outcome using the most likely class variable and uncertainty rates computed in step 2. For each outcome we computed a Wald test for the overall effect of class, and then conducted a region-stratified analysis and computed a Wald test of equality of coefficients to test whether associations were consistent across regions. We omit tests involving cells with a count of less than 5. Covariate associations were held equal across regions in the stratified models. In describing the results, we consider effects with *p*-value <0.01 as statistically significant and <0.05 as marginal.

**3. Results**

*3.1. Sample*. Characteristics of the sample are shown in Table 1. Cities in the South and West regions contributed the largest proportions. The women were mostly aged 40 years and older (66.0%), and non-Hispanic black (41.2%) or non-Hispanic white (32.2%). A sizeable minority identified as bisexual (21.8%), about half had experienced homelessness in the past year, and over 80% had incomes below the federal poverty level. Few (6.5%) had never been tested for HIV; 53.1% reported being tested in the past year. Over half reported obtaining free condoms in the past 12 months and overall about one-third reported using them. San Juan had the highest proportions of women obtaining (79.7%) and using (59.4%) free condoms. In the mainland U.S., rates of obtaining and using free condoms ranged from 43.5% and 27.7% in the Midwest to 57.5% and 37.6% in the Northeast. Regional variation in obtaining free condoms was marginally significant (p=0.031), using free condoms was statistically significant (p=0.006), and participation in interventions was similar across regions (data not shown).

*3.2. Latent class analysis*. The past-year sexual risk behaviors used for the latent class analysis are shown in Table 2. 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=11.32, p< 0.001), therefore we concluded that the latent class structure was invariant across regions. Seven women had missing values on one or more of the covariates, leaving a sample of 2,617 for the multinomial regression analyses. Class structure shifted slightly when including covariates in the model; therefore, we present the covariate-adjusted model. Table 2 reports the covariate-adjusted risk behavior profiles of the six classes: **1) low risk** (17.7%)**:** high likelihood of no male partner; **2) monogamous** (34.4%)**:** high likelihood of only one sex partner, no more than one new or exchange sex partner, no condomless casual sex; **3)** **casual partner** (4.1%)**:** high likelihood of only one sex partner, no more than one new or exchange sex partner, or condomless sex with not more than one casual sex partner; **4)** **multiple partners** (16.7%)**:** more than one male sex partner, high likelihood of at least one new partner; **5) exchange sex** (19.0%): high likelihood of multiple exchange sex partners and multiple new sex partners, high likelihood of condomless sex with multiple casual sex partners; **6)** **exchange plus main** (8.1%): high likelihood of multiple exchange sex partners, multiple new sex partners, or condomless sex with multiple casual sex partners, plus high likelihood of condomless vaginal and anal sex with a main sex partner.

The class distribution for San Juan was markedly different than in the mainland U.S. regions, with an estimated 64% of women in the exchange sex class, 17% in the monogamous class, and 1% in the multiple partner class in the unadjusted analysis. Figure 1 shows the conditional latent class probabilities by region after covariate adjustment. The results of the covariate analysis are presented in Table 3. Low-risk class (class 1) was used as the reference category in the multinomial regression. After covariate adjustment the West had a significantly smaller likelihood of exchange sex class versus the low risk class compared to the Northeast.

Sexual orientation, age, and past-year homelessness had significant associations with latent class (p<0.001). Poverty was not significant after including homelessness and was dropped from the analysis. Women who identified as homosexual had a significantly greater likelihood of being in the low-risk class than heterosexual women, while women who identified as bisexual had a significantly greater likelihood of being in the exchange, exchange plus, or casual partner classes than in the low-risk class compared to heterosexual women. Women younger than 50 years of age had significantly higher odds of being in the monogamous, multiple partner, exchange, or exchange plus classes than in the low-risk class compared with women who were 50 years of age or older. Women 50 and older comprised an estimated 71% of the low-risk class. Women under 30 had the highest odds of being in the multiple-partner risk class compared to the low-risk class, and comprised 31% of the multiple partner class. Women who were homeless in the past year had a significantly greater likelihood of being in the casual partner, multiple partners, exchange or exchange plus classes than in the low risk class compared to women who were not homeless.

*3.3. Intervention outcomes.* The prevalence of participation in behavioral interventions did not vary significantly by risk class, and there were no significant covariate associations. Table 4 shows the model estimated probabilities of obtaining free condoms, and using free condoms by sexual risk class and region. Across regions, both obtaining free condoms and using free condoms varied significantly by risk class, with the highest probabilities for the casual partner and exchange sex, followed by exchange plus and multiple-partners risk classes. Independent of risk class, women who identified as bisexual were significantly more likely to obtain free condoms (OR=2.03, 95% CI 1.40-2.95), and marginally more likely to use them (OR=1.53, 95% CI 1.11-2.13) than heterosexual women. The results were similar for women who were homeless in the past year compared to those who were not (obtain free condoms, OR=1.68, 95% CI 1.30-2.17; use free condoms, OR=1.49, 95% CI 1.04-2.12), (see Table S2, Supplemental Digital Content). Non-Hispanic black women were marginally more likely than white women to obtain free condoms (OR=1.88, 95% CI 1.11-3.18), and significantly more likely to report using them (OR=2.49, 95% CI 1.59-3.90). There were no effects of age on obtaining condoms, however women 30-39 were more likely to use free condoms than women 50 or older (OR=1.68, 95% CI 1.16-2.42). Women in the South were marginally less likely to obtain condoms (OR=0.56, 95% CI 0.33-0.94), and significantly less likely to use them (OR=0.50, 95% CI 0.30-0.83) than women in the Northeast.

*3.3.1. Regional effects.* In region-stratified analyses, some effects could not be estimated due to an estimated cell prevalence of zero or one. There were no significant effects of region on intervention outcomes. There was significant variation across regions in obtaining free condoms for the exchange and monogamous classes; and in using free condoms for the exchange and low-risk classes. The prevalence of obtaining and using free condoms among women in the exchange class was higher in San Juan and in the West than in other regions. There was a high prevalence of obtaining free condoms among women in the monogamous class in San Juan (n≈7), while using free condoms was elevated among low-risk women in the Northeast.

*3.4. HIV test outcome*. The one-step model including HIV test outcome resulted in changes to the latent class structure, therefore we used the manual 3-step approach. Table 4 shows the model estimated probabilities of HIV positive test results by sexual risk class and region. There was modest variation in HIV-positive test outcomes across classes, with the casual partner class having the highest adjusted prevalence of HIV-positive test results (9.1%), significantly greater than the exchange class (2.3%; *Wald*[1]=7.28, p=0.007) and marginally greater than the low-risk class (1.6%; *Wald*[1]=6.20, p=0.013). Independent of risk class, non-Hispanic black women (*vs.* non-Hispanic white, OR=5.76, 95% CI 2.45–13.53) and women in the 40-49 age group (*vs.* 50 and older, OR=4.64, 95% CI 2.15–10.02) were significantly more likely to have a positive HIV test (results not shown).

*3.4.1. Regional effects*. In the region-stratified model (Table 4), the class effect for HIV-positive result was significant only in the South region (*Wald*[5]=20.47, p=0.001). Between region effects were not significant with the exception of the low risk class (Wald[2]=19.53, p=0.0001) due to high prevalence in San Juan; again, we note the extremely small number in this group (n=3).

**4. Discussion**

In this study, we investigated latent classes of sexual risk among self-reported HIV-negative or untested WWID across cities in four regions of mainland U.S. and San Juan, P.R., and associations with accessing prevention services and testing positive for HIV. LCA of injection behaviors is presented elsewhere.36 We identified six classes of sexual behavior described as low risk, monogamous, casual partner, multiple partners, exchange sex, and exchange plus main partner. The distribution of classes was similar across mainland regions, with the monogamous class being the most prevalent (34%), and the casual-partner class being the least prevalent (4%). However, the exchange-sex class was less prevalent in the West (18% vs. 27-30%). The San Juan sample was markedly different, with the exchange-sex class estimated at 71% in the covariate-adjusted model; however this was not a statistically significant difference and may be attributable to sampling error. Sexual orientation, age, and homelessness were significant predictors of class membership, while race/ethnicity was not.

Participation in behavioral interventions for HIV prevention did not vary significantly by risk class. This could be the result of interventions for PWID being more closely related to injection risk, which was not considered here. However, there was significant variation in obtaining and using free condoms. About half of the women in the casual, exchange, and the exchange plus classes reported using free condoms, while only one-third of women in the multiple-partners class did so. Notably, the prevalence of obtaining and using free condoms among women in the exchange class was significantly higher in San Juan and in the West than in other regions.

HIV prevalence varied moderately across classes, and the highest prevalence was found in the casual class. While the estimate for the casual class may not be highly reliable due to the low frequency of membership in this class, this finding highlights a small but potentially high-risk group of WWID who may have impromptu high-risk sexual encounters. It is also notable that there was no difference in HIV prevalence between the monogamous class and other classes engaging in more risky behavior. This finding highlights the importance of HIV detection for these women whose partners’ sexual and syringe-sharing behavior, in addition to their own injection risk behavior, may place them at risk.

Overall, non-Hispanic black women were more likely to use free condoms, and more likely to have HIV infections than non-Hispanic white women. Women 40-49 were also more likely than any other age group to test positive for HIV. The persistence of these race and age disparities after adjusting for sexual risk class indicates that they are driven by factors not considered in this analysis, such as injection risk behavior or structural factors. Independent of risk class, women in the South were marginally less likely to obtain free condoms, and significantly less likely to use them. These differences may be related to the availability or accessibility of condom distribution programs in this region.

Sexual minorities are under-targeted for interventions even though research from the U.S and Australia show that the prevalence of women who have sex with women (WSW) within the WWID community is substantial.5,10-12 One-fourth of WWID in our sample reported being a sexual minority, either bisexual (21.8%) or homosexual (3.4%). Although bisexual women were significantly more likely to obtain free condoms, and marginally more likely to use them, they were also significantly more likely to be in the highest-risk classes. Further research is needed to identify and address factors contributing to sexual risk among sexual minority WWID.

The high rate of homelessness in this and other studies11,60-62, and the significant contribution of homelessness to sexual risk among WWID, points to the need to expand development of interventions to address this problem. Stable housing is associated with injection cessation,63 while homelessness is associated with multiple harms, including relapse, overdose, injection-related risk behavior, and exchange sex.60,61,63-66

*Limitations.* The analysis presented in this paper does not address injection risk. There are some limitations of the NHBS sample. NHBS recruitment was 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.65,67 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. There may be differences between cities that are not detected in this analysis, and cities included in NHBS may not be representative of the region. Some regional differences might be related to data not collected in the 2012 cycle of NHBS. The small number of women in the San Juan sample resulted in very small cell sizes for some classes, and consequently estimates that cannot be considered reliable for those classes. In addition, the small number of women recruited may indicate that the RDS chains failed to reach some segment of the population.

*Conclusions*. Latent class analysis identified distinct classes of sexual risk behavior, providing a more nuanced measure of behavior than unidimensional measures. The results suggest that condom distribution programs in the South may be less effective at reaching WWID, while those in the West and San Juan may be more effective at reaching WWID who exchange sex compared to other regions. Race and age disparities in HIV infections existed independent of sexual risk class, underscoring the importance of non-sexual risk factors.

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**Disclaimer**

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**References**

**1.** Mathers BM, Degenhardt L, Phillips B, et al. Global epidemiology of injecting drug use and HIV among people who inject drugs: A systematic review. *The Lancet.* 2008;372(9651):1733-1745.

**2.** United Nations Office on Drugs and Crime. Policy Brief - Women who inject drugs and HIV: Addressing specific needs. 2014. <http://www.unodc.org/documents/hiv-aids/publications/WOMEN_POLICY_BRIEF2014.pdf>. Accessed June 25, 2017.

**3.** Wejnert C, Hess KL, Hall HI, et al. Vital Signs: Trends in HIV diagnoses, risk behaviors, and prevention among persons who inject drugs - United States. *MMWR Morbidity and Mortality Weekly Report.* 2016;65:1336-1342.

**4.** Roberts A, Mathers B, Degenhardt L. *Women who inject drugs: A review of their risks, experiences and needs.* Sydney, Australia: University of New South Wales;2010. Available from: <https://www.unodc.org/documents/hiv-aids/Women_who_inject_drugs.pdf>.

**5.** Absalon J, Fuller CM, Ompad DC, et al. Gender differences in sexual behaviors, sexual partnerships, and HIV among drug users in New York City. *AIDS Behav.* Nov 2006;10(6):707-715.

**6.** Azim T, Bontell I, Strathdee SA. Women, drugs and HIV. *Int. J. Drug Policy.* Feb 2015;26 Suppl 1:S16-21.

**7.** Davey-Rothwell MA, Latkin CA. Gender differences in social network influence among injection drug users: perceived norms and needle sharing. *J. Urban Health.* Sep 2007;84(5):691-703.

**8.** Esmaeili A, Mirzazadeh A, Carter GM, et al. Higher incidence of HCV in females compared to males who inject drugs: A systematic review and meta-analysis. *J. Viral Hepat.* Feb 2017;24(2):117-127.

**9.** Evans JL, Hahn JA, Page-Shafer K, et al. Gender differences in sexual and injection risk behavior among active young injection drug users in San Francisco (the UFO Study). *J. Urban Health.* Mar 2003;80(1):137-146.

**10.** Friedman SR, Ompad DC, Maslow C, et al. HIV prevalence, risk behaviors, and high-risk sexual and injection networks among young women injectors who have sex with women. *Am. J. Public Health.* 2003;93(6):902-906.

**11.** German D, Latkin CA. HIV risk, health, and social characteristics of sexual minority female injection drug users in Baltimore. *AIDS Behav.* Jul 2015;19(7):1361-1365.

**12.** Hotton AL, Boodram B. Gender, transience, network partnerships and risky sexual practices among young persons who inject drugs. *AIDS Behav.* Apr 2017;21(4):982-993.

**13.** Iversen J, Page K, Madden A, et al. HIV, HCV, and health-related harms among women who inject drugs: Implications for prevention and treatment. *J. Acquir. Immune Defic. Syndr.* Jun 01 2015;69 (Suppl 2):S176-181.

**14.** Magnus M, Kuo I, Phillips G, 2nd, et al. Differing HIV risks and prevention needs among men and women injection drug users (IDU) in the District of Columbia. *J. Urban Health.* Feb 2013;90(1):157-166.

**15.** Morris MD, Bates A, Andrew E, et al. More than just someone to inject drugs with: Injecting within primary injection partnerships. *Drug Alcohol Depend.* 2015;156:275-281.

**16.** Tracy D, Hahn JA, Fuller Lewis C, et al. Higher risk of incident hepatitis C virus among young women who inject drugs compared with young men in association with sexual relationships: A prospective analysis from the UFO Study cohort. *BMJ Open.* May 29 2014;4(5):e004988.

**17.** Armstrong G. Commentary on McFall et al. (2017): The need for harm reduction interventions that are effective for women who use drugs. *Addiction.* 2017;112(8):1488-1489.

**18.** Hurtado Navarro I, Alastrue I, Del Amo J, et al. Differences between women and men in serial HIV prevalence and incidence trends. *Eur. J. Epidemiol.* 2008;23(6):435-440.

**19.** Des Jarlais DC, Feelemyer JP, Modi SN, et al. Are females who inject drugs at higher risk for HIV infection than males who inject drugs: An international systematic review of high seroprevalence areas. *Drug Alcohol Depend.* Jul 1 2012;124(1-2):95-107.

**20.** Morris MD, Evans J, Montgomery M, et al. Intimate injection partnerships are at elevated risk of high-risk injecting: A multi-level longitudinal study of HCV-serodiscordant injection partnerships in San Francisco, CA. *PLoS ONE.* 2014;9(10):e109282.

**21.** El-Bassel N, Shaw SA, Dasgupta A, et al. People who inject drugs in intimate relationships: It takes two to combat HIV. *Current HIV/AIDS Reports.* Mar 2014;11(1):45-51.

**22.** El-Bassel N, Gilbert L, Wu E, et al. Relationship between drug abuse and intimate partner violence: A longitudinal study among women receiving methadone. *Am. J. Public Health.* Mar 2005;95(3):465-470.

**23.** El-Bassel Na, Wechsberg WMb, Shaw SAa. Dual HIV risk and vulnerabilities among women who use or inject drugs: No single prevention strategy is the answer. *Current Opinion in HIV & AIDS.* 2012;7(4):326-331.

**24.** Spittal PM, Bruneau J, Craib KJP, et al. Surviving the sex trade: A comparison of HIV risk behaviours among street-involved women in two Canadian cities who inject drugs. *AIDS Care.* 2003/04/01 2003;15(2):187-195.

**25.** Bailey SL, Ouellet LJ, Mackesy-Amiti ME, et al. Perceived risk, peer influences, and injection partner type predict receptive syringe sharing among young adult injection drug users in five U.S. cities. *Drug Alcohol Depend.* 2007;91(Supplement 1):S18-S29.

**26.** Shannon K, Csete J. Violence, condom negotiation, and HIV/STI risk among sex workers. *J. Am. Med. Assoc.* Aug 04 2010;304(5):573-574.

**27.** Shannon K, Strathdee SA, Shoveller J, et al. Structural and environmental barriers to condom use negotiation with clients among female sex workers: Implications for HIV-prevention strategies and policy. *Am. J. Public Health.* 2009;99(4):659-665.

**28.** Shannon K, Goldenberg SM, Deering KN, et al. HIV infection among female sex workers in concentrated and high prevalence epidemics: why a structural determinants framework is needed. *Curr Opin HIV AIDS.* Mar 2014;9(2):174-182.

**29.** Wagner KD, Hudson SM, Latka MH, et al. The effect of intimate partner violence on receptive syringe sharing among young female injection drug users: An analysis of mediation effects. *AIDS Behav.* Apr 2009;13(2):217-224.

**30.** El-Bassel N, Gilbert L, Witte S, et al. Intimate partner violence and HIV among drug-involved women: contexts linking these two epidemics--challenges and implications for prevention and treatment. *Subst. Use Misuse.* 2011;46(2-3):295-306.

**31.** Gilbert L, Raj A, Hien D, et al. Targeting the SAVA (Substance Abuse, Violence, and AIDS) syndemic among women and girls: A global review of epidemiology and integrated interventions. *J. Acquir. Immune Defic. Syndr.* 2015;69 Suppl 2:S118-127.

**32.** Shannon K, Rusch M, Shoveller J, et al. Mapping violence and policing as an environmental–structural barrier to health service and syringe availability among substance-using women in street-level sex work. *Int. J. Drug Policy.* 2008;19(2):140-147.

**33.** Amnesty International. *Criminalizing Pregnancy: Policing Pregnant Women Who Use Drugs in the USA.* Amnesty.org2017. Available from: <https://www.amnesty.org/en/documents/amr51/6203/2017/en/>.

**34.** Child Welfare Information Gateway. *Parental Drug Use as Child Abuse.* Washington, D.C.: U.S. Department of Health and Human Services, Children’s Bureau;2016. Available from: <http://www.childwelfare.gov>.

**35.** Sherman SG, Latkin CA. Intimate relationship characteristics associated with condom use among drug users and their sex partners: A multilevel analysis. *Drug Alcohol Depend.* Sep 1 2001;64(1):97-104.

**36.** Mackesy-Amiti ME, Boodram B, Spiller MW, et al. Injection-related risk behavior and engagement in outreach, intervention and prevention services across 20 US cities. *J. Acquir. Immune Defic. Syndr.* 2017;75(Supplement 3):S316-S324.

**37.** McCutcheon AL. *Latent Class Analysis.* Vol 64. Newbury Park, CA: Sage; 1987.

**38.** Goodman LA. Latent Class Analysis: The Empirical Study of Latent Types, Latent Variables, and Latent Structures. In: Hagenaars JA, McCutcheon AL, eds. *Applied Latent Class Analysis*. New York, NY: Cambridge University Press; 2002.

**39.** Konda KA, Celentano DD, Kegeles S, et al. Latent class analysis of sexual risk patterns among esquineros (street corner men) a group of heterosexually identified, socially marginalized men in urban coastal Peru. *AIDS Behav.* 2011;15(4):862-868.

**40.** Mackesy-Amiti ME, Ouellet LJ, Finnegan L, et al. Transitions in latent classes of sexual risk behavior among young injection drug users following HIV prevention intervention. *AIDS Behav.* 2014;18(3):464-472.

**41.** Noor SB, Ross M, Lai D, et al. Use of latent class analysis approach to describe drug and sexual HIV risk patterns among injection drug users in Houston, Texas. *AIDS Behav.* 2014;18(3):276-283.

**42.** Pflieger JC, Cook EC, Niccolai LM, et al. Racial/ethnic differences in patterns of sexual risk behavior and rates of sexually transmitted infections among female young adults. *Am. J. Public Health.* 2013;103(5):903-909.

**43.** Gallagher KM, Sullivan PS, Lansky A, et al. Behavioral surveillance among people at risk for HIV infection in the U.S.: The National HIV Behavioral Surveillance System. *Public Health Rep.* 2007;122(Suppl 1):32-38.

**44.** Lansky A, Abdul-Quader AS, Cribbin M, et al. Developing an HIV behavioral surveillance system for injecting drug users: The National HIV Behavioral Surveillance System. *Public Health Rep.* 2007;122(S1):48-55.

**45.** Spiller MW, Broz D, Wejnert C, et al. HIV infection and HIV-associated behaviors among persons who inject drugs - 20 cities, United States, 2012. *MMWR. Morb. Mortal. Wkly. Rep.* 2015;64(10):270-275.

**46.** Centers for Disease Control and Prevention. *HIV Infection, Risk, Prevention, and Testing Behaviors among Persons Who Inject Drugs-National HIV Behavioral Surveillance: Injection Drug Use, 20 U.S. Cities, 2012.*  March 2015 2015. HIV Surveillance Special Report 11. Available from: <http://www.cdc.gov/hiv/library/reports/surveillance>.

**47.** Heckathorn DD. Respondent-driven sampling: A new approach to the study of hidden populations. *Soc. Probl.* 1997;44(2):174-199.

**48.** U.S. Census Bureau Geographic Division. Geographic Terms and Concepts - Census Divisions and Census Regions. <http://www.census.gov/geo/reference/gtc/gtc_census_divreg.html>. Accessed September 19, 2017.

**49.** Heckathorn DD. Respondent-driven sampling II: Deriving valid population estimates from chain-referral samples of hidden populations. *Soc. Probl.* 2002;49(1):11-34.

**50.** Heckathorn DD. Extensions of respondent driven sampling: Analyzing continuous variables and controlling for differential recruitment. *Socio. Meth.* December 7 2007;37(1):151-207.

**51.** Schonlau M, Liebau E. Respondent-driven sampling. *Stata Journal.* 2012;12(1):72-93.

**52.** *MPlus* [computer program]. Version 7. Los Angeles, CA: Muthén & Muthén; 2012.

**53.** Kankaras M, Moors G, Vermunt JK. Testing for measurement invariance with latent class analysis. In: Davidov E, Schmidt P, Billiet J, eds. *Cross-cultural analysis: Methods and applications*. New York, NY: Routledge; 2010:359-384.

**54.** Muthen BO. Latent variable mixture modeling. In: A.Marcoulides G, E.Schumacker R, eds. *New Developments and Techniques in Structural Equation Modeling*. Mahwah, NJ: Lawrence Erlbaum Associates; 2001.

**55.** Feingold A, Tiberio SS, Capaldi DM. New approaches for examining associations with latent categorical variables: Applications to substance abuse and aggression. *Psychol. Addict. Behav.* 2014;28(1):257-267.

**56.** Hagenaars JA. Loglinear models with latent variables. *Quantitative Applications in the Social Sciences.* Vol 94. Newbury Park, CA: Sage; 1993.

**57.** Bandeen-Roche K, Miglioretti DL, Zeger SL, et al. Latent variable regression for multiple discrete outcomes. *Journal of the American Statistical Association.* Dec 1997;92(440):1375-1386.

**58.** Asparouhov T, Muthén B. Auxiliary Variables in Mixture Modeling: A 3-Step Approach Using Mplus. *Mplus Web Notes: No. 15*2013.

**59.** Asparouhov T, Muthén B. Auxiliary variables in mixture modeling: Three-step approaches using Mplus. *Structural Equation Modeling.* 2014;21(3):329-341.

**60.** Coady M, Latka M, Thiede H, et al. Housing status and associated differences in HIV risk behaviors among young injection drug users (IDUs). *AIDS Behav.* 2007;11(6):854-863.

**61.** Des Jarlais DC, Braine N, Friedmann P. Unstable housing as a factor for increased injection risk behavior at US syringe exchange programs. *AIDS Behav.* November 01 2007;11(2):78-84.

**62.** Song JY, Safaeian M, Strathdee SA, et al. The prevalence of homelessness among injection drug users with and without HIV infection. *J. Urban Health.* December 01 2000;77(4):678-687.

**63.** Shah NG, Galai N, Celentano DD, et al. Longitudinal predictors of injection cessation and subsequent relapse among a cohort of injection drug users in Baltimore, MD, 1988-2000. *Drug Alcohol Depend.* 2006;83(2):147-156.

**64.** Linton SL, Celentano DD, Kirk GD, et al. The longitudinal association between homelessness, injection drug use, and injection-related risk behavior among persons with a history of injection drug use in Baltimore, MD. *Drug Alcohol Depend.* Apr 8 2013;132(3):457-465.

**65.** Boodram B, Mackesy-Amiti ME, Latkin C. The role of social networks and geography on risky injection behaviors of young persons who inject drugs. *Drug Alcohol Depend.* 2015;154:229-235.

**66.** Calvo M, MacFarlane J, Zaccaro H, et al. Young people who use drugs engaged in harm reduction programs in New York City: Overdose and other risks. *Drug Alcohol Depend.* 9/1/ 2017;178:106-114.

**67.** Akselrod H, Grau LE, Barbour R, et al. Seroprevalence of HIV, hepatitis B virus, and HCV among injection drug users in Connecticut: Understanding infection and coinfection risks in a nonurban population. *Am. J. Public Health.* 2014;104(9):1713-1721.

**Figure 1.** **Conditional estimated latent class probabilities at the mean of all covariates.** Covariates include age, race/ethnicity, sexual orientation, and homelessness. Risk classes are: **1) low risk:** high likelihood of no male partner (reference category); **2) monogamous:** one partner, no unprotected casual sex; **3)** **casual partner:** one new/exchange partner; **4)** **multiple partners:** more than one male partner; high likelihood of at least one new partner; **5) exchange sex**: high likelihood of multiple exchange partners and multiple new or casual unprotected sex partners; **6)** **exchange plus main** high likelihood of multiple exchange partners, multiple new or casual unprotected sex partners, and unprotected vaginal and anal sex with main partner.

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