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Association between Alcohol Consumption and Injection and Sexual Risk Behaviors among People Who Inject Drugs in Rural Puerto Rico

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Abstract

Although alcohol use has been associated with risky behavior generally, the relationship between alcohol use and multiple types of risk behaviors that could lead to the acquisition and transmission of HIV and hepatitis C (HCV) among people who inject drugs (PWID) has not been fully examined. The current study seeks to contribute to the understanding of how alcohol use is related to both injection risk and sexual risk, among a non-treatment, cross-sectional sample of mostly male PWID in rural Puerto Rico ($n = 315$). “At-risk” alcohol use was defined as consuming 14 drinks per week for males and 7 drinks per week for females. Binge drinking frequency was defined as consuming 5 drinks on one occasion for males and 4 drinks on a single occasion for females. Multivariate regression models were used to examine the association between the alcohol use variables and injection and sexual risk outcomes, adjusting for demographic characteristics. Overall, 14% ($n = 45$) of the participants in this sample were considered at-risk drinkers (44% low risk drinkers and 42% alcohol abstainers), and participants reported binge drinking, on average, at least once per month. At-risk drinking, compared to low risk or no drinking, increased both injection and sexual risk behaviors. Frequency of past year binge drinking was also associated with both injection and sexual risk behaviors. Interventions aimed at reducing HIV and HCV transmission among injection drug users non-PWID networks should both target individuals who drink alcohol frequently and in high volumes, and include strategies for reducing risky behaviors while heavy drinking is occurring.

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1. Introduction

Alcohol use has been associated with risk behaviors that can lead to HIV and hepatitis C (HCV) acquisition and transmission among diverse populations, including adolescents and young adults (Graves & Leigh, 1995), men who have sex with men (Koblin et al., 2006), and non-injection substance abusers (Scheidt, 1999; Woods et al., 1996). Less attention, however, has focused on the association between various dimensions of alcohol use and risky behaviors conducive to HIV and HCV transmission among people who inject drugs (PWID). Co-use of alcohol and injection drugs likely magnifies risky behaviors (Harrell, Mancha, Petras, Trenz, & Latimer, 2012; Keen, Khan, Clifford, Harrell, & Latimer, 2014), and increases the risk of contracting and transmitting HIV and HCV among PWID and non-PWID social networks. Moreover, among HIV and HCV positive PWID, heavy and frequent alcohol use may exacerbate symptoms and lead to more severe conditions and early mortality such as cirrhosis among HCV positive PWID (Pol et al., 1998; Pol, Vallet-Pichard, Corouge, & Mallet, 2012) and accelerated HIV progression (Hahn & Samet, 2010). Consequently, understanding the association between various dimensions of alcohol use and its associations with injection and sexual risk behaviors among PWID is warranted for understanding and improving the general health of PWID and reducing risk transmission to non-PWID social networks.

Of the 6.6 million current or former injection drug users in the United States (U.S.) in 2011, it is estimated that 2.85 million were living with Hepatitis C and 141,970 were living with HIV (Lansky et al., 2014). Despite recent declines in injection related HIV infection, in 2010 the CDC estimated that 8% of contemporary new HIV infections are attributable to injection drug use and over 25% of AIDS related deaths were attributable to injection drug use in the U.S. (Centers for Disease Control & Prevention, 2015). Among people who inject drugs (PWID), HIV and HCV are transmitted through risky injection practices, such as sharing needles, syringes, or other injection equipment (e.g., cookers, cotton), and HIV is transmitted through unprotected sex with both other injectors and with non-injectors (Abadie, Welch-Lazoritz, Gelpi-Acosta, Reyes, & Dombrowski, 2016; Centers for Disease Control & Prevention, 2015; Paintsil, Binka, Patel, Lindenbach, & Heimer, 2013; Paintsil, He, Peters, Lindenbach, & Heimer, 2010).

Transmission of HIV and HCV through injection drug use is especially important to understand in the island of Puerto Rico, where injection drug use comprises the most common route of HIV and HCV transmission, and accounts for over 40% of new HIV cases in males, compared to the 8% estimate of the U.S. as a whole (AIDS United, 2016; Centers for Disease Control & Prevention, 2015). Comparative research between Puerto Rican PWID residing in the San Juan metropolitan area and New York City indicates that PWID in San Juan and nearby Bayamon engage in riskier injection and sexual behaviors (Mino, Deren, & Colón, 2011). Furthermore, island born Puerto Rican adults have been shown to be at greater risk for alcohol and drug use disorders compared to mainland born Puerto Ricans and mainland born non-Hispanics (Alegría, Canino, Stinson, & Grant, 2006). These findings suggest a possible association between alcohol consumption and drug use specific to Puerto Rico, with potential implications for HIV-risk taking behavior among Puerto Rican PWID (Matos et al., 2004).

One potential mechanism that may link alcohol use with injection and sexual risk behaviors that transmit HIV and HCV is that alcohol use lowers inhibitions and impairs cognitive functioning (U.S. Department of Health and Human Services, 2004), which could contribute to risk-taking. Latkin et al. (1994) describe one of the first studies to examine alcohol use and risk among a population of people who inject drugs (Latkin, Mandell, Oziemkowska, Vlahov, & Celentano, 1994). They found that among male PWID, heavy drinking was significantly associated with increases in sexual risk behaviors, such as casual sex and exchanging money or drugs for sex (Latkin et al., 1994). Stein et al. (2000) evaluated whether alcohol was an independent risk factor for injection risk behaviors. They found that increased levels of alcohol use and alcohol abuse were significantly related to increased levels of overall injection risk (e.g., shared needles, cooker, cotton, etc.) and an increase in needle sharing (Stein et al., 2000), a finding which has been subsequently replicated among diverse PWID samples (Matos et al., 2004; Stein, Charuvastra, Anderson, Sobota, & Friedmann, 2002; Wang et al., 2014). Where Stein et al. (2000) had a sample of injection drug users recruited through a syringe exchange program (SEP), Rees et al. (2001) examined a sample of recent drug users (not necessarily injection) recruited from in-patient detoxification units. Like Latkin and colleagues (1994), they found that alcohol use was significantly associated with various sexual risk behaviors (Rees, Saitz, Horton, & Samet, 2001), which has since been replicated among various PWID samples (Arasteh & Des Jarlais, 2009; Matos et al., 2004; Stein, Anderson, Charuvastra, & Friedmann, 2001). Rees et al. (2001), however, failed to find an association between alcohol use and injection risk behaviors with a restricted sample of only those who recently injected drugs and entered detoxification services. A recent study by Fairbairn and colleagues (2016) also found that among PWID in Vancouver, BC hazardous alcohol use was associated with sexual risk behavior, but not receptive needle sharing.

The current study seeks to contribute to the understanding of how alcohol use is related to both injection risk and sexual risk, among a sample of people who currently inject drugs, who given the high prevalence of both infections in injection risk networks on the island arguably, are arguably more vulnerable to contracting HIV or hepatitis C than mainland PWID. This study drew participants from four rural municipalities in central Puerto Rico where the mountain terrain adds to the geographical isolation of the area. In these conditions, conventional SEPs operating out of a single permanent location are unrealistic. Instead, the total area is supported by a single outreach project operating from a mobile van (Des Jarlais et al., 2013). Under such conditions, structural barriers to clean injection equipment may enhance the effect of alcohol of risky behaviors found in prior research. As such, it is particularly important to understand how alcohol use influences risk behaviors that potentially can spread these infections. The results will help to understand the association between alcohol use and HIV risk behaviors among this already at-risk group, knowledge that can be used to tailor intervention programs and identify the types of individuals most at risk for contracting or transmitting these communicable diseases. Alcohol consumption, particularly heavy and frequent use, is expected to be associated with an increase in both risky injection behaviors and risky sexual behaviors. Support for these hypotheses may provide insights to improve and tailor resource limited harm reduction and desistance efforts in rural Puerto Rico.

2. Methods

2.1. Sample

This paper uses data collected from 315 injection drug users residing in four rural towns in central Puerto Rico, about 30–40 miles from metropolitan San Juan. The data was collected between April 2015 and June 2015. Sample recruitment was managed using respondent driven sampling (RDS). Two seeds were recruited in each of the four towns (for a total of 8 seeds, 307 recruits) and a local syringe exchange program (SEP) introduced us to each seed respondent. Although initially recruited through SEP, the seeds quickly recruited new participants who had not visited an SEP in the past year (58% were not SEP clients). Seed participants who completed the survey were given three referral coupons to pass out to other PWID they knew and who had not previously participated in the study. Eligible participants recruited by the initial seeds comprise the first wave of sampling, and are given three referral coupons to recruit the next wave, and so on. More information about recruitment and clustering of the final network sample can be found elsewhere (Coronado-García et al., 2017; Thrash et al., 2017). Upon completion of the questionnaire, participants were given \$25. Every eligible referral earned the recruiter an additional \$10. Participants were 18 years of age or older, alert at the time of the interview, and active injection drug users (injected drugs within the last 30 days).

The questionnaire was interviewer-administered and based off of the Centers for Disease Control's National HIV Behavioral Surveillance Survey (NHBS) Injection Drug User Round 3 Questionnaire (version 13). In addition to demographic characteristics, we collected information about type and frequency of drug use, alcohol use, as well as HIV and HCV risk behaviors such as sharing of needles, cookers, cotton, and water in addition to sexual behaviors. Written informed consent was obtained from all participants, and the study received IRB approval through the University of Nebraska-Lincoln and the University of Puerto Rico School of Medicine.

2.2. Measures

Alcohol Use—Consistent with prior research (Dawson, Grant, & Li, 2005; NIAAA, 2005; Stein et al., 2000), the National Institute on Alcohol Abuse and Alcoholism (NIAAA) definition for at-risk alcohol use was used. We measure *30 day alcohol use risk* with three categories: (0) no alcohol use in past 30 days, (1) low risk use in the past 30 days—less than 14 drinks per week (for four weeks) for men and less than 7 drinks per week for women (for four weeks), and (3) at-risk use—more than 14 drinks per week (for four weeks) for men, more than 7 drinks per week for women (for four weeks) during the past 30 days. In the regression models, alcohol use risk was dummy coded with no alcohol use serving as the reference category. We also include *past year frequency of binge drinking* which measures how often, on average, respondents had 5 or more (4 or more for females) alcoholic drinks in one sitting, with response options including never (0), less than once a month (1), once a month (2), 2–3 days per month (3), once a week (4), 2–6 days per week (5), or everyday (6). Both alcohol use variables were examined in separate models. One drink was defined as 12 oz. beer, 5 oz. glass of wine, or a 1.5 oz. shot of liquor.

Injection Risk—Three injection risk variables were examined separately, including: “how often did you use needles that someone else had already injected with?”, “how often did you use a cooker that someone else had used?”, and “how often did you use a cotton that someone else had already used?”. All three variables had the same response options of (0) never, (1) rarely, (2) about half the time, (3) most of the time, and (4) always. We also created an *injection risk scale* as a composite measure of past year injection risk by summing the answers to these three questions ($\alpha = .75$). A principle axis factor analysis indicated that one factor sufficiently explains the variation among these three variables, and factors loadings were sufficiently high ($> .45$). In addition to these four variables, *frequency of sterile needle use* was assessed with the question “in the past 12 months when you injected, how often did you use a new, sterile needle? By new sterile needle, I mean a needle never used before by anyone, including you.” Response options were (0) never, (1) rarely, (2) about half the time, (3) most of the time, and (4) always.

Sexual risk—To assess sexual risk, we examined two indicators of risky sexual behavior. First, *total number of unprotected sex partners* is the total number of people that a respondent had sex with during the past year without using a condom (continuous response options). *Total number of casual partners* measures the total number of people a respondent had sex with in the past year that they deemed ‘casual’ where casual means “a person you have sex with but do not feel committed to or don’t know very well.” Because of several extreme outliers (i.e., above 3 S.D. above the mean), four or more casual sex partners was set as the upper-bound.

Demographics—Five demographic variables were included in each of the models: gender (0 = male; 1 = female), past year homelessness (0 = no; 1 = yes), marital status (0 = single; 1 = married/cohabitating; 2 = divorced/separated/widowed), highest level of education (0 = less than high school; 1 = high school diploma or GED; 2 = some college). In addition, frequency of past year injection drug use was examined, and response categories ranged from (1) less than one time per month to (7) four or more times per day. In the regression models, marital status and education were dummy coded with single and less than high school education as the reference groups, respectively.

2.3. Analytic Approach

A total of 33 respondents (10.4%) were missing data on any variable examined. To account for missing data, multiple imputation by chained equations (MICE; (Raghunathan, Lepkowski, Van Hoewyk, & Solenberger, 2001; van Buuren, 2007; White, Royston, & Wood, 2011) was used. A negative binomial specification was used to impute number of unprotected sex partners ($n_{\text{missing}} = 1$) and total number of casual sex partner ($n_{\text{missing}} = 29$), a logit specification was used to impute homelessness ($n_{\text{missing}} = 1$) and gender ($n_{\text{missing}} = 1$), and an ordered logit specification was used to impute frequency of sterile needle use ($n_{\text{missing}} = 1$). All other variables had complete data. Ten imputed datasets were generated in Stata version 13 (StataCorp, 2013), and estimates were pooled using Rubin’s rules (Rubin, 1987).

Multivariate regression models were used to examine the association between the alcohol use variables and the seven injection and sexual risk outcomes. For the composite injection risk variable, ordinary least squares regression was used. For frequency of shared needle, shared cooker, shared cotton, and clean needle use, ordered logit models were used because the variables were ordinal (Long, 1997). Estimates were exponentiated and are expressed as odds ratios (OR), which can be interpreted as the odds of being in a higher category rather than a lower category for a one-unit change in an independent variable. Because the total number of unprotected sex partners and total number of casual sex partners are counts with an over dispersion of zeros, negative binomial regression was used (Long, 1997). Estimates were exponentiated and are expressed as incident rate ratios (IRR), which can be interpreted as the change in expected count for a unit change in an independent variable. All estimates were adjusted for gender, past year homelessness, marital status, highest level of education, and frequency of injection drug use in Stata version 13 (StataCorp, 2013).

3. Results

Descriptive Statistics

This rural sample consisted of primarily heterosexual (96.2%), low-income (average annual per capita income of <\$5,000), HIV negative (94.0%) and HCV positive (78.4%) adults (see Abadie et al., 2016 for additional sample characteristics). Table 1 displays the descriptive statistics analyzed in the models. The sample was comprised of primarily males (males – 90.8%; females – 9.2%), single individuals (single – 47.0%; married/cohabitating – 22.2%; divorced/separated/widowed – 30.8%), respondents with low education (less than high school diploma – 47.6%; high school diploma or GED – 33.7%; some college – 18.7%), and daily injectors ($M = 5.89$, $S.D. = 1.39$; a value of five indicates an average past year injection frequency of one time per day). In addition, approximately one-third (38.6%) of the sample reported being homeless in the past year. For the alcohol use risk variables, most respondents were considered as no alcohol use (42.2%; $n = 133$) or low alcohol risk (43.5%; $n = 137$). A small proportion of the sample fell into the at-risk alcohol use category (14.3%; $n = 45$). On average, participants binge drank between less than once per month and once per month ($M = 1.68$, $S.D. = 1.92$). A total of 43.2% reported no binge drinking in the past year.

Alcohol Risk Categories

Table 2 displays the multivariate regression models, adjusting for the five demographic variables. The top part of Table 2 (Model 1) displays the results with the alcohol use risk groups as the focal independent variable. Compared to the no alcohol use group, at-risk alcohol use increases overall injection risk behaviors by 0.86 standard deviations ($\beta = 0.86$, $CI = 0.73, 1.65$). There were no significant differences between the no alcohol use group and the low risk alcohol use group on the composite injection risk scale. Moreover, at-risk alcohol use was significantly associated with the three injection risk variables separately; however, frequency of shared needle use was only marginally significant ($p < .10$). Similar to the composite injection risk variable, the odds of being in a higher frequency (i.e., riskier) category compared to a lower frequency category for shared needle use ($OR = 1.85$, $CI = 0.91, 3.81$), shared cooker use ($OR = 1.94$, $CI = 1.02, 3.71$), and shared cotton use ($OR =$

1.96, $CI = 1.04, 3.72$) were almost double for those in the at-risk alcohol use group, compared to the no alcohol use group. Conversely, the odds of being in a higher frequency (i.e., protective) sterile needle use category decreased for those in the at-risk alcohol use group, compared to the no alcohol use group ($OR = 0.42, CI = 0.22, 0.81$). For these three outcomes, there were no significant differences between low alcohol risk and no alcohol use groups. For the two sexual risk outcomes, alcohol risk was only significantly associated with the number of casual sex partners. Respondents in the at-risk alcohol use group compared to no alcohol use group, have an expected rate 1.64 times greater for the number of casual sex partners ($IRR = 1.64, CI = 1.06, 2.54$).

Binge Drinking Frequency

The bottom portion of Table 2 (Model 2) displays the demographic adjusted results with binge drinking frequency as the focal independent variable. For select outcomes, the results were probed further using Stata's *margins* command to estimate the adjusted predicted probabilities or number of events at various levels of past year binge drinking frequency. For every one standard deviation increase in binge drinking frequency, overall injection risk increases by 0.18 standard deviations ($\beta = 0.18, CI = 0.05, 0.32$). To aid in the interpretation, the composite injection risk variable was dichotomized at one standard deviation above the mean to represent "high injection risk." The adjusted predicted probabilities of being a high-risk injector increase 218% from 0.11 ($CI = 0.06, 0.15$) for those reporting no past year binge drinking to 0.35 ($CI = 0.20, 0.51$) for those reporting binge drinking every day. As a point of comparison, the predicted probability of being a high-risk injector was 0.13 ($CI = 0.09, 0.18$), 0.16 ($CI = 0.12, 0.21$), 0.20 ($CI = 0.14, 0.26$), 0.25 ($CI = 0.17, 0.33$), and 0.30 ($CI = 0.18, 0.41$) for binge drinking less than month, once a month, two to three times per month, once per week, and two to six days per week, respectively.

Likewise, for every unit increase in binge drinking frequency, the odds of being in a higher frequency risk category versus a lower frequency category increases for shared needle use ($OR = 1.19, CI = 1.04, 1.35$), shared cooker use ($OR = 1.14, CI = 1.02, 1.27$), and shared cotton use ($OR = 1.14, CI = 1.01, 1.27$). Similarly, binge drinking frequency was negatively associated with the odds of being in a higher frequency sterile needle use category rather than a lower risk category ($OR = 0.89, CI = 0.79, 0.99$). To aid in the interpretation, the adjusted predicted probability of never using shared needles decreases 32% from 0.75 ($CI = 0.68, 0.81$) for those reporting no past year binge drinking to 0.51 ($CI = 0.37, 0.66$) for those reporting binge drinking every day. As a point of comparison, the adjusted predicted probability of never using shared needles was 0.71 ($CI = 0.66, 0.77$), 0.68 ($CI = 0.62, 0.73$), 0.64 ($CI = 0.57, 0.70$), 0.60 ($CI = 0.51, 0.69$), and 0.55 ($CI = 0.44, 0.67$) for binge drinking less than monthly, once per month, two to three times per month, once per week, and two to six times per week, respectively.

For the two sexual risk outcomes, every one-unit increase in binge drinking frequency increased the expected count of total number of unprotected sex partners ($IRR = 1.13, CI = 1.04, 1.23$) and total number of casual sex partners ($IRR = 1.09, CI = 1.01, 1.18$). The adjusted predicted number of unprotected sex partners increases 117% from 1.03 ($CI = 0.81, 1.25$) sex partners for those reporting no past year binge drinking to 2.23 ($CI = 1.40, 3.06$)

sex partner for those reporting binge drinking every day. As a point of comparison, the adjusted predicted number of sex partners was 1.17 (CI = 0.97, 1.36), 1.33 (CI = 1.13, 1.53), 1.51 (CI = 1.24, 1.78), 1.72 (CI = 1.32, 2.12), and 1.96 (CI = 1.40, 3.06) for the binge drinking less than monthly, once per month, two to three times per month, once per week, and two to six days per week, respectively.

4. Discussion

Puerto Rican PWID are at disproportionate risk for contracting and transmitting HIV and HCV (Abadie et al., 2016) compared to their counterparts living in the mainland of the United States (Deren et al., 2003; Duncan et al., 2017; Mino et al., 2011). Little is known, however, about the role that alcohol use plays in HIV and HCV risk among PWID in general and in rural networks of PWID specifically. The current study addresses these gaps in the literature by examining the association between alcohol use and both injection and sexual behaviors that are conducive to HIV and HCV acquisition and transmission among a rural sample of PWID in Puerto Rico. The results provide evidence that frequent binge drinking and high quantity alcohol consumption may be an underlying factor for the high HIV and HCV rates among PWID in rural Puerto Rico.

Using the NIAAA definition of at-risk alcohol use (Dawson et al., 2005; NIAAA, 2005; Stein et al., 2000), a relatively small proportion of the sample were considered at-risk drinkers (14%). Prior research among PWID samples show heavy alcohol use prevalence estimates ranging from 11% to 68% (Campbell et al., 2006; Le Marchand, Evans, Page, Davidson, & Hahn, 2013), perhaps due to differences in sample recruitment (e.g., HIV and/or HCV positive PWID, PWID in treatment or harm reduction settings, young PWID). Our estimates appear to be similar to Campbell et al.'s (2006) findings of HCV positive PWID. Nearly three-quarters of the participants in the current sample tested positive for HCV, yet only half of those participants were aware of their HCV seropositive status prior to participation in our study (Abadie et al., 2016; Duncan et al., 2017). Prior evidence suggests that alcohol use may decrease after testing positive for HCV (McCusker, 2001), which may explain these similarities.

Despite this relative low prevalence of heavy quantity drinkers, the results show that both high frequency of binge drinking and high quantity alcohol consumption, compared to less frequent binge drinking and low quantity consumption, increase both risky injection and sexual risk behaviors conducive to HIV and HCV acquisition and transmission. These associations with both injection and sexual risk factors are consistent with past research among PWID (Arasteh & Des Jarlais, 2009; Le Marchand et al., 2013; Matos et al., 2004), and studies that separately analyzed injection (Hottes, Bruneau, & Daniel, 2011; Stein et al., 2000; Stein, Charuvastra, Maksad, & Anderson, 2002; Wang et al., 2014) and sexual risk (Michael D Stein et al., 2002). These results also support polysubstance use research among PWID, such that co-use of alcohol and other injection drugs predict increased risk of injection and sexual behavior, compared to primary use of one substance (Harrell et al., 2012; Keen et al., 2014).

Several processes may explain the association between alcohol consumption and risky injection and sexual behavior. During periods of intoxication, individuals may be behaviorally disinhibited and focus on proximal cognitive cues (e.g., sexual arousal, achieving injection drug intoxication) conducive to HIV/HCV risk taking while focusing less attention to distal cognitive cues (e.g., condom use, sterile needle and preparation equipment) that may reduce the odds of HIV/HCV acquisition and transmission (Steele & Josephs, 1990). Alternatively, heavy alcohol consumption, injection risk behaviors, and sexual risk behaviors may be associated via some third variable such as low impulse control, low self-control, and high sensation seeking personality characteristics (Shuper et al., 2010). Understanding these potential causal pathways among PWID may help tailor various treatment and harm reduction modalities.

Our findings diverge from several studies that have found that alcohol use is associated with only sexual risk behaviors and not injection risk behaviors (Fairbairn et al., 2016; Rees et al., 2001). The lack of association between alcohol use and injection risk behaviors found by Rees et al. (2001) may be due to their unique sample, which was comprised of a group of injection drug users who have made the decision to enter detoxification services. Though this does not necessarily or in all cases mean that they stopped using drugs, it suggests that their current patterns of injection behavior at the time of the interview may be quite different from what they were prior to entering detoxification and may be reducing their injection risk. In addition, Fairbairn and colleagues (2016) only assessed one injection risk behavior—needle sharing. Although there is only a marginal association between at-risk alcohol use and needle sharing frequency in this sample, binge drinking frequency increased the odds of needle sharing. Consequently, use of one alcohol risk measure and one injection risk behavior may conceal possible associations between alcohol use and injection risk behaviors broadly defined.

The findings also suggest that heavy quantity of weekly alcohol use predicts risk behavior compared to no alcohol use or moderate alcohol use. The post hoc analyses examining the predicted probabilities of engaging in any injection or sexual risk behavior were generally significantly higher for those reporting binge drinking every day or two to six days per week, compared to those reporting no past year binge drinking. This has potential implications for interventions aimed at reducing HIV and HCV risk. Among PWID who use needle exchange programs, brief behavioral interventions have been shown to decrease alcohol use among heavy users (Stein, Charuvastra, et al., 2002) and reduce injection risk behaviors (Stein, Anderson, Charuvastra, Maksad, & Friedmann, 2002). Among HCV positive PWID, brief behavioral interventions that focus on educating individuals on the harmful effects of alcohol on HCV disease progression have been shown to reduce drinking behaviors (McCusker, 2001). The small prevalence of heavy alcohol users in this study may provide some practical hope for the minimization of the risks implicit in our findings. Interventions targeting the relatively small number of heavy and frequent alcohol using PWID may help to reduce poor health outcomes among PWID as a whole and reduce overall social transmission risks to the non-injecting sex partners of PWID.

This study is limited in that it utilizes cross-sectional data so causal order cannot be established. The study compares past month alcohol use measures to past year injection and

sexual risk behaviors. Although prior research has established an association between alcohol use and risky behaviors within the same day (Stein, Anderson, et al., 2002; Stein, Charuvastra, et al., 2002), reverse causation may be plausible such that risky injection and sexual behavior influence levels of alcohol consumption (Sander, Cole, Ostrow, Mehta, & Kirk, 2010). Future research using longitudinal data would be better suited in establishing proper time ordering. In addition, the validity of self-reported alcohol use and risk behaviors may be biased among PWID (Falck, Siegal, Forney, Wang, & Carlson, 1992; Greenfield, Bigelow, & Brooner, 1995; Magura & Kang, 1996). Prior research, however, suggests that self-reported drug use and risk behaviors assessed by trained interviewers in non-treatment settings provide valid assessments (Dowling-Guyer et al., 1994; Needle et al., 1995). Time Follow-Back methods such as the one used by Stein et al. (2002) and longitudinal research may simultaneously address the temporal ordering and recall bias limitations. In addition to temporal ordering and possible self-report bias, our sample was mostly male and may not be generalizable to other PWID populations. Other studies of Puerto Rican PWID using RDS (Centers for Disease Control and Prevention, 2012) and recruitment from heavy drug use areas and health service locations (Deren et al., 2003) generated samples comprised of mostly males (> 85%). Prior research suggests that alcohol use has a stronger effect on sexual risk behaviors for females compared to males in substance abuse treatment (Brooks et al., 2010). This association, however, does not appear to operate for injection risk behaviors (Hottes et al., 2011). More research is needed to elucidate possible gender differences in alcohol use and risky injection and sexual behavior.

Despite these limitations, our results have direct policy implications for HIV and HCV prevention efforts. Interventions that address only one type of drug use may fail to capture the complexity of co-use of multiple substances, which is common among PWID (Harrell et al., 2012; Keen et al., 2014). Interventions aimed at reducing HIV and HCV transmission among injection drug users should both target individuals who drink alcohol frequently and in high volumes, and include strategies for reducing risky behaviors while heavy drinking is occurring.

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Highlights

- Risk behaviors are either sexual or injection behaviors that could transmit HIV or hepatitis C.
- Examined the relationship between alcohol and sexual/injection risk behaviors for PWID.
- Heavy alcohol use was linked to increased injection and sexual risk behaviors.
- Interventions aimed at reducing HIV and HCV transmission among injection drug users should both target individuals who drink alcohol frequently and in high volumes, and include strategies for reducing risky behaviors while heavy drinking is occurring.

Table 1

Descriptive Statistics (N = 315)

	Mean (Std. Dev.) or % (N)	Available N	No Alcohol Use (n = 133)	Low Risk Alcohol Use (n = 137)	At-Risk Alcohol Use (n = 45)
Injection Risk Behavior:					
Composite Injection Risk	5.20 (2.29)	315	5.03 (2.35)	5.14 (2.16)	5.88 (2.40)
Shared needle use ^a	0.40 (0.64)	315	0.38 (0.70)	0.39 (0.58)	0.49 (0.59)
Shared cooker ^a	1.06 (1.11)	315	0.94 (1.06)	1.08 (1.12)	1.36 (1.17)
Shared cotton ^a	0.74 (0.99)	315	0.71 (1.00)	0.67 (0.95)	1.04 (1.07)
Sterile needle use ^a	2.64 (1.04)	314	2.78 (1.04)	2.60 (1.02)	2.33 (1.04)
Sexual Risk Behavior:					
Number of unprotected sex partners	1.37 (2.51)	314	1.32 (2.56)	1.31 (2.40)	1.73 (2.61)
Total number of casual sex partners	1.20 (1.43)	286	1.02 (1.31)	1.24 (1.44)	1.59 (1.65)
Alcohol Use:					
Binge drinking frequency ^b	1.68 (1.92)	315	0.32 (0.77)	2.05 (1.62)	4.58 (1.31)
Demographics:					
Gender		314			
Male	91% (285)		86% (115)	92% (125)	100% (45)
Female	9% (29)		14% (18)	8% (11)	0% (0)
Past year homelessness		314			
Yes	39% (121)		41% (54)	35% (48)	43% (19)
No	61% (193)		59% (79)	65% (89)	57% (25)
Marital status		315			
Single	47% (148)		51% (68)	46% (63)	38% (17)
Married/Cohabiting	22% (70)		20% (26)	27% (37)	16% (7)
Divorced/Separated/Widowed	31% (97)		29% (39)	27% (37)	47% (21)
Highest level of education		315			
Less than high school diploma	48% (150)		48% (64)	44% (60)	58% (26)
High school diploma or GED	34% (106)		33% (44)	36% (49)	29% (13)
Some college	19% (59)		19% (25)	20% (28)	13% (6)
Frequency of injection ^c	5.90 (1.39)	315	5.98 (1.39)	5.88 (1.42)	5.69 (1.29)

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Note: Due to some item missing data, not all variables add to 315

^dResponse Options: (0) Never; (1) Rarely; (2) About Half the Time; (3) Most of the Time; (4) Always

^eResponse Options: (0) Never; (1) Less Than Once a Month; (2) Once a Month; (3) Two-Three Days Per Month; (4) Once a Week; (5) Two-Six Days Per Week; (6) Everyday

^fResponse Options: (0) Less Than Once Time Per Month; (1) One Time Per Month; (2) Two-Three Times Per Month; (3) One Time Per Week; (4) Two-Six Times Per Week; (5) One Time Per Day; (6) Two-Three Times Per Day; (7) Four or More Times Per Day

Table 2

Regression Models Predicting Past Year Injection and Sexual Risk Behaviors ($n = 315$)^a

	Composite Injection Risk Scale ^b	Frequency of Shared Used Needle ^c	Frequency of Shared Used Cooker ^c	Frequency of Shared Used Cotton ^c	Frequency of Sterile Needle Use ^c	Total Number of Unprotected Sex Partners ^d	Total Number of Casual Sex Partners ^d
	β 95% CI	OR 95% CI	OR 95% CI	OR 95% CI	OR 95% CI	IRR 95% CI	IRR 95% CI
Model 1:							
No Alcohol Use	ref	ref	ref	ref	ref	ref	ref
Low-Risk Alcohol Use	0.13 [-0.42, 0.68]	1.28 [0.75, 2.19]	1.23 [0.79, 1.92]	0.96 [0.60, 1.54]	0.68 [†] [0.44, 1.05]	0.98 [0.70, 1.37]	1.26 [0.90, 1.77]
At-Risk Alcohol Use	0.86* [0.07, 1.65]	1.86 [†] [0.91, 3.80]	1.95* [1.02, 3.70]	1.96* [1.04, 3.71]	0.42** [0.22, 0.81]	1.35 [0.86, 2.14]	1.65* [1.06, 2.56]
Model 2:							
Binge Drinking Freq.	0.18** [0.05, 0.32]	1.19** [1.04, 1.35]	1.14* [1.02, 1.27]	1.14* [1.01, 1.27]	0.89* [0.79, 0.99]	1.13** [1.04, 1.23]	1.09* [1.01, 1.18]

[†] $p < .10$;* $p < .05$;** $p < .01$;*** $p < .001$ ^a All estimates were adjusted for gender, past year homelessness, marital status, highest level of education, and frequency of injection drug use^b Ordinary least squares regression—coefficients are standardized^c Ordered logit regression—coefficients are expressed as odds ratios (OR)^d Negative binomial regression—coefficients are expressed as incident rate ratios (IRR)

Note: CI—Confidence interval; Ref—Reference category