

Individual and Socio-Environmental Factors Associated with Unsafe Injection Practices Among Young Adult Injection Drug Users in San Diego

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Published online: 12 June 2014
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Abstract Unsafe injection practices significantly increase the risk of hepatitis C virus (HCV) and human immunodeficiency virus (HIV) infection among injection drug users (IDUs). We examined individual and socio-environmental factors associated with unsafe injection practices in young adult IDUs in San Diego, California. Of 494 IDUs, 46.9 % reported receptive syringe sharing and 68.8 % sharing drug preparation paraphernalia in the last 3 months. Unsafe injection practices were associated with increased odds of having friends who injected drugs with used syringes, injecting with friends or sexual partners, and injecting heroin. Perceived high susceptibility to HIV and perceived barriers to obtaining sterile syringes were associated with increased odds of receptive syringe sharing, but not with sharing injection paraphernalia. Over half the IDUs reported unsafe injection practices. Our results suggest that personal relationships might influence IDUs' perceptions that dictate behavior. Integrated interventions addressing individual and socio-environmental factors are needed to promote safe injection practices in this population.

Resumen Las prácticas inseguras de inyección aumentan significativamente el riesgo de infección para el virus de la hepatitis C (VHC) y el virus de la inmunodeficiencia

humana (VIH) entre usuarios de drogas inyectables (UDI). Se examinó la asociación de los factores individuales y socio-ambientales con las prácticas inseguras de inyección entre los adultos jóvenes UDIs en San Diego, California. De los 494 UDIs, el 46.9 % reportaron que se han inyectado con jeringas usadas y el 68.8 % que han compartido el equipo de preparación de drogas en los últimos 3 meses. Las prácticas inseguras de inyección se asociaron con mayor probabilidad de: tener amigos que se inyectaban drogas con jeringas usadas, inyectarse heroína, y de inyectarse con amigos o con su pareja sexual. La percepción de una alta susceptibilidad para la infección del VIH y la percepción de barreras para la obtención de jeringas estériles se asociaron con una mayor probabilidad de inyectarse con jeringas usadas, pero no se asociaron con el uso compartido del equipo para preparación de drogas. Más de la mitad de los UDIs reportaron prácticas inseguras de inyección. Nuestros resultados sugieren que las relaciones personales pueden influir en las percepciones de los UDIs que dictan su comportamiento. Se necesitan intervenciones integradas que aborden los factores individuales y socio-ambientales para promover prácticas seguras de inyección en esta población.

Keywords HIV/AIDS · Hepatitis C virus · Injection drug use · Unsafe injection practices · Risk perception

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Introduction

Unsafe injection practices such as receptive syringe sharing and drug preparation paraphernalia (i.e., cotton filter, cooker, rinse water) are well established mechanisms that significantly increase the risk of hepatitis C virus (HCV)

and human immunodeficiency virus (HIV) infection [1–4]. In the US, 8 % of new HIV infections, 16 % of the 1.2 million people living with HIV [4] and the majority of HCV infections are among injecting drug users (IDUs) [5]. San Diego has an estimated 25,000–28,000 IDUs [6] and is the third leading city for cumulative cases of HIV infection and AIDS where injection drug use is the second leading route of transmission [5]. San Diego is located in Southern California, immediately adjacent to the Mexican border city of Tijuana, Baja California, and its border crossing is known as an international drug trafficking route from South America to the United States [7, 8]. Mexico serves as a major producer of heroin, marijuana, and methamphetamine, and Baja California has the highest prevalence of injection drug use and methamphetamine use among Mexico's 32 states [9]. Prior research in the San Diego/Tijuana border region found that IDUs travel across the border for drugs, creating a potential interaction among IDUs in both countries and increasing their risk of HIV infection [8–10].

From 1990 to present, HIV incidence has declined among IDUs in the US and countries in Latin America. This may reflect prevention program effectiveness and behavior changes within different contexts [11–13]. However, in some countries the HIV epidemic is still dominated by exposure to blood-contaminated equipment for injecting illicit drugs. Prevalence of unsafe injection practices varies greatly from 32 to 73 % depending on location and population differences across studies [3, 12, 14–16]. A study conducted in 23 cities in the US found that half of the IDUs from San Diego reported shared syringes and almost three-quarters shared other injection paraphernalia in the past 12 months [17]. A separate study found that 43 % of San Diegan IDUs who crossed the border to Tijuana reported distributive syringe sharing there [8, 18]. These findings are particularly concerning given that sharing syringes is a well-established risk factor for HIV infection [19], and young IDUs who may be new to injecting are at increased risk for HIV and HCV infections through these behaviors [20–24].

Individual psychological factors may influence injection practices among IDUs. For example, if IDUs perceive higher risk or susceptibility to HIV infection or other negative health outcomes due to syringe sharing, they may practice fewer high-risk behaviors and avoid HIV infection [25–29]. Likewise, perceived barriers to engaging in safe behaviors (e.g., not sharing or always using new syringes), have also been found to be associated with HIV risk behaviors [25, 30, 31]. Hence improved integration of HIV prevention and treatment services at the individual and structural levels, including environmental factors, is critical to reducing HIV risk [1]. According with the framework proposed by Rhodes et al. the risk environment has been

defined as a product of the social or physical space in which a variety of factors interact to increase the chances of drug-related harm [24, 32]. Having friends who share injection equipment, injecting with friends or sexual partners [33, 34], injecting in public places, homelessness, and incarceration history [35–37] are examples of environmental risk factors that have been associated with unsafe injection practices. Other barriers to carrying sterile syringes include social factors such as stigma, discrimination, laws, policing and fear of arrest for syringe possession. These factors influence IDUs' perceptions and decisions to engage in unsafe injection practices [35, 38–42].

Given the importance of understanding the relations between individual and socio-environmental factors on the presence of IDUs' unsafe injection behaviors, we examined the independent association of individual (e.g., perceived susceptibility to HIV, perceived barriers to obtaining sterile syringes and drug preparation paraphernalia) and socio-environmental factors (e.g., injection relationships, homelessness, drug injection location and syringe sources) with unsafe injection practices among young adult IDUs in San Diego.

Methods

Study Population and Recruitment

A secondary analysis was performed using data from a cross-sectional study conducted between March 2009 and July 2010 to estimate the prevalence and identify correlates of HCV and HIV infection among young adult IDUs in San Diego, CA [43]. Individuals were invited to participate if they were 18–40 years old, reported illicit drug injection in the previous 6 months, resided in San Diego County, agreed to a blood draw for HCV and HIV testing and were willing to provide informed consent and contact information. Participation involved two visits. During the first visit participants completed an interview, pre-test counseling, and venipuncture for HCV and HIV testing. Test results and post-test counseling were given 2 or 3 weeks later during their second visit. Participants were referred to medical care if they tested positive for HCV or HIV infection. The study was reviewed and approved by the University of California, San Diego, Human Research Protections Program.

Recruitment methods included; street outreach, which involved outreach workers engaging individuals and distributing recruitment cards where IDUs are known to frequent; venue-based recruitment [i.e., syringe exchange program (SEP)]; and respondent-driven sampling (RDS). Although RDS has the advantage of allowing statistical

weighting to produce prevalence estimates that are unbiased by non-random seed selection [44, 45], only 15.9 % of the participants in this study were recruited by RDS [43]. Furthermore, all three recruitment methods took place simultaneously and since each method appeared to capture different subsets of this hidden population, we pooled the data for analyses in order to represent a broad cross-section of IDUs in San Diego [43–45]. Participants were compensated \$25 for completing the assessment visit and \$10 for the results visit. Participants who recruited other IDUs through RDS received \$10 for each eligible participant they referred (maximum 3).

Data Collection

The behavioral assessment consisted of a structured self-administrated questionnaire using audio computer-assisted self-interview technology (ACASI) and took approximately 1 h to complete. The questionnaire included demographics, and individual and socio-environmental factors which are described below.

Measures

The primary outcome for the present analysis was unsafe injection practices, which included receptive syringe sharing and sharing drug preparation paraphernalia (i.e., cookers, cotton, rinse water). We examined these behaviors separately because their potential for HIV transmission differs and previous research has shown that some specific characteristics of IDUs appear to be more related with sharing syringes (e.g., situational factors) or specifically with drug preparation paraphernalia (e.g., perceived risk to HIV/AIDS, injecting partners) [17, 43, 46, 47]. Moreover, public health interventions place greater emphasis on receptive syringe sharing, which could influence IDUs' perceived risks from these behaviors [26, 47]. “*Receptive syringe sharing*” was assessed by asking participants, “In the last 3 months, when you injected, how often did you use a syringe that you knew or suspected had been used before by someone else?” and “In the last 3 months, how often did you inject with syringes that had been used before by someone else, even if the syringe was cleaned first?”. For this analysis, the responses for these questions (i.e., never, less than half the time, about half the time, more than half the time and always) were condensed into two categories “yes” and “no”. Participants who responded “never” to both questions were automatically coded as “no” and all the other responses (always/more than half/half/less than half) were coded as “yes”. “*Sharing drug preparation paraphernalia*” was assessed by asking participants three questions: “In the last 3 months, how often did you use a *cooker* at the same time or after someone else

used it?”; “In the last 3 months, how often did you use *cotton* at the same time or after another person used it?” and “In the last 3 months, how often did you use *rinse water* at the same time or after another person drew up water or rinsed their syringe in it?” Categories of responses were on a 5-point scale from “never” to “always”. For the current analysis, responses of each question were dichotomized as “yes” (always/more than half/half/less than half) or “no” (never). The outcome variable was created by dichotomizing the responses of the three questions above. If any paraphernalia (i.e., cooker, cotton or rinse water) was used after someone else, it was coded as “yes”; “never” to all three questions was coded as “no” [43].

Demographics variables included age, sex, birth country, race/ethnicity, and educational attainment. Individual factors included drug use history and HIV perceptions and beliefs. Participants were asked to report the age they first injected any illicit drug and drug type most frequently used (non-injected and injected) in the past 3 months. *Perceived high susceptibility to HIV* was assessed by asking participants, “Compared with other drug users in the San Diego area, how likely do you think you are to get infected with HIV/AIDS?” and “How likely do you think it is that you will become infected with HIV from injecting drugs in the next 3 months?” Responses for both of these questions were recoded to create a single dichotomized answer as “yes” (i.e., very likely, somewhat likely) or “no” (i.e., very unlikely, somewhat unlikely, neither likely nor unlikely). Participants were also asked to report the extent to which they were in current need of drug treatment on a 4-point scale (i.e., urgent need, great need, some need, no need). Responses were recoded to “need” or “no need”. Perceived barriers to obtaining sterile syringes was assessed by asking participants, “In the last 3 months, how easy or hard was it for you to get new, unused syringes when you injected drugs?”. Responses for this question were dichotomized as “yes” (i.e., hard, very hard) or “no” (i.e., easy, very easy). HIV/AIDS beliefs included true or false responses to the following statements; “once people get infected with HIV most will have it forever” and “most people with HIV cannot tell that they are infected”.

Socio-environmental factors included: place lived in most of the time over the past 6 months (e.g., own or parents' house, family, friends or sexual partner's house); personal income over the past 12 months (i.e., greater or less than \$10,000); considered themselves homeless in the past 6 months (i.e., in the past 6 months, have you ever thought of yourself as homeless? yes/no); ever been in a jail or juvenile detention center; ever been beaten, physically attacked or abused as an adult; and whether previous encounters with police affected their access to new syringes. Participants were also asked to report if any of their friends had injected with a used syringe in the past 3 months, place injected most

often (i.e., own home, someone else's home, street, shooting gallery, other), who they inject with (i.e., friends, sexual partner/spouse, other or alone), sources used to obtain new syringes (i.e., friends, sexual partner, pharmacies, SEP or other), and if they are aware of or have used the SEP in San Diego in the past 3 months. Measurements of socio-environmental variables are described in Table 2.

Statistical Analysis

Of the 566 participants enrolled, 56 were excluded from the current analysis due to missing values for the outcome variables and 16 due to self-identifying as HIV-positive, because questions about perceived HIV susceptibility were not applicable to these participants. Thus, the current analysis included 494 participants. In comparing characteristics of participants enrolled with those who were excluded for this analysis, we found no significant differences for demographics including ethnicity, gender, education and main exposure factor variables. Separate analyses were conducted to identify factors independently associated with receptive syringe sharing and sharing injection paraphernalia. Continuous variables were examined using the *t* test, while categorical data were examined using Chi square tests. Univariate and multivariate logistic regression models were used to identify factors associated with both sharing variables. Variables that had a significance level of $p < 0.10$ in the univariate analysis were considered potential factors for inclusion in the multivariate models. Multivariate models were developed using a backward stepwise approach beginning with those with the lowest *p* value and proceeding in order to the variable with the highest *p* value (up to $p < 0.10$). The likelihood ratio test was used to compare nested models, using a significance level of $p < 0.05$ to select variables for retention in the final model. We tested for possible interaction to determine whether gender modified the effect of perceived susceptibility to HIV/AIDS on each type of unsafe injection practice, because women might have a different perception of the prevalence of HIV in their partners compared to men [48]. A correlation matrix was run to identify collinearity prior multivariate analysis. We also controlled for recruitment method in order to address any differences in the association of outcome variables and exposures factors of interest by recruitment method. Data were analyzed using STATA 11.0.

Results

Of 494 IDUs, 46.9 % reported receptive syringe sharing and 68.8 % reported sharing drug preparation paraphernalia in the past 3 months. Most were recruited via venue-based recruitment (i.e., SEP) and street outreach, 44.8 and 39.3 %,

respectively. Only 15.9 of the sample was recruited via RDS (Table 1). There were no significant differences by recruitment method on receptive syringe sharing and sharing drug paraphernalia, and exposure factors (e.g., perceived HIV risk infection, barriers to get new syringes). We found significant differences for sex, race, education level, income and living conditions (i.e., where they sleep most often and homeless) by recruitment method (data not shown). Mean age was 28.5 years [standard deviation (SD) = 6], 73.3 % were male, 95.6 % were born in the US, and more than half (64.6 %) had a high school or lower level of education. A third (29.8 %) were Hispanic or Latino, 53.7 % non-Hispanic white and 6.7 % African American. Mean age at first injection of illegal drug was 21 years (SD = 6). Heroin was the most frequently reported drug injected in the past 3 months (65.9 %), followed by methamphetamine (45.5 %) and cocaine (20.4 %). A quarter (25.3 %) tested HCV-positive and 2.4 % tested HIV-positive in the study. Characteristics of the study sample used for this analysis are described in Table 1.

Regarding HIV perceptions and beliefs, 26.6 % of the participants perceived high susceptibility to HIV compared with others drug users in San Diego and 27.4 % perceived barriers to obtaining sterile syringes. Most participants (95.4 %) believed that once people get infected with HIV most will have it forever, and 75.1 % believed that most people with HIV cannot tell they are infected.

Univariate analyses show potential associations between receptive syringe sharing and sharing drug preparation paraphernalia with individual (Table 1) and socio-environmental factors (Table 2). Being female, injecting heroin and cocaine (each drug alone or in combination), injecting with friends or a sexual partner, and most of the socio-environmental variables (e.g., lived in the streets, homelessness, having been in a jail) were associated with sharing syringes and drug preparation paraphernalia. Regarding HIV perceptions and beliefs about their risks from injecting drugs, we found some similarities and differences in the associations with our outcome variables. Perceived high susceptibility to HIV compared with other IDUs in San Diego, perceived need for drug treatment, and perceived barriers to obtaining sterile syringes were all associated with receptive syringe sharing and sharing drug preparation paraphernalia. However, perceived high susceptibility to HIV from injecting drugs in the next 3 months only was associated with receptive syringe sharing.

In multivariate analysis (Table 3), IDUs who reported receptive syringe sharing had higher odds of reporting perceived high susceptibility to HIV from injecting drugs in the next 3 months [Adjusted Odd Ratio (AOR) = 2.54, 95 % confidence interval (CI): 1.12–5.78], perceived barriers to obtaining sterile syringes (AOR = 2.65, 95 % CI 1.57–4.47) and injecting heroin (AOR = 3.81, 95 % CI

Table 1 Univariate analyses of demographic characteristics and individual behaviors by unsafe injection practices among young adult injection drug users in San Diego, CA, 2009–2010

Description ^a	Receptive syringe sharing ^b			Sharing drug preparation paraphernalia ^c			
	Total (N = 494) %	Yes (n = 232) %	No (n = 262) %	OR (95 % CI)	Yes (n = 340) %	No (n = 154) %	OR (95 % CI)
Recruitment methods							
RDS	15.9	15.9	16.1	1.00	15.9	16.2	1.00
SEP	44.8	47.8	42.0	1.14 (0.67–1.91)	45.9	42.2	1.11 (0.63–1.94)
Outreach	39.3	36.3	41.9	0.87 (0.52–1.46)	38.2	41.6	0.96 (0.53–1.64)
Demographics							
Mean age (SD)	28.5 (6)	27.8 (6)	29.2 (6)	0.96 (0.93–0.98)**	28.4 (6)	28.9 (6)	0.98 (0.96–1.01)
Male	73.3	69.4	76.7	1.00	70.0	79.9	1.00
Female	26.7	30.6	23.3	1.49 (1.017–2.16)*	30.0	20.1	1.68 (1.07– 2.65)*
Born in the U.S.	95.6	96.6	94.6	1.58 (0.65–3.83)	97.0	92.2	2.78 (1.17–6.60)*
High School or lower level of education	64.6	67.0	62.9	1.22 (0.85–1.76)	65.1	65.6	0.96 (0.65–1.43)
Ethnic background							
Non-Hispanic white	53.7	56.5	51.2	1.00	55.7	49.7	1.00
Hispanic or Latino	29.8	30.8	28.8	0.96 (0.63–1.46)	29.0	31.3	0.82 (0.53–1.29)
African-American	6.7	3.3	9.8	0.30 (0.12–0.73)**	5.4	9.5	0.50 (0.23–1.08)≠
Other: Asian, Native Hawaiian	9.8	9.4	10.2	0.83 (0.43–1.57)	9.9	9.5	0.92 (0.46–1.84)
Individual factors							
Drug use history and risk behaviors							
Non-injection drug used^d							
Marijuana or hashish	61.3	64.6	58.4	1.30 (0.90–1.87)	63.8	55.8	1.39 (0.94–2.05)≠
Methamphetamine	53.5	58.1	49.4	1.42 (0.99–2.03)≠	55.4	49.4	1.27 (0.87–1.87)
Heroin	47.9	51.2	45.0	1.28 (0.90–1.83)	49.4	44.8	1.20 (0.82–1.76)
Powder cocaine	39.5	39.6	39.4	1.00 (0.70–1.44)	41.5	35.0	1.31 (0.88–1.95)
Mean age at first injection of illegal drugs (SD)	21.0 (6)	20.1 (5)	21.0 (6)	0.94 (0.91–0.97)***	21.1 (6)	20.9 (5)	1.01 (0.97–1.04)
Drugs injected^d							
Heroin and cocaine together	26.9	34.0	20.5	1.99 (1.33–2.99)***	29.7	20.5	1.64 (1.03–2.59)*
Heroin and methamphetamine together	18.1	25.0	12.0	2.44 (1.51–3.93)***	21.5	10.6	2.31 (1.29–4.13)**
Heroin by itself	65.9	76.2	56.6	2.46 (1.67–3.64)***	70.8	54.9	1.98 (1.33–2.95)***
Cocaine by itself	20.4	26.7	14.7	2.11 (1.34–3.31)***	23.0	14.5	1.75 (1.04–2.94)*
Methamphetamine	45.5	46.9	44.1	1.11 (0.78–1.59)	47.7	40.4	1.35 (0.91–1.99)
HIV & drug use perceptions and beliefs							
Perceived high susceptibility to HIV compared with other drug users in San Diego	26.6	31.2	22.4	1.57 (1.04–2.38)*	29.7	19.1	1.79 (1.10–2.89)*
Perceived high susceptibility to HIV from injecting drugs in the next 3 months	9.9	14.7	5.6	2.90 (1.50–5.57)***	10.8	7.8	1.45 (0.71–2.94)
Perceived they currently are in need of treatment for their drug use	68.8	74.4	63.9	1.64 (1.10–2.43)*	75.2	54.7	2.51 (1.67–3.77)***

Table 1 continued

Description ^a	Total (N = 494) %	Receptive syringe sharing ^b			Sharing drug preparation paraphernalia ^c		
		Yes (n = 232) %	No (n = 262) %	OR (95 % CI)	Yes (n = 340) %	No (n = 154) %	OR (95 % CI)
Perceived barriers to obtaining sterile syringes	27.4	41.0	15.4	3.81 (2.48–5.84)***	32.1	17.1	2.29 (1.42–3.71)***
Believed that once people get infected with HIV, most will have it forever	95.4	95.1	95.7	0.88 (0.37–2.09)	95.8	94.5	1.31 (0.53–3.20)
Believed that most people with HIV/AIDS cannot tell that they are infected	75.1	72.7	77.2	0.78 (0.51–1.19)	76.6	71.8	1.28 (0.83–1.99)
Tested HCV-positive in the study	25.3	28.8	22.1	1.42 (0.95–2.14)≠	28.2	18.8	1.69 (1.06–2.70)*
Tested HIV-positive in the study	2.4	2.1	2.7	0.80 (0.25–2.56)	2.7	1.9	1.36 (0.36–5.12)

OR = Odds Ratio, CI = Confidence Interval

≠ $p < 0.10$; * $p < 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$ (p values for comparing the characteristics between IDUs are from t test and Chi square test)

^a Referent time period for all factors was the past 3 months, unless otherwise specified

^b Receptive syringe sharing “Yes” (always/more than half/half/less than half) vs. “No” (never)

^c Sharing drug preparation paraphernalia “Yes” (always/more than half/half/less than half) vs. “No” (never)

^d For each type of injected and non-injected drugs: “Ever” (5 or more times a day/2–4 a day/once a day/a week/less than a week) vs. “Never”

2.20–6.57). With respect of the socio-environmental factors, receptive sharing syringes was also associated with increased odds of ever being in jail, prison or detention center (AOR = 1.92, 95 % CI 1.10–3.34), having friends who inject drugs with a syringe that has been used before (AOR = 4.67, 96 % CI 2.79–7.80), injecting most often with friends (AOR = 2.06, 95 % CI 1.16–3.64) or with their sexual partner (AOR = 2.35, 95 % CI 1.15–4.78), and injecting most often on the streets (AOR = 2.40, 95 % CI 1.15–4.78) or other: bar, shooting gallery, park (AOR = 1.98, 95 % CI 1.02–3.83).

As with receptive sharing syringes, sharing drug preparation paraphernalia was independently associated with reporting perceived high susceptibility to HIV/AIDS compared with other drug users in San Diego (AOR = 1.96, 95 % CI 1.09–3.52), injected heroin (AOR = 2.50, 95 % CI 1.49–4.52) and ever having been in jail, prison or a detention center (AOR = 1.87, 95 % CI 1.07–3.28). Injecting most often with friends (AOR = 1.79, 95 % CI 1.01–3.16) or sexual partner (AOR = 4.36, 95 % CI 1.90–10.01) and injecting at some else’s home (AOR = 1.91, 95 % CI 1.02–3.63) were also socio-environmental factors associated with sharing drug preparation paraphernalia. Additionally, participants who reported sharing drug paraphernalia also had increased odds of reporting perceived current need of drug treatment (AOR = 2.04, 95 % CI 1.23–3.37) and had friends who inject drugs with a syringe that has been used before (AOR = 3.21, 95 % CI 1.96–5.26).

We examined the independent effect of gender on all the variables in the final model. In particular, our results indicated a significant interaction between gender and perceived high susceptibility to HIV on the odds of receptive syringe sharing ($p = 0.03$) (Table 3). This significant interaction suggests that females with perceived high susceptibility to HIV compared with other drug users had increased odds in receptive syringe sharing. However, this association was not found among male participants. The correlation matrix that was performed to identify collinearity among independent variables showed that the highest coefficient of correlation was <10 %, no correlations were found. No significant interactions were found for sharing drug preparation paraphernalia and there were no significant differences by recruitment method in the groups for each dependent variable.

Discussion

This study revealed that unsafe injection practices continue to be common among young adult IDUs. Nearly half of the participants currently inject drugs with used syringes and two-thirds reported sharing drug preparation paraphernalia in the past 3 months. This is particularly concerning given that most of the IDUs surveyed began injecting after the risks from sharing syringes and injection paraphernalia were clearly established and public health interventions

Table 2 Univariate analyses of socio-environmental factors by unsafe injection practices among young adult injection drug users in San Diego, CA, 2009–2010

Description ^a	Receptive syringe sharing ^b			Sharing drug preparation paraphernalia ^c			
	Total (N = 494) %	Yes (n = 232) %	No (n = 262) %	OR (95 % CI)	Yes (n = 340) %	No (n = 154) %	OR (95 % CI)
Socio-environmental factors							
Place lived most of the time (past 6 months)							
Own or parents' house	38.6	31.7	44.6	1.00	34.4	47.7	1.00
Family, friend's or sexual partner's house	22.7	21.6	23.6	1.28 (0.79–2.06)	23.9	19.9	1.66 (1.00–2.78)*
Shelter, jail or drug treatment facility	19.2	22.5	16.3	1.93 (1.27–3.20)**	20.1	17.2	1.61 (0.93–2.76)†
Streets, abandoned building, car or truck	19.5	24.2	15.5	2.19 (1.32–3.63)**	21.6	15.2	1.95 (1.12–3.41)*
Income < \$10,000 (past 12 months)	78.4	83.2	74.6	1.69 (1.08–2.64)*	80.2	75.1	1.34 (0.85–2.11)
Homeless (past 6 months)	55.2	62.0	49.2	1.68 (1.17–2.41)**	58.8	47.4	1.58 (1.08–2.32)*
Ever in jail, prison or juvenile detention center	77.3	82.3	72.9	1.73 (1.12–2.67)**	80.2	70.7	1.68 (1.08–2.60)*
Ever been beaten, physically attacked or abused as an adult	29.6	32.6	27.0	1.30 (0.88–19.92)	32.0	24.3	1.46 (0.94–2.26)†
Have experience with police affected their access to new syringes	12.5	18.5	7.2	2.90 (1.64–5.15)***	15.6	5.8	2.97 (1.42–6.20)**
Had friends who inject drugs with a syringe that has been used before	66.2	82.7	51.4	4.52 (2.94–6.95)***	75.3	45.0	3.74 (2.46–5.68)***
Location injected most often ^a							
IDUs' home	46.7	39.8	52.9	1.00	42.7	55.7	1.00
Someone else's home	23.3	25.1	21.6	1.54 (0.98–2.43)†	26.1	16.8	2.02 (1.20–3.41)**
Street, vacant lot or alleyway	12.7	15.2	10.6	2.22 (1.07–3.35)*	12.5	13.4	1.21 (0.66–2.19)
Other: bar, shooting gallery, park, public restroom	17.3	19.9	14.9	1.77 (1.07–2.94)*	18.7	14.1	1.71 (0.98–3.03)†
Persons injected with most often ^a							
Alone	26.8	20.4	32.5	1.00	21.7	38.3	1.00
Friends	44.1	46.0	42.3	1.73 (1.10–2.71)*	45.6	40.9	1.95 (1.24–2.09)**
Sexual partner/spouse	18.8	22.1	15.7	2.25 (1.30–3.89)**	23.2	8.7	4.68 (2.36–9.26)***
Other: acquaintance, drug dealer, stranger, sex worker	10.3	11.3	9.4	1.91 (0.98–3.70)†	9.5	12.1	1.38 (0.70–2.72)
Sources used most often to obtain new syringes ^a							
Other: drug dealer/shooting gallery/clinic/market	23.3	19.4	26.7	1.00	18.2	34.4	1.00
Friends/sexual partner/spouse	40.1	46.6	34.4	1.86 (1.16–2.97)**	44.4	30.5	2.74 (1.67–4.48)***
Pharmacies	9.1	6.0	11.8	0.70 (0.33–1.46)	8.0	11.7	1.28 (0.63–2.58)
SEP	27.5	28.0	27.1	1.42 (0.86–2.35)	29.4	23.4	2.37 (1.39–4.02)*
Aware of syringe exchange program in San Diego	76.8	78.3	75.4	1.17 (0.77–1.79)	77.8	74.5	1.20 (0.77–1.87)
Used syringe exchange program in San Diego (past 3 months)	47.7	50.6	45.2	1.24 (0.87–1.77)	50.7	41.1	1.47 (1.00–2.16)*

OR = Odds Ratio, CI = Confidence Interval

† $p < 0.10$; * $p < 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$ (p values for comparing the characteristics between IDUs are from t test and Chi square test)^a Referent time period for all factors was the past 3 months, unless otherwise specified^b Receptive syringe sharing “Yes” (always/more than half/half/less than half) vs. “No” (never)^c Sharing drug preparation paraphernalia “Yes” (always/more than half/half/less than half) vs. “No” (never)

focused on reducing these behaviors. We found a number of individual and socio-environmental factors associated with unsafe injection practices. This provides a broad view of the factors that may be influencing IDUs' decisions and behaviors. Perceiving themselves at greater risk for HIV than other IDUs, injecting heroin in the last 3 months, having friends who inject drugs with used syringes, injecting most of the time with friends or sexual partners, injecting in someone else's home, and ever having been incarcerated were associated with both receptive syringe sharing and sharing drug preparation paraphernalia. In contrast, perceived high susceptibility to HIV from injecting drugs in the next 3 months, perceived barriers to obtaining syringes, and injecting on the streets were factors not associated with sharing drug preparation paraphernalia.

Although we found a strong association between perceived HIV susceptibility and sharing syringes or drug paraphernalia, there is a significant interaction between gender and perceived high susceptibility. Women who perceived higher HIV susceptibility had higher odds of reporting receptive syringe sharing compared with their male counterparts. Female IDUs reported more unsafe injection practices that may be contributing to their perceived HIV susceptibility. This result may indicate a cultural context and gender inequality in which female IDUs are involved [49]. Historically, harm reduction programs have focused mainly on male IDUs [50]. Further study is imperative to identify and understand the factors influencing receptive syringe sharing among vulnerable females IDUs who already are aware of increased HIV susceptibility associated with unsafe injection practices, as well as the development of interventions that address these specific factors [48].

One of the most important public health challenges is how to predict risk behaviors and what motivates the adoption or maintenance of health behaviors [51]. Several studies have shown that cognitive behavioral theories (e.g., Health Belief Model, Theory of Reasoned Action, Theory of Planned Behavior) are commonly used in research surrounding injection risk behaviors [30, 31]. While the positive association between perceived high susceptibility to HIV and unsafe injection practices observed in this study is consistent with findings from Budapest [25], Montreal [26], Baltimore [48] and Los Angeles [52], other studies contradict these findings. For example, a longitudinal study conducted in five US cities found that low levels of perceived risk of HIV and HCV infection were significant predictors of receptive syringe sharing [53]. IDUs frequently injected with other individuals and their perceptions about the susceptibility or risk to HIV infection may be influenced depending on who they are sharing syringes with. For example, Smyth and colleagues found that syringe borrowing is commonly practiced by young IDUs and that

the concepts of "sharing" and "preparing to share in the future" were significantly associated with lower perceived risk when borrowing from sexual partners, close friends and acquaintances [54, 55]. Compared to other studies, we found no association between relationship to the person they inject with most often and perceived susceptibility to HIV. This result indicates that even if IDUs share syringes with their sexual partners or friends, their perceived susceptibility to HIV will not modify their likelihood of engaging in unsafe injection practices.

Our study also revealed that IDUs who perceived barriers to obtaining sterile syringes reported increased odds of unsafe injection practices. This finding, in accordance with other studies [26], suggests that IDUs could be experiencing difficulties in accessing sterile syringes due to fear of the police [25, 38, 56] or stigma [41, 42]. Despite the fact that 43 % of the participants were recruited from SEP, there were no significant differences between unsafe injection practices and recruitment method. Additionally, in our final model after controlling for method of recruitment, the associations between perceived barriers to obtaining sterile syringes and the dependent variables did not change. An explanation of this is that IDUs perhaps use the SEP services; however, in San Diego the program operates through a mobile unit only two days per week (3–4 h/day) in two different locations. Thus, it is unlikely that the number of syringes obtained through the program is sufficient to meet their needs. Since perceived susceptibility to acquiring HIV and perceived barriers to engaging in safe injection practices are the two most significant individual constructs in determining behavior change [28]. Our results highlight an important factor of 'perceived barriers to obtaining sterile syringes' that could be addressed by expanding the services provided by the local SEP.

Our results are consistent with other studies [35, 57–59], which found that injecting heroin and previous incarceration were strongly associated with unsafe injection practices. Given the severity of withdrawal symptoms experienced by IDUs addicted to heroin during periods of abstinence, the perceived risk of acquiring HIV from syringe sharing is outweighed by the immediate need for a fix. This situation significantly affects IDUs' behaviors because sharing injection equipment or fluids can facilitate several consequences of heroin abuse; HIV, hepatitis B and C [39, 60]. History of incarceration could be another consequence of IDUs' addiction that is associated with HIV risk behaviors. In our study, three-quarters of the participants reported a history of incarceration. Recent studies have demonstrated a strong link between unsafe injection practices and incarceration; during incarceration the majority of IDUs have no other option but to inject with borrowed or used syringes [37, 57]. Although we do not know if drug

Table 3 Factors independently associated with unsafe injection practices among young adult injection drug users in San Diego, CA, 2009–2010 (n = 443)

Description ^a	Receptive syringe sharing ^b		Sharing drug preparation paraphernalia ^c
	Model 1 AOR (95 % CI)	Model 2 AOR (95 % CI)	
Female (ref = male)	1.33 (0.80–2.21)	0.92 (0.50–1.67)	1.41 (0.55–2.24)
Individual factors			
Perceived high susceptibility to HIV compared with other drug users in San Diego ^d	1.67 (1.01–2.80)*	1.18 (0.64–2.18)	1.96 (1.09–3.52)*
Perceived high susceptibility to HIV from injecting drugs, in the next 3 months ^{d, e}	2.41 (1.08–5.39)*	2.54 (1.12–5.78)*	–
Perceived they currently are in need of treatment for their drug use ^d	1.02 (0.62–1.68)	0.99 (0.60–1.65)	2.04 (1.23–3.37)**
Perceived barriers to obtaining sterile syringes ^d	2.82 (1.69–4.70)***	2.65 (1.57–4.47)***	1.65 (0.91–2.98)
Injected heroin by itself	3.71 (2.21–6.23)***	3.81 (2.20–6.57)***	2.50 (1.49–4.52)***
Socio-environmental factors			
Ever in jail, prison or juvenile detention center	2.01 (1.16–3.46)*	1.92 (1.10–3.34)*	1.87 (1.07–3.28)*
Had friends who inject drugs with a syringe that has been used before	4.55 (2.73–7.58)***	4.67 (2.79–7.80)***	3.21 (1.96–5.26)***
Persons who injected with most often: (ref = alone)			
Friends	1.98 (1.12–3.48)*	2.06 (1.16–3.64)	1.79 (1.01–3.16)*
Sexual partner/spouse	2.25 (1.12–4.51)**	2.35 (1.15–4.78)*	4.36 (1.90–10.01)***
Other: acquaintance, drug dealer, etc.	2.10 (0.91–4.87)	2.13 (0.91–4.97)	1.12 (0.48–2.58)
Location injected most often in past 3 months: (ref = own or parents' house)			
Someone else's home	1.78 (1.01–3.14)*	1.78 (0.99–3.19)*	1.91 (1.02–3.63)*
Street/vacant lot/alleyway	2.24 (1.10–4.58)*	2.40 (1.15–4.78)*	1.28 (0.59–2.75)
Other: bar, shooting gallery, park, public restroom	1.84 (0.96–3.53)	1.98 (1.02–3.83)*	1.87 (0.90–3.82)
Female × Perceived high susceptibility to HIV compared with other drug users	–	3.37 (1.05–10.76)*	–

Note Controlled by recruitment method and all the other variables in the table

AOR = Adjusted Odds Ratio, CI = Confidence Interval, Model 1 = without interaction term, Model 2 = with interaction term

* $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

^a Period of time 3 months

^b In the past 3 months, receptive syringe sharing “Yes” (always/more than half/half/less than half) vs. “No” (never)

^c In the past 3 months, sharing drug preparation paraphernalia “Yes” (always/more than half/half/less than half) vs. “No” (never)

^d “Yes” vs. “No”

^e Variable not significant at the univariate analysis

use or unsafe injection practices began before, during, or after incarceration, it is important to recognize that IDUs with a history of incarceration are more likely to engage in unsafe injection practices. They also might be facing more barriers to obtaining new/sterile syringes through the SEP that in this population subgroup at high risk for HIV is crucial.

Several studies have found an association between structural or socio-environmental factors and unsafe injection behaviors, including sharing syringes and drug injection paraphernalia [33, 35, 36, 38, 61]. The present study revealed that IDUs who have friends that inject with

used syringes, inject with close companions (i.e., friends or sexual partners), and inject on the street, had increased odds of engaging in unsafe injection practices. Public injecting environments, such as shooting galleries, streets, or any place in which IDUs gather to inject drugs, play an important role in HIV risk behaviors. Understanding the physical places where drug injection commonly occurs provides an opportunity to develop interventions to reduce drug-related harm focused on the environment [62]. It is also widely accepted that social relations with other individuals who are engaging in risk behaviors influence or predict unsafe injection practices [63]. One study found

that IDUs who reported having intimate social relationships with other IDUs and usually preferred injecting in the company of other IDUs, were more likely to report syringe borrowing [54]. Another study found that having a close relationship and injecting with a sex partner or close friend were risk factors for non-syringe paraphernalia sharing [35]. Higher rates of unsafe injecting practices among IDUs who mostly inject with friends and sex partners could suggest that social relationships may influence IDUs' beliefs and perceptions that dictate behavior. Further studies are needed to elucidate under what circumstances these risk behaviors with friends and sex partners take place and how these could be addressed by improving the local SEP.

Some important variables that were only significant at the univariate level include age, low personal income, place where sterile syringes are obtained, homelessness and interactions with police. In this study population, younger IDUs were more likely to report receptive syringe sharing, which is consistent with other studies where young IDUs were less likely to use syringe exchange programs and more likely to face barriers in accessing HIV prevention programs [20, 21]. Our participants obtained sterile syringes from their friends, and these relationships play a critical role in the IDUs' decision to avoid or engage in unsafe injection practices. Low personal income, homelessness and interactions with police are also some important environmental factors that influence in the association between other social and individual factors with unsafe injection practices [36, 56]. Although these factors could predispose the risk of HIV infection, in our population, perceiving themselves at greater risk for HIV or perceiving barriers to obtaining syringes, injecting heroin, having friends who inject drugs with used syringes and ever having been incarcerated were more important factors independently associated with unsafe injection practices. Based in our results, a prospective study should be considered in order to better understand the relation of these associations over time and determine the predictors of unsafe injection practices.

Several limitations in this study should be considered. Because this is a cross-sectional study and the IDU perceptions were measured after the unsafe injection practices, perceived high risk to HIV could be a consequence rather than a predictor of unsafe injection behaviors. Longitudinal research is needed to clarify the temporality of HIV risk perceptions and injection risk behaviors. All measures were self-reported; therefore, misclassification due to problems with recall could have occurred. Efforts to mitigate recall problems in the study included assessing a short recall period of 3 months for drug use and unsafe injection practices, and the use of ACASI self-interview method was used to reduce possible bias from socially desirable responses [64]. Our findings are not generalizable to all

IDUs from San Diego, given that the study enrolled young adults (18–40 years) and IDUs are hidden population [43–45]. However, the prevalence unsafe injection practices observed was consistent with the National HIV Surveillance (CDC) and local research studies. Another potential limitation of the study involves the pooling of data from three different recruitment methods, one of which was RDS. By pooling the data, we did not exploit the technique's ability to provide unbiased prevalence estimates of key variables. However, only 15.9 % of the participants were recruited by RDS and there were no significant differences by recruitment method on unsafe injection practices or other primary independent variables (e.g., perceived HIV risk infection, barriers to obtain sterile syringes). Additionally, since socio-demographic variables differed by recruitment method, the pooled sample might have captured a broader cross-section of IDUs in San Diego than we would have obtained from any single method [65].

In summary, young adult IDUs in San Diego are at high risk for acquiring HIV or HCV infections through unsafe injection practices. We found that half of the participants reported recent unsafe injection practices, and a number of individual and socio-environmental factors were strongly associated with sharing used syringes and drug preparation paraphernalia, suggesting that interventions focused only on one level might be insufficient to produce behavior change among young adult IDUs. Most importantly, our results bring to light that only half of IDUs have used the SEP and they also perceived barriers to obtaining sterile syringes; we consider that expanding the services provided by the local SEP (h/days) in San Diego more IDUs will reduce their risk behaviors. Our findings also emphasize the need for future studies, for example, specific more vulnerable subgroups (e.g., female IDUs) to identify factors that could mediate the relationship between individual and environmental factors and drug use behaviors.

Acknowledgments We are grateful to all the participants in our study. Funding for the Study to Assess Hepatitis C Risk (STHR), which yielded the data, was provided by a contract (#200-2007-21016) from the Centers for Disease Control and Prevention (PI: Garfein). Dr. Muñoz was supported by an NIH/NIAID T32 Training Grant (2T32A1007384-21A1). Support for additional HIV and HCV testing was provided by grants from the National Institutes of Health (AI36214, AI074621, and AI007384) and the California HIV/AIDS Research Program (RN07-SD-702).

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