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Cross-border injection drug use and HIV and hepatitis C virus seropositivity among people who inject drugs in San Diego, California

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Abstract

Background—The prevalence of HIV and Hepatitis C Virus (HCV) are significantly lower among people who inject drugs (PWID) in San Diego, CA, USA compared with PWID in Tijuana, Mexico, located directly across the border. We investigated associations between cross-border injection drug use (IDU), HIV and HCV seroprevalence and engagement in injecting risk behaviours while on each side of the border.

Methods—Using baseline interviews and serologic testing data from *STAHR II*, a longitudinal cohort study of PWID in San Diego, bivariate and multivariable logistic regression analyses examined associations between recent (past six months) cross-border IDU and HIV and HCV antibody seropositivity, socio-demographics, drug use characteristics, and participants' connections to, and perceptions about Mexico. Chi-squared tests and McNemar tests examined associations between cross-border IDU and injecting risk behaviours.

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Author contributions RG, KW and DH conceptualised the manuscript. DH conducted data analysis and wrote the initial draft of the manuscript. All authors commented and contributed text, and gave approval for the manuscript to be submitted.

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Results—Of the 567 participants (93% US-born, 73% male, median age 45 years), 86 (15%) reported recent cross-border IDU. Cross-border IDU was not associated with HIV (OR: 0.85, 95% CI: 0.37–1.95) or HCV seropositivity (OR: 1.01, 95% CI: 0.62–1.65). Age, identifying as Hispanic or Latino/a, and being concerned about risk of violence when travelling to Mexico were independently associated with decreased odds of recent cross-border IDU. Injecting cocaine at least weekly, having ever lived in Mexico and knowing PWID who reside in Mexico were associated with increased odds of recent cross-border IDU. PWID who reported cross-border IDU were significantly less likely to engage in receptive needle sharing, equipment sharing, and public injection while in Mexico compared with in San Diego (all $p<0.001$).

Conclusion—Prevalence of HIV and HCV infection was similar among PWID who had and had not injected in Mexico, possibly due to practicing safer injecting while in Mexico. Research is needed to elucidate contextual factors enabling U.S. PWID to inject safely while in Mexico.

Keywords

Injection drug use; Mexico; HIV; Hepatitis C virus; Risk behaviour; Border crossing

Introduction

Population mobility plays an important role in health, particularly in relation to infectious diseases (Hirsch, 2014; Michalopoulos, Aifah, & El-Bassel, 2016; Rachlis et al., 2007; Weine & Kashuba, 2012). Although there is often a concern that mobile populations can introduce infectious diseases to populations in the settings to which they travel (Grove & Zwi, 2006; Kamper-Jorgensen et al., 2012), they may also be exposed to new or increased risks in these settings compared with their place of origin (Goldenberg, Strathdee, Perez-Rosales, & Sued, 2012; Rachlis et al., 2007; Weine & Kashuba, 2012). This vulnerability is particularly important as mobile populations can act as bridge populations when infected travellers transmit infections upon returning home (Kramer et al., 2008; Rachlis et al., 2007; Rai et al., 2014).

The United States (U.S.)-Mexico border region spans 10 states, and is characterised by extensive cross-border mobility for the purposes of employment, trade, visiting family and friends, and tourism (Lee et al., 2013; Murià & Chávez, 2011; Romo & Marquez, 2010). The border crossing between San Diego, California, and Tijuana, Baja California is the busiest in the world, with an estimated 33 million crossings in each direction in 2015 (San Diego Association of Governments, 2016). Located on a prominent drug trafficking route, Tijuana is experiencing a syndemic of injection drug use (IDU) and HIV (Brouwer et al., 2006; Instituto Nacional de Salud Pública, 2008; Strathdee, Magis-Rodriguez, Mays, Jimenez, & Patterson, 2012).

Cross-border travel for the purposes of buying and injecting drugs has been reported among people who inject drugs (PWID) in the U.S-Mexico border region, as well as international settings including the China-Vietnam and China-Myanmar border regions (Hammett et al., 2005; Li, Assanangkornchai, Duo, McNeil, & Li, 2014; Williams, Liu, & Levy, 2011). In San Diego, approximately one-third of PWID have ever injected drugs in Mexico, with cheaper price, ease of access to drugs and higher quality drugs the most commonly reported

reasons for cross-border injection (Volkmann et al., 2011; K. D. Wagner et al., 2012). In August 2009, Mexico enacted drug policy reform which decriminalised small amounts of drugs for personal use (Mackey et al., 2014), potentially influencing patterns of cross-border IDU among U.S. PWID, and prompting a need for research to characterise PWID who engage in this behaviour, in order to appropriately target services.

Cross-border IDU in this region may have significant implications for infectious disease transmission. First, there is disparity in disease prevalence, with prevalence of HIV and Hepatitis C Virus (HCV) among PWID in San Diego estimated at 4% and 27–51%, respectively, compared with 4–10% and 96% among PWID in Tijuana, respectively (Garfein et al., 2013; Gunn et al., 2003; Strathdee, Lozada, Ojeda, et al., 2008; Strathdee, Lozada, Pollini, et al., 2008; White et al., 2007). Second, contextual factors that impact PWIDs' ability to practice safe injecting may also differ. Compared to established residents, newcomers often engage in riskier injecting practices, including sharing injecting equipment and injecting in public spaces (Rachlis et al., 2007), potentially due to a lack of resources and established social networks. Although syringe possession is legal and pharmacies may sell syringes without a prescription in Tijuana, reports from Mexican PWID suggest that access to sterile syringes is limited and drug use commonly occurs in informal settings with poor amenities (e.g. shooting galleries), creating barriers to safe injecting (Davidson et al., 2012; Philbin et al., 2008; Smith et al., 2016). Little is known about whether these conditions extend to U.S. PWID who inject in Mexico.

Although evidence from a binational disease surveillance system has identified cross-border travel as a risk factor for acute viral hepatitis in the U.S.-Mexico border region (Spradling et al., 2013), few studies have examined cross-border IDU specifically. Despite some evidence of receptive syringe sharing while in Mexico (Volkmann et al., 2011), no significant associations between cross-border IDU and HIV or HCV seropositivity were detected in earlier cross-sectional studies (Garfein et al., 2013; Volkmann et al., 2011), however these studies did not examine injecting risk behaviours specific to each setting. Consequently, the objective of this paper was to explore in detail the relationships between cross-border IDU, HIV/HCV prevalence and injecting risk behaviours. Specifically, the primary aim was to measure the prevalence of recent (past six-month) cross border IDU, test for associations between recent cross-border IDU and HIV and HCV seropositivity, and identify independent correlates of recent cross-border IDU in order to identify sub-populations of mobile PWID who may be in need of health information and prevention resources. To help interpret the results of this primary analysis, a secondary analysis was conducted which aimed to: 1) compare self-reported engagement in injecting risk behaviours between PWID who did and did not report recent cross-border IDU, and 2) compare self-reported injecting risk behaviours among those who report cross-border IDU during injection events in each location.

Methods

Study methods

Data were drawn from the Study of Tuberculosis, AIDS, and Hepatitis C Risk (STAHR II), a mixed methods longitudinal cohort study designed to assess the putative consequences of

Mexico's drug policy reform on U.S. PWID. Study methods have been described in detail elsewhere (Robertson et al., 2014). In brief, 574 participants were recruited from sites across San Diego County between 2012 and 2014, using targeted outreach methods. Eligible individuals were those aged 18 years and over who had injected illicit drugs within the past 30 days, spoke English or Spanish, and had no plans to move away from San Diego County in the next two years. The study received ethical approval from the University of California San Diego Human Research Protections Program.

After providing written informed consent, participants completed a structured interviewer-administered questionnaire using computer-assisted personal interviewing technology. The interview assessed socio-demographics, patterns of drug use and associated risk behaviours, health status and health behaviours, and experiences of travel to and drug use in Mexico. Testing for HIV and HCV was performed using the Uni-Gold Recombigen (Trinity Biotech PLC, Bray, Ireland), and OraQuick® (OraSure Technologies, Bethlehem, USA) rapid antibody testing kits, respectively. Positive HIV test results were confirmed with a second rapid antibody test (OraQuick ADVANCE®, OraSure Technologies, Bethlehem, USA), and confirmatory testing conducted by the San Diego County Public Health Laboratory (Robertson et al., 2014). Pre- and post-test counselling was provided, and participants with positive test results were referred to health services. Participants completed behavioural and biological testing bi-annually for two years, and were reimbursed $25 for completion of baseline interview and serologic testing, with escalating incentives for follow-up visits.

Measures

The primary measures of interest for this analysis were recent (past six month) cross-border IDU (yes vs. no) and HIV and HCV antibody seropositivity (yes vs. no; assessed using rapid testing as described above). Although an incidence analysis would be a more informative way to assess the relationship between cross-border IDU and infectious diseases transmission, current serostatus was selected as the primary outcome as there was a high baseline prevalence of HCV, some loss to follow-up, and preliminary data analysis suggested a low incidence of both HIV and HCV, limiting power to conduct such analyses.

Recent (past six month) injecting risk behaviours were secondary measures of interest. Four risk behaviours known to be associated with HIV and/or HCV risk, or with reduced likelihood of safe and hygienic injecting practices (Fuller et al., 2003; Marshall, Kerr, Qi, Montaner, & Wood, 2010; Palmateer et al., 2013; Pouget, Hagan, & Des Jarlais, 2012; Tim Rhodes et al., 2006) were examined: (1) receptive syringe sharing; (2) sharing of cotton, cookers or water; (3) injecting in a public place; and (4) injecting in a shooting gallery. Receptive syringe sharing and sharing of cotton/cookers /water in San Diego were derived from participants' responses on a 5-point Likert Scale (Never/Less than half the time/About half the time/More than half the time/Always); however, in relation to drug use in Mexico, these questions were asked with binary (yes vs. no) response categories. As such, responses regarding drug use in San Diego were dichotomised to enable comparisons. Injecting in a public place was defined as injecting in any of the following locations: construction site, alleyway, on the street, vacant lot, park, freeway overpass, bridge, or canyon.

Our analysis of potential correlates of cross-border IDU was exploratory in nature and was informed by a risk environment framework (T. Rhodes, 2002). We focused on individual and socio-environmental variables as these have been associated with a variety of drug use behaviours in this setting, including cross-border IDU (e.g. Munoz, Burgos, Cuevas-Mota, Teshale, & Garfein, 2015; Ramos et al., 2009; Volkmann et al., 2011; K. D. Wagner et al., 2012). These included sociodemographic characteristics (age, sex, country of birth, ethnic identity, educational attainment, marital status, income, homelessness, incarceration history, and recent arrest) and drug use characteristics (age at first injection, duration of injecting, patterns of heroin, cocaine and methamphetamine injecting in the past six months, engagement in drug treatment, and perceptions about the price and purity of heroin and methamphetamine, the most commonly used drugs among the sample). As previous qualitative research highlighted the importance of familiarity with the border region in cross-border drug use (K. D. Wagner et al., 2012) we also examined participants' connections to, and perceptions about Mexico, including: duration of residence in San Diego, Spanish language proficiency (spoken), ever residing in Mexico, having family or friends in Mexico, knowing PWID who live in Mexico, knowing PWID in San Diego who have travelled to Mexico to buy or use drugs, having a current passport, perceptions and level of concern about risk of violence in Mexico, and familiarity with the Mexican drug law reform. Familiarity with Mexican drug laws was assessed using the following questions: "Has anyone ever told you that you are not subject to arrest or detention if you are carrying a small amount of drugs considered for personal use?" and if 'yes', "Where does this law apply?" Participants were coded as being familiar with Mexican drug law reform if they answered 'yes' to the first question and correctly reported that this law applied in Mexico only. Participants who did not know about decriminalisation or incorrectly reported that this law applied in the U.S. alone or in both U.S. and Mexico were coded as being unfamiliar with the Mexican drug law reform. These questions were added to the survey part-way through baseline data collection; participants who were not asked (n=232, 41%) were coded as 'Question not asked' for this analysis.

Data analysis

This analysis draws on baseline quantitative interviews from the cohort. Seven participants with missing data on recent cross-border IDU were excluded from analysis, resulting in sample of 567 participants.

Descriptive statistics were used first to examine baseline characteristics of the sample, cross-border IDU characteristics, HIV and HCV seroprevalence, and engagement in injecting risk behaviours.

To address our primary aim, we used logistic regression to test for associations between recent cross-border IDU and HIV and HCV seroprevalence, and identify independent correlates of recent cross-border IDU. Bivariate logistic regression models were run to assess the association between cross-border IDU and HIV and HCV seroprevalence, as well as socio-demographics, drug use characteristics, and participants' connections to, and perceptions about Mexico. As this was an exploratory analysis, we used a statistically-driven approach to build a parsimonious multivariable model. We began with all variables where

p<0.2 in bivariate analysis. After removing multicollinear variables, we used a backwards stepwise process to eliminate variables until we reached a final model that retained only significant variables (all p-values <0.05). We ran both a complete model including all variables considered in bivariate analysis and a series of additional models where hypothesised important confounders were retained in the multivariable model, however findings did not change appreciably (data not shown).

To better understand the results of the primary analysis, we conducted two secondary analyses. First, we compared self-reported engagement in injecting risk behaviours between PWID who did and did not report recent cross-border IDU using chi-squared tests. Second, we compared self-reported engagement in injecting risk behaviours during injection events in San Diego and Mexico among those who reported cross-border IDU. For this analysis, we grouped participants into four mutually exclusive categories: 1) those who engaged in a specified risk behaviour in both San Diego and Mexico; 2) those who engaged in the risk behaviour in neither setting; 3) those who did so in San Diego, but not in Mexico; and 4) those who did so in Mexico, but not in San Diego. McNemar tests for paired nominal data were used to compare these categories. These tests assess discordant pairs only (i.e. groups three and four above). Significance for all tests was set at p<0.05. All analyses were conducted using Stata 13.1 (Statacorp LP, TX, USA).

Results

Participant characteristics

The sample was predominantly male (73%; Table 1), U.S.-born (93%), with a median age of 45 years (Range: 18–70 years). One-third of participants (31%) identified as Hispanic or Latino/a, among whom 80% identified as Mexican. One-quarter (25%) had ever lived in Mexico. The median duration of injecting among the cohort was 20 years (Interquartile Range [IQR]: 9–32 years). Around half (56%) reported daily IDU at the time of interview, with heroin and methamphetamine the most commonly injected drugs.

Overall, 86% of participants (n=486) had ever travelled to Mexico, of whom 32% (n=154) had done so in the six months preceding interview, with a median of four trips (IQR: 2–20). Reasons for travel to Mexico included dining at restaurants (41%), enjoying the nightlife (38%), shopping (35%) and visiting family or friends (31%). Drug-related reasons for travel to Mexico were also common, with 41% ever purchasing illicit drugs, 34% using illicit drugs and 11% purchasing syringes in Mexico.

Correlates of recent cross-border IDU

Eighty-six participants (15% of the total sample; 56% of those who had travelled to Mexico in the past six months) had injected drugs in Mexico in the six months preceding interview. The most commonly injected drugs while in Mexico were heroin (70%), methamphetamine (45%) and powder cocaine (8%). Commonly reported motivations for purchasing drugs in Mexico were cheaper price (69%), greater availability (60%), and perceived better drug quality (48%).

Table 1 presents results from bivariate regression analyses. There were no significant differences between participants who did and did not report recent cross-border IDU in the seroprevalence of HIV (8% vs. 10%, Odds Ratio [OR]: 0.85, 95% Confidence Interval [CI]: 0.37–1.95) or HCV (66% in both groups, OR: 1.01, 95% CI: 0.62–1.65). Variables significantly associated with decreased odds of cross-border IDU were age, age at first injection, and duration of residence in San Diego. Variables associated with increased odds of recent cross-border IDU were injecting cocaine at least weekly in the past six months, heroin/methamphetamine co-injection in the past six months, having ever lived in Mexico, having family and/or friends in Mexico, knowing PWID who reside in Mexico, and knowing PWID from San Diego who have travelled to Mexico to buy or use drugs.

Variables independently associated with reduced odds of recent cross-border IDU in the final multivariable model (Table 2) were: age (Adjusted Odds Ratio [AOR]: 0.95, 95% CI: 0.93–0.98), identifying as Hispanic or Latino/a (AOR: 0.43, 95% CI: 0.23–0.82), and being concerned about risk of violence when travelling to Mexico (AOR: 0.57, 95% CI: 0.33–0.99). Variables independently associated with increased odds of recent cross-border IDU were injecting cocaine at least weekly (AOR: 3.98, 95% CI: 1.03–15.44), having ever lived in Mexico (AOR: 2.50, 95% CI: 1.39–4.50) and knowing PWID who reside in Mexico (AOR: 6.09, 95% CI: 3.35–11.07).

Engagement in injecting risk behaviours in San Diego, stratified by recent cross-border IDU

Our secondary analysis aims were developed to examine the relationships between self-reported engagement in injecting risk behaviours and cross-border IDU, in order to better understand the relationships between cross-border IDU and HIV and HCV seropositivity.

Among the complete sample (N=567), compared with PWID who did not report recent cross-border IDU, those who did were more likely to report public injection (62% vs. 48%, χ^2 p=0.017), and injecting at a shooting gallery (26% vs. 6%, χ^2 p<0.001; Figure 1). There were no statistically significant differences in receptive syringe sharing (69% vs. 57%, χ^2 p=0.056) and ancillary equipment sharing (73% vs. 68%, χ^2 p=0.313).

Engagement in injecting risk behaviours in San Diego and Mexico among those reporting cross-border IDU

Among the 86 participants who reported recent cross-border IDU, two thirds (66%) of participants reported engaging in one or more injecting risk behaviours in Mexico in the six months preceding interview (median number of injecting risk behaviours engaged in: 1, IQR: 0–2). The most prevalent risk behaviour engaged in was receptive needle sharing (33%), followed by sharing injecting equipment (30%), public injection (26%) and injecting in a shooting gallery (26%). Thirty-two percent of participants reported engaging in receptive syringe sharing in both San Diego and Mexico, 31% shared injecting equipment, 20% reported public injection and 14% injected in a shooting gallery in both settings (Figure 2). The percentage of PWID who reported receptive syringe sharing, sharing injecting equipment and public injection while injecting in Mexico but not in San Diego was significantly lower than the percentage reporting engaging in these injecting risk behaviours

while injecting in San Diego but not in Mexico (receptive syringe sharing: 3% reported this behaviour while in Mexico, but not in the U.S. vs. 38% in the U.S., but not in Mexico; sharing injecting equipment: 1% vs. 42%; public injection: 6% vs. 42%; McNemar's $p<0.001$ for all comparisons; Figure 2). The proportion of PWID reporting shooting gallery use was similar in both groups (16% vs. 12%, McNemar's $p=0.414$).

Discussion

Among this large sample of PWID residing in the U.S.-Mexico border region, although travel to Mexico was common, only 15% of participants reported injecting drugs in Mexico in the six months preceding interview. The prevalence of recent cross-border IDU among this sample is comparable to earlier studies in this setting (Volkmann et al., 2011; K. D. Wagner et al., 2012). Despite concerns that U.S. PWID may be increasingly likely to travel to Mexico to inject drugs following the implementation of Mexico's drug law reform, awareness of this reform was extremely low among our sample, with only 2% of participants familiar with this law (3% of those who answered this question) up to five years after implementation. It is possible that as an increasing number of U.S. PWID become aware of this law once it is better established, they may be more likely to travel to Tijuana to inject drugs. It is also possible, however, that changes in law and policing practice are unlikely to influence U.S. PWIDs' decisions about whether or not to engage in cross-border drug use. A recent analysis exploring our study participants' experiences with law enforcement in Mexico found that although they perceived it was likely they would be stopped by law enforcement and may be targeted for bribes, they felt they were unlikely to be arrested or detained (Wood et al., 2017). As the relationship between the Mexican drug law reform and cross-border IDU remains unclear, continued monitoring of patterns of cross-border IDU among U.S. PWID including future analysis of longitudinal data from the current study, will be important.

The prevalence of both HIV (9%) and HCV (66%) in our sample was higher than reported in previous studies in San Diego (Garfein et al., 2013; Gunn et al., 2003) but lower than national estimates (Nelson et al., 2011; Spiller, Broz, Wejnert, Nerlander, & Paz-Bailey, 2015). This likely reflects the older age and longer duration of injecting among our current sample, resulting in a higher cumulative risk of HIV/HCV.

Despite mobility being a known risk factor for infectious disease transmission, we found no significant associations between cross-border IDU and HIV or HCV seropositivity, consistent with previous research in this setting (Garfein et al., 2013; Volkmann et al., 2011). In international settings varying results have been reported, with no significant association between cross-border IDU and HIV seropositivity detected on the China-Vietnam border (Hammett et al., 2005), and a marginally significant association detected on the China-Myanmar border (Williams et al., 2011). These studies have conducted only cross-sectional analyses and are thus not able to examine associations between cross-border IDU and HIV/HCV seroconversion, which may yield different results. Longitudinal studies with large sample sizes are needed to conduct these more informative analyses.

Our findings regarding the lack of association between cross-border IDU and HIV/HCV seropositivity could be explained by our findings regarding engagement in injecting risk behaviours. Although participants who report cross-border IDU were significantly more likely to engage in risky injection behaviours in San Diego compared to those who did not, engagement in injecting risk behaviours in Mexico was relatively uncommon. Moreover, when we examined engagement in injecting risk behaviours in each location, we found that, with the exception of attending a shooting gallery (where there was no significant difference), a significantly smaller percentage reported engaging in risk behaviours in Mexico but not in the US compared to those engaging in risk behaviours in the US but not Mexico. Thus, injecting in Mexico does not appear to confer extra risk for HIV or HCV transmission. This is an important finding which shows that it is possible to practice safe injecting behaviours even in high-risk settings such as Tijuana.

There are several possible explanations for the finding that PWID practice fewer injecting risk behaviours in Mexico compared with in San Diego. First, recent evidence suggests that U.S. PWID injecting in Mexico take precautions to avoid drawing attention to themselves in order to minimise likelihood of police encounters (Wood et al., 2017); in particular this type of behaviour may explain the low prevalence of public injection and injecting at shooting galleries that we observed. Second, they may be aware of the high prevalence of HIV and HCV among local PWID populations and be fearful of becoming infected, so take extra precautions during injecting events that they do not take at home, either due to choice or barriers to syringe access. Third, they may have small injecting networks in Mexico or may be more likely to inject alone, reducing opportunities for syringe or other equipment sharing (De, Cox, Boivin, Platt, & Jolly, 2007). Fourth, they may not experience the same barriers to safe injecting as local PWID; for example, Mexican PWID report experiencing discrimination when attempting to purchase syringes at pharmacies (Davidson et al., 2012), a barrier which might not exist for U.S. PWID. There is a need for further research, particularly qualitative research, to better understand the contextual factors enabling U.S. PWID to inject safely in Mexico, given this finding conflicts with international literature which has found riskier injection behaviours among mobile populations (Rachlis et al., 2007). Future studies may inform harm reduction interventions which could be implemented on both sides of the border, particularly since over half of participants reported syringe sharing while at home in the U.S.

This study generated important findings regarding correlates of cross-border IDU in a highly mobile binational setting. First, PWID with established connections to Mexico (i.e. participants who had ever lived in Mexico; those who knew PWID residing in Mexico) were significantly more likely to engage in cross-border IDU, and those who were concerned about risk of violence when travelling to Mexico were significantly less likely to report cross-border IDU. As suggested in earlier qualitative research, this may reflect greater familiarity with the Mexican border context, lower risk perceptions and a greater level of comfort travelling to Mexico (K. D. Wagner et al., 2012). In recent years, travel through the San Diego-Tijuana border has become increasingly restrictive. For example, prior to 2015 a state-issued identification card (e.g. driver’s license) was sufficient documentation for crossing into the U.S., but a valid passport is now required (L. Wagner, 2015). Although some study participants reported crossing without a passport, and having a passport was not

associated with cross-border IDU, it may be that those who are unfamiliar with the process perceive it to be complex and burdensome, deterring them from travel. Additionally, although around one-third of our sample reported that a reason they travelled to Mexico was to use illicit drugs, social reasons for travel to Mexico were also common. It is possible that PWID with established connections to Mexico travelled for social reasons and used illicit drugs opportunistically within social contexts, rather than travelling for the express purpose of using drugs. PWID with established connections to Mexico may also have a higher 'comfort level' with injecting in Mexico specifically, potentially being better able to navigate processes such as drug procurement and pharmacy syringe purchases.

Interestingly, participants who identified as Hispanic or Latino/a were less likely to report cross-border injecting, an association in the opposite direction from other 'connections to Mexico' variables. It is possible that these participants may be visibly perceived as Mexican and felt concerned about unwanted attention from police in Mexico, or experiencing problems when attempting to re-enter the U.S. (Sabo et al., 2014). Conversely, it is also possible that this reflects a sub-group of participants with few ties to Mexico, or perhaps to this region of Mexico in particular. Qualitative research may help to explain this unexpected finding.

Older participants in our study were less likely to report cross-border IDU. It is possible that older PWID perceive cross-border IDU as a high-risk practice; this finding would be consistent with previous research which found significant relationships between increasing age and lower engagement in high-risk injecting practices (Degenhardt et al., 2008; Horyniak et al., 2013). In our dataset, age was collinear with duration of residence in San Diego; it is possible that longer-term residents of San Diego may be less likely to engage in cross-border IDU due to entrenched negative perceptions of Tijuana resulting from high levels of drug-related violence in the late 2000's (Heinle, Molzahn, & Shirk, 2015) or due to having more established connections to the San Diego drug market and, therefore less motivation to travel to Tijuana to purchase drugs (K. D. Wagner et al., 2012).

Finally, PWID who engaged in at least weekly cocaine injection were more likely to report cross-border IDU. There is some evidence of an increase in purity-adjusted price of cocaine in the U.S. (United Nations Office on Drugs and Crime, 2016). As most cocaine entering the U.S. is trafficked through Mexico (Bucardo et al., 2005), lower cocaine prices in Mexico could make cross-border IDU appealing to cocaine users specifically. Among the small number of participants reporting high-frequency cocaine injection, 86% reported cheaper price as a reason for buying drugs in Mexico, supporting this theory. Given cocaine injection has been associated with high risk of HIV acquisition (Tavitian-Exley, Vickerman, Bastos, & Boily, 2015; Tyndall et al., 2003), cocaine injectors who travel to Mexico may be particularly at risk. Future research is needed to explore this association in more detail, and to assess whether there is a need for targeted interventions to reduce HIV risk among this group.

This study has some limitations. First, although we used multiple recruitment methods to minimise selection bias, participants were not systematically recruited into the study, so findings might not be generalisable to all PWID in San Diego. Second, as analyses were

cross-sectional, temporal relationships between cross-border IDU and infectious disease seropositivity cannot be established. As noted earlier, although data were drawn from a prospective cohort study, preliminary analysis indicated a low incidence of both HIV and HCV. Options for future analyses measuring incidence rather than prevalence or potentially examining recent infections at baseline, which could provide a more informative assessment of the association between cross-border IDU and infectious disease transmission, are currently being explored and will be the focus of a forthcoming manuscript. Third, as our analysis of correlates of cross-border IDU was exploratory we used a statistically-driven approach to model building, which may be susceptible to Type 1 errors. Fourth, our survey relied on self-reported data on engagement in injecting risk behaviours, which may be subject to socially desirable responding. However, there is no reason to believe that this would differ between those who did and did not report cross-border IDU, so the effect of this bias would be a reduction in odds ratios toward null findings. Finally, we did not capture information about the frequency of injecting events in Mexico; it is possible that participants reported lower engagement in injecting risk behaviours during injecting events in Mexico compared with in San Diego because they had few injection events, and thus few opportunities to engage in these behaviours.

Conclusion

Recent cross-border IDU was relatively uncommon among PWID residing on the US-Mexico border region, and was not associated with HIV or HCV seropositivity. This may be due to PWID engaging in safer behaviours while injecting in Mexico. Qualitative research could shed light on contextual factors contributing to U.S. PWID injecting safely in Mexico.

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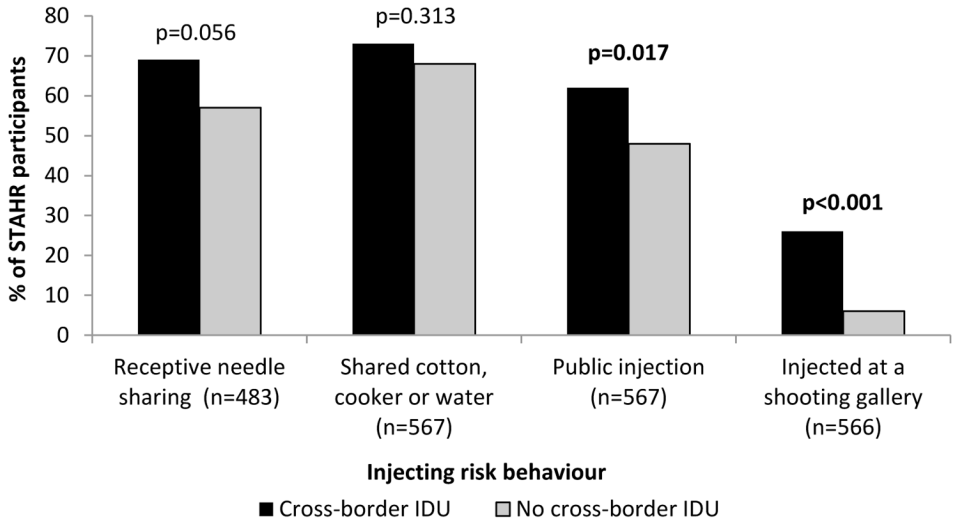

Figure 1. Risk behaviours practiced while injecting in San Diego, stratified by recent cross-border IDU (N=567)

χ^2 p-values reported, significant results (p<0.05) bolded.

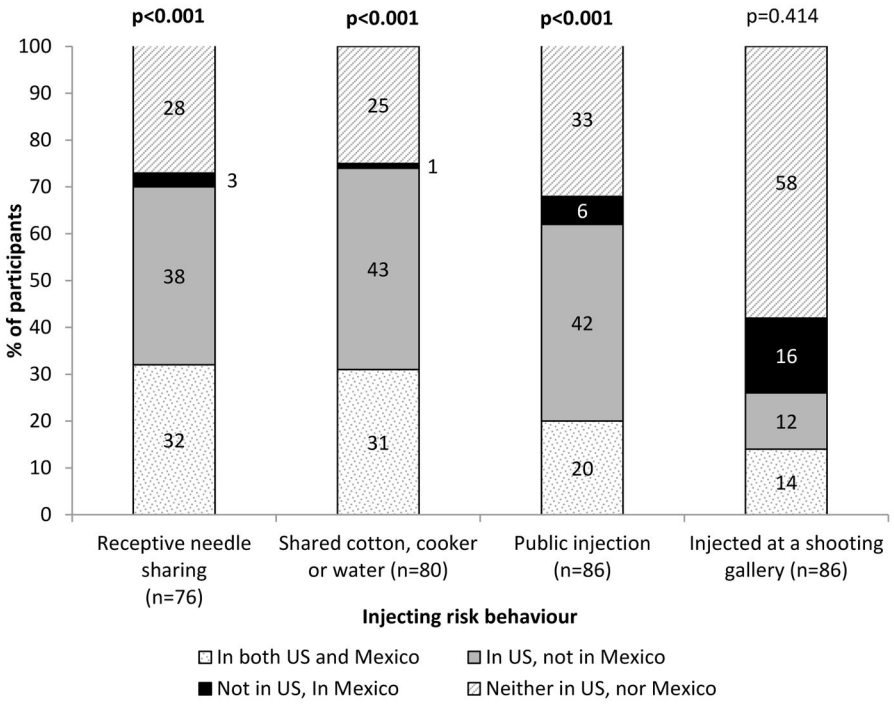

Figure 2. Risk behaviours practiced among participants reporting recent cross-border IDU, stratified by injecting location (N=86)

McNemar test p-values reported. McNemar test assesses discordant pairs only (i.e. includes only those who engaged in injecting risk behaviour in the U.S. but not in Mexico [coloured grey in figure], or in Mexico but not the U.S. [coloured black in figure]). Significant results ($p<0.05$) bolded.

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Table 1

Bivariate analysis of serological testing results, sociodemographic characteristics, drug use characteristics, and connections to and perceptions about Mexico associated with recent cross-border injection drug use among people who inject drugs residing in San Diego (N=567)

Variable	Total N=567 n (%)	Recent cross-border IDU		Unadjusted Odds Ratio (95% CI)	p- value
		No N=481 n (%)	Yes N=86 n (%)		
Serological testing	*n=545*[1]	*n=460*	*n=85*		
HIV seropositive[2]	51 (9)	44 (10)	7 (8)	0.85 (0.37–1.95)	0.699
HCV seropositive[2]	358 (66)	302 (66)	56 (66)	1.01 (0.62–1.65)	0.967
Socio-demographic characteristics					
Age, Median (IQR)	45 (33– 52)	45 (35– 53)	38 (27– 49)	0.96 (0.95–0.98)	<0.001
Sex					
Female	148 (26)	130 (27)	18 (21)	1	
Male (incl. transgender)	419 (74)	351 (73)	68 (79)	1.40 (0.80–2.44)	0.237
Country of Birth					
USA	531 (94)	448 (93)	83 (97)	1	
Other	36 (6)	33 (7)	3 (3)	0.49 (0.15–1.64)	0.247
Identify as Hispanic or Latino/a[2]	177(31)	156 (32)	21 (24)	0.67 (0.40–1.14)	0.141
Marital status					
Single/never married	308 (54)	254 (53)	54 (63)	1	
Married/common law/other[3]	259 (56)	227 (47)	32 (37)	0.66 (0.41–1.06)	0.088
Highest level of school completed					
Grade 11 or below	361 (64)	308 (64)	53 (62)	1	
Grade 12 or higher	206 (36)	173 (36)	33 (38)	1.11 (0.69–1.78)	0.669
Income amount (last 12m)					

Variable	Total N=567 n (%)	Recent cross-border IDU		Unadjusted Odds Ratio (95% CI)	p- value
		No N=481 n (%)	Yes N=86 n (%)		
<$10,000	384 (68)	330 (69)	54 (63)	1	
≥$10,000	181 (32)	149 (31)	32 (37)	1.31 (0.81–2.12)	0.265
Main income source (last 6m)					
Employed with regular salary	77 (14)	65 (14)	12 (14)	1	
Public assistance/disability	149 (26)	131 (27)	18 (21)	0.74 (0.34–1.64)	0.463
Selling drugs/running drugs/touting	35 (6)	27 (6)	8 (9)	1.60 (0.59–4.37)	0.354
Other	302 (54)	255 (53)	47 (55)	1.00 (0.50–1.99)	0.996
Homeless (last 6m)[2]	345 (61)	288 (60)	57 (66)	1.32 (0.81–2.13)	0.263
Ever incarcerated in U.S.[2]	512 (90)	434 (91)	78 (91)	0.94 (0.43–2.09)	0.886
Arrested (last 6m)[2]	154 (27)	123 (26)	31 (36)	1.63 (1.00–2.64)	0.050
Drug use characteristics					
Age at first injection, Median (IQR)	20 (17– 26)	20 (17– 26)	20 (17– 24)	0.96 (0.93–0.99)	0.016
Duration of injecting, Median (IQR)	20 (9– 32)	21 (10– 32)	16 (6–30)	0.99 (0.97–1.00)	0.091
Typically injected ≥ daily (last 6m)[2]	316 (56)	265 (56)	51 (60)	1.19 (0.75–1.91)	0.459
Injected heroin ≥ daily (last 6m)[2]	212 (39)	174 (38)	38 (45)	1.36 (0.85–2.17)	0.201
Injected MA ≥ weekly (last 6m)[2]	221 (40)	182 (39)	39 (46)	1.30 (0.82–2.08)	0.263
Injected cocaine ≥ weekly (last 6m)[2]	18 (3)	11 (2)	7 (8)	3.76 (1.41–10.00)	0.008
Heroin/cocaine co–injection (last 6m)[2]	91 (19)	73 (18)	18 (22)	1.25 (0.70–2.24)	0.448
Heroin/MA co-injection (last 6m)[2]	110 (24)	81 (21)	29 (37)	2.21 (1.32–3.73)	0.003
Ever prescribed opioid substitution therapy[2]	134 (24)	109 (23)	25 (31)	1.50 (0.89–2.52)	0.125

Variable	Total N=567 n (%)	Recent cross-border IDU		Unadjusted Odds Ratio (95% CI)	p- value
		No N=481 n (%)	Yes N=86 n (%)		
Perceived heroin price increase (last 6m)[2]	84 (20)	68 (19)	16 (23)	1.19 (0.64–2.21)	0.582
Perceived heroin purity decrease (last 6m)[2]	263 (46)	212 (63)	51 (71)	1.41 (0.81–2.45)	0.226
Perceived MA price increase (last 6m)[2]	106 (25)	93 (26)	13 (20)	0.71 (0.37–1.36)	0.297
Perceived MA purity decrease (last 6m)[2]	250 (44)	212 (58)	38 (58)	0.98 (0.58–1.66)	0.939
Connections to and perceptions about Mexico					
Years lived in San Diego, Median (IQR)	25 (12– 40)	27 (13– 42)	17 (8–28)	0.97 (0.95–0.98)	<0.001
Proficient in Spanish (spoken)[2]	162 (29)	138 (29)	24 (28)	0.96 (0.58–1.60)	0.882
Ever lived in Mexico [2]	137 (25)	94 (20)	43 (50)	4.01 (2.48–6.48)	<0.001
Have family and/or friends in Mexico[2]	205 (36)	151 (32)	54 (63)	3.64 (2.26–5.87)	<0.001
Know at least one PWID who lives in Mexico[1]	161(30)	107 (23)	54 (64)	5.71 (3.49–9.34)	<0.001
Know at least one person from San Diego who has bought or used drugs in Mexico[2]	383 (76)	312 (74)	71 (87)	2.32 (1.18–4.53)	0.014
Have a current passport[2]	68 (12)	53 (11)	15 (17)	1.70 (0.91–3.18)	0.097
Read/heard media about drug-related violence in Mexico (past 6m)[2]	419 (79)	345 (77)	74 (86)	1.82 (0.95–3.49)	0.070
Concerned about risk of violence when travelling to Mexico[2]	256 (51)	220 (53)	36 (42)	0.66 (0.41–1.05)	0.082
Familiar with Mexican drug law reform[2,4]	10 (2)	6 (1)	4 (5)	3.67 (1.00–13.46)	0.050

[1]Excludes 22 participants who did not complete testing;

[2]Yes vs. no;

[3]Other includes separated, divorced and widowed participants;

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[4]Question added part-way through baseline data collection–denominator includes 232 participants coded as ‘question not asked’ (data not shown)

Missing data excluded.

Abbreviations: IQR = Interquartile Range; MA = methamphetamine; PWID = people who injects drugs

Table 2

Multivariable logistic regression analysis of factors independently associated with recent cross-border injection drug use among people who inject drugs in San Diego (N=471)

Variable[1]	Adjusted Odds Ratio (95% CI)	p-value
Age (per 1-year increase)	0.95 (0.93–0.98)	<0.001
Identify as Hispanic or Latino/a[2]	0.43 (0.23–0.82)	0.010
Concerned about risk of violence when travelling to Mexico[2]	0.57 (0.33–0.99)	0.046
Injected cocaine ≥ weekly (last 6m)[2]	3.98 (1.03–15.44)	0.046
Ever lived in Mexico[2]	2.50 (1.39–4.50)	0.002
Know at least one PWID who lives in Mexico[2]	6.09 (3.35–11.07)	<0.001

[1]Variables not included in model due to collinearity: Duration of injecting (collinear with age), duration of residence in San Diego (collinear with age), and have family and/or friends in Mexico (collinear with having ever lived in Mexico);

[2]Yes vs. no

Missing data excluded

Abbreviations: PWID = people who injects drugs

Hosmer-Lemeshow Goodness-of-fit p=0.4198