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Network Correlates of Using a Syringe After an Injection Partner Among Women Who Inject Drugs in Philadelphia Pennsylvania

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Abstract

This analysis aims to identify relationship-level correlates of receptive syringe sharing among women who inject drugs in Philadelphia. Sixty-four women who injected daily were recruited from Prevention Point Philadelphia's syringe exchange program (9/2/20-11/23/20). Interviewer-administered surveys collected (1) individual-level demographics and risk behaviors and (2) relationship-level information about each past-6-month injection partner and injecting practices between the two. We built two separate log-binomial regression models which accounted for clustering of network members within participants to identify relationship-level correlates of using a syringe after a partner. Women reported injecting with a syringe previously used by 21.14% of partners. Women were more likely to use a syringe after sex partners (Adjusted Prevalence Ratio [APR]_{model_1}=2.77) and those who provided injection assistance (APR_{model_1}=1.92) or emotional support (APR_{model_2}=6.19). Future harm reduction efforts could train women to negotiate safer injection practices with sex partners and those who provide injection assistance and/or emotional support.

Resumen

Este análisis tiene como objetivo identificar los correlatos a nivel de relación del compartimento de jeringas receptivas en las mujeres que se inyectan drogas en Filadelfia. Sesenta y cuatro mujeres que se inyectaron diariamente fueron reclutadas en el programa de intercambio de jeringas de Prevention Point Philadelphia (9/2/20-11/23/20). Las encuestas fueron administradas por un entrevistador y recabaron (1) características demográficas y comportamientos de riesgo a

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nivel del individuo y (2) información sobre la relación con cada pareja de inyección durante los últimos 6 meses, incluidas las prácticas de inyección entre los dos. Construimos dos modelos de regresión logarítmico-binomial separados que representaban la agrupación de miembros de la red dentro de los participantes para identificar correlatos a nivel de relación del uso de una jeringa después de una pareja. Las mujeres utilizaron una jeringa que había sido utilizada previamente por 21.14% de las parejas de inyección enumeradas. Las mujeres eran más probables en usar una jeringa después de las parejas sexuales (Razón de prevalencia ajustada [RPA]_{model_1} = 2.77) y de quienes las ayudaron a inyectarse (RPA_{model_1} = 1.92) o les brindaron apoyo emocional (RPA_{model_2} = 6.19). Los esfuerzos futuros de reducción del daño podrían capacitar a las mujeres para negociar prácticas de inyección más seguras con sus parejas sexuales y quienes brindan asistencia para la inyección y/o apoyo emocional.

Keywords

social networks; women who inject drugs; receptive syringe sharing; fentanyl; injection drug use

Background

Injection Drug Use and Infectious Disease Risk

People who inject drugs (PWID) are at increased risk for bloodborne pathogens (BBPs) including human immunodeficiency virus (HIV), Hepatitis C virus (HCV), and Hepatitis B virus (HBV) due to unsafe injection risk practices (i.e., sharing needles, syringes and other drug injection equipment) and skin and soft tissue infections (SSTIs), bacteremia, and infective endocarditis at the injection site due to re-using contaminated injecting equipment or not cleaning the injection site prior to injecting (1–4). According to a 2020 Report from the United Nations Office on Drugs and Crime, there are more than 11 million PWID globally, 1.4 million of whom are living with HIV, 5.6 million of whom are living with HCV, and 1.2 million of whom are living with both HIV and HCV (5). Within the United States, the number of new HIV diagnoses attributed to injection drug use had been on the decline; however, recent changes in the types of drugs used and the frequency of injection have led to several outbreaks of HIV among PWID in all regions of the United States. The first of these was the 2015 outbreak in rural Scott County, Indiana, which was attributed to injection of oxymorphone and frequent injection sharing practices (6). Between 2016 and 2019, several HIV outbreaks occurred among PWID in urban areas across the United States (7, 8), including in Lawrence and Lowell, Massachusetts (9, 10); Northern Kentucky/Hamilton County, Ohio (11); Seattle, Washington (11); Philadelphia, Pennsylvania (12); Cabell County, West Virginia (13); and Portland, Oregon (14). In most cases, these outbreaks were driven by changes in the frequency of injection due in large part to the rise of synthetic opioids in the United States drug supply and increases in the use of stimulants alone or in combination with opioids (7, 15, 16). The prevalence of SSTIs among PWID has also increased dramatically over the past 20 years, with hospitalizations for SSTI-related complications doubling among PWID in the United States between 2000 to 2010 (1).

Changing drug markets influence patterns of substance use and injection frequency

The opioid epidemic in the United States has been characterized as four distinct waves. The third wave, starting in 2013, was characterized by a marked increase in overdose deaths involving synthetic opioids, including fentanyl and fentanyl analogs (17–19). Though fentanyl is up to fifty times more potent than heroin, it produces a shorter period of intoxication, resulting in a need to inject more frequently to prevent withdrawal symptoms (20). The fourth and current wave is characterized by the concurrent use of stimulants (e.g., cocaine and methamphetamine) and opioids (15, 21, 22), either intentionally (i.e., speedballs, goofballs, etc.) or unintentionally (i.e., due to fentanyl being laced with other drugs) (23). Because stimulants typically have shorter half-lives than opioids, those using stimulants may also need to inject more frequently to sustain a high (4). Both of these trends toward more frequent injection exacerbate the likelihood of needing to reuse or share a needle for injection.

Risk factors for using a syringe after someone else

Reasons for syringe sharing are multifaceted but include a scarcity of resources (i.e., limited access to sterile syringes either due to cost or availability), injection frequency, and the relationships between those who inject together (24). Syringe service programs (SSPs) address scarcity of syringes as a driver for sharing by providing syringes to PWID at no cost. SSPs also provide ancillary equipment (alcohol pads to prevent abscesses, tourniquets for easier vein finding, etc.), which when used correctly, can decrease the risk of injection-related injuries and disease (i.e., sepsis, SSTIs, and endocarditis) among PWID (25). Some SSPs also provide cookers (vessels for drug mixing) and filtration equipment (usually cotton) to further reduce the risk of HIV/HCV transmission. According to a recent estimate, SSPs in the United States distributed fewer than 50 syringes per PWID per year (26), which is less than one syringe per week, on average. Given that approximately 66.6% of PWID in the United States inject at least daily (4), the need for sterile syringes surpasses their availability. Additionally, as noted above, due to the shorter half-life of stimulants and synthetic opioids compared with heroin, those who inject cocaine, methamphetamine, and fentanyl or other analogs must inject more frequently, which requires greater access to sterile syringes to reduce the risk of infectious disease transmission and injection site infections.

Social networks and injection risk

According to Berkman's conceptual model for how social networks impact health, social networks (measured via network characteristics, network relationships, and structure) act at the mezzo level to provide opportunities for social support, social influence/selection, social engagement, access to resources, and person-to-person contact. These in turn influence both risk (i.e., opportunities for disease transmission) and health-seeking behaviors (i.e., harm reduction and use of health services) (27, 28). Neaigus and colleagues reported that PWID used a syringe after 26% of their injection partners; relationship-level correlates of receptive syringe sharing included daily interaction, injecting with a partner for more than one year, relationship closeness, and being a sex partner (29). In a separate study, syringe sharing among both men and women was more likely with sex partners, those who provided emotional and material support, those they shared drugs with at least daily, those they used

drugs with at least daily, and those who helped them acquire drugs when in withdrawal (30). Frequency of sharing has also been shown to be more likely with closer ties (sexual relationships, family members, and close friends) (31–33).

Some gender differences have also been reported. For example, women were more likely than men to (1) be in a relationship with someone who injects even if they did not (34), (2) inject with a sex partner (35, 36), (3) have sex partners that are also injection partners and report injecting with a sex partner (35, 37), and (4) share syringes with more network members (30). Rhodes and colleagues further noted that couples whose relationships center around drug use tend to have an “everything together” attitude, which is strengthened by outside stigma and threats, making codependency a useful survival tactic (38).

The current study aims to identify relationship-level correlates of receptive syringe sharing among women who inject drugs (WWID) in Philadelphia. Philadelphia is an important setting to conduct this research, as (1) the prevalence of acute HCV and HBV cases and the number of hospitalizations for SSTIs, bacteremia, and sepsis have increased among PWID in recent years (39), (2) the proportion of new HIV diagnoses attributed to injection drug use increased by 151% between 2016 and 2019 (39), and (3) 63% of PWID newly diagnosed with HIV in 2019 were coinfecting with HCV (13% were infected with HIV, HCV, and HBV) (40). The increasing presence of fentanyl in Philadelphia’s drug supply (i.e., 560% increase in the prevalence of fentanyl seized by law enforcement between 2016 and 2019) has contributed to more frequent injections which are thought to be driving the rise in HIV, HIV/HCV co-infections, and SSTIs among PWID (39). For example, based on surveys conducted by the Philadelphia Department of Public Health in 2018, the percentage of PWID reporting that they use a new syringe each time they inject dropped from 44% in 2012 to 31% in 2018, 89% reported injecting more than once per day, and 44% reported injecting more than four times daily (39).

Methods

Recruitment

Between September and December 2020, 64 eligible women were recruited from Prevention Point Philadelphia (PPP), which hosts the largest syringe exchange in Pennsylvania. Although Pennsylvania’s drug paraphernalia laws criminalize possession of syringes, an executive order signed by Philadelphia’s Mayor in 1992 legalized syringe exchange at PPP and the possession of syringes by those participating in PPP’s Sterile Syringe Exchange Program. On-site syringe exchange occurs from 12-3 pm on Monday through Friday. Twice weekly, a research assistant approached female-presenting PPP participants receiving services at the syringe exchange and asked if they were interested in participating in a study about injection practices and HIV/HCV risk. Those interested first completed an eligibility screener to assess age, gender, sex at birth, frequency of injection (past 6 months), and whether they injected in the company of others or in a group setting (past 6 months). Those eligible were 18 years old, non-male gender, assigned female sex at birth, reported injecting drugs at least once daily (past 6 months), and injected drugs in the company of at least one other person (past 6 months). On average, 4-5 new study participants were recruited each week over the 4-month study period. After providing written informed

consent, eligible participants completed a 20- to 30-minute interviewer-administered survey. Participants received a \$10 Wawa gift card after completing the survey. All study materials were approved by Temple University's institutional review board.

Data Collection

The survey collected individual sociodemographics (i.e., age, gender, sex, race, ethnicity, highest level of education attained, employment status [past 6 months], income [past 6 months], housing status [past 6 months], whether they had experienced homelessness [past 6 months]), self-reported HIV and HCV status, and history of incarceration (time spent in jail or prison over the past 2 years). Time spent in jail was defined as a stay of less than one year in a city or county jail. Time in prison was defined as a long-term incarceration in a minimum- or maximum-security prison (either state or federal). Participants also reported the types of drugs used (past 6 months), frequency of drug (and injection) use for each drug used in the past 6 months, age at first injection (continuous), number of times injected per day (continuous), history of witnessing and surviving an overdose (ever and in the past 6 months), and history of exchanging sex for drugs (past 6 months). Participants were also asked to list those with whom they had “injected frequently or have shared an injection setting (i.e., inject at the same time and in the same location) during the past 6 months”. To preserve anonymity, participants were asked to provide nicknames or code names for each network member rather than their legal names. Participants were then asked to describe each network member listed with respect to their demographic characteristics (i.e., age, gender, race, ethnicity, etc.), relationship type (i.e., a friend, family member, romantic partner, associate/acquaintance), relationship duration (months), whether the injection partner also helped them to inject drugs (i.e., injected drugs into them), frequency of injecting together in the past 6 months (collected using a Likert scale but dichotomized as daily vs. less than daily), frequency of interaction in the past 6 months (collected using a Likert scale but dichotomized as daily vs. less than daily), whether they lived together in the past 6 months (yes/no), and whether the network member provided financial support in the past 6 months (yes/no). Emotional support was measured using the question “How likely are you to discuss personal or private matters with [network member]”. Likert scale response ranged from “extremely likely” to “extremely unlikely”. This variable was then dichotomized as “extremely likely” for a high level of emotional support, versus all other responses. Participants also described their injection practices (past 6 months) with each partner (i.e., frequency of injecting together [5-item Likert scale recoded as daily vs. less than daily]; frequency of using syringes before vs. after each partner in the past 6 months [5-item Likert scale ranging from never to every time; recoded as ever vs. never], and frequency of using injection equipment before vs. after each partner in the past 6 months [5-item Likert scale ranging from never to every time; recoded as ever vs. never]). To assess risk perception, women were asked whether they knew or suspected that each partner (1) was living with HIV, (2) was living with HCV, and (3) shared syringes and/or injection equipment with others. Participants were also asked whether they had sex with each injection partner in the past 6 months. For each sex partner, participants were also asked to categorize their sexual relationship (i.e., main/steady, casual, exchange partner), how often condoms were used (past 6 months), and about physical and sexual violence in the relationship (past 6 months).

Our primary outcome was whether a syringe was ever used after the network member in the past 6 months (yes vs. no).

Data Analysis

Overall, 64 participants provided information about 123 injection partners. We first described individual participant characteristics, injection partner characteristics, and the overlap in relationship roles for each injection partner listed. Participants reported using a syringe after 21.14% of injection partners listed and the intraclass correlation coefficient for the outcome was 0.27. To determine which individual- and relationship-level variables were associated with the outcome of interest, we used generalized estimating equations (GEE) log-binomial regression models which clustered on participant ID to account for the fact that relationships are clustered within individuals. We specified an exchangeable correlation structure and a robust variance estimator to account for misspecification of the correlation structure. Given the high prevalence of the outcome, we used log-binomial rather than logistic regression, as it better approximates risk when the outcome is not rare. Variables that were statistically significant in the unadjusted bivariate regression models ($p < 0.05$) were tested for inclusion in the adjusted models, but due to convergence issues associated with including age, race, ethnicity, and employment status, these variables were not included in the adjusted models. Given our hypotheses that women would be more likely to use a syringe after sex partners and those who provided emotional support and the fact that most sex partners also provided emotional support, we constructed two final models (one for each hypothesis) using GEE log-binomial regression; each model clustered on participant ID and specified a robust variance.

Results

Descriptive statistics for participants and their injection partners

Table I describes study participants and their injection partners. The median participant age was 37 (interquartile range [IQR]: 32-41.5). Overall, a majority of participants identified as white (78.1%), and a quarter identified as Hispanic/Latinx. Most reported housing instability in the past 6 months (82.8% homelessness, 48.3% living on the street or in a car, and 17.2% transitional housing), were unemployed (67.2%), earned no income or less than or equal to \$500/month (62.5%), reported an illegal source of income (75%; primarily sex work or selling drugs), and had previously overdosed (73.4%). In the past two years, 59.4% and 10.9% had spent time in jail or prison, respectively. Just over 10% reported a prior HIV diagnosis, while 79.7% reported a prior HCV diagnosis. The drugs most commonly injected were fentanyl (92%), followed by heroin (86%), cocaine (50%), methamphetamine (45%), and tranquilizers (22%). The median number of injections per day was 8 (IQR: 5-10) and the median number of years injecting was 6 (IQR: 3-15). Overall, 56.25% of women reported only one injection partner in the past 6 months. Women reported using a syringe after 21.14% of the injection partners listed. Overall, most injecting partners were male (61.8%), white (64.2%), and were described as friends (56.9%). Women interacted with 66.7% of their injecting partners at least daily, shared an injection setting with 55.3% at least daily, lived with 56.1% (including in the same encampment), reported sex with 22.8%, were extremely likely to discuss personal/private matters with 40.7%, and received financial

support from 37.4%. The median age of network members was 36 (IQR: 31-42) and the median relationship duration was 2 years (IQR: 1-6 years).

Table II describes the overlapping relationship roles of injection partners with respect to emotional support (extremely likely to discuss personal/private matters), financial support, injection assistance, frequency of interaction (daily), frequency of injecting together (daily), and sex. Overall, there was a high degree of overlap across relationship roles. For example, 46% of those providing emotional support were sex partners. Compared with other relationship roles, sex partners were the most likely to also provide emotional (82%) and financial (75%) support, to live with participants (96%), and to be daily injection partners (93%).

Individual and Network Correlates of Using a Syringe After an Injection Partner

As seen in Table III, prior to adjustment, those who were younger, identified as white, and reported full or part-time employment (past 6 months) were statistically significantly more likely to report using a syringe after an injection partner. Those who reported more injection partners were significantly less likely to use a syringe after an injection partner (prevalence ratio [PR]=0.49; 95%CI: 0.34-0.70). Specifically, those who reported only one injection partner were significantly more likely to use a syringe after their partner than those who reported more than one injection partner (PR=3.27; 95%CI: 1.45-7.40). Of note, women who listed 4 or 5 injection partners did not report using a syringe after any of these partners. On the contrary, for women who reported only one partner, 44.4% reported using a syringe after this partner in the past 6 months. To further explore the relationship between number of injection partners listed and partner attributes, we conducted a supplementary analysis, where we compared relationship-level characteristics of injection partners who were one of several partners vs. those who were a woman's sole injecting partner. Overall, injection partners who were the woman's sole injecting partner were significantly more likely to provide emotional support (62% vs. 26%), live with her (74% vs. 43%), be a sex partner (44% vs. 11%), provide financial support (52% vs. 26%), and inject with her daily (64% vs. 44%) (data not shown in tables).

Women were also more likely to report using a syringe after those with whom they interacted at least daily (PR=3.47, 95%CI: 1.47-8.20), shared an injection setting at least daily (PR=3.62; 95%CI: 1.59-8.23), lived (PR=3.84; 95%CI: 1.73-8.53), and had sex (PR=3.54; 95%CI: 1.94-6.45). They were also more likely to report using a syringe after those who provided them with financial support (PR=2.69; 95%CI: 1.24-5.85), emotional support (PR=8.86; 95%CI: 3.42-22.96), or injection assistance (PR=1.91; 95%CI: 1.11-3.29).

Given the extent of overlap between relationship roles, we built two final models (model 1 includes sex partners and model 2 includes those providing emotional support) (See Table IV). As seen in Model 1, after adjustment, women were significantly more likely to use syringes after injection partners who provided injection assistance (Adjusted Prevalence Ratio [APR]=1.92; 95%CI: 1.10-3.37) and who were sex partners (APR=2.77; 95%CI: 1.36-5.64). As seen in Model 2, after adjustment, women were significantly more likely to use syringes after injection partners who provided emotional support (APR=6.19; 95%CI:

2.12-18.06). In both models, women with more injection partners were less likely to use syringes after their partners ($APR_{\text{Model 1}}=0.66$; 95%CI: 0.47-0.91; $APR_{\text{Model 2}}=0.65$; 95%CI: 0.45-0.93). Of note, all four women who reported full/part-time employment in the past 6 months also reported experiencing homelessness in the past 6 months and all reported only one injection partner.

Discussion

In this sample of predominately white women who reported injecting daily and used syringe services at PPP, most reported housing instability (many of whom lived in encampments), a prior HCV diagnosis, a history of overdose, and frequent injection of fentanyl, heroin, and stimulants (e.g., cocaine and methamphetamine). Given that women reported injecting a median of 8 times per day, this would require approximately 56 syringes per week to permit the use of a new sterile syringe for each injection. According to Eva Gladstein, Deputy Managing Director of Health and Human Services for the City of Philadelphia “In the year ending June 30, 2020, Prevention Point distributed 4,797,776 syringes in Kensington, with an 87% collection rate” (41). On average, approximately 300 unique clients exchange syringes at PPP per day, of whom 20% are female. If each person who obtains syringes from PPP injects 8 times per day (study median), 4,797,776 syringes would be enough to allow 1,643 unique people to inject with a new sterile syringe each time they injected. According to PPP Exchange Report data, 4,087 unique individuals exchanged syringes in November 2020 and 3,930 unique individuals exchanged syringes in December 2020. This means that there are not enough syringes available to ensure that PWID in Philadelphia (even those who access syringes through PPP) can inject with a new sterile syringe each time they inject.

Women sampled reported an average of two injecting partners and using a syringe after 21% of partners. Findings from this dyadic analysis show that prior to adjustment, women were more likely to use syringes after injection partners with whom they had close personal relationships (i.e., sex partners, those providing high levels of emotional support, those providing financial support, those with whom they interacted (or injected) most frequently, and those with whom they lived). Many of these relationships confer a level of intimacy, which may skew their perception of risk and promote sharing. Although we did not observe a statistically significant association between receptive syringe sharing and any of the measures of risk perception assessed here, future work could explore the mechanism responsible for our finding that women were more likely to report receptive syringe sharing with ‘closer’ relationships (i.e., greater intimacy, more frequent sharing, an “everything together” attitude, etc.). Our findings are consistent with those from other studies which have shown that compared with injection partners where syringes are not shared, syringe-sharing partners are more likely to be family members, sex partners, closer or more intimate relationships, those that provided emotional or financial support, and those with whom money was pooled for drugs (31–33, 42–47). Our findings are also compatible with those reported by Sherman and colleagues, with the exception that Sherman and colleagues did not report an association between frequency of interaction and syringe sharing (30). We additionally found that those with more injection partners were less likely to report using a syringe after their partner. In other words, those with fewer partners (and one partner vs. more than one partner) were more likely to report using syringes after their partner.

This finding can be further contextualized by those from our supplementary analysis which showed that individuals reported closer and more intimate relationships with injection partners that were their sole injecting partners compared to those who were one of several injecting partners listed.

Housing instability was also frequently reported by study participants and although we did not specifically ask about living or injecting in encampments in the survey, encampments created by people experiencing homelessness are scattered throughout the city, including over a quarter-mile stretch in Kensington, where PPP is located. As the majority of people who live in encampments report opioid use, those living in these communities may have greater opportunities to inject with others who use opioids due to a shared living space. As a result, women living in encampments may have been more likely to report multiple injecting partners and to report injecting with others or in group settings. This may also explain our finding that individuals with whom women reported living and injecting were not always close relationships. For example, of the 69 injection partners with whom individuals reported living, women reported seeing only 81% daily, receiving emotional support from 59%, and receiving financial support from 51%.

There are a few limitations to this study. Due to the cross-sectional nature of this study, we are unable to assess temporality or a causal relationship. Additionally, due to the large percentage of white WWID in the sample, our results may not be generalizable to all WWID in Philadelphia. Based on data provided by the PPP syringe exchange, 54% of their clients during the same timeframe were white, although the breakdown by gender is not known. Additionally, because women were recruited directly from the syringe exchange, they represent women who are already accessing harm reduction services and may consequently have safer injection practices than those who do not access harm reduction services. As a result, women who do not access PPP exchange services may report more syringe sharing and the relationship-level correlates of receptive syringe sharing may differ. WWID included in this sample also experienced a high degree of housing instability which may not reflect the range of housing experiences of all WWID in Philadelphia. Finally, very few women included in this sample reported full or part-time employment (6%) and a majority reported monthly incomes less than \$1,500 (84%). Thus, our findings may not be generalizable to WWID who are employed and earning higher wages.

Conclusion

Findings from this study suggest that relationship-level factors were strongly correlated with injection practices, and specifically one's likelihood of using a syringe after an injection partner. Because injection often takes place within a social context (i.e., with another person(s) and in a particular environment), focusing on safe injection practices within a real-world context is of paramount importance. In addition to focusing harm reduction efforts on women's individual-level risk behaviors, future efforts could incorporate trainings on how to negotiate safer injection practices with close relationships (i.e., sex partners, those who provide injection assistance, and who provide emotional support).

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References

1. Sanchez DP, Tookes H, Pastar I, Lev-Tov HA. Wounds and skin and soft tissue infections in people who inject drugs and the utility of syringe service programs in their management. *Advances in Wound Care*. 2021(ja).
2. Baltés A, Akhtar W, Birstler J, Olson-Streed H, Eagen K, Seal D, et al. Predictors of skin and soft tissue infections among sample of rural residents who inject drugs. *Harm Reduction Journal*. 2020;17(1):1–10. [PubMed: 31906957]
3. Noroozi M, Armoon B, Ghisvand H, Noroozi A, Karimy M, Bazrafshan MR, et al. Prevalence and risk factors for injection site skin infections among people who inject drugs (PWID) in Tehran. *Journal of cosmetic dermatology*. 2019;18(1):258–62. [PubMed: 29781249]
4. Colledge S, Leung J, Larney S, Peacock A, Grebely J, Hickman M, et al. Frequency of injecting among people who inject drugs: A systematic review and meta-analysis. *International Journal of Drug Policy*. 2020;76:102619. [PubMed: 31864107]
5. The United Nations Office on Drugs and Crime. HIV and AIDS 2020 [Available from: <https://www.unodc.org/lpo-brazil/en/hiv-aids/index.html>].
6. Peters PJ, Pontones P, Hoover KW, Patel MR, Galang RR, Shields J, et al. HIV infection linked to injection use of oxycodone in Indiana, 2014–2015. *New England Journal of Medicine*. 2016;375(3):229–39. [PubMed: 27468059]
7. Oster AM, Lyss SB, McClung RP, Watson M, Panneer N, Hernandez AL, et al. HIV cluster and outbreak detection and response: the science and experience. *American Journal of Preventive Medicine*. 2021;61(5):S130–S42. [PubMed: 34686282]
8. Lyss SB, Buchacz K, McClung RP, Asher A, Oster AM. Responding to Outbreaks of Human Immunodeficiency Virus Among Persons Who Inject Drugs—United States, 2016–2019: Perspectives on Recent Experience and Lessons Learned. *The Journal of Infectious Diseases*. 2020;222(Supplement_5):S239–S49. [PubMed: 32877545]
9. Alpre C, Dawson EL, John B, Cranston K, Panneer N, Fukuda HD, et al. Opioid use fueling HIV transmission in an urban setting: an outbreak of HIV infection among people who inject drugs—Massachusetts, 2015–2018. *American journal of public health*. 2020;110(1):37–44. [PubMed: 31725317]
10. Tumpney M, John B, Panneer N, McClung RP, Campbell EM, Roosevelt K, et al. Human Immunodeficiency Virus (HIV) outbreak investigation among persons who inject drugs in Massachusetts enhanced by HIV sequence data. *The Journal of Infectious Diseases*. 2020;222(Supplement_5):S259–S67. [PubMed: 32877558]
11. Golden MR, Lechtenberg R, Glick SN, Dombrowski J, Duchin J, Reuer JR, et al. Outbreak of human immunodeficiency virus infection among heterosexual persons who are living homeless and inject drugs—Seattle, Washington, 2018. *Morbidity and Mortality Weekly Report*. 2019;68(15):344. [PubMed: 30998671]
12. Kim MM, Conyngham SC, Smith C, Higgins D, Nassau T, Terrell C, et al. Understanding the Intersection of Behavioral Risk and Social Determinants of Health and the Impact on an Outbreak of Human Immunodeficiency Virus Among Persons Who Inject Drugs in Philadelphia. *J Infect Dis*. 2020;222(Suppl 5):S250–s8. [PubMed: 32877552]
13. McClung R, Panneer N, Atkins A, editors. Large HIV outbreak among people who inject drugs, West Virginia, 2018–2019. *Conference on Retroviruses and Opportunistic Infections*; 2020.
14. Oregon Health Authority. HIV infection among people who use drugs. 2019.
15. Ciccarone D The rise of illicit fentanyl, stimulants and the fourth wave of the opioid overdose crisis. *Current Opinion in Psychiatry*. 2021;34(4):344–50. [PubMed: 33965972]

16. Cai Y, Dai Z, Wen S, Bhandari R. Risk Factors Associated With Infection of Blood-Borne Virus among People Who Used Methamphetamine 2020.
17. Gladden RM, Martinez P, Seth P. Fentanyl law enforcement submissions and increases in synthetic opioid-involved overdose deaths—27 states, 2013–2014. *Morbidity and Mortality Weekly Report*. 2016;65(33):837–43. [PubMed: 27560775]
18. O'Donnell JK, Gladden RM, Seth P. Trends in deaths involving heroin and synthetic opioids excluding methadone, and law enforcement drug product reports, by census region—United States, 2006–2015. *MMWR Morbidity and mortality weekly report*. 2017;66(34):897. [PubMed: 28859052]
19. O'Donnell JK, Halpin J, Mattson CL, Goldberger BA, Gladden RM. Deaths involving fentanyl, fentanyl analogs, and U-47700—10 states, July–December 2016. *MMWR Morbidity and mortality weekly report*. 2017;66(43):1197. [PubMed: 29095804]
20. Lambdin BH, Bluthenthal RN, Zibbell JE, Wenger L, Simpson K, Kral AH. Associations between perceived illicit fentanyl use and infectious disease risks among people who inject drugs. *International Journal of Drug Policy*. 2019;74:299–304. [PubMed: 31733979]
21. McCann Pineo M, Schwartz RM. Commentary on the coronavirus pandemic: Anticipating a fourth wave in the opioid epidemic. *Psychological Trauma: Theory, Research, Practice, and Policy*. 2020;12(S1):S108. [PubMed: 32496102]
22. Jenkins RA. The fourth wave of the US opioid epidemic and its implications for the rural US: a federal perspective. *Preventive medicine*. 2021;152(Pt 2):106541. [PubMed: 34482994]
23. Drug Enforcement Administration. National drug threat assessment. DEA-DCT-DIR-007-20. Drug Enforcement Administration, Washington, DC; 2019.
24. Kral AH, Anderson R, Flynn NM, Bluthenthal RN. Injection risk behaviors among clients of syringe exchange programs with different syringe dispensation policies. *JAIDS Journal of Acquired Immune Deficiency Syndromes*. 2004;37(2):1307–12. [PubMed: 15385739]
25. Larney S, Peacock A, Mathers BM, Hickman M, Degenhardt L. A systematic review of injecting-related injury and disease among people who inject drugs. *Drug and alcohol dependence*. 2017;171:39–49. [PubMed: 28013096]
26. Larney S, Peacock A, Leung J, Colledge S, Hickman M, Vickerman P, et al. Global, regional, and country-level coverage of interventions to prevent and manage HIV and hepatitis C among people who inject drugs: a systematic review. *The Lancet Global Health*. 2017;5(12):e1208–e20. [PubMed: 29074410]
27. Berkman LF, Glass T, Brissette I, Seeman TE. From social integration to health: Durkheim in the new millennium. *Social science & medicine*. 2000;51(6):843–57. [PubMed: 10972429]
28. Berkman LF, Glass T. Social integration, social networks, social support, and health. *Social epidemiology*. 2000;1:137–73.
29. Neaigus A, Friedman SR, Goldstein M, Idefonso G, Curtis R, Jose B. Using dyadic data for a network analysis of HIV infection and risk behaviors among injecting drug users. *NIDA Research Monograph*. 1995;151:20–37. [PubMed: 8742759]
30. Sherman SG, Latkin CA, Gielen AC. SOCIAL FACTORS RELATED TO SYRINGE SHARING AMONG INJECTING PARTNERS: A FOCUS ON GENDER. *Substance Use & Misuse*. 2001;36(14):2113–36. [PubMed: 11794586]
31. Morris MD, Evans J, Montgomery M, Yu M, Briceno A, Page K, et al. Intimate injection partnerships are at elevated risk of high-risk injecting: a multi-level longitudinal study of HCV-serodiscordant injection partnerships in San Francisco, CA. *PloS one*. 2014;9(10):e109282. [PubMed: 25286346]
32. Latkin C, Kuramoto S, Davey-Rothwell M, Tobin K. Social norms, social networks, and HIV risk behavior among injection drug users. *AIDS and Behavior*. 2010;14(5):1159–68. [PubMed: 19466537]
33. Johnson RA, Gerstein DR, III AP, Cerbone FG, Brown J. HIV risk behaviors in African-American drug injector networks: implications of injection-partner mixing and partnership characteristics. *Addiction (Abingdon, England)*. 2002;97(8):1011–24. [PubMed: 12144604]

34. El-Bassel N, Shaw SA, Dasgupta A, Strathdee SA. People who inject drugs in intimate relationships: it takes two to combat HIV. *Current Hiv/Aids Reports*. 2014;11(1):45–51. [PubMed: 24477931]
35. Latkin CA, Mandell W, Knowlton AR, Doherty MC, Vlahov D, Suh T, et al. Gender differences in injection-related behaviors among injection drug users in Baltimore, Maryland. *AIDS education and prevention: official publication of the International Society for AIDS Education*. 1998;10(3):257–63. [PubMed: 9642423]
36. Gollub EL, Rey D, Obadia Y, Moatti J-P, Group MS. Gender differences in risk behaviors among HIV+ persons with an IDU history: The link between partner characteristics and women's higher drug-sex risks. *Sexually transmitted diseases*. 1998;25(9):483–8. [PubMed: 9800261]
37. Freeman RC, Rodriguez GM, French JF. A comparison of male and female intravenous drug users' risk behaviors for HIV infection. *The American journal of drug and alcohol abuse*. 1994;20(2):129–57. [PubMed: 8042600]
38. Rhodes T, Rance J, Fraser S, Treloar C. The intimate relationship as a site of social protection: Partnerships between people who inject drugs. *Social Science & Medicine*. 2017;180:125–34. [PubMed: 28343111]
39. Philadelphia Department of Public Health. *Infectious Diseases Continue to Spread Among People Who Inject Drugs*. CHART. 2021;6(2):1–7.
40. Philadelphia Department of Public Health. *HIV Continues to Spread Among People Who Inject Drugs*. CHART. 2019;4 (7):1–4.
41. Lineman T Prevention Point distributed 4,797,776 syringes in Kensington – in 1 Year. *Juniata News* Available at: <https://juniatanewsphillycom/2020/09/18/prevention-point-distributed-4797776-syringes-in-kensington-in-1-year/>. September 18, 2020.
42. Rhodes T, Quirk A. Drug users' sexual relationships and the social organisation of risk: the sexual relationship as a site of risk management. *Social science & medicine*. 1998;46(2):157–69. [PubMed: 9447640]
43. Rhodes T Risk theory in epidemic times: sex, drugs and the social organisation of 'risk behaviour'. *Sociology of Health & Illness*. 1997;19(2):208–27.
44. Rhodes T, Treloar C. The social production of hepatitis C risk among injecting drug users: a qualitative synthesis. *Addiction (Abingdon, England)*. 2008;103(10):1593–603. [PubMed: 18821870]
45. Morris MD, Bates A, Andrew E, Hahn J, Page K, Maher L. More than just someone to inject drugs with: Injecting within primary injection partnerships. *Drug and alcohol dependence*. 2015;156:275–81. [PubMed: 26460140]
46. Gyarmathy VA, Li N, Tobin KE, Hoffman IF, Sokolov N, Levchenko J, et al. Injecting equipment sharing in Russian drug injecting dyads. *AIDS and Behavior*. 2010;14(1):141–51. [PubMed: 19214731]
47. Morris MD, Andrew E, Tan JY, Maher L, Hoff C, Darbes L, et al. Injecting-related trust, cooperation, intimacy, and power as key factors influencing risk perception among drug injecting partnerships. *PloS one*. 2019;14(5):e0217811. [PubMed: 31150518]

Table I.

Individual and Network Characteristics of 64 Women who Inject Drugs in Philadelphia Pennsylvania (2020)

	N	(%)
<i>Individual-level (N=64)</i>		
Female gender identity	63	98.44
Hispanic/Latinx	16	25.00
Race		
White	50	78.13
Black/African American	3	4.69
Other ¹	11	17.19
Sexual orientation		
Straight	46	71.9
Bisexual	15	23.4
Lesbian/gay/pansexual	3	4.69
High school education / GED or greater	24	37.50
Living situation (past 6 months) ²		
Stable housing (house or apartment, including rental)	22	34.38
Transitional housing (i.e., halfway housing, group home, jail, shelter)	11	17.19
Live on the street (including car)	44	48.28
Homeless at any point during the past 6 months (i.e., were living on the street, in a car, park, abandoned building, tent, campsite, or squatting)	53	82.81
Employment (past 6 months) ²		
Full/part-time	4	6.25
Unemployed	43	67.19
Unable to work	18	28.13
Other (furloughed/self-employed)	2	3.13
Average monthly income (past 6 months)		
No income	15	23.44
Less than or equal to \$500 a month	25	39.06
Greater than \$500 and less than \$1,500	14	21.88
Greater than \$1,500 and less than \$2,500	8	12.50
Greater than \$4,000 and less than \$5,000	2	3.13
Any source of illegal income (past 6 months)	48	75.00
Selling drugs	37	57.81
Sex work	26	40.63
Boosting	10	15.63
Selling syringes	9	14.06
Other (looting, fighting, lookout, panhandling)	4	6.25
Monthly income (past 6 months) is ___ ³		
Not enough to make ends meet	44	69.84
Just enough to make ends meet	13	20.63

	N	(%)
Some money left over	6	9.52
Any children under 18 years of age	42	65.6
Incarceration history		
Jail (past 2 years)	38	59.38
Prison (past 2 years)	7	10.94
Ever tested positive for HIV	7	11.11
Ever tested positive for HCV	51	79.69
Drugs injected (past 6 months)		
Cocaine	32	50.00
Heroin	55	85.94
Fentanyl	59	92.19
Prescription opioids	4	6.25
Synthetics	1	1.56
Methamphetamine	29	45.31
Ketamine	4	6.25
Tranquilizers	14	21.88
Ever overdosed	47	73.44
Engaged in sex exchange (past 6 months)	28	43.75
Only one injection partner (past 6 months)	36	56.25
Age, median (IQR)	37	(32 – 41.5)
Age at first injection, median (IQR)	28	(24 – 33)
Years injecting, median (IQR)	6	(3 – 15)
Number of times inject per day (past 6 months), median (IQR)	8	(5 – 10)
Number of injection partners (past 6 months), median (IQR)	1	(1 – 3)
Number of overdoses (past 6 months), median (IQR)	0	(0 – 1)
Number of overdoses witnessed (past 6 months), median (IQR)	9.5	(2.5 – 20)
<i>Network-level Characteristics (N=123)</i>		
<i>Network member demographics</i>		
Age, median (IQR)	36	(31-42)
Female	47	38.21
Hispanic/Latinx	28	22.76
Race		
White	79	64.23
Black/African American	15	12.20
Other ¹	29	23.57
<i>Relationship characteristics</i>		
Relationship type ²		
Romantic	28	22.76
Family	6	4.88
Friend	70	56.91
Associate	22	17.89

	N	(%)
Interact with partner at least daily (past 6 months)	82	66.67
Share an injection setting at least daily (past 6 months)	68	55.28
Live together (past 6 months)	69	56.10
Injection partner provided financial support (past 6 months)	46	37.40
Emotional support (i.e., extremely likely to discuss personal/private matters with injection partner) (past 6 months)	50	40.65
Sex partner (past 6 months)	28	22.76
Injection partner helped her to inject drugs (past 6 months)	49	39.84
Share injection equipment with injection partner (past 6 months)	69	56.10
Relationship duration in months, median (IQR)	24	(12-72)
<i>Risk perception</i>		
Individual perceives that injection partner is living with HIV ⁴	10	8.20
Individual perceives that injection partner is living with HCV ⁴	82	67.21
Individual perceives that injection partner shares syringes or injection equipment with others		
No – neither syringes nor equipment	49	39.84
Yes – syringes	0	0.00
Yes - cookers/cotton	12	9.76
Yes – syringes and cookers/cotton	20	16.26
Don't know	42	34.15

¹Other includes Asian/Pacific Islander, Native American, two or more races, other race, and don't know

²Numbers do not sum to 100% because multiple responses were permitted

³N=63

⁴N=122

Table II. Overlapping Relationship Roles among Women who Inject Drugs in Philadelphia, Pennsylvania (N=123 Injecting Partnerships)

	Emotional Support N (%) ^I	Inject with Daily N (%) ^I	Sex Partner N (%) ^I	Live With N (%) ^I	Financial Support N (%) ^I	See Daily N (%) ^I	Injection Assistance N (%) ^I
Emotional Support		39 (57.4%)	23 (82.1%)	41 (59.4%)	35 (76.1%)	41 (50.0%)	26 (53.1%)
Inject with Daily	39 (78.0%)		26 (92.9%)	50 (72.5%)	34 (73.9%)	66 (80.5%)	25 (51.0%)
Sex Partner	23 (46.0%)	26 (38.2%)		27 (39.1%)	21 (45.7%)	26 (31.7%)	10 (20.4%)
Live With	41 (82.0%)	50 (73.5%)	27 (96.4%)		35 (76.1%)	56 (68.3%)	27 (55.1%)
Financial Support	35 (70.0%)	34 (50.0%)	21 (75.0%)	35 (50.7%)		36 (43.9%)	17 (34.7%)
See Daily	41 (82.0%)	66 (97.1%)	26 (92.9%)	56 (81.2%)	36 (78.3%)		30 (61.2%)
Injection Assistance	26 (52.0%)	25 (36.8%)	10 (35.7%)	27 (39.1%)	17 (37.0%)	26 (53.1%)	
TOTAL	50	68	28	69	46	82	49

^I% is computed using column totals as the denominator.

Table III.

Unadjusted Prevalence Ratios for Individual and Network Correlates of Using a Syringe Second in the Past 6 Months (N=123 Injection Partnerships)

	PR	95% CI
Individual-level (N=64)		
Age	0.94	(0.90, 1.00)
Hispanic/Latinx	0.12	(0.02, 0.89)
Race (White vs. Other)	4.32	(1.04, 17.92)
Sexual orientation		
Straight	ref	ref
Bisexual	0.85	(0.32, 2.26)
Lesbian/gay/pansexual	1.18	(0.22, 6.20)
High school education / GED or greater	0.96	(0.42, 2.21)
Living situation (past 6 months)		
Stable housing (house or apartment, including rental)	0.45	(0.17, 1.22)
Transitional housing (i.e., halfway housing, group home, jail, shelter)	1.15	(0.38, 2.75)
Live on the street (including car)	1.07	(0.49, 2.33)
Homeless at any point during the past 6 months (i.e., were living on the street, in a car, park, abandoned building, tent, campsite, or squatting)	1.15	(0.46, 2.90)
Employed full/part-time (past 6 months)	3.05	(1.52, 6.12)
Any monthly income (past 6 months)	0.63	(0.30, 1.33)
Any source of illegal income (past 6 months)	0.68	(0.32, 1.47)
Monthly income (past 6 months) is ___ ¹		
Not enough to make ends meet	ref	ref
Just enough to make ends meet	0.68	(0.25, 1.89)
Some money left over	0.45	(0.06, 3.11)
Any children under 18 years of age	1.22	(0.55, 2.70)
Incarceration history		
Jail (past 2 years)	1.07	(0.51, 2.26)
Prison (past 2 years)	0.57	(0.15, 2.23)
Ever tested positive for HIV ¹	1.52	(0.54, 4.28)
Ever tested positive for HCV	0.57	(0.27, 1.22)
Drugs injected (past 6 months)		
Cocaine	1.02	(0.49, 2.11)
Heroin	1.60	(0.41, 6.26)
Fentanyl ²	n/a	n/a
Prescription opioids	1.04	(0.30, 3.59)
Synthetics	1.13	(0.24, 5.31)
Methamphetamine	1.18	(0.57, 2.44)
Ketamine ²	n/a	n/a
Tranquilizers	1.42	(0.66, 3.03)

	PR	95% CI
Ever overdosed	0.54	(0.26, 1.11)
Engaged in sex exchange (past 6 months)	0.67	(0.31, 1.47)
Number of times inject per day (past 6 months)	0.99	(0.95, 1.04)
Number of injection partners (past 6 months)	0.49	(0.34, 0.70)
One injection partner vs. more than one injection partner (past 6 months)	3.27	(1.45, 7.40)
Number of overdoses (past 6 months)	0.32	(0.08, 1.40)
Number of overdoses witnessed (past 6 months)	0.98	(0.96, 1.01)
Network-level Characteristics (N=123)		
<i>Network member demographics</i>		
Age	1.00	(1.00, 1.00)
Female gender	1.47	(0.95, 2.29)
Hispanic/Latinx	0.58	(0.27, 1.23)
Race (White vs. Other)	0.87	(0.55, 1.38)
<i>Relationship characteristics</i>		
Interact with partner at least daily (past 6 months)	3.47	(1.47, 8.20)
Share an injection setting at least daily (past 6 months)	3.62	(1.59, 8.23)
Live together (past 6 months)	3.84	(1.73, 8.53)
Injection partner provided financial support (past 6 months)	2.69	(1.24, 5.85)
Emotional support (extremely likely to discuss personal/private matters with injection partner) (past 6 months)	8.86	(3.42, 22.96)
Sex partner (past 6 months)	3.54	(1.94, 6.45)
Injection partner helped her to inject drugs (past 6 months)	1.91	(1.11, 3.29)
Share injection equipment with injection partner (past 6 months)	3.13	(1.14, 8.61)
Relationship duration in months	1.00	(1.00, 1.00)
<i>Risk perception</i>		
Individual perceives that network member is living with HIV ¹	1.02	(0.50, 2.07)
Individual perceives that network member is living with HCV ¹	1.02	(0.52, 1.97)
Individual perceives that injection partner does not share syringes or injection equipment with others vs. any perceived level of sharing with others (including don't know)	1.62	(0.89, 2.95)

¹N=122

²Prevalence ratios for fentanyl injection in the past 6 months and ketamine injection in the past 6 months could not be computed due to collinearity

Note: women use the needle second in 26 of 123 injection partnerships (21.14%)

Table IV.

Adjusted Prevalence Ratios for Individual and Network Correlates of Using a Syringe Second in the Past 6 Months Using Two Different Model-building Strategies (N=123)¹

	Model 1		Model 2	
	APR	95% CI	APR	95% CI
<i>Individual-level Characteristics</i>				
Number of injection partners (past 6 months)	0.66	(0.47, 0.91)	0.65	(0.45, 0.93)
<i>Network-level Characteristics</i>				
Injection partner helped her to inject drugs (past 6 months)	1.92	(1.10, 3.37)		
Emotional support (extremely likely to discuss personal/private matters with injection partner) (past 6 months)			6.19	(2.12, 18.06)
Sex partner (past 6 months)	2.77	(1.36, 5.64)		

¹All variables included in each model are presented in the table

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