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Trends in HIV and HCV Risk Behaviors and Prevalent Infection Among People Who Inject Drugs in New York City, 2005–2012

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Abstract

Background: We assess trends in HIV and hepatitis C virus (HCV) risk behaviors and prevalent infection among people who inject drugs (PWID) in New York City (NYC).

Methods: PWID in NYC were sampled using respondent-driven sampling in 2005, 2009, and 2012 (serial cross sections) for the Centers for Disease Control and Prevention–sponsored National HIV Behavioral Surveillance study. Participants were interviewed about their current (≤12 months) risk behaviors and tested for HIV and HCV. The crude and adjusted risk ratio (RR) and 95% confidence interval (95% CI) for linear time trends were estimated using generalized estimating equations regression with a modified Poisson model.

Results: The sample comprised 500, 514, and 525 participants in 2005, 2009, and 2012, respectively. Significant ($P < 0.05$) linear trends in risk behaviors included a decline in unsafe syringe sources (60.8%, 31.3%, 46.7%; RR = 0.86, 95% CI: 0.81 to 0.92), an increase in all syringes from syringe exchanges or pharmacies (35.4%, 67.5%, 50.3%; RR = 1.15, 95% CI: 1.09 to 1.22), and an increase in condomless vaginal or anal sex (53.6%, 71.2%, 70.3%; RR = 1.14, 95% CI: 1.09 to 1.19). Receptive syringe sharing (21.4%, 27.0%, 25.1%), sharing drug preparation equipment (45.4%, 43.4%, 46.7%), and having ≥2 sex partners (51.2%, 44.0%, 50.7%) were

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stable. Although HIV seroprevalence declined (18.1%, 12.5%, 12.2%), HCV seroprevalence was high (68.2%, 75.8%, 67.1%). In multivariate analysis, adjusting for sample characteristics significantly associated with time, linear time trends remained significant, and the decline in HIV seroprevalence gained significance (adjusted RR = 0.76, 95% CI: 0.64 to 0.91, $P = 0.003$).

Conclusions: This trend analysis suggests declining HIV prevalence among NYC PWID. However, HCV seroprevalence was high and risk behaviors were considerable. Longitudinal surveillance of HIV and HCV risk behaviors and infections is needed to monitor trends and for ongoing data-informed prevention among PWID.

Keywords

HIV; hepatitis C; people who inject drugs; risk behaviors; trends; New York City

INTRODUCTION

In the United States, many people who inject drugs (PWID) have been infected with or are at risk of infection with HIV. Nationally, PWID account for an estimated 19.6% of 931,526 adult and adolescent people living with diagnosed HIV/AIDS (2013) and 8.8% of an estimated 43,899 new diagnoses (2014).[1] In New York City (NYC) in 2014, PWID accounted for 15.7% of 119,550 people living with diagnosed HIV/AIDS and 3.4% of 2718 new diagnoses.[2]

Many PWID have also been infected with or are at risk of infection with the hepatitis C virus (HCV). The health consequences of HCV infection are serious, including liver cirrhosis and/or progression to hepatocellular carcinoma.[3] HCV prevalence among PWID is high nationally and in NYC. In 2014, of 1030 cases of acute HCV infection with information on injection drug-use history that were reported to the Centers for Disease Control and Prevention (CDC), 68.2% had injected drugs.[4] A systematic review estimated 73.4% HCV prevalence in the 2001–2004 period among PWID in the United States.[5] In a meta-analysis of 4 national probability surveys conducted during 1999–2008, HCV prevalence was estimated at 43.1% among PWID aged 43–65 years.[6] In NYC, a study of 1535 PWID entering drug treatment in 2006–2013 found 67% HCV prevalence.[7]

Some risk behaviors for HIV, particularly those involving blood exchange, overlap with those for HCV. HIV infection among PWID has mainly occurred through parenteral transmission, including sharing syringes and (less efficiently) drug preparation equipment (eg, syringes used to mix drugs), although sexual transmission through condomless (without using condoms) vaginal or anal sex has become more prevalent.[8–11] HCV can be efficiently transmitted parenterally through sharing syringes and, because HCV infectivity is high, through sharing drug preparation equipment.[12–15] Although less likely than with HIV, HCV can be transmitted sexually.[16,17] The probability of HIV and HCV transmission is also a function of their background prevalence. HIV prevalence among PWID in NYC was high during the 1980s and early 1990s and was more than 50% in some studies.[18,19] The background prevalence of HCV among PWID in NYC is high. Moreover, between 75%–85% of those infected with HCV are chronically infected and are able to transmit the virus.[4,15,20]

In the following, we report on trends in HIV and HCV injection and sexual risk behaviors and prevalent infection (ie, seroprevalence) across 3 consecutive PWID samples recruited in NYC in 2005, 2009, and 2012 for the CDC-sponsored National HIV Behavioral Surveillance (NHBS) study. During this period, legal sterile syringe distribution was provided in NYC through syringe exchange programs (SEPs) and retail pharmacies.[21–23]

METHODS

Sampling and Protocol

NHBS is a serial cross-sectional study that monitors HIV risk behaviors, testing history, exposure to HIV prevention services, and HIV prevalence among men who have sex with men, PWID, and heterosexuals at high risk in 3-year cycles.[24,25] In the PWID cycles, HCV testing is offered. The study is implemented in approximately 20 cities (with small variations by cycle) in the United States.

Active drug injectors were recruited in NYC using respondent-driven sampling (RDS).[26] Initial sample participants (seeds) were recruited from locations where PWID were known to reside or congregate. After completing the study interview, seeds were given 3 coupons to refer up to 3 PWID to the study. Eligible nonseed participants had to present a valid study coupon, were ≥18 years of age, were NYC residents, understood English or Spanish, and injected illicit drugs in the past 12 months. Eligible participants could only participate once during any study cycle but, if eligible, could participate in other cycles. Study participation was anonymous. Consenting participants were administered a structured interview in private by trained interviewers and were offered HIV and HCV tests. Trained phlebotomists collected blood specimens using venipuncture from consenting participants who were asked to return for their results in 2 weeks. During their return visit, participants who tested positive were referred to health and social service providers. Participants who completed the study interview were given 3 coupons for PWID social network members they could refer to the study. Successive waves were recruited until the desired sample size was reached. Participants were provided small monetary incentives for completing the interview, for HIV and HCV testing, and for each eligible participant they referred to the study.

Measures

Participants were interviewed using a standardized structured questionnaire developed by CDC and collaborating local NHBS sites. The interview covered topics such as sociodemographic characteristics, drug and sexual behaviors, HIV and HCV testing history and diagnoses, and alcohol or drug treatment history.

Sample characteristics analyzed included sociodemographic variables (age, race/ethnicity, gender, sexual orientation, country of birth, NYC borough of residence, education, homelessness in the past 12 months, and household income in the past 12 months), drug use–related variables in the past 12 months (injecting heroin by itself, injecting cocaine by itself, injecting “speedball” [heroin and cocaine mixed together], and injecting drugs >1 time a day), and health-related variables (being in alcohol or drug treatment in the past 12 months, self-reported HIV status, and self-reported HCV status).

Outcome variables analyzed included injecting and sexual behaviors in the past 12 months, HIV testing in the past 12 months, and HIV and HCV serostatus (the study tests). Injecting behaviors included obtaining syringes from any potentially unsafe sources (friend, dealer, or other unsafe sources), obtaining all syringes from a SEP or pharmacy, not always injecting with sterile needles, engaging in receptive syringe sharing, and sharing drug preparation equipment (cookers, cotton, water, or syringe-mediated drug sharing). Sexual behaviors included engaging in condomless vaginal or anal sex, engaging in exchange sex (buying or selling), and having ≥2 sex partners. HIV and HCV serostatus was for all participants tested and for those tested who did not report previously testing positive. Not reporting previously testing positive for those testing positive, as a measure of undiagnosed infection, was also analyzed.

Time (the exposure variable) was based on the NHBS PWID cycle, with 2005 = "1," 2009 = "2," and 2012 = "3."

Blood specimens were tested for HIV antibodies on HIV1/2 enzyme-linked immunosorbent assay and HIV1 Western blot platforms (Bio-Rad Laboratories, Hercules, CA). In 2005 and 2009, blood specimens were tested for HCV antibodies using an enzyme-linked immunosorbent assay platform (Abbott Laboratories, Chicago, IL) and in 2012 a chemiluminescence immunoassay platform (VIT-ROS Anti-HCV assay; Ortho-Clinical Diagnostics, Raritan, NJ).

Analysis

Analyses were restricted to NYC residents. Bivariate analyses examined the linear association of time with sample characteristics and with outcomes. In multivariate analysis, the linear association of time with outcomes was adjusted for sample characteristics with a significant ($P < 0.05$) linear association with time because changes in sample characteristics across time may be confounded with trends in outcomes. Categorical data were analyzed using frequencies and percentages, normally distributed continuous data using means and standard deviations, and nonnormally distributed continuous data using medians and interquartile ranges. Time trends in sample characteristics were tested using Spearman's rank correlation coefficient (rho) for nonnormal continuous data (medians) and generalized estimating equations regression with a modified Poisson model and robust error variance for dichotomous data.[27–29] The modified Poisson model was used to estimate the risk ratio (RR), adjusted RR (ARR), and 95% confidence interval (95% CI) for time trends.

To assess the robustness of the multivariate models, a sensitivity analysis was conducted, in which the interaction of time with participants' race/ethnicity, residential geographic location (NYC borough of residence), and age was added to the multivariate models. These variables have been associated with HIV risk or prevalence in other studies and, as described in the Results, also had a significant ($P < 0.05$) quadratic association with time.[30–33] The P values for time and the size of the time effect for the models in the sensitivity analysis were compared with the original models to determine whether the models gained or lost significance ($P < 0.05$) and whether the size of the time effect increased or decreased by ≥10%.

The statistical analyses are unweighted. Using RDS weights for time trend analysis is in development.[34] However, because a participant's probability of being recruited through RDS may be influenced by their peer social network size, the PWID social network size was controlled in the multivariate models.[33]

The Statistical Analysis System (SAS Institute, Cary, NC) was used for statistical analyses.

Ethics

Study procedures involving human subjects were approved by Institutional Review Boards at the NYC Department of Health and Mental Hygiene, the National Development and Research Institutes, and John Jay College of Criminal Justice.

RESULTS

Sample Characteristics

The analysis sample included 1539 PWID, with 500 participants in 2005, 514 in 2009, and 525 in 2012 (Table 1). There were significant linear increases in categorical and median age, in the proportion of participants with a household income <$10,000, and in the proportion who injected speedball. The proportion who injected drugs >1 time a day and the proportion who reported being HIV positive significantly declined. The median number of PWID social network members significantly increased. No other sample characteristics had significant linear trends.

Significant quadratic associations with time were found for age (≥40 years, $P < 0.0001$), race/ethnicity (Black/African American, $P < 0.0001$; White, $P < 0.0001$), and NYC borough of residence (Manhattan, $P < 0.0001$; Brooklyn, $P < 0.0001$; Queens, $P = 0.0444$). Gender was not significant (male, $P = 0.104$; female, $P = 0.086$; transgender, $P = 0.40$).

Drug and Sexual Behaviors, HIV Testing, and HIV and HCV Seroprevalence

There was a significant linear decline in the proportion who obtained syringes from potentially unsafe sources (60.8%, 31.3%, 46.7% [RR: 0.86; 95% CI: 0.81 to 0.92; $P < 0.001$]) and a significant linear increase in the proportion obtaining all syringes from a SEP or pharmacy (35.4%, 67.5%, 50.3% [RR: 1.15; 95% CI: 1.09 to 1.22; $P < 0.001$]) (Table 2). There were no significant linear trends in other injecting risk behaviors, although many engaged in these behaviors. In each cycle, approximately half did not always inject with a sterile needle (47.4%, 59.7%, 52.2%), about a quarter engaged in receptive syringe sharing (21.4%, 27.0%, 25.1%), and more than 40% (45.4%, 43.4%, 46.7%) shared drug preparation equipment.

Sexual risk was considerable. There was a large and significant increase in the proportion who engaged in condomless vaginal or anal sex (53.6%, 71.2%, 70.3% [RR: 1.14; 95% CI: 1.09 to 1.19; $P < 0.001$]). There were no significant linear trends in other sexual risk behaviors, although many engaged in these behaviors. Engaging in exchange sex increased from about a quarter in 2005 to almost a third in 2012 (26.2%, 13.2%, 30.5%), and approximately half in each cycle reported ≥2 sex partners (51.2%, 44.0%, 50.7%).

A majority of participants in each cycle who did not report previously testing positive were tested for HIV in the past 12 months (75.8%, 61.3%, 72.2%), with no significant linear trend. There was a marginally significant ($P = 0.051$) linear decline in HIV-positive seroprevalence (18.1%, 12.5%, 12.2%). HIV-positive seroprevalence among those who did not report previously testing HIV positive was low, with no significant linear trend (2.9%, 6.3%, 4.6%). Among those who tested HIV seropositive, there was a significant linear increase in the proportion who did not report previously testing positive (13.3%, 46.9%, 34.4% [RR: 1.33; 95% CI: 1.03 to 1.71; $P = 0.029$]). There were no significant linear trends in the HCV variables. HCV-positive seroprevalence was consistently high (68.2%, 75.8%, 67.1%). HCV-positive seroprevalence among those who did not report previously testing HCV positive varied between a third and a half (38.1%, 53.2%, 35.6%). Among those who tested HCV seropositive, between a quarter and a third did not report previously testing HCV positive (27.3%, 34.8%, 25.9%).

In the multivariate analyses, adjusting for age, household income <$10,000, injecting speedball, injecting drugs >1 time a day, self-reported HIV status, and the number of PWID social network members, the significant linear trends in the unadjusted analyses remained significant in the adjusted analyses. These included a decline in the proportion who obtained any syringes from potentially unsafe sources (ARR: 0.85; 95% CI: 0.79 to 0.91; $P < 0.001$), an increase in the proportion who obtained all syringes from a SEP or pharmacy (ARR: 1.17; 95% CI: 1.10 to 1.24; $P < 0.001$), an increase in the proportion who engaged in condomless vaginal or anal sex (ARR: 1.11; 95% CI: 1.06 to 1.16; $P < 0.001$), and an increase in the proportion who did not report previously testing HIV positive among those who tested HIV positive (ARR: 1.62; 95% CI: 1.20 to 2.20; $P = 0.002$). The linear decline in HIV seroprevalence became significant in the adjusted analysis (ARR: 0.76; 95% CI: 0.64 to 0.91; $P = 0.003$).

In the sensitivity analysis, with the interaction of time with participants' race/ethnicity, NYC borough of residence, and age added to the original multivariate models, no models that were significant in the original models lost significance and none that were nonsignificant gained significance. With the exception of the time effect for HIV-positive seroprevalence, none of the changes in the effect sizes for time were ≥10%. The time effect for HIV-positive seroprevalence increased by 31.6% (ARR: 0.76; 95% CI: 0.64 to 0.91; $P = 0.003$ [original model] vs. ARR: 0.52; 95% CI: 0.36 to 0.74; $P = 0.0003$ [revised model]).

DISCUSSION

The analysis of trend data for HIV and HCV risk behaviors and prevalent infection among PWID in NYC from the 2005, 2009, and 2012 NHBS cycles showed a mixture of stability and change. Among variables that changed, some demonstrated increasing risk and others declining risk. This mixed pattern was found in analyses of previous trends in HIV risk (and by implication HCV risk) and infection among PWID in NYC.[18,30,35,36]

Lower risk trends were found in the decline in obtaining syringes from unsafe sources and the increase in obtaining all syringes from a SEP or pharmacy, which reflects the relatively long-standing availability of sterile syringes in NYC, with the introduction of SEPs in 1992

and retail pharmacy sales in 2001.[21–23] In addition, since 2007, there has been an increase in the distribution of syringes from SEPs in NYC through the Peer-Delivered Syringe Exchange program. This program is overseen by the AIDS Institute in the New York State Department of Health and allows for secondary syringe distribution by PWID directly attending SEPs within their PWID social networks.[37] However, although not a significant trend, between 2009 and 2012, obtaining syringes from potentially unsafe sources increased and obtaining all syringes from a SEP or pharmacy decreased. This change may indicate a rebound in injecting risk and/or an effect of how participants may have understood the questions about syringe sources, with participants who received sterile syringes through Peer-Delivered Syringe Exchange secondary syringe distribution reporting this as receiving syringes “from a friend” (the direct source) instead of “from a SEP” (the original and indirect source).

Injecting behaviors which did not exhibit significant change but which constitute a continuing risk of infection with HIV or HCV, included receptive syringe sharing, sharing drug preparation equipment, and not always injecting with a sterile needle. The substantial prevalence of receptive syringe sharing may generate an increase in HIV infection among PWID in NYC if the background prevalence of HIV increases in this population. For HCV transmission risk, the high prevalence of sharing drug preparation equipment, an efficient transmitter of HCV, along with the high background prevalence of chronic HCV, increases the likelihood that the rate of HCV transmission among PWID will continue to be high.[7,13–15] Not always injecting with a sterile needle may be a risk for HIV or HCV infection (eg, through inadvertent sharing) and for other serious diseases, such as bacterial infections, particularly those caused by *Staphylococcus aureus*, a well-recognized cause of injection-related bacterial endocarditis.[38]

Trends in sexual behaviors indicate a persisting sexual risk for HIV. There was a large and significant increase in condomless vaginal or anal sex. Also, approximately half of participants reported ≥2 sex partners in each cycle, and in 2012, almost a third engaged in exchange sex. The large proportion of PWID in NYC who continue to engage in unsafe sexual behaviors may drive the ongoing spread of HIV and sustain endemic HIV infection in this population and among their sexual partners.[8,9,39]

One factor that may account for the persistence of high-risk injection and sexual behaviors among NYC PWID is suggested by the high proportion (half or more) of the sample in each cycle which was homeless. Homelessness has been associated with high-risk injection and sexual behaviors that could lead to infection with HIV or HCV.[40–42]

The decline in HIV seroprevalence overall and the low HIV seroprevalence among those who did not report previously testing HIV positive most probably reflect the widening access to legal sterile syringe distribution programs in NYC. These trends in HIV seroprevalence are consistent with NYC Department of Health and Mental Hygiene HIV surveillance data for new HIV diagnoses in 2014, where 3.4% of 2718 new diagnoses were attributed to injection drug use.[2] The results of the sensitivity analysis suggest, however, that differences in trends in HIV prevalence among PWID in NYC persist by age, race/ethnicity, and NYC borough of residence.[30–32,35]

The trends in HIV testing are of concern. Among those testing HIV positive, there was a significant linear increase in the proportion who did not report previously testing HIV positive, which may indicate recent HIV infection and/or inadequate testing frequency. In addition, although a majority of those who did not report being HIV positive were tested for HIV in the past 12 months, many, as high as 38% in 2009, did not get tested. PWID unaware of being infected with HIV will not be linked to care and treated with antiretroviral therapy to suppress the virus and are at risk of onward transmission of HIV to their injecting and sexual partners.[43]

HCV seroprevalence was high across cycles, which is consistent with the substantial proportion in each cycle who shared drug preparation equipment, a persisting risk factor for HCV infection among PWID.[13–15] Many participants may have been recently infected with HCV,[7] with at least a third of those in each cycle who did not report previously testing HCV positive testing positive and many, as high as 35% in 2009, who tested HCV positive not reporting previously testing HCV positive. HCV infection can be asymptomatic for most of those with newly acquired infections or in the earlier stages of chronic infection. Unless there is regular testing for HCV among PWID, many recent HCV infections are likely to be missed.[4] PWID unaware of being infected with HCV will not be treated with direct-acting antiviral therapy that can eradicate the virus and will be unable to disclose their HCV status to their injecting and sexual partners, increasing the risk of onward HCV transmission.

In serial cross-sectional studies, changes in sample characteristics across time may be confounded with trends in outcome variables. This was addressed by adjusting for sample characteristics that had significant linear associations with time and by the sensitivity analysis. Some participants may have underreported stigmatizing, sensitive, or illegal behaviors. To minimize this limitation, experienced interviewers were selected and trained using a CDC-developed protocol addressing these concerns. Trends in HIV and HCV risk behaviors and infections among PWID can vary by demographic group, such as by race/ethnicity, which is an area for future research. The samples are not random and participants were recruited using RDS, which assumes that PWID are a networked population. Although RDS weights were not used, to control for the possibility that participants with larger PWID social networks were more likely to enter the study, PWID social network size was controlled in the adjusted analyses. Also, PWID with weak or nonexistent network ties to other PWID would not be adequately represented in RDS samples. Caution is therefore necessary in generalizing the results to all PWID in NYC and to PWID in other cities.

CONCLUSIONS

Since the peak of the HIV epidemic among PWID in NYC during the 1980s and early 1990s, HIV prevalence and incidence have declined and sterile syringe distribution programs have achieved wide coverage. The study results reflect this larger context and show a decline in HIV seroprevalence to a relatively low level and an increase in PWID who obtained all their syringes from SEPs or pharmacies. Sexual risk, however, remained high and may drive future HIV outbreaks in NYC among PWID and their sexual partners. Along with the promotion of ongoing reduction in injecting and sexual risk among PWID, a rapid response

to HIV outbreaks and linkage to HIV antiretroviral therapy for those infected are needed to prevent an expanding epidemic.[44]

HCV seroprevalence was consistently high and is likely sustained by the persistence of receptive syringe sharing, the substantial proportion of PWID who share drug preparation equipment, and the high background prevalence of HCV. With the large and continuing HCV epidemic among PWID, interventions are needed to reduce even further the sharing of syringes and drug preparation equipment. Also, expanding HCV testing among PWID and treating those infected with direct-acting antiviral-based therapy to eradicate the virus can lower the background prevalence of HCV, which will reduce the risk of exposure and will help to contain and eventually reduce the HCV epidemic among PWID.

The results of this study demonstrate the need for ongoing surveillance, prevention, and medical therapies for HIV and HCV among PWID in NYC and in other localities where there are PWID populations.

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REFERENCES

1. Centers for Disease Control and Prevention. HIV Surveillance Report, 2014;26. Available at: http://www.cdc.gov/hiv/library/reports/surveillance/. Accessed December 1, 2016.
2. New York City Department of Health and Mental Hygiene. HIV Epidemiology and Field Services Program. HIV Surveillance Annual Report, 2014. Available at: http://www1.nyc.gov/assets/doh/downloads/pdf/dires/2014-hiv-surveillance-annual-report.pdf. Accessed December 1, 2016.
3. Chen SL, Morgan TR. The natural history of hepatitis C virus (HCV) infection. Int J Med Sci. 2006;3:47–52. [PubMed: 16614742]
4. Centers for Disease Control and Prevention. Surveillance for Viral Hepatitis—United States, 2014. Available at: https://www.cdc.gov/hepatitis/statistics/2014surveillance/commentary.htm#summary. Accessed December 1, 2016.
5. Nelson PK, Mathers BM, Cowie B, et al. Global epidemiology of hepatitis B and hepatitis C in people who inject drugs: results of systematic reviews. Lancet. 2011;378:571–583. [PubMed: 21802134]
6. Lansky A, Finlayson T, Johnson C, et al. Estimating the number of persons who inject drugs in the United States by meta-analysis to calculate national rates of HIV and hepatitis C virus infections. PLoS One. 2014;9:e97596. [PubMed: 24840662]

7. Jordan AE, Des Jarlais DC, Arasteh K, et al. Incidence and prevalence of hepatitis c virus infection among persons who inject drugs in New York City: 2006–2013. Drug Alcohol Depend. 2015;152:194–200. [PubMed: 25891230]
8. Strathdee SA, Sherman SG. The role of sexual transmission of HIV infection among injection and non-injection drug users. J Urban Health. 2003;80(4 suppl 3):7–14.
9. Des Jarlais DC, Arasteh K, McKnight C, et al. Associations between herpes simplex virus type 2 and HCV with HIV among injecting drug users in New York City: the current importance of sexual transmission of HIV. Am J Public Health. 2011;101:1277–1283. [PubMed: 21566021]
10. Kaplan EH, Heimer R. A model-based estimate of HIV infectivity via needle sharing. J Acquir Immune Defic Syndr. 1992;5:1116–1118. [PubMed: 1403641]
11. Jose B, Friedman SR, Neaigus A, et al. Syringe-mediated drug-sharing (backloading): a new risk factor for HIV among injecting drug users. AIDS. 1993;7:1653–1660. [PubMed: 8286076]
12. Neaigus A, Gyarmathy VA, Miller M, et al. Injecting and sexual risk correlates of HBV and HCV seroprevalence among new drug injectors. Drug Alcohol Depend. 2007;89:234–243. [PubMed: 17289298]
13. Hagan H, Thiede H, Weiss NS, et al. Sharing of drug preparation equipment as a risk factor for hepatitis C. Am J Public Health. 2001;91: 42–46. [PubMed: 11189822]
14. Hagan H, Pouget ER, Williams IT, et al. Attribution of hepatitis C virus seroconversion risk in young injection drug users in 5 US cities. J Infect Dis. 2010;201:378–385. [PubMed: 20053137]
15. Pouget ER, Hagan H, Des Jarlais DC. Meta-analysis of hepatitis C seroconversion in relation to shared syringes and drug preparation equipment. Addiction. 2012;107:1057–1065. [PubMed: 22168373]
16. Tohme RA, Holmberg SD. Is sexual contact a major mode of hepatitis C virus transmission? Hepatology. 2010;52:1497–1505. [PubMed: 20635398]
17. Bradshaw D, Matthews G, Danta M. Sexually transmitted hepatitis C infection: the new epidemic in MSM? Curr Opin Infect Dis. 2013;26: 66–72. [PubMed: 23242342]
18. Des Jarlais DC, Friedman SR, Sotheran JL, et al. Continuity and change within an HIV epidemic: injecting drug users in New York City, 1984 through 1992. J Am Med Assoc. 1994;271:121–127.
19. Des Jarlais DC, Marmor M, Paone D, et al. HIV incidence among injecting drug users in New York City syringe-exchange programmes. Lancet. 1996;348:987–991. [PubMed: 8855855]
20. Alter MJ, Margolis HS, Krawczynski K, et al. The natural history of community-acquired hepatitis C in the United States. The sentinel counties chronic non-a, non-B hepatitis study team. N Engl J Med. 1992;327:1899–1905. [PubMed: 1280771]
21. Burris S, Vernick JS, Ditzler A, et al. The legality of selling or giving syringes to injection drug users. J Am Pharm Assoc (Wash). 2002;42(6 suppl 2):S13–S18. [PubMed: 12489604]
22. New York State Department of Health. Expanded Syringe Access Program (ESAP): Overview of the Law and Regulations. Available at: https://www.health.ny.gov/diseases/aids/consumers/prevention/needles_syringes/esap/overview.htm. Accessed December 1, 2016.
23. Center for Urban Epidemiologic Studies—New York Academy of Medicine, Beth Israel Medical Center, and National Development and Research Institutes, Inc. New York State Expanded Syringe Access Demonstration Program Evaluation. New York, NY: New York Academy of Medicine; 2003.
24. Gallagher KM, Sullivan PS, Lansky A, et al. Behavioral surveillance among people at risk for HIV infection in the U.S.: the National HIV Behavioral Surveillance System. Public Health Rep. 2007 (suppl 1):122. [PubMed: 17236618]
25. Lansky A, Sullivan PS, Gallagher KM, et al. HIV behavioral surveillance in the U.S.: a conceptual framework. Public Health Rep. 2007(suppl 1):122. [PubMed: 17236618]
26. Heckathorn DD. Respondent-driven sampling: a new approach to the study of hidden populations. Social Probl. 1997;44:174–199.
27. Centers for Disease Control and Prevention. HIV testing and risk behaviors among gay, bisexual, and other men who have sex with men—United States. MMWR Morb Mortal Wkly Rep. 2013;62:958–962. [PubMed: 24280915]
28. Zou G A modified poisson regression approach to prospective studies with binary data. Am J Epidemiol. 2004;159:702–706. [PubMed: 15033648]

29. Fang J Using SAS Procedures FREQ, GENMOD, LOGISTIC, and PHREG to Estimate Adjusted Relative Risks—A Case Study. SAS Global Forum 2011 (Paper 345–2011). Available at: http://support.sas.com/resources/papers/proceedings11/345-2011.pdf. Accessed December 1, 2016.
30. Friedman SR, Chapman TF, Perlis TE, et al. Similarities and differences by race/ethnicity in changes of HIV seroprevalence and related behaviors among drug injectors in New York City, 1991–1996. J Acquir Immune Defic Syndr. 1999;22:83–91. [PubMed: 10534151]
31. Des Jarlais DC, Bramson HA, Wong C, et al. Racial/Ethnic Disparities in HIV infection among people who inject drugs: an international systematic review and meta-analysis. Addiction. 2012;107:2087–2095. [PubMed: 22823178]
32. Rockwell R, Deren S, Goldstein MF, et al. Trends in the AIDS epidemic among New York City's injection drug users: localized or citywide? J Urban Health. 2002;79:136–146. [PubMed: 11937622]
33. Broz D, Pham H, Spiller M, et al. Prevalence of HIV infection and risk behaviors among younger and older injecting drug users in the United States, 2009. AIDS Behav. 2014;18(suppl 3):284–296. [PubMed: 24242754]
34. Burt RD, Thiede H. Evaluating consistency in repeat surveys of injection drug users recruited by respondent-driven sampling in the Seattle area: results from the NHBS-IDU1 and NHBS-IDU2 surveys. Ann Epidemiol. 2012;22:354–363. [PubMed: 22420929]
35. Des Jarlais DC, Arasteh K, Hagan H, et al. Persistence and change in disparities in HIV infection among injection drug users in New York City after large-scale syringe exchange programs. Am J Public Health. 2009; 99(suppl 2):S445–S451. [PubMed: 19797757]
36. Des Jarlais DC, Arasteh K, Perlis T, et al. Convergence of HIV seroprevalence among injecting and non-injecting drug users in New York City. AIDS. 2007;21:231–235. [PubMed: 17197815]
37. Winkelstein E User-to-User: Peer-Delivered Syringe Exchange in New York City. Harm Reduction Coalition With Support From New York City AIDS Fund. Available at: http://harmreduction.org/wp-content/uploads/2011/12/user2user.pdf. Accessed March 10, 2017.
38. Del Giudice P Cutaneous complications of intravenous drug abuse. Br J Dermatol. 2004;150:1–10.
39. Jenness SM, Neaigus A, Hagan H, et al. Heterosexual HIV and sexual partnerships between injection drug users and noninjection drug users. AIDS Patient Care STDS. 2010;24:175–181. [PubMed: 20214485]
40. Des Jarlais DC, Braine N, Friedmann P. Unstable housing as a factor for increased injection risk behavior at US syringe exchange programs. AIDS Behav. 2007;11(6 suppl):78–84. [PubMed: 17447132]
41. Salazar LF, Crosby RA, Holtgrave DR, et al. Homelessness and HIV-associated risk behavior among African American men who inject drugs and reside in the urban south of the United States. AIDS Behav. 2007;11 (6 suppl):70–77. [PubMed: 17487578]
42. Sypsa V, Paraskevis D, Malliori M, et al. Homelessness and other risk factors for HIV infection in the current outbreak among injection drug users in Athens, Greece. Am J Public Health. 2015;105:196–204. [PubMed: 24524508]
43. Marks G, Crepaz N, Janssen RS. Estimating sexual transmission of HIV from persons aware and unaware that they are infected with the virus in the USA. AIDS. 2006;20:1447–1450. [PubMed: 16791020]
44. Conrad C, Bradley HM, Broz D, et al. Community outbreak of HIV infection linked to injection drug Use of Oxymorphone–Indiana, 2015. MMWR Morb Mortal Wkly Rep. 2015;64:443–444. [PubMed: 25928470]

TABLE 1.

Time Trends in Sample Characteristics of NYC PWID National HIV Behavioral Surveillance Participants (2005, 2009, 2012)

	2005 (N = 500) n (%)	2009 (N = 514) n (%)	2012 (N = 525) n (%)	RR (95% CI) for Linear Trend	*P*
Age					
≥40	306 (61.2)	271 (52.7)	352 (67.1)	1.05 (1.001 to 1.10)	0.045
18–39	194 (38.8)	243 (47.3)	173 (33.0)		
Median age in years (interquartile ranges)	43 (35, 49)	41 (33, 46)	45 (37, 51)	S.R. = 0.10 *	<0.001
Race/ethnicity					
Black/African American	132 (26.4)	45 (8.8)	110 (21.0)	0.87 (0.76 to 1.001)	0.052
Hispanic	284 (56.8)	289 (56.2)	329 (62.7)	1.05 (0.9992 to 1.11)	0.054
White	81 (16.2)	177 (34.4)	80 (15.2)	0.97 (0.88 to 1.08)	0.583
Other/multiple	3 (0.6)	3 (0.6)	6 (1.1)	1.43 (0.67 to 3.05)	0.349
Gender					
Male	358 (71.6)	396 (77.0)	394 (75.1)	1.02 (0.99 to 1.06)	0.221
Female	139 (27.8)	113 (22.0)	128 (24.4)	0.93 (0.84 to 1.04)	0.222
Transgender	3 (0.6)	5 (1.0)	3 (0.6)	0.98 (0.51 to 1.88)	0.942
Sexual orientation					
Straight	420 (85.2)	445 (86.6)	455 (86.8)		
Gay/bisexual	73 (14.8) (N = 493)	69 (13.4) (N = 514)	69 (13.2) (N = 524)	0.94 (0.81 to 1.10)	0.454
Country of birth					
United States	332 (66.4)	352 (68.5)	337 (64.2)	0.98 (0.94 to 1.03)	0.447
Puerto Rico	151 (30.2)	136 (26.5)	174 (33.1)	1.05 (0.96 to 1.16)	0.298
Foreign	17 (3.4)	26 (5.1)	14 (2.7)	0.90 (0.68 to 1.20)	0.474
NYC borough of residence					
Manhattan	94 (18.8)	144 (28.0)	86 (16.4)	0.94 (0.84 to 1.05)	0.278
Brooklyn	188 (37.6)	134 (26.1)	198 (37.7)	1.005 (0.92 to 1.10)	0.921
Bronx	173 (34.6)	165 (32.1)	184 (35.1)	1.007 (0.92 to 1.10)	0.869
Queens	43 (8.6)	66 (12.8)	55 (10.5)	1.09 (0.92 to 1.29)	0.321
Staten Island	2 (0.4)	5 (1.0)	2 (0.4)	0.98 (0.51 to 1.88)	0.942

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	2005 (N = 500) n (%)	2009 (N = 514) n (%)	2012 (N = 525) n (%)	RR (95% CI) for Linear Trend	*P*
Education					
<High school graduate/General Education Diploma	243 (48.6)	209 (40.7)	255 (48.6)		
≥High school graduate/General Education Diploma	257 (51.4)	305 (59.3)	270 (51.4)	0.99 (0.94 to 1.06)	0.974
Homeless (p12m)					
Yes	241 (48.2)	336 (65.4)	264 (50.3)	1.02 (0.96 to 1.08)	0.562
No	259 (51.8)	178 (34.6)	261 (49.7)		
Household income (p12m)					
<$10,000	323 (64.6)	310 (60.3)	383 (73.0)	1.07 (1.02 to 1.11)	0.004
≥$10,000	177 (35.4)	204 (39.7)	142 (27.1)		
Injected heroin by itself (p12m)					
Yes	463 (92.6)	457 (88.9)	482 (91.8)	0.97 (0.98 to 1.01)	0.660
No	37 (7.4)	57 (11.1)	43 (8.2)		
Injected cocaine by itself (p12m)					
Yes	250 (50.0)	224 (43.6)	279 (53.1)	1.03 (0.97 to 1.10)	0.296
No	250 (50.0)	290 (56.4)	246 (46.9)		
Injected speedball (p12m)					
Yes	298 (59.6)	324 (63.0)	357 (68.0)	1.07 (1.02 to 1.12)	0.005
No	202 (40.4)	190 (37.0)	168 (32.0)		
Injected drugs >1 time a day (p12m)					
Yes	279 (55.8)	391 (76.1)	241 (45.9)	0.92 (0.87 to 0.97)	0.001
No	221 (44.2)	123 (23.9)	284 (54.1)		
Alcohol or drug treatment (p12m)					
Yes	290 (58.0)	251 (48.8)	279 (53.1)	0.96 (0.90 to 1.01)	0.127
No	210 (42.0)	263 (51.2)	246 (46.9)		
HIV status (self-reported)					
HIV+	100 (20.0)	36 (7.0)	43 (8.2)	0.59 (0.49 to 0.72)	<0.001
HIV−/unknown	400 (80.0)	478 (93.0)	482 (91.8)		
HCV status (self-reported)					
HCV+	274 (54.8)	257 (50.0)	267 (50.9)	0.96 (0.91 to 1.02)	0.212

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	2005 (N = 500) n (%)	2009 (N = 514) n (%)	2012 (N = 525) n (%)	RR (95% CI) for Linear Trend	*P*
HCV−/unknown	226 (45.2)	257 (50.0)	258 (49.1)		
Median number of PWID social network members (interquartile ranges)	10 (6, 24)	15 (7, 30)	27 (13, 50)	S.R. = 0.28 *	<0.001

* S.R. = Spearman's Rho.

p12m = past 12 months.

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TABLE 2.

Time Trends in Injecting and Sexual Risk Behaviors, Recent HIV Testing, and HIV and HCV Seroprevalence Among NYC PWID National HIV Behavioral Surveillance Participants (2005, 2009, 2012)

	2005 (N = 500) n (%)	2009 (N = 514) n (%)	2012 (N = 525) n (%)	RR (95% CI) for Linear Trend	*P*	ARR (95% CI)	*P*
Syringe sources (p12 m)							
Any unsafe syringe sources (yes)	304 (60.8)	161 (31.3)	245 (46.7)	0.86 (0.81 to 0.92)	<0.001	0.85 (0.79 to 0.91) *	<0.001
All syringes from SEP or pharmacy (yes)	177 (35.4)	347 (67.5)	264 (50.3)	1.15 (1.09 to 1.22)	<0.001	1.17 (1.10 to 1.24) *	<0.001
Injecting risk behaviors (p12m)							
Sterile needle injection (not always) (yes)	237 (47.4)	307 (59.7)	274 (52.2)	1.04 (0.99 to 1.11)	0.140	1.06 (0.99 to 1.13) *	0.054
Receptive syringe sharing (yes)	107 (21.4)	139 (27.0)	132 (25.1)	1.08 (0.97 to 1.20)	0.164	1.04 (0.93 to 1.16) *	0.500
Shared cooker, cotton or water, or syringe-mediated drug sharing (yes)	227 (45.4)	223 (43.4)	245 (46.7)	1.01 (0.95 to 1.09)	0.674	0.98 (0.92 to 1.06) *	0.660
Sexual risk behaviors (p12m)							
Vaginal or anal sex without condoms (yes)	268 (53.6)	366 (71.2)	369 (70.3)	1.14 (1.09 to 1.19)	<0.001	1.11 (1.06 to 1.16) *	<0.001
Exchange sex (yes)	131 (26.2)	68 (13.2)	160 (30.5)	1.10 (0.98 to 1.24)	0.111	1.10 (0.97 to 1.24) *	0.137
No. sex partners ≥2 (yes)	256 (51.2)	226 (44.0)	266 (50.7)	0.99 (0.94 to 1.07)	0.893	0.99 (0.93 to 1.05) *	0.720
HIV test (p12m), HIV seroprevalence, HCV seroprevalence, not reporting positive of those testing positive							
HIV tested (p12m) (yes)†	303 (75.8) (N = 400)	293 (61.3) (N = 478)	348 (72.2) (N = 482)	0.98 (0.94 to 1.02)	0.361	0.97 (0.93 to 1.01)‡	0.192
HIV positive (study tested)	45 (18.1) (N = 249)	64 (12.5) (N = 511)	61 (12.2) (N = 502)	0.83 (0.69 to 1.001)	0.051	0.76 (0.64 to 0.91)‡	0.003
HIV positive (study tested) of those who did not report previously testing HIV positive	6 (2.9) (N = 209)	30 (6.3) (N = 475)	21 (4.6) (N = 461)	1.08 (0.80 to 1.48)	0.607	1.08 (0.79 to 1.46)‡	0.641
Did not report previously testing HIV positive of those testing HIV positive	6 (13.3) (N = 45)	30 (46.9) (N = 64)	21 (34.4) (N = 61)	1.33 (1.03 to 1.71)	0.029	1.62 (1.20 to 2.20)‡	0.002
HCV positive (study tested)	165 (68.2) (N = 242)	382 (75.8) (N = 504)	324 (67.1) (N = 483)	0.98 (0.93 to 1.03)	0.332	0.98 (0.93 to 1.03) *	0.466
HCV positive (study tested) of those who did not report previously testing HCV positive	45 (38.1) (N = 118)	133 (53.2) (N = 250)	84 (35.6) (N = 236)	0.92 (0.82 to 1.04)	0.167	0.94 (0.83 to 1.07) *	0.367
Did not report previously testing HCV positive of those testing HCV positive	45 (27.3) (N = 165)	133 (34.8) (N = 382)	84 (25.9) (N = 324)	0.94 (0.82 to 1.07)	0.352	0.96 (0.83 to 1.10) *	0.560

[*] Adjusted for age (18–39, ≥40 years), household income in the past 12 months (<$10,000, ≥$10,000), injected speedball in the past 12 months (yes/no), injected drugs >1 time a day in the past 12 months (yes/no), HIV status self-report (HIV+, HIV−/unknown), number of PWID social network members.

[†] Of those who did not report being HIV positive.

[‡] Adjusted for age (18–39, ≥40 years), household income in the past 12 months (<$10,000, ≥$10,000), injected speedball in the past 12 months (yes/no), injected drugs >1 time a day in the past 12 months (yes/no), number of PWID social network members.

p12m = past 12 months.