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Past-year HIV testing, current antiretroviral therapy use, and participation in services for people who inject drugs

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Abstract

Evaluating routine HIV testing and treatment and associated characteristics among people who inject drugs (PWID) is critical to curb the ongoing HIV epidemic. We analyzed the 2018 National HIV Behavioral Surveillance PWID data using log-linked Poisson regression models to examine the associations between demographics and PWID service use, past-year HIV testing,

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Competing Interests: The authors declare no conflicts of interest, either financially or otherwise.

Statements and Declarations

Ethical approval: This study involved secondary data analysis. All NHBS participating sites received approval of the CDC and the appropriate local IRB before conducting surveys and must abide by the Data Security and Confidentiality Guidelines. This study was approved by the Committee for Protection of Human Subjects of the University of Texas Health Science Center. All human subject procedures were in accordance with ethical standards of the institutional and/or national research committee and with Helsinki Declaration of 1975, as revised in 2013.

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and current antiretroviral therapy (ART) use. Approximately 56% of HIV-negative and 30% of HIV-positive-unaware PWID reported past-year HIV testing, while 71% of HIV-positive-aware reported current ART use. Of the HIV-negative PWID, 64% (2874/4482) in drug use treatment (DUT) and 62% (3386/5440) who used syringe service programs (SSP) reported past-year HIV testing. Among HIV-negative PWID, past-year HIV testing was associated with DUT (aPR 1.27, 95% CI 1.23–1.32), SSP (aPR 1.26, 95% CI 1.22–1.31), black (aPR 1.26, 95% CI 1.21–1.32), Hispanic (aPR 1.10, 95% CI 1.05–1.15) race/ethnicity, health insurance (aPR 1.10, 95% CI 1.05–1.15), homelessness (aPR 1.18, 95% CI 1.14–1.24), age ≥50 years (aPR 0.86, 95% CI 0.81–0.91) and marriage (aPR 0.93, 95% CI 0.88–0.99). For HIV-positive-unaware PWID, past-year HIV testing was associated with SSP (aPR 2.49, 95% CI 1.51–4.11), females (aPR 1.86, 95% CI 1.23–2.83), > high school education (aPR 2.01, 95% CI 1.16–3.47), age [40–49 years (aPR 0.41, 95% CI 0.22–0.78) and ≥50 years (aPR 0.43, 95% CI 0.21–0.84)]. For HIV-positive-aware, current ART use was associated with marriage (aPR 1.16, 95% CI 1.02–1.31) and health insurance (aPR 1.68, 95% CI 1.30–2.17). Interventions targeting PWID's unique characteristics associated with HIV testing and treatment can increase early detection and treatment.

Keywords

people who inject drugs; injection drug use; HIV testing; antiretroviral therapy; drug use treatment; syringe service program

INTRODUCTION

Worldwide, human immunodeficiency virus (HIV) incidence rates have declined substantially but slowly over the past decades, largely due to advancements in prevention and treatment [1]. Notwithstanding, people who inject drugs (PWID) remain at considerable risk of acquiring, transmitting, and dying from HIV infection [2]. According to the 2021 United Nations Office on Drugs and Crime report, an estimated 13% of the 11 million PWID globally are living with HIV infection [3]. In the United States (US), over 185,000 of the 1.2 million people with HIV (PWH) in 2018 had previously injected drugs [4]. In addition, injection drug use accounted for 1 in 15 of the 30,635 newly diagnosed HIV infections among persons aged 13 or older in the US and dependent areas in 2020 [5]. Undiagnosed and untreated HIV infections account for many HIV transmissions and are major barriers to HIV epidemic control [6].

The ongoing opioid epidemic, complicated by the COVID-19 pandemic [7,8], and intermittent outbreaks of HIV infection among multiple PWID communities [9,10] raise concerns about rapid HIV spread among PWID as a critical public health issue. Effective strategies for early detection and treatment of HIV are essential to achieve viral load suppression and reduce transmission [11]. Antiretroviral therapy (ART) slows the progress of HIV infection and is a preventive measure for reducing HIV transmission [12]. Despite the availability of ART and declining mortality from HIV, PWID continue to have poor outcomes due to late diagnosis and poor engagement with HIV care [13,14]. Early diagnosis of HIV infection is pivotal to ending the HIV epidemic among this disproportionately burdened population. Thus, the Centers for Disease Control and Prevention (CDC)

recommends HIV testing for all individuals ages 13–64 during routine care at least once and annual screening for high-risk people [15].

HIV interventions for PWID, including drug use treatment (DUT) and syringe services programs (SSPs), reduce the risk of HIV infection and transmission [16,17]. Prior studies have suggested that DUT reduces HIV transmission by decreasing injection drug use and injection risk behaviors [18–20]. DUT and SSP reduce HIV risk behaviors and could potentially enhance HIV testing and treatment uptake among PWID [21]. Identifying predictors of HIV testing and current ART use among PWID, such as services for PWID (DUT and SSPs), as well as subgroups of PWID in need of additional HIV intervention, can inform strategies to increase engagement with HIV prevention and care programs. Our analysis serves as an update on factors associated with HIV testing and ART use and explores them among HIV-negative, HIV-positive-unaware, and HIV-positive-aware PWID who participated in the 2018 IDU cycle of NHBS in 23 US cities. Our objectives were to determine the associations between the use of services for PWID (DUT and SSPs), demographic characteristics, and (i) past-year HIV testing among HIV-negative and HIV-positive-unaware PWID, and (ii) current ART use among HIV-positive-aware PWID. We hypothesized that the use of services for PWID (i.e., DUT and SSP) and some unique demographic characteristics would be associated with past-year HIV testing and current ART use. The results of this study can inform the development of targeted interventions for early HIV diagnosis and care engagement among PWID.

METHODS

Data Source and Study Population

We analyzed data from the 2018 National HIV Behavioral Surveillance (NHBS) cycle among PWID. NHBS is an HIV surveillance system established by the CDC to monitor HIV-related risks and behaviors, and HIV prevalence across US cities or metropolitan statistical areas (MSA) with a high prevalence of HIV [22]. Surveillance is conducted in multiple cycles among three key populations: people who inject drugs, men who have sex with men, and heterosexually active people at risk for HIV. For the PWID cycle, NHBS uses respondent-driven sampling (RDS) method to recruit eligible PWID. RDS is a probability-based sampling approach for recruiting hard-to-reach populations [23,24]. The 23 cities sampled in 2018 were: Atlanta, Georgia; Baltimore, Maryland; Boston, Massachusetts; Chicago, Illinois; Dallas, Texas; Denver, Colorado; Detroit, Michigan; Houston, Texas; Los Angeles, California; Memphis, Tennessee; Miami, Florida; Nassau-Suffolk, New York; New Orleans, Louisiana; New York, New York; Newark, New Jersey; Philadelphia, Pennsylvania; Portland, Oregon; San Diego, California; San Francisco, California; San Juan, Puerto Rico; Seattle, Washington; Virginia Beach, Virginia; and Washington, District of Columbia.

Individuals were eligible to participate if they were 18 years or older, reported injection of drugs in the past 12 months, resided in an NHBS participating city, were English- or Spanish-speaking, and had no prior participation in the current NHBS cycle. Trained interviewers conducted anonymous standardized in-person interviews with eligible participants who provided informed consent. During the interview, participants were asked questions to assess if they had previously tested positive for HIV, and after the interview

participants were offered HIV testing. A nonreactive rapid HIV test was determined a definitive HIV negative result, while a reactive rapid HIV test was subjected to a confirmatory test (e.g., nucleic acid amplification test or Western blot assay). PWID with confirmed HIV-positive results who had reported being HIV-positive during the interview were classified as HIV-positive-aware, and participants with confirmed HIV positive results who reported being HIV-negative during the interview were considered HIV-positive-unaware. Details of the sampling methodology have been published elsewhere [22]. The current study analyzed data from three subpopulations from the 2018 NHBS cycle. For past-year HIV testing analysis, we included HIV-negative PWID and HIV-positive-unaware. Current ART use analysis was limited to HIV-positive-aware PWID. A flowchart showing the study population selection is available in Supplementary Figure S1.

Measures

The primary outcomes of interest were past-year HIV testing and current ART use. Past-year HIV testing was defined as having received an HIV test in the 12 months before the NHBS survey. HIV-positive-aware PWID were considered to have current ART use if they reported current ART use at the time of the survey.

The main exposure variables were participation in DUT and SSPs, determined by the response to the question: “Have you participated in a program to treat drug use in the past 12 months?” PWID were considered to have participated in an SSP based on the response to the questions: “In the past 12 months, that is, since [fill interview month] of last year, have you gotten any sterile needles? By sterile needle, I mean no one – not even you – had ever used it before? An affirmative response is followed up by “From which of the following places or people did you get new sterile needles in the past 12 months? You may choose more than one option”. PWID who selected “Needle or syringe exchange program” are considered to have participated in an SSP.

Sociodemographic variables included were age (18–29, 30–39, 40–49, or ≥50 years), gender (male or female), race/ethnicity (Black/African American, Hispanic/Latino, White, or Other), educational attainment (less than high school, high school diploma, or greater than high school), marital status (never married, divorced/separated/widowed, and married/living as married), poverty status (above or at/below federal poverty level based on the U.S. Department of Health and Human Services guideline in 2018 [25]), homelessness (no or yes [defined as living in a shelter, on the street, hotel/motel, or in a car at any time in past 12 months]), and health insurance coverage (no or yes).

Statistical Analysis

We described sample characteristics for each subgroup and stratified them by past-year HIV testing for HIV-negative and HIV-positive-unaware subgroups and by current ART use for HIV-positive-aware PWID and compared the characteristics using chi-squared test. We performed bivariate and multivariable analyses using log-linked Poisson regression with generalized linear model to examine associations between the outcomes (past-year HIV testing and current ART use) and PWID characteristics. We included only statistically significant variables ($P < 0.05$) from the bivariate analyses in the multivariable models. We

used robust standard errors to account for sample variability [26]. The significance level was set at 5% throughout the study. Analyses for this model were limited to eligible participants with no missing responses to variables included in the analyses (missing responses excluded was approximately 4.5%). We reported adjusted prevalence ratios (aPR) and 95% confidence intervals (CI) for the multivariable models. All data analyses were performed using Stata Software version 18.0 (StataCorp LLC)

RESULTS

Table 1 shows the descriptive characteristics of all HIV-negative, HIV-positive-unaware, and HIV-positive-aware PWID. Of the 10,311 HIV-negative PWID, 56% reported testing for HIV testing in the past 12 months, while 30% of 181 HIV-positive-unaware PWID reported past-year HIV testing. Approximately 74% (519/700) of HIV-positive PWID in our sample were aware of their infection (HIV-positive-aware) and 71% (369/519) were on ART. Additionally, among HIV-negative individuals in drug treatment, 64% (2874/4482) reported past-year HIV testing, and of those who used SSPs, 62% (3386/5440) got tested for HIV. For HIV-positive-unaware PWID, 31% (18/58) of those who were in drug treatment had HIV testing in the previous 12 months, and 42% (39/93) of those who participated in SSP reported past-year HIV testing. Among HIV-positive-aware PWID, 77% (178/230) of those in drug treatment were on ART, and of those using SSPs, 69% (192/277) were on ART.

Factors associated with Past-year HIV testing

Table 2 shows the results of bivariate analyses. Among HIV-negative PWID, past-year HIV testing was positively associated with Black and Hispanic race/ethnicity, health insurance, homelessness, DUT, and SSP. In contrast, negative associations were observed among PWID ≥50 years, who were divorced/separated/widowed or married/living as married. Among HIV-positive-unaware PWID, past-year testing was positively linked to female gender, >high school educational attainment, and SSP, but negatively related to older age (40–49 years and ≥50 years), Black, Hispanic, and being below the federal poverty level.

Table 3 depicts the results of multivariable analyses. For HIV-negative PWID, past-year HIV testing was reported more frequently by Black (aPR 1.26, 95% CI 1.21–1.32) and Hispanic (aPR 1.10, 95% CI 1.05–1.15) PWID compared to white PWID. Also, PWID with health insurance coverage (aPR 1.10, 95% CI 1.05–1.15), who were homeless (aPR 1.18, 95% CI 1.14–1.24), participated in DUT (aPR 1.27, 95% CI 1.23–1.32), or SSPs (aPR 1.26, 95% CI 1.22–1.31) in the past 12 months were more likely to report HIV testing than those who did not. In contrast, PWID ≥50 years (aPR 0.86, 95% CI 0.81–0.91) or married (aPR 0.93, 95% CI 0.88–0.99) were less likely to report testing for HIV in the last 12 months compared to those who were not.

Among HIV-positive-unaware PWID, past-year HIV testing was more common among females (aPR 1.86, 95% CI 1.23–2.83), those with > high school education (aPR 2.01, 95% CI 1.16–3.47), or reported SSP use (aPR 2.49, 95% CI 1.51–4.11). In contrast, PWID 40–49 years (aPR 0.41, 95% CI 0.22–0.78), ≥50 years (aPR 0.43, 95% CI 0.21–0.84) were less likely to report past-year HIV testing than those 18–29 years.

Factors associated with current antiretroviral therapy use

Table 2, bivariate analyses among HIV-positive-aware PWID, suggested positive associations between current ART and ≥50 years, being Hispanic, Black, married, having health insurance, and DUT, while homelessness was negatively linked with current ART use.

In the multivariable analysis of current ART use among HIV-positive-aware PWID (Table 3), we found that current ART use was more frequent among married/living as married PWID (aPR 1.16, 95% CI 1.02–1.31) than those who had never been married, with health insurance (aPR 1.68, 95% CI 1.30–2.17) than those without.

DISCUSSION

We examined past-year HIV testing among HIV-negative and HIV-positive-unaware PWID and current ART use among HIV-positive-aware using data from a geographically diverse sample of PWID from 23 U.S. cities. In the HIV-negative subgroup, we found that past-year HIV testing was positively associated with DUT, SSP, black and Hispanic race/ethnicity, health insurance, and homelessness. It was negatively related to being ≥50 years old or married. For HIV-positive-unaware, past-year HIV testing was also positively linked to SSP, as well as female gender, and > high school education, but negatively associated with older age (≥40 years). Current ART use among HIV-positive-aware was positively related to being married or having health insurance. In addition, only 74% of HIV-positive PWID in our sample were aware of their infection, and 71% were on ART. These rates are suboptimal compared to the United Nations' 2025 AIDS targets to end the HIV epidemic (95-95-95), i.e., 95% of people living with HIV (PLHIV) to be aware of their HIV status, 95% of PLHIV initiate treatment, and 95% in treatment achieve viral suppression [27].

Similar to prior studies [28,29], past-year HIV testing was related to drug treatment programs. Previous findings indicate that individuals with substance use disorder in DUT programs were more likely to report HIV testing [29]. DUT is an effective intervention for HIV prevention. If people are on medication for drug use disorder, they are more likely to be stable overall and able to engage in other healthcare-related activities, including HIV testing [30]. Some DUT programs offer onsite HIV testing to patients, including rapid HIV testing [31–33]. A longitudinal study found an increase in the percentage of patients who reported testing at DUT programs with onsite HIV testing services in the US [33]. Prevention of new HIV infections is among the priorities of the National HIV/AIDS strategy [34]. Despite evidence showing the effectiveness of DUT in increasing HIV testing, a prior study found that fewer than one-third of DUT facilities offered onsite HIV testing [31,33]. Larger DUT programs were more likely to offer onsite HIV testing and treatment compared to smaller programs [33]. DUT centers are uniquely positioned to reduce missed opportunities for early diagnosis and care engagement among PWID. Strengthening drug treatment programs for HIV prevention may increase early detection and treatment.

Additionally, we found that HIV-negative and HIV-positive-unaware PWID who participated in SSPs were more likely to report past-year HIV testing. Harm reduction, including SSPs, is an evidence-based intervention for HIV [35]. Onsite HIV testing provision is one of the essential elements of the SSP strategy [36], and most SSPs offer the service[37–39]. A

study of 127 SSPs in the US found that 94% offered onsite HIV testing, including 87% providing rapid HIV testing [38]. These findings further corroborate the critical role SSPs play in HIV early detection because SSPs often provide services for hard-to-reach PWID who may not otherwise engage with healthcare [40]. However, larger and healthcare/social services-administered programs were more likely to provide onsite HIV screening services than smaller independent SSPs [39]. Empowering smaller SSPs and establishing new ones to increase accessibility to onsite HIV testing may increase early detection of HIV among PWID. Among our sample, services for PWID had a key role in recent HIV testing but were not associated with current ART use among HIV-positive-aware PWID. A prior service reported that only 25% of SSPs offered onsite HIV treatment, and less than two-thirds tracked whether newly diagnosed HIV-positive clients were in treatment [38]. Larger DUT programs were more likely to provide HIV treatment and HIV support group programs than smaller facilities [33]. SSPs and DUT programs should be strengthened to provide linkage to HIV treatments and expanded to provide onsite HIV care to increase viral load suppression. In a model-based analysis, Bernard and colleagues [41] found that scaling up services, including SSPs, DUT, and HIV testing and treatment (Test & Treat initiatives) individually or in combination, was a potential cost-effective measure to reduce HIV transmission among PWID. Strengthening drug treatment programs with HIV prevention services may increase early detection and treatment.

We found variations in demographic characteristics associated with past-year HIV testing depending on HIV status/awareness. Our results showing black and Hispanic PWID were more likely to report past-year HIV testing are consistent with previous studies [42,43]. Many HIV interventions are targeted at racial minority populations, specifically black and Hispanic individuals, [44] because they have higher risks of acquiring and transmitting HIV and are disproportionately affected by the disease [45]. People of color may be more likely to receive HIV screening. Additionally, we observed that homeless HIV-negative PWID were more likely to report past-year HIV testing. It is unclear from this study why homelessness was positively associated with recent HIV testing. However, similar results have been published [46,47]. This may be due to the effectiveness of interventions targeting people with unstable housing for HIV rapid screening [48].

HIV-positive-unaware PWID is an important subgroup because undiagnosed infection accounts for approximately 40% of HIV transmissions in the U.S. Our data showed less than one-third of this group received HIV testing 12 months prior to the survey. It is possible that healthcare providers did not offer them HIV screening, or they did not accept screening. In addition, we observed gender differences in past-year HIV testing among HIV-positive-unaware PWID. HIV testing is recommended for all pregnant women to prevent perinatal transmission [49]. Some female PWID in this subgroup may have received routine HIV screening during healthcare visits, including pregnancy care. However, we are unsure why this did not apply to HIV-negative female PWID.

Our data also indicated a link between health insurance and past-year testing among HIV-negative PWID and a stronger association with current ART use among HIV-positive-aware PWID. Past studies have reported associations between health insurance and healthcare utilization, including HIV testing and care engagement [50,51]. Prior research showed

that PWID in Medicaid expansion states were more likely to have health insurance and engage with a usual source of healthcare than those in non-Medicaid expansion states [52]. Expanding healthcare access for those at risk for or living with HIV may increase engagement with healthcare, early detection, and viral load suppression among PWID.

Additionally, older HIV-negative or HIV-positive-unaware PWID were less likely to have received past-year HIV testing. This is similar to the results of another study [53]. The authors suggested that older people living with HIV may remain undiagnosed and continue to transmit the infection, probably because some providers may not assess HIV risks among older patients and not routinely offer them HIV tests [53]. Also, some older people who consider themselves at risk may be ashamed to request HIV tests. Older PWID may benefit from interventions tailored to their unique needs and interventions targeting their healthcare providers to reduce missed opportunities for early diagnosis and treatment.

Lastly, current ART use, which requires greater stability and longer-term engagement, was positively associated with marriage or living as married. This finding is consistent with the result of a prior US study that reported higher odds of viral suppression among married people living with HIV [54]. The Centers for Disease Control and Prevention recommends that persons at increased risk for HIV infection, including PWID, undergo HIV testing at least once a year [55]. A priority for the National HIV/AIDS Strategy is to improve HIV-related health outcomes for people with HIV by linking them to care after diagnosis and providing low-barrier access to HIV treatment [34]. Our data could guide tailored interventions that take into account the unique characteristics of PWID subgroups to enhance engagement with HIV prevention and care.

Limitations

The results here are subject to several limitations. First, the data used in this study were collected using respondent-driven sampling. The approach might be subject to selection bias and not represent all PWID who were not contacted for participation. As a result, our findings may not be generalizable to the entire PWID community. Second, although the data were collected from PWID in multiple U.S. cities, only 23 metropolitan statistical areas (MSAs) were included, and the results may not be nationally representative. In addition, PWID willing to participate in a survey may be more likely to seek out or use services. Also, because NHBS is a cross-sectional study, we cannot establish causality or temporality. Additionally, the NHBS is yet to complete another IDU-cycle data collection, and it is possible that the characteristics of PWID might have changed post-COVID-19 pandemic. Lastly, NHBS does not ask about the type of drug treatment the participant is receiving, which may bias the findings.

CONCLUSIONS

Early diagnosis and treatment of HIV are essential in reducing HIV transmission and improving the disease outcome among PWID. Use of services directed toward PWID was associated with past-year HIV testing among HIV-negative PWID (DUT and SSP) and HIV-positive-unaware (SSP). Although we found variations in demographic characteristics associated with HIV testing and ART use among the understudied PWID subpopulations,

older PWID were less likely to report recent HIV screening. Interventions tailored to the unique characteristics of PWID are needed to promote engagement with HIV prevention and care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Characteristics of people who inject drugs, National HIV Behavioral Surveillance, 2018[a]

Characteristic	Total Sample (n=10,311)	HIV-negative PWID			HIV-positive-unaware PWID				HIV-positive-aware PWID			
		Past-year HIV testing			Total Sample (n=181)	Past-year HIV testing			Total Sample (n=519)	Current ART use		
		Yes (%) (n=5724)	No (%) (n=4587)	*p-value*		Yes (%) (n=55)	No (%) (n=126)	*p-value*		Yes (%) (n=369)	No (%) (n=150)	*p-value*
Age				**<0.001**				**0.025**				**<0.001**
18–29	1493 (14.5)	877 (15.3)	616 (13.4)		17 (9.4)	9 (16.4)	8 (6.4)		44 (8.5)	24 (6.5)	20 (13.3)	
30–39	2775 (26.9)	1641 (28.7)	1134 (24.7)		41 (22.6)	17 (30.9)	24 (19.0)		88 (17.0)	53 (14.4)	35 (23.3)	
40–49	2371 (23.0)	1348 (23.6)	1023 (22.3)		51 (28.2)	13 (23.6)	38 (30.2)		143 (27.5)	99 (26.8)	44 (29.4)	
50+	3672 (35.6)	1858 (32.5)	1814 (39.6)		72 (39.8)	16 (29.1)	56 (44.4)		244 (47.0)	193 (52.3)	51 (34.0)	
Gender				0.339				**0.020**				0.291
Male	7168 (69.5)	3957 (69.1)	3211 (70.0)		127 (70.2)	32 (58.2)	95 (75.4)		370 (71.3)	268 (72.6)	102 (68.0)	
Female	3143 (30.5)	1767 (30.9)	1376 (30.0)		54 (29.8)	23 (41.8)	31 (24.6)		149 (28.7)	101 (27.4)	48 (32.0)	
Race/Ethnicity				**0.016**				**0.022**				0.102
White	4176 (40.5)	2246 (39.2)	1930 (42.1)		48 (26.5)	22 (40.0)	26 (20.6)		116 (22.6)	72 (19.5)	44 (29.3)	
Black	3323 (32.2)	1867 (32.6)	1456 (31.7)		75 (41.4)	20 (36.4)	55 (43.7)		246 (47.4)	182 (49.3)	64 (42.7)	
Hispanic/Latino	2090 (20.3)	1209 (21.1)	881 (19.2)		58 (32.1)	13 (23.6)	45 (35.7)		124 (23.9)	92 (24.9)	32 (21.3)	
Other[bc]	722 (7.0)	402 (7.0)	320 (7.0)		--	--	--		33 (6.4)	23 (6.2)	10 (6.67)	
Marital Status				**<0.001**				0.662				**0.017**
Never Married	5775 (56.0)	3321 (58.0)	2454 (53.5)		119 (65.7)	37 (67.3)	82 (65.1)		298 (57.4)	203 (55.0)	95 (63.3)	
Divorced/Separated/ Widowed	3189 (30.9)	1700 (29.7)	1489 (32.5)		51 (28.2)	16 (29.1)	35 (27.8)		157 (30.3)	111 (30.1)	46 (30.7)	
Married/Living as married	1347 (13.1)	703 (12.3)	644 (14.0)		11 (6.1)	2 (3.6)	9 (7.1)		64 (12.3)	55 (14.9)	9 (6.0)	
Educational attainment				0.132				0.072				0.306
< High school	2886 (28.0)	1604 (28.0)	1282 (28.0)		64 (35.4)	16 (29.1)	48 (38.1)		166 (32.0)	125 (33.9)	41 (27.3)	
High school	4265 (41.4)	2324 (40.6)	1941 (42.3)		77 (42.5)	21 (38.2)	56 (44.4)		223 (43.0)	152 (41.2)	71 (47.3)	
> High school	3160 (30.6)	1796 (31.4)	1364 (29.7)		40 (22.1)	18 (32.7)	22 (17.5)		130 (25.0)	92 (24.9)	38 (25.4)	

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Characteristic	HIV-negative PWID				HIV-positive-unaware PWID				HIV-positive-aware PWID			
	Total Sample (n=10,311)	Past-year HIV testing			Total Sample (n=181)	Past-year HIV testing			Total Sample (n=519)	Current ART use		
		Yes (%) (n=5724)	No (%) (n=4587)	*p-value*		Yes (%) (n=55)	No (%) (n=126)	*p-value*		Yes (%) (n=369)	No (%) (n=150)	*p-value*
Federal poverty level 2018				0.380				0.111				0.963
Above	2590 (25.1)	1457 (25.5)	1133 (24.7)		25 (13.8)	11 (20.0)	14 (11.1)		101 (19.5)	72 (19.5)	29 (19.3)	
At/Below	7721 (74.9)	4267 (74.5)	3454 (75.3)		156 (86.2)	44 (80.0)	112 (88.9)		418 (80.5)	297 (80.5)	121 (80.7)	
Had health insurance, past 12 months				**<0.001**				0.792				**<0.001**
No	2715 (26.3)	1335 (23.3)	1380 (30.1)		60 (33.2)	19 (34.6)	41 (32.5)		86 (16.6)	36 (9.8)	50 (33.3)	
Yes	7596 (73.7)	4389 (76.7)	3207 (69.9)		121 (66.8)	36 (65.4)	85 (67.5)		433 (83.4)	333 (90.2)	100 (66.7)	
Homeless, past 12 months				**<0.001**				0.293				**<0.001**
No	3242 (31.4)	1559 (27.2)	1683 (36.7)		49 (27.1)	12 (21.8)	37 (29.4)		205 (39.5)	169 (45.8)	36 (24.0)	
Yes	7069 (68.6)	4165 (72.8)	2904 (63.3)		132 (72.9)	43 (78.2)	89 (70.6)		314 (60.5)	200 (54.2)	114 (76.0)	
DUT participation, past 12 months				**<0.001**				0.896				**0.005**
No	5829 (56.5)	2850 (49.8)	2979 (64.9)		123 (68.0)	37 (67.3)	86 (68.3)		289 (55.7)	191 (51.8)	98 (65.3)	
Yes	4482 (43.5)	2874 (50.2)	1608 (35.1)		58 (32.0)	18 (32.7)	40 (31.7)		230 (44.3)	178 (48.2)	52 (34.7)	
SSP participation, past 12 months				**<0.001**				**0.001**				0.337
No	4871 (47.2)	2338 (40.9)	2533 (55.2)		88 (48.6)	16 (29.1)	72 (57.1)		242 (46.6)	177 (48.0)	65 (43.3)	
Yes	5440 (52.8)	3386 (59.1)	2054 (44.8)		93 (51.4)	39 (70.9)	54 (42.9)		277 (53.4)	192 (52.0)	85 (56.7)	

Abbreviations: HIV, Human immunodeficiency virus; PWID, people who inject drugs; ART, antiretroviral therapy; DUT, drug use treatment; SSP, syringe service program

[a]A nonreactive rapid HIV test was determined a definitive HIV negative result, while a reactive rapid HIV test was subjected to a confirmatory test. PWID with confirmed HIV-positive results who had reported being HIV-positive during the interview were classified as HIV-positive-aware, and participants with confirmed HIV positive results who reported being HIV-negative during the interview were considered HIV-positive-unaware.

[b]Other includes American Indian/Alaska Native, Asian, Native Hawaiian/Pacific Islander, and multiple races

[c]Other: PWID who identified as Other race were not included in the HIV-positive-unaware analysis due to small sample size (see Supplementary Figure 1)

p-value was derived from chi-squared test.

Boldface: Statistically significant (p <0.05).

Table 2.

Bivariate analyses of characteristics associated with past-year HIV testing and current ART use[a]

Characteristic	HIV-negative PWID (n=10,311)		HIV-positive-unaware PWID (n=181)		HIV-positive-aware PWID (n=519)	
	Past-year HIV testing		Past-year HIV testing		Current ART use	
	PR (95% CI)	*p-value*	PR (95% CI)	*p-value*	PR (95% CI)	*p-value*
Age						
18–29	Reference		Reference		Reference	
30–39	1.01 (0.96–1.06)	0.803	0.78 (0.44–1.40)	0.408	1.10 (0.80–1.52)	0.543
40–49	0.97 (0.92–1.02)	0.246	0.48 (0.25–0.92)	**0.028**	1.27 (0.95–1.70)	0.109
50+	0.86 (0.82–0.91)	**<0.001**	0.42 (0.22–0.78)	**0.006**	1.45 (1.10–1.91)	**0.009**
Gender						
Male	Reference		Reference		Reference	
Female	1.02 (0.98–1.06)	0.337	1.69 (1.10–2.60)	**0.017**	0.94 (0.82–1.06)	0.308
Race/Ethnicity						
White	Reference		Reference		Reference	
Black	1.04 (1.00–1.09)	**0.037**	0.58 (0.36–0.95)	**0.029**	1.19 (1.02–1.40)	**0.032**
Hispanic/Latino	1.08 (1.03–1.13)	**0.002**	0.49 (0.28–0.87)	**0.014**	1.20 (1.00–1.43)	**0.047**
Other[b]	1.04 (0.96–1.11)	0.338	----	----	1.12 (0.86–1.47)	0.394
Marital Status						
Never Married	Reference		Reference		Reference	
Divorced/Separated/ Widowed	0.93 (0.89–0.96)	**<0.001**	1.01 (0.62–1.64)	0.971	1.04 (0.91–1.18)	0.567
Married/Living as married	0.91 (0.86–0.96)	**0.001**	0.58 (0.16–2.11)	0.413	1.26 (1.11–1.43)	**<0.001**
Educational attainment						
< High school	Reference		Reference		Reference	
High school	0.98 (0.94–1.02)	0.363	1.09 (0.62–1.91)	0.761	0.91 (0.80–1.03)	0.119
> High school	1.02 (0.98–1.07)	0.326	1.80 (1.04–3.11)	**0.035**	0.94 (0.82–1.08)	0.388
Federal poverty level 2018						
Above	Reference		Reference		Reference	
At/Below	0.98 (0.94–1.02)	0.378	0.64 (0.39–1.07)	0.087	1.00 (0.87–1.14)	0.963
Had health insurance, past 12 months						
No	Reference		Reference		Reference	
Yes	1.18 (1.13–1.23)	**<0.001**	0.94 (0.59–1.49)	0.792	1.84 (1.42–2.37)	**<0.001**
Homeless, past 12 months						
No	Reference		Reference		Reference	
Yes	1.23 (1.18–1.28)	**<0.001**	1.33 (0.77–2.31)	0.310	0.77 (0.70–0.86)	**<0.001**
DUT participation, past 12 months						

Characteristic	HIV-negative PWID (n=10,311)		HIV-positive-unaware PWID (n=181)		HIV-positive-aware PWID (n=519)	
	Past-year HIV testing		Past-year HIV testing		Current ART use	
	PR (95% CI)	*p-value*	PR (95% CI)	*p-value*	PR (95% CI)	*p-value*
No	Reference		Reference		Reference	
Yes	1.31 (1.27–1.36)	**<0.001**	1.03 (0.64–1.65)	0.897	1.17 (1.05–1.30)	**0.004**
SSP participation, past 12 months						
No	Reference		Reference		Reference	
Yes	1.30 (1.25–1.34)	**<0.001**	2.31 (1.39–3.82)	**0.001**	0.95 (0.85–1.06)	0.336

Abbreviations: HIV, Human immunodeficiency virus; PWID, people who inject drugs; ART, antiretroviral therapy; DUT, drug use treatment; SSP, syringe service program

[a]A nonreactive rapid HIV test was determined a definitive HIV negative result, while a reactive rapid HIV test was subjected to a confirmatory test. PWID with confirmed HIV-positive results who had reported being HIV-positive during the interview were classified as HIV-positive-aware, and participants with confirmed HIV positive results who reported being HIV-negative during the interview were considered HIV-positive-unaware.

[b]Other includes American Indian/Alaska Native, Asian, Native Hawaiian/Pacific Islander, and multiple races

Boldface: Statistically significant (p <0.05)

Table 3.

Multivariable analyses of PWID characteristics and past-year HIV testing and current ART use[a]

Characteristic	HIV-negative PWID (n=10,311)		HIV-positive-unaware PWID (n=181)		HIV-positive-aware PWID (n=519)	
	Past-year HIV testing		Past-year HIV testing		Current ART use	
	aPR (95% CI)	*p-value*	aPR (95% CI)	*p-value*	aPR (95% CI)	*p-value*
Age						
18–29	Reference		Reference		Reference	
30–39	1.00 (0.96–1.06)	0.832	0.76 (0.44–1.31)	0.322	1.02 (0.76–1.39)	0.872
40–49	0.97 (0.91–1.02)	0.222	0.41 (0.22–0.78)	**0.006**	1.13 (0.85–1.49)	0.396
50+	0.86 (0.81–0.91)	**<0.001**	0.43 (0.21–0.84)	**0.014**	1.22 (0.93–1.61)	0.155
Gender						
Male	Reference		Reference		Reference	
Female	1.01 (0.98–1.05)	0.474	1.86 (1.23–2.83)	**0.004**	0.97 (0.86–1.09)	0.605
Race/Ethnicity						
White	Reference		Reference		Reference	
Black	1.26 (1.21–1.32)	**<0.001**	1.34 (0.80–2.25)	0.281	1.06 (0.90–1.24)	0.506
Hispanic/Latino	1.10 (1.05–1.15)	**<0.001**	0.66 (0.38–1.15)	0.149	1.10 (0.94–1.29)	0.250
Other[b]	1.04 (0.97–1.12)	0.245			1.13 (0.88–1.46)	0.332
Marital Status						
Never Married	Reference		—	—	Reference	
Divorced/Separated/ Widowed	0.98 (0.94–1.02)	0.242	—	—	0.98 (0.86–1.11)	0.760
Married/Living as married	0.93 (0.88–0.99)	**0.015**	—	—	1.16 (1.02–1.31)	**0.022**
Educational attainment						
< High school	—	—	Reference		—	—
High school	—	—	1.18 (0.69–2.00)	0.550	—	—
> High school	—	—	2.01 (1.16–3.47)	**0.012**	—	—
Federal poverty level 2018						
Above	—	—	—	—	—	—
At/Below	—	—	—	—	—	—
Had health insurance, past 12 months						
No	Reference		—	—	Reference	
Yes	1.10 (1.05–1.15)	**<0.001**	—	—	1.68 (1.30–2.17)	**<0.001**
Homeless, past 12 months						
No	Reference		—	—	Reference	
Yes	1.18 (1.14–1.24)	**<0.001**	—	—	0.90 (0.81–1.00)	0.050
DUT participation, past 12 months						

Characteristic	HIV-negative PWID (n=10,311)		HIV-positive-unaware PWID (n=181)		HIV-positive-aware PWID (n=519)	
	Past-year HIV testing		Past-year HIV testing		Current ART use	
	aPR (95% CI)	*p-value*	aPR (95% CI)	*p-value*	aPR (95% CI)	*p-value*
No	Reference		—	—	Reference	
Yes	1.27 (1.23–1.32)	**<0.001**	—	—	1.10 (0.99–1.23)	0.081
SSP participation, past 12 months						
No	Reference		Reference		Reference	
Yes	1.26 (1.22–1.31)	**<0.001**	2.49 (1.51–4.11)	**<0.001**	0.92 (0.83–1.02)	0.131

Abbreviations: HIV, Human immunodeficiency virus; PWID, people who inject drugs; ART, antiretroviral therapy; DUT, drug use treatment; SSP, syringe service program

[a]A nonreactive rapid HIV test was determined a definitive HIV negative result, while a reactive rapid HIV test was subjected to a confirmatory test. PWID with confirmed HIV-positive results who had reported being HIV-positive during the interview were classified as HIV-positive-aware, and participants with confirmed HIV positive results who reported being HIV-negative during the interview were considered HIV-positive-unaware.

[b]Other includes American Indian/Alaska Native, Asian, Native Hawaiian/Pacific Islander, and multiple races

Boldface: Statistically significant (p <0.05)