HHS Public Access

Author manuscript

AIDS Care. Author manuscript; available in PMC 2025 May 01.

Published in final edited form as:

AIDS Care. 2024 May ; 36(5): 641–651. doi:10.1080/09540121.2023.2288646.

Structural Vulnerabilities and PrEP Awareness Among Boston Heterosexuals and People who Inject Drugs at Risk for HIV: Findings from 2018–2019 Cycles from the Boston, MA site of the NHBS

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Abstract

Low pre-exposure prophylaxis (PrEP) awareness is a barrier to PrEP uptake, but little is known about biopsychosocial factors relating to PrEP awareness among people who have either heterosexual or injection drug use HIV risk behaviors. Data were collected from 2018–2019 in Boston, MA. Participants engaged in vaginal/anal sex with a person of the opposite sex (N=515) or were people who injected drugs (PWID; N=451) in the past 12 months. We examined associations between PrEP awareness and: homelessness; perceived HIV-related stigma; country of birth; bacterial STDs, chlamydia, and/or gonorrhea in the past 12 months, lifetime hepatitis C virus (HCV) infection, sexual orientation, and poverty. We controlled for race, ethnicity, age, gender, and education. More PWID (36.8%) were aware of PrEP than were people who engaged in heterosexual HIV risk behavior (28%; p=.001). Among people with heterosexual risk, homelessness (aOR=1.99, 95%CI[1.26,3.12], p=.003), and among PWID: homelessness (aOR=2.11, 95%CI[1.09,4.31], p=.032); bacterial STD (aOR=2.96, 95%CI[1.30,7.12], p=.012); chlamydia (aOR=6.14, 95%CI[1.79,28.43], p=.008); and HCV (aOR=2.40, 95%CI[1.50,3.92], p<.001) were associated with increased likelihood of PrEP awareness. In the combined sample:

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Conflicts of Interest. All authors do not have conflicts of interest to report.

Compliance with Ethical Standards

Ethics Approval. All procedures were approved by the Massachusetts Department of Public Health IRB; CDC classifies NHBS as surveillance and not human subjects research. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Consent to Participate. Informed consent was obtained from all individual participants included in the study.

homelessness (aOR=2.25, 95%CI [1.61, 3.15], p<.001); HCV (aOR=2.18, 95%CI[1.52,3.14], p<.001); identifying as homosexual (aOR=3.71, 95%CI[1.13,14.20], p=.036); and as bisexual (aOR=1.55, 95%CI[1.08,2.20], p=.016) were each associated with PrEP awareness. Although having an STD, HCV, identifying as homosexual or bisexual, and experiencing homelessness were associated with increased PrEP awareness, most participants were unaware of PrEP. Efforts to increase PrEP awareness could engage PWID and heterosexual HIV risk behavior, especially those who may not access public or social health services.

Keywords

pre-exposure prophylaxis (PrEP); PrEP awareness; people who inject drugs; sexually transmitted infection; homelessness

One of the four main pillars of the ending the HIV epidemic (EHE) initiative in the United States (US) relies on preventing new HIV infections (Fauci et al., 2019). Pre-exposure prophylaxis (PrEP), an effective medication for preventing HIV acquisition, has been approved for oral use by the US Food and Drug Administration (FDA) since 2012 (FDA, 2012). Although PrEP rollout has increased in recent years, it is still well below optimal levels. In the US, the majority of the research on PrEP awareness, uptake, and persistence has been conducted among men who have sex with men (MSM; (Hillis et al., 2020) because HIV incidence predominantly occurs among MSM (68%) (CDC, 2022).

However, there is a lack of research among other groups at risk for HIV acquisition, including cisgender women, transgender people, and heterosexual cisgender men, and people who inject drugs (PWID (Grov et al., 2021; Mistler et al., 2021). People engaging in heterosexual sexual activity account for over 20% of all HIV incidence in the US, and PWID account for another nearly 7% (CDC, 2022)—more than a quarter of all new HIV infections in 2020. Given the clear HIV disparities affecting MSM, there is a continued need to improve the PrEP treatment cascade among MSM. However, there is also a need to better understand factors associated with the PrEP cascade among populations whose barriers and facilitators of PrEP awareness, uptake, and persistence are understudied, such as PWID and people with heterosexual risk of HIV acquisition. Most existing research has focused on barriers and facilitators to PrEP initiation and persistence (Sullivan & Siegler, 2018), with structural barriers (e.g., lack of physician training, insufficient funding, and suboptimal access within healthcare systems) and psychosocial problems (e.g., stigma, homophobia, transphobia, and racism) emerging as barriers (Pinto et al., 2018). Limited research, however, has focused on PrEP awareness, particularly among among PWID and people whose primary risk factor for HIV acquisition is heterosexual behavior.

PrEP awareness disparities appear to differ by risk group. Using National HIV Behavioral Surveillance (NHBS) data—a large, multicity study of factors related to HIV acquisition—a recent study demonstrated that MSM had a high rate of PrEP awareness (85%), whereas PWID were much less aware of PrEP (26%) and heterosexual individuals had even lower PrEP awareness (7%) (Jones et al., 2021). Another study using NHBS data examined PrEP awareness among PWID in Boston and found that 39% of PWID for whom PrEP use would be indicated were aware of PrEP in 2018 (Earlywine et al., 2021). In other research, PrEP

awareness among PWID ranges from 22%–57% (Assoumou et al., 2021; McFarland et al., 2020; Sherman et al., 2019; Walters et al., 2020).

Given low rates of PrEP awareness among PWID and people whose primary risk factor for HIV acquisition is heterosexual behavior (i.e., having had vaginal or anal sex with an opposite sex partner as one's primary risk behavior for HIV acquisiton), we sought to extend research on PrEP awareness to these populations and explore possible associations with perceived HIV-related stigma, structural factors, sexual health, and identity. Most individuals become aware of PrEP through conversations with their primary care physicians and other physicians, social media campaigns, advertising, social networks, mobile health platforms, and other technological interventions (Kudrati et al., 2021; Silapaswan et al., 2017; Sophus & Mitchell, 2019). Enhancing our understanding of factors associated with PrEP awareness among understudied groups may inform future public health interventions.

Method

Participants and Procedures

Participants were people whose primary risk factor for HIV was either PWID or heterosexual sexual activity who participated in the fifth cycle of the Centers for Disease Control and Prevention's (CDC) NHBS study. The full protocol for the NHBS (CDC, 2018) has been published elsewhere, as have surveillance reports (CDC, 2022). Briefly, the NHBS study is conducted in large cities or metropolitan statistical areas (MSA) in the US with high HIV prevalence rates. Every three years, MSM, PWID, and people with heterosexual risk are surveyed in a rotating manner such that a different group disproportionately affected by HIV is sampled each year. These groups are selected for behavioral surveillance based on increased likelihood of HIV acquisiton. The present study utilized data from the Boston MSA. Data on PWID were collected from January to December 2018, and data on people with heterosexual risk were collected from January to December 2019. Participants in these cycles were recruited using respondent driven sampling (Heckathorn, 1997). All procedures were approved by the Massachusetts Department of Public Health IRB; CDC classifies NHBS as surveillance and not human subjects research.

Inclusion/exclusion Criteria.

Eligible participants for the PWID cycle: had a valid NHBS coupon, had not participated in the current PWID cycle before, lived in the Boston MSA, were aged 18 years or older, had engaged in PWID without a prescription in the previous 12 months, and were able to complete the interview in either English or Spanish. Participants were eligible for the heterosexual risk cycle if they: had a valid NHBS coupon, had not participated in the current heterosexual risk cycle before, had not engaged in injection drug use in the previous 12 months, lived in the Boston MSA, were aged 18 to 60 years old, had vaginal or anal sex with an opposite sex partner in the past 12 months, were either assigned male or female sex at birth, and were able to complete the interview in either English or Spanish. In both the PWID and heterosexual samples, people who were recruitment seeds were not included in these analyses.

Measures

Demographics.—Participants provided demographic information that included: race, ethnicity, gender identity, sexual orientation, education level, country of birth, employment status, income, current homelessness and experiences of homelessness in the past 12 months, and number of sexual partners in the past 12 months. Sexual orientation was dummy coded and identifying as heterosexual was the referent group in these analyses. Due to the distribution of employment status, we dichotomized whether participants were currently unemployed or had some other employment status (e.g., part-time employed, full-time employed, receiving disability, etc.). Income was examined as a dichotomous variable based on 2018 federal poverty cutoffs.

PrEP.—Participants reported whether they were aware of PrEP prior to participating in this survey. They were also asked if they had discussed PrEP with a healthcare provider in the past 12 months and if they had used PrEP in the past 12 months. Each of these variables were dichotomous.

Healthcare and health behaviors.—Participants reported on whether or not they had a visit with a healthcare provider in the past 12 months, as well as when their most recent healthcare visit occurred. History of sexually transmitted diseases and infections (STDs) was also collected, including whether they had any bacterial STDs diagnosed in the past 12 months. Additionally, participants were asked whether they had ever received a diagnosis of hepatitis C virus in their lifetime. Participants also reported on their number of sexual partners in the past 12 months, as well as the number of partners with whom they had condomless sex in the past 12 months. Number of total sexual partners and number of condomless sex partners were collected as continuous self-reported variables. PWID reported on the frequency of injection drug use.

Stigma.—Perceived HIV stigma was assessed with four variables measured on a 5-point Likert-type from strongly agree (0) to strongly disagree (4), with lower scores indicating greater perceived stigma. Example items include “most people in Boston would discriminate against someone with HIV” and “most people in Boston would not be friends with someone with HIV.”. The internal reliability of this stigma measure in this sample was low (α=0.66), though this is similar to the internal reliability of this measure found in previous research on the psychometrics of the NHBS stigma measure (Algarin et al., 2022).

Data Analysis

Logistic regression analyses, in R version 4.2.0 (R Development Core Team, 2016), examined the association of variables of interest with PrEP awareness. Analyses were conducted separately in the heterosexual risk sample, the PWID sample, and the combined overall sample. The sample was combined for analyses in order to examine associations with PrEP awareness across populations, as well as to obtain sufficient power to examine associations of PrEP awareness and sexual minority identity among PWID and those with primarily heterosexual risk. All analyses controlled for race, ethnicity, age, gender, and education. Variables of interest were selected based on intersecting identities (sexual orientation, race, ethnicity, age, gender), sexual risk (STDs), socioeconomic

status (education, homelessness, and poverty), and perceived HIV stigma. Each variable's association with PrEP awareness was examined in separate logistic regression analyses that each included the covariates. Subsequently, we conducted multivariate logistic regressions. For each of the three samples (heterosexual risk, PWID, and combined), we examined a multivariate logistic regression model that included the covariates and all of the variables of interest (except for gonorrhea and chlamydia in the past 12 months). To account for multicollinearity, these multivariate logistic models included having had a bacterial STD in the past 12 months only, and the variables for gonorrhea and chlamydia in the past 12 months were not included.

Among PWID, five participants identified as transgender. In the sample of participants who had vaginal or anal sex with a person of the opposite sex in the past 12 months, having a gender other than cis-gender man or woman was an exclusion criterion. Despite a low number of participants identifying as transgender in this study, we chose to include transgender individuals as a covariate in analyses to avoid exclusion based on gender identity.

Results

Descriptive Statistics

The final sample (n = 966) included 515 people who had vaginal or anal sex with a person of the opposite sex in the past 12 months 451 people who injected drugs (PWID) in the past 12 months. Full demographic and descriptive statistics are presented in Table 1 for each set of respondents and the combined sample. In the combined sample, participants had an average age of 40.2 years (SD=12.1, Median=40), 494 (51.1%) participants were assigned male at birth, and 467 (48.3%) were assigned female. Most participants identified as Black (n=468, 48.4%), followed by White (n=350, 36.2%), or another race (n=128, 13.3%). Additionally, 247 (25.6%) participants identified as Hispanic or Latinx. Most participants identified as heterosexual (770, 79.7%), 14 (1.4%) identified as lesbian or gay, and 181 (18.7%) as bisexual.

With respect to other key variables, approximately half of the sample (506, 52.4%) endorsed having experienced homelessness. Sixty (6.2%) participants reported having any bacterial STDs in the past 12 months, and 335 (34.7%) participants reported ever having been diagnosed with hepatitis C. Overall, participants reported an average of 5.05 (SD=9.25, median=2, range=0–100, IQR=1–5) sexual partners in the past 12 months. There were no significant differences between PWID and people with heterosexual risk in total number of sexual partners. However, with respect to condomless sex partners in the past 12 months, PWID reported a mean of 4.7 (SD=8.51, median=2, range=0–80, IQR=1–5) condomless sex partners, and people with heterosexual risk reported a mean of 2.07 (SD=2.66, median=1, range=0–25, IQR=1–2), and this difference was statistically significant (p<.001). PWID also reported on their frequency of having shared a needle to inject drugs, and approximately 219 (48.6%) used a needle to inject drugs after another individual in the past 12 months. Differences between the PWID and heterosexual cycles are reported in Table 1.

Overall, most participants (n=624, 64.6%) were not aware of PrEP, few (n=50, 5.2%) had discussed PrEP with a healthcare provider, and only 7 (0.7%) had used PrEP in the past 12 months, despite the majority (861, 89.1%) having had a visit with a healthcare provider in the past 12 months. Significantly more PWID (n=166, 36.8%) were aware of PrEP than were people with heterosexual risk (n=144, 28%), p=.001; see Table 1). Most participants strongly agreed (n=289, 29.9%) or agreed (n=362, 37.5%) that people with HIV would be discriminated against by most people in their city.

Logistic regression analyses predicting PrEP awareness among people with heterosexual risk

Results of the logistic regression analyses predicting the likelihood of being aware of PrEP among participants with heterosexual risk are presented in Table 2. Controlling for covariates, having experienced homelessness in the past 12 months was related to a 2-fold greater likelihood of PrEP awareness (aOR=1.99, 95%CI [1.26, 3.12], p = .003). We also examined potential associations of perceived HIV-related stigma, country of birth, history of any bacterial STD (as well as chlamydia and gonorrhea specifically) in the past 12 months, having ever received a diagnosis of Hepatitis C in one's life, sexual orientation, and poverty with PrEP awareness and found that no significant relationships existed (p > .05). Results of the multivariate logistic regression, with all covariates and variables of interest, indicated that above and beyond the effects of other variables, having experienced homeless remained significantly associated with increased likelihood of being aware of PrEP (aOR=2.30, 95%CI [1.42, 3.73], p = .001).

Logistic regression analyses predicting PrEP awareness among PWID

Results of the series of logistic regressions examining predictors of PrEP awareness among PWID, controlling for covariates, are presented in Table 2. Among PWID, having experienced homelessness in the past 12 months was associated with a more than 2-fold increase in the likelihood of PrEP awareness (aOR=2.11, 95%CI [1.09, 4.31], p = .032), much like the results for people with heterosexual HIV risk. Additionally, in an adjusted model, having had any bacterial STD in the past 12 months was related to a 296% increased likelihood of being aware of PrEP (aOR=2.96, 95%CI [1.30, 7.12], p = .012). Having had chlamydia in the past 12 months was associated with a 614% increased likelihood of PrEP awareness (aOR=6.14, 95%CI [1.79, 28.43], p = .008), and having had Hepatitis C in one's lifetime was related to a 240% increased likelihood (aOR=2.40, 95%CI [1.50, 3.92], p < .001). There were no significant associations between PrEP awareness and perceived HIV-related stigma, country of birth, history of gonorrhea in the past 12 months, sexual orientation, and poverty (ps > .05). Results of the multivariate logistic regression indicated that above and beyond the effects of other variables, having had any bacterial STD (aOR=2.78, 95%CI [1.18, 6.89], p = .022) and having had Hepatits C (aOR=2.29, 95%CI [1.41, 3.81], p = .001) remained significantly associated with increased likelihood of being aware of PrEP.

Logistic regression analyses predicting PrEP awareness in the combined sample

We then conducted a series of logistic regressions examining the same set of predictors in the combined full sample, again controlling for covariates (Table 2). Results revealed

that having experienced homelessness in the past 12 months was associated with a more than 2-fold increase in the likelihood of PrEP awareness (aOR=2.25, 95%CI [1.61, 3.15], $p < .001$), as was a lifetime diagnosis of Hepatitis C (aOR=2.18, 95%CI [1.52, 3.14], $p < .001$). Lastly, there were significant associations between sexual orientation and PrEP awareness. Compared to identifying as as heterosexual, identifying as gay or lesbian was associated with a 371% increase in the likelihood of being aware of PrEP (aOR=3.71, 95%CI [1.13, 14.20], $p = .036$), and identifying as bisexual was associated with a 155% increased likelihood (aOR=1.55, 95%CI [1.08, 2.20], $p = .016$). Perceived HIV-related stigma, country of birth, history of any bacterial STD (as well as gonorrhea specifically) in the past 12 months, and poverty were not significantly related to PrEP awareness ($ps > .05$). Results of the multivariate logistic regression indicated that above and beyond the effects of other variables, having experienced homelessness (aOR=1.95, 95%CI [1.35, 2.83], $p < .001$) and having had Hepatits C (aOR=1.72, 95%CI [1.18, 2.51], $p = .005$) remained significantly associated with increased likelihood of being aware of PrEP.

Discussion

The present study examined rates of PrEP awareness and biopsychosocial factors (e.g., Hepatits C, stigma, homelessness) associated with PrEP awareness in a large sample of people in Boston, MA whose primary risk behavior for HIV acquisition was either injection drug use or heterosexual sexual activity. We found limited awareness of PrEP in these two groups: 36.7% among PWID and 28% among people with heterosexual risk. Even among those who were aware, few participants had discussed PrEP with a healthcare provider (5.2%), despite the sample having overall high rates of having had a healthcare visit in the past 12 months (89%), and few used PrEP in the past 12 months (0.7%). To increase awareness, healthcare providers could utilize these visits to discuss PrEP with PWID or those with heterosexual risk. Compared to extant research using the same or similar groups, PrEP awareness was higher in the present study (Jones et al., 2021) –36.7% of PWID in Boston were aware of PrEP, relative to 26% of PWID in the same cycle from NHBS sites nationwide. More people with heterosexual risk in the current study were aware of PrEP (28%, in 2019) compared to country-wide samples collected in 2016 (7%) (Jones et al., 2021).

The current study also extends prior research involving people of color with heterosexual risk in Philadelphia, PA, which found low PrEP awareness in the 2016 heterosexual NHBS cycle Although most participants with heterosexual risk identified as a member of a marginalized racial or ethnic group, more people with heterosexual risk were aware of PrEP in the 2019 heterosexual cycle of the NHBS in Boston than were those in the 2016 cycle in Philadelphia.

To better understand the contexts in which PrEP awareness occurs, we also investigated factors associated with PrEP awareness in each of these two groups individually, as well as in the combined sample, controlling for race, ethnicity, gender, age, and education. For people with heterosexual activity as their primary risk behavior for HIV, only experiencing homelessness was associated with PrEP awareness, and this finding remained significant in a multivariate model examining all variables of interest among people with heterosexual

risk only and in the combined sample. This association was also found among PWID who experienced homelessness. Rates of homelessness in the past year were different among Boston PWID (86%) and people with heterosexual risk (23%), but in both groups, homelessness was associated with greater PrEP awareness., which may be related to service access. This finding suggests that PrEP awareness services provided to those experiencing homelessness could potentially be rolled out to a broader population to increase PrEP awareness.

Among PWID and in the combined sample, having had bacterial STDs was also related to an increased likelihood of PrEP awareness. Having ever received a Hepatitis C diagnosis, a viral infection transmitted through blood and associated with injection drug use (Des Jarlais et al., 2018), was also significantly associated with increased likelihood of PrEP awareness among PWID. In the multivariate model among PWID, both having had a bacterial STD or Hepatitis C remained significant, but in the multivariate model among the combined sample, only Hepatitis C remained significant. Taken together, these findings suggest that PWID and people with heterosexual risk in the Boston Metropolitan area who may have a need for public health and social services, whether to alleviate the effects of unstable housing or for diagnosis and possible treatment of STDs or viral infections associated with HIV-risk behavior, are more likely to be aware of PrEP than those who may not need to access such services. These findings highlight the importance of specifically tailoring HIV prevention messages to at-risk heterosexuals and PWID who are not engaged in clinical care or experiencing unstable housing, in addition to tailored messaging for those who are engaged in care or unstably housed. Moreover, it is worth highlighting that additional care and support is needed to transition indiviuals experiencing homelessness and other profound structural barriers through the full PrEP cascade, starting with PrEP awareness.

In the combined sample, we also found that sexual orientation was significantly associated with PrEP awareness in the separate logistic regressions; however, this finding did not remain significant in the multivariate model. Participants who identified as gay/lesbian or bisexual were significantly more likely to be aware of PrEP than those who identified as heterosexual. This finding is consistent with the landscape of interventions to improve PrEP initiation and/or continuation. Owing to the large disparity in HIV incidence among sexual and gender minority groups (CDC, 2022), most studies of PrEP have been conducted among these individuals (Pinto et al., 2019). Though it is important to focus intervention efforts on groups most disproportionately affected by HIV, targeting PrEP messaging almost exclusively to sexual and gender minority individuals may serve to inadvertently increase stigma regarding PrEP use generally (Calabrese, 2020; Hedrick & Carpentier, 2021).

The results of the present study suggest an important area of focus: concurrently developing novel PrEP engagement strategies and interventions to enhance PrEP awareness among people with heterosexual risk for HIV or PWID. Specific efforts should also focus on individuals in these groups for whom PrEP would be recommended but who typically do not access public health services designed for people experiencing homelessness or treating STDs and other viral infections. For example, public health interventions targeted to individuals accessing emergency contraceptives or needle exchange services maybe improve PrEP awareness.

These findings should be interpreted with consideration of the study's limitations. Scientific innovations in PrEP occur rapidly, and PrEP uptake rates have risen dramatically, as evidenced by a more than 8-fold increase in PrEP use in just five years (CDC, 2021). Results of the present study should be replicated with more recent data, as these data were collected in 2018 for PWID and in 2019 for people with heterosexual risk. Relatedly, these data were collected prior to the SARS-COV-2 (COVID-19) pandemic. The COVID-19 pandemic negatively affected PrEP use (Pampati et al., 2021), and it is unclear if these effects extend to PrEP awareness. We found that those who were most likely to be aware of PrEP were individuals accessing services. However, COVID-19 significantly disrupted access to care and exacerbated health disparities (Chudasama et al., 2020; Kim et al., 2020). Additionally, a number non-medical resources in the Boston Metropolitan area are available to those who are unhoused or unstably housed and PWID, which may have impacted these findings. Efforts and funding are needed to move these services from helping to increase awareness of PrEP to faciltiating PrEP initaition through additional patient navigation and linkage to care efforts. Lastly, these data were self-reported and cross-sectional, and as such are susceptible to self-report and sampling bias, though bias may be somewhat mitigated due to the use of respondent-driven sampling. Because these data are cross-sectional, no assumptions about temporality or causality can be made.

Taken together, the present study demonstrates that, in a sample of people with a primary HIV risk factor related to PWID or heterosexual behavior, there were modest rates of PrEP awareness. Additionally, people who had experienced homelessness in the past 12 months, PWID who had chlamydia or Hepatitis C, and people who identified as sexual minorities were more likely to be aware of PrEP. These findings suggest the need to develop broader public health interventions to increase PrEP awareness and subsequent PrEP initiation and continuation among people with a primary risk factor for HIV acquisition related to heterosexual behavior or PWID.

Acknowledgments:

The content of this study is the sole responsibility of the authors and does not necessarily represent the views of the funders. Publication of the study results was not contingent on the sponsor's approval of the manuscript. We would like to thank the participants for their time and information. We would also like to thank the teams of individuals who made this study possible at the Massachusetts Department of Public Health and The Fenway Institute, such as Justin Hinchey, Chris Wittke, and many others. RMK was supported by the Centers for Disease Control and Prevention Cooperative Agreement No. NU62PS005074. JSL's time on this manuscript was supported by T32MH116140 (Henderson, Fricchione). AWB's time on this manuscript was supported by K23DA043418. AMS's time on this manuscript was supported by K23MH131438. This study was funded by the US Department of Health and Human Services (grant number NU62PS005074).

Funding.

RMK was supported by the Centers for Disease Control and Prevention Cooperative Agreement No. NU62PS005074. JSL's time on this manuscript was supported by T32MH116140 (Henderson, Fricchione). AWB's time on this manuscript was supported by K23DA043418. AMS's time on this manuscript was supported by K23MH131438. This study was funded by the US Department of Health and Human Services (grant number NU62PS005074).

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Table 1.

Demographic and descriptive statistics.

	PWID (N=451)	People with Heterosexual Risk (N=515)	*p*-value	Overall (N=966)
Age				
Mean (SD)	41.8 (11.2)	38.8 (12.6)	<0.001	40.2 (12.1)
Median [Min, Max]	40.0 [18.0, 70.0]	39.0 [18.0, 60.0]		40.0 [18.0, 70.0]
Stigma				
Mean (SD)	2.53 (0.851)	2.46 (0.735)	0.181	2.49 (0.791)
Median [Min, Max]	2.50 [0.500, 4.50]	2.50 [0.500, 4.50]		2.50 [0.500, 4.50]
Missing	5 (1.1%)	1 (0.2%)		6 (0.6%)
Race				
Black (ref)	67 (14.9%)	401 (77.9%)	<0.001	468 (48.4%)
White	307 (68.1%)	43 (8.3%)		350 (36.2%)
Another race	63 (14.0%)	65 (12.6%)		128 (13.3%)
Missing	14 (3.1%)	6 (1.2%)		20 (2.1%)
Hispanic or Latinx ethnicity				
No	363 (80.5%)	355 (68.9%)	<0.001	718 (74.3%)
Yes	87 (19.3%)	160 (31.1%)		247 (25.6%)
Missing	1 (0.2%)	0 (0%)		1 (0.1%)
PrEP aware				
No	263 (58.3%)	361 (70.1%)	0.001	624 (64.6%)
Yes	166 (36.8%)	144 (28.0%)		310 (32.1%)
Missing	22 (4.9%)	10 (1.9%)		32 (3.3%)
PrEP discussed with healthcare provider in past 12 months				
No	123 (27.3%)	137 (26.6%)	<0.001	260 (26.9%)
Yes	43 (9.5%)	7 (1.4%)		50 (5.2%)
Missing	285 (63.2%)	371 (72.0%)		656 (67.9%)
PrEP use in past 12 months				
No	159 (35.3%)	144 (28.0%)	0.035	303 (31.4%)
Yes	7 (1.6%)	0 (0%)		7 (0.7%)
Missing	285 (63.2%)	371 (72.0%)		656 (67.9%)
Gender				
Male (ref)	291 (64.5%)	203 (39.4%)	<0.001	494 (51.1%)
Female	155 (34.4%)	312 (60.6%)		467 (48.3%)
Transgender	5 (1.1%)	0 (0%)		5 (0.5%)
Sexual orientation				
Heterosexual	321 (71.2%)	449 (87.2%)	<0.001	770 (79.7%)
Homosexual, Gay, or Lesbian	10 (2.2%)	4 (0.8%)		14 (1.4%)
Bisexual	120 (26.6%)	61 (11.8%)		181 (18.7%)
Missing	0 (0%)	1 (0.2%)		1 (0.1%)

	PWID (N=451)	People with Heterosexual Risk (N=515)	*p*-value	Overall (N=966)
Experienced homelessness in the past 12 months				
No	64 (14.2%)	396 (76.9%)	<0.001	460 (47.6%)
Yes	387 (85.8%)	119 (23.1%)		506 (52.4%)
Currently experiencing homelessness				
No	66 (14.6%)	55 (10.7%)	<0.001	121 (12.5%)
Yes	321 (71.2%)	64 (12.4%)		385 (39.9%)
Missing	64 (14.2%)	396 (76.9%)		460 (47.6%)
Country of birth				
United States (50 states)	418 (92.7%)	454 (88.2%)	0.02	872 (90.3%)
Puerto Rico	22 (4.9%)	33 (6.4%)		55 (5.7%)
Other country	10 (2.2%)	28 (5.4%)		38 (3.9%)
Missing	1 (0.2%)	0 (0%)		1 (0.1%)
Education				
Grades 1–8	24 (5.3%)	11 (2.1%)	0.028	35 (3.6%)
Grades 9–11	94 (20.8%)	126 (24.5%)		220 (22.8%)
Grade 12 or GED	215 (47.7%)	254 (49.3%)		469 (48.6%)
Some college, Associate's Degree, or Technical Degree	104 (23.1%)	109 (21.2%)		213 (22.0%)
Bachelor's Degree	10 (2.2%)	15 (2.9%)		25 (2.6%)
Any post graduate studies	3 (0.7%)	0 (0%)		3 (0.3%)
Missing	1 (0.2%)	0 (0%)		1 (0.1%)
Unemployed				
No	223 (49.4%)	390 (75.7%)	<0.001	613 (63.5%)
Yes	228 (50.6%)	125 (24.3%)		353 (36.5%)
Poverty				
No	102 (22.6%)	129 (25.0%)	0.464	231 (23.9%)
Yes	345 (76.5%)	386 (75.0%)		731 (75.7%)
Missing	4 (0.9%)	0 (0%)		4 (0.4%)
Visited a healthcare provider in past 12 months				
No	48 (10.6%)	57 (11.1%)	0.914	105 (10.9%)
Yes	403 (89.4%)	458 (88.9%)		861 (89.1%)
Last healthcare provider visit				
Within past year	403 (89.4%)	458 (88.9%)	0.373	861 (89.1%)
More than 1 but less than 2 years ago	27 (6.0%)	41 (8.0%)		68 (7.0%)
2–5 years ago	17 (3.8%)	14 (2.7%)		31 (3.2%)
More than 5 years ago	4 (0.9%)	2 (0.4%)		6 (0.6%)
Bacterial STD in past 12 months				
No	420 (93.1%)	483 (93.8%)	0.888	903 (93.5%)
Yes	29 (6.4%)	31 (6.0%)		60 (6.2%)
Missing	2 (0.4%)	1 (0.2%)		3 (0.3%)

	PWID (N=451)	People with Heterosexual Risk (N=515)	*p*-value	Overall (N=966)
Lifetime Hepatitis C diagnosis				
No	131 (29.0%)	466 (90.5%)	<0.001	597 (61.8%)
Yes	315 (69.8%)	20 (3.9%)		335 (34.7%)
Missing	5 (1.1%)	29 (5.6%)		34 (3.5%)
Gonorrhea in past 12 months				
No	438 (97.1%)	506 (98.3%)	0.446	944 (97.7%)
Yes	11 (2.4%)	8 (1.6%)		19 (2.0%)
Missing	2 (0.4%)	1 (0.2%)		3 (0.3%)
Chlamydia in past 12 months				
No	434 (96.2%)	489 (95.0%)	0.308	923 (95.5%)
Yes	15 (3.3%)	25 (4.9%)		40 (4.1%)
Missing	2 (0.4%)	1 (0.2%)		3 (0.3%)
Syphilis in past 12 months				
No	440 (97.6%)	512 (99.4%)	0.04	952 (98.6%)
Yes	9 (2.0%)	2 (0.4%)		11 (1.1%)
Missing	2 (0.4%)	1 (0.2%)		3 (0.3%)
Number of sexual partners in past 12 months				
Mean (SD)	5.56 (9.09)	4.33 (9.45)	0.15	5.05 (9.25)
Median [Min, Max] (IQR)	3.00 [0, 80.0] (1.00, 6.00)	2.00 [1.00, 100] (1.00, 4.00)		2.00 [0, 100] (1.00, 5.00)
Missing	163 (36.1%)	312 (60.6%)		475 (49.2%)
Number of condomless sex partners in past 12 months				
Mean (SD)	4.70 (8.51)	2.07 (2.66)	<0.001	3.29 (6.25)
Median [Min, Max] (IQR)	2.00 [0, 80.0] (1.00, 5.00)	1.00 [0, 25.0] (1.00, 2.00)		2.00 [0, 80.0] (1.00, 3.00)
Missing	5 (1.1%)	0 (0%)		5 (0.5%)
Frequency of using a shared needle to inject drugs				
Never	232 (51.4%)	-	-	-
Rarely	150 (33.3%)	-		-
About half the time	50 (11.1%)	-		-
Most of the time	14 (3.1%)	-		-
Always	5 (1.1%)	-		-

Note. The *p*-value column refers to the p-value of the test examining whether statistically significant differences were present between the people who inject drugs (PWID) and heterosexual risk groups. For categorical variables, a chi-square test of independence was conducted. For continuous variables, a standard 2-sample t-test was computed. Referent groups for variables used in the analyses in Table 2 are presented here as (ref). Race was dummy coded such that Black race was the referent group. Sex was dummy coded such that male sex was the referent group.

Table 2.

Results of logistic regression analyses examining factors associated with PrEP awareness among people with heterosexual risk and PWID.

	People with Heterosexual Risk			PWID			Combined		
				Stigma					
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***
(Intercept)	0.50	0.19–1.27	0.146	0.93	0.25 – 3.48	0.916	0.49	0.23 – 1.03	0.062
White	0.59	0.24 – 1.30	0.215	0.91	0.47 – 1.79	0.786	1.29	0.95 – 1.76	0.101
Another race	0.94	0.50 – 1.70	0.829	1.04	0.47 – 2.30	0.927	1.22	0.79 – 1.87	0.367
Hispanic/ Latinx	0.75	0.47 – 1.19	0.229	1.04	0.58 – 1.84	0.895	0.72	0.51 – 1.02	0.064
Age	0.99	0.98 – 1.01	0.375	0.97	0.95 – 0.99	**0.002**	0.98	0.97 – 1.00	**0.009**
Female	1.11	0.74 – 1.67	0.626	1.28	0.83 – 1.98	0.263	1.10	0.83 – 1.47	0.493
Transgender	-	-	-	4.36	0.64 – 37.50	0.135	4.88	0.76 – 38.97	0.094
Education	1.20	0.93 – 1.53	0.159	1.27	1.01 – 1.62	**0.047**	1.21	1.02 – 1.44	**0.025**
Perceived HIV Stigma	0.89	0.67 – 1.16	0.384	1.21	0.95 – 1.54	0.130	1.06	0.88 – 1.26	0.544
				Ever homeless					
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***
(Intercept)	0.34	0.14 – 0.82	**0.017**	0.60	0.14 – 2.51	0.488	0.41	0.21 – 0.80	**0.009**
White	0.54	0.22 – 1.19	0.145	0.92	0.48 – 1.80	0.801	0.88	0.62 – 1.25	0.482
Another race	0.87	0.46 – 1.59	0.658	0.97	0.44 – 2.16	0.943	0.93	0.59 – 1.45	0.749
Hispanic/ Latinx	0.79	0.49 – 1.27	0.337	1.02	0.57 – 1.82	0.941	0.81	0.57 – 1.14	0.231
Age	0.99	0.97 – 1.01	0.217	0.97	0.95 – 0.99	**0.007**	0.98	0.97 – 0.99	**0.004**
Female	1.16	0.77 – 1.76	0.474	1.34	0.86 – 2.08	0.193	1.26	0.94 – 1.69	0.130
Transgender	-	-	-	4.35	0.65 – 36.46	0.132	4.09	0.65 – 32.24	0.133
Education	1.22	0.95 – 1.57	0.121	1.27	1.00 – 1.61	0.055	1.23	1.04 – 1.46	**0.017**
Ever Homeless	1.99	1.26 – 3.12	**0.003**	2.11	1.09 – 4.31	**0.032**	2.25	1.61 – 3.15	**<0.001**
				Country of birth					
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***

	People with Heterosexual Risk			PWID			Combined		
					Stigma				
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***
(Intercept)	0.38	0.16 – 0.90	**0.030**	1.26	0.36 – 4.42	0.717	0.52	0.27 – 1.00	0.052
White	0.62	0.25 – 1.35	0.254	0.96	0.50 – 1.88	0.897	1.31	0.96 – 1.78	0.088
Another race	1.02	0.54 – 1.87	0.946	1.06	0.48 – 2.34	0.894	1.26	0.81 – 1.93	0.305
Hispanic/ Latinx	0.88	0.53 – 1.46	0.628	1.08	0.57 – 2.02	0.813	0.83	0.56 – 1.20	0.316
Age	0.99	0.98 – 1.01	0.513	0.97	0.95 – 0.99	**0.003**	0.99	0.97 – 1.00	**0.027**
Female	1.12	0.75 – 1.70	0.573	1.25	0.81 – 1.92	0.319	1.11	0.83 – 1.47	0.484
Transgender	-	-	-	4.02	0.60 – 33.83	0.153	4.39	0.69 – 34.89	0.116
Education	1.18	0.92 – 1.52	0.198	1.26	1.00 – 1.61	0.056	1.20	1.02 – 1.43	**0.033**
Puerto Rico	0.45	0.12 – 1.35	0.186	0.81	0.19 – 2.89	0.751	0.58	0.23 – 1.30	0.207
Another country	0.42	0.12 – 1.13	0.119	1.05	0.20 – 4.58	0.949	0.51	0.20 – 1.14	0.125
					Any bacterial STD in the past 12 months				
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***
(Intercept)	0.43	0.18 – 1.01	0.056	1.21	0.34 – 4.28	0.768	0.53	0.28 – 1.02	0.057
White	0.60	0.25 – 1.32	0.232	0.99	0.51 – 1.96	0.977	1.30	0.95 – 1.76	0.097
Another race	0.93	0.50 – 1.69	0.824	1.12	0.50 – 2.51	0.780	1.24	0.80 – 1.90	0.333
Hispanic/ Latinx	0.73	0.46 – 1.17	0.196	0.99	0.55 – 1.77	0.977	0.72	0.51 – 1.01	0.060
Age	0.99	0.97 – 1.01	0.245	0.97	0.95 – 0.99	**0.002**	0.99	0.97 – 1.00	**0.013**
Female	1.12	0.75 – 1.69	0.584	1.16	0.75 – 1.80	0.507	1.08	0.81 – 1.44	0.602
Transgender	-	-	-	4.49	0.67 – 37.87	0.124	4.88	0.77 – 38.80	0.093
Education	1.20	0.93 – 1.54	0.155	1.27	1.00 – 1.62	0.052	1.21	1.02 – 1.44	**0.025**
Bacterial STD	0.79	0.32 – 1.78	0.589	2.96	1.30 – 7.12	**0.012**	1.52	0.87 – 2.63	0.135
					Lifetime Hepatitis C diagnosis				
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***
(Intercept)	0.51	0.21 – 1.20	0.125	0.88	0.24 – 3.22	0.846	0.62	0.32 – 1.21	0.164
White	0.63	0.26 – 1.38	0.270	0.80	0.41 – 1.58	0.509	0.86	0.59 – 1.24	0.413

	People with Heterosexual Risk			PWID			Combined		
					Stigma				
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***
Another race	0.97	0.51 – 1.76	0.915	0.91	0.41 – 2.05	0.827	0.97	0.61 – 1.51	0.881
Hispanic/ Latinx	0.81	0.50 – 1.29	0.376	0.99	0.55 – 1.78	0.978	0.81	0.56 – 1.14	0.234
Age	0.99	0.97 – 1.01	0.187	0.97	0.95 – 0.99	**0.001**	0.98	0.97 – 0.99	**0.001**
Female	1.13	0.75 – 1.72	0.564	1.22	0.79 – 1.90	0.368	1.18	0.88 – 1.58	0.282
Transgender	-	-	-	6.48	0.91 – 57.70	0.064	5.75	0.87 – 46.73	0.068
Education	1.13	0.88 – 1.46	0.341	1.30	1.02 – 1.67	**0.035**	1.22	1.02 – 1.45	**0.026**
Hepatitis C diagnosis	0.63	0.14 – 2.04	0.482	2.40	1.50 – 3.92	**<0.001**	2.18	1.52 – 3.14	**<0.001**
					Gonorrhea in the past 12 months				
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***
(Intercept)	0.42	0.18 – 0.99	**0.048**	1.13	0.32 – 4.03	0.848	0.55	0.29 – 1.04	0.069
White	0.60	0.25 – 1.32	0.231	1.00	0.52 – 1.98	0.993	1.30	0.95 – 1.76	0.096
Another race	0.93	0.50 – 1.69	0.818	1.09	0.49 – 2.42	0.838	1.22	0.79 – 1.87	0.373
Hispanic/ Latinx	0.73	0.45 – 1.15	0.181	1.05	0.58 – 1.85	0.875	0.72	0.51 – 1.02	0.067
Age	0.99	0.98 – 1.01	0.262	0.97	0.95 – 0.99	**0.004**	0.98	0.97 – 1.00	**0.011**
Female	1.13	0.76 – 1.71	0.547	1.22	0.79 – 1.88	0.377	1.10	0.82 – 1.46	0.528
Transgender	-	-	-	4.22	0.63 – 35.42	0.139	4.81	0.75 – 38.26	0.096
Education	1.20	0.94 – 1.54	0.150	1.27	1.01 – 1.62	**0.047**	1.21	1.03 – 1.44	**0.024**
Gonorrhea	0.31	0.02 – 1.80	0.277	2.65	0.65 – 13.35	0.190	1.29	0.46 – 3.48	0.614
					Chlamydia in the past 12 months				
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***
(Intercept)	0.42	0.17 – 0.98	**0.046**	1.20	0.34 – 4.26	0.776	0.51	0.27 – 0.98	**0.045**
White	0.60	0.25 – 1.31	0.224	0.95	0.49 – 1.86	0.869	1.30	0.95 – 1.76	0.098
Another race	0.95	0.50 – 1.72	0.862	1.09	0.49 – 2.43	0.834	1.25	0.80 – 1.91	0.318
Hispanic/ Latinx	0.74	0.46 – 1.17	0.202	0.97	0.54 – 1.74	0.932	0.71	0.50 – 1.00	0.054
Age	0.99	0.98 – 1.01	0.294	0.97	0.95 – 0.99	**0.003**	0.99	0.97 – 1.00	**0.020**

	People with Heterosexual Risk			PWID			Combined		
Stigma									
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***
Female	1.10	0.74 – 1.67	0.635	1.10	0.70 – 1.71	0.677	1.07	0.80 – 1.43	0.650
Transgender	-	-	-	4.34	0.65 – 36.52	0.131	4.84	0.76 – 38.49	0.094
Education	1.19	0.93 – 1.53	0.160	1.30	1.03 – 1.67	**0.031**	1.22	1.03 – 1.44	**0.023**
Chlamydia	1.10	0.43 – 2.61	0.842	6.14	1.79 – 28.43	**0.008**	1.86	0.95 – 3.62	0.066
Sexual Orientation									
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***
(Intercept)	0.37	0.15 – 0.89	**0.028**	1.09	0.31 – 3.90	0.891	0.52	0.27 – 0.99	**0.046**
White	0.61	0.25 – 1.34	0.247	1.04	0.54 – 2.07	0.900	1.26	0.93 – 1.72	0.142
Another race	0.95	0.51 – 1.72	0.866	1.09	0.49 – 2.41	0.840	1.16	0.74 – 1.78	0.511
Hispanic/ Latinx	0.74	0.46 – 1.18	0.218	1.01	0.56 – 1.79	0.976	0.73	0.52 – 1.03	0.080
Age	0.99	0.98 – 1.01	0.390	0.97	0.95 – 0.99	**0.004**	0.99	0.97 – 1.00	**0.014**
Female	1.01	0.66 – 1.55	0.977	1.16	0.74 – 1.80	0.525	1.02	0.76 – 1.37	0.897
Transgender	-	-	-	3.72	0.57 – 30.78	0.172	3.83	0.61 – 30.14	0.152
Education	1.22	0.95 – 1.57	0.123	1.24	0.98 – 1.58	0.078	1.21	1.02 – 1.44	**0.028**
Homosexual, lesbian, gay	2.26	0.27 – 19.25	0.421	3.79	0.82 – 26.93	0.115	3.71	1.13 – 14.20	**0.036**
Bisexual	1.53	0.83 – 2.80	0.168	1.35	0.83 – 2.18	0.219	1.55	1.08 – 2.20	**0.016**
Poverty									
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***
(Intercept)	0.47	0.19 – 1.18	0.111	1.56	0.41 – 5.97	0.517	0.62	0.31 – 1.24	0.178
White	0.60	0.25 – 1.31	0.225	0.94	0.49 – 1.83	0.841	1.31	0.97 – 1.78	0.082
Another race	0.95	0.50 – 1.72	0.860	0.98	0.44 – 2.18	0.951	1.18	0.76 – 1.82	0.446
Hispanic/ Latinx	0.74	0.46 – 1.17	0.200	1.02	0.57 – 1.81	0.946	0.72	0.51 – 1.01	0.064
Age	0.99	0.98 – 1.01	0.295	0.97	0.95 – 0.99	**0.001**	0.98	0.97 – 1.00	**0.008**
Female	1.11	0.74 – 1.68	0.609	1.24	0.80 – 1.91	0.343	1.10	0.83 – 1.47	0.506

	People with Heterosexual Risk			PWID			Combined		
					Stigma				
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***
Transgender	-	-	-	4.09	0.61 – 34.56	0.149	4.79	0.75 – 38.25	0.098
Education	1.18	0.92 – 1.52	0.192	1.25	0.98 – 1.60	0.071	1.20	1.01 – 1.42	**0.039**
Poverty	0.86	0.55 – 1.35	0.495	0.95	0.58 – 1.57	0.845	0.92	0.66 – 1.28	0.624
					Multivariate Model				
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***
(Intercept)	0.49	0.16 – 1.45	0.202	0.37	0.07 – 1.84	0.226	0.47	0.20 – 1.10	0.084
White	0.56	0.23 – 1.26	0.182	0.91	0.45 – 1.89	0.801	0.71	0.48 – 1.06	0.093
Another race	0.92	0.47 – 1.71	0.787	0.89	0.39 – 2.08	0.795	0.81	0.50 – 1.30	0.385
Hispanic/ Latinx	1.05	0.62 – 1.77	0.852	1.02	0.52 – 1.97	0.945	0.96	0.65 – 1.41	0.836
Age	0.99	0.97 – 1.01	0.421	0.97	0.95 – 0.99	**0.004**	0.98	0.97 – 0.99	**0.002**
Female	1.21	0.77 – 1.92	0.409	1.14	0.71 – 1.83	0.596	1.23	0.90 – 1.69	0.192
Transgender	-	-	-	6.70	0.89 – 62.05	0.066	4.03	0.62 – 32.70	0.145
Education	1.14	0.87 – 1.49	0.337	1.23	0.95 – 1.60	0.122	1.19	0.99 – 1.42	0.064
HIV Stigma	0.90	0.68 – 1.19	0.462	1.13	0.88 – 1.46	0.335	1.05	0.87 – 1.27	0.588
Predictors	**OR**	**CI**	***p***	**OR**	**CI**	***p***	**OR**	**CI**	***p***
Ever Homeless	2.30	1.42 – 3.73	**0.001**	1.95	0.98 – 4.09	0.064	1.95	1.35 – 2.83	**<0.001**
Puerto Rico	0.48	0.13 – 1.46	0.227	0.86	0.20 – 3.21	0.831	0.68	0.27 – 1.57	0.388
Another country	0.45	0.13 – 1.27	0.167	0.70	0.12 – 3.35	0.662	0.59	0.23 – 1.37	0.245
Bacterial STD	0.58	0.23 – 1.35	0.230	2.78	1.18 – 6.89	**0.022**	1.27	0.71 – 2.24	0.408
Hepatitis C diagnosis	0.57	0.13 – 1.91	0.406	2.29	1.41 – 3.81	**0.001**	1.72	1.18 – 2.51	**0.005**
Homosexual, lesbian, gay	0.74	0.03 – 8.33	0.810	2.95	0.60 – 21.59	0.214	2.07	0.59 – 8.28	0.268
Bisexual	1.38	0.72 – 2.62	0.321	1.28	0.77 – 2.13	0.341	1.25	0.85 – 1.82	0.251
Poverty	0.80	0.50 – 1.29	0.353	0.82	0.49 – 1.39	0.466	0.84	0.59 – 1.18	0.313

Note. For all analyses examining PrEP awareness, the following covariates were used: race, Hispanic or Latinx ethnicity, age, sex, and education. Race was dummy coded such that Black race was the referent group. Sex was dummy coded such that male sex was the referent group. For analyses in the heterosexual risk group, there were no transgender people, which is denoted with a hyphen. In the analyses examining the association of country of birth and PrEP awareness, being born in the US was the referent group. For analyses examining the association of sexual orientation and PrEP awareness,

heterosexual orientation was the referent group. Ever homeless refers to having experienced homelessness in the past 12 months (c.f. currently experiencing homelessness). Acronyms are: people who inject drugs (PWID), odds ratio (OR), 95% confidence interval (CI), sexually transmitted disease or infection (STD)